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Cardiac Arrest During Delivery Hospitalization: A Cohort Study

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Abstract

Background: Estimates of cardiac arrest occurring during delivery guide evidence-based strategies to reduce pregnancy-related death.

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See also:
Web-Only
Supplement

Objective: To investigate rate of, maternal characteristics associated with, and survival after cardiac arrest during delivery hospitalization.

Design: Retrospective cohort study.

Setting: U.S. acute care hospitals, 2017 to 2019.

Participants: Delivery hospitalizations among women aged 12 to 55 years included in the National Inpatient Sample database.

Measurements: Delivery hospitalizations, cardiac arrest, underlying medical conditions, obstetric outcomes, and severe maternal complications were identified using codes from the International Classification of Diseases, 10th Revision, Clinical Modification. Survival to hospital discharge was based on discharge disposition.

Results: Among 10 921 784 U.S. delivery hospitalizations, the cardiac arrest rate was 13.4 per 100 000. Of the 1465 patients who had cardiac arrest, 68.6% (95% CI, 63.2% to 74.0%) survived to hospital discharge. Cardiac arrest was more common among patients who were older, were non-Hispanic Black, had Medicare or Medicaid, or had underlying medical conditions. Acute respiratory distress syndrome was the most common co-occurring diagnosis (56.0% [CI, 50.2% to 61.7%]). Among co-occurring procedures or interventions examined, mechanical ventilation was the most common (53.2% [CI, 47.5% to 59.0%]). The rate of survival to hospital discharge after cardiac arrest was lower with co-occurring disseminated intravascular coagulation (DIC) without or with transfusion (50.0% [CI, 35.8% to 64.2%] or 54.3% [CI, 39.2% to 69.5%], respectively).

Limitations: Cardiac arrests occurring outside delivery hospitalizations were not included. The temporality of arrest relative to the delivery or other maternal complications is unknown. Data do not distinguish cause of cardiac arrest, such as pregnancy-related complications or other underlying causes among pregnant women.

Conclusion: Cardiac arrest was observed in approximately 1 in 9000 delivery hospitalizations, among which nearly 7 in 10 women survived to hospital discharge. Survival was lowest during hospitalizations with co-occurring DIC.

Primary Funding Source: None.

Cardiac arrest is an uncommon but serious maternal complication. During 1998 to 2011, it occurred in 1 in 12 000 delivery hospitalizations in the United States (1). Among these, 58.9% of patients survived to hospital discharge, with survival varying by underlying cause of arrest (1).

Maternal cardiac arrest is an indicator of severe maternal morbidity—that is, unexpected outcomes of labor and delivery that result in significant short- or long-term health consequences (2). If not identified and treated promptly, these conditions can lead to pregnancy-related death (3). An analysis of Canadian delivery hospitalizations during 2012 to 2016 found that case fatality rates among severe maternal morbidity subtypes were highest among women who had cardiac arrest and resuscitation (241.1 deaths per 1000 deliveries) (4).

Estimates of severe maternal complications occurring during delivery hospitalization provide information for evidence-based strategies to reduce pregnancy-related death. The objectives of these analyses were to calculate weighted annual estimates of and assess trends in cardiac arrest and survival during delivery hospitalization in the United States in 2017 to 2019; to examine cardiac arrest by patient-, hospital-, and community-level characteristics; and to estimate the prevalence of co-occurring severe maternal complications, the rate of cardiac arrest among deliveries with each complication, and the percentage of survival to hospital discharge by each complication.

METHODS

Study Population

This retrospective cohort study used data from the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS). The NIS is an all-payer inpatient health care database that is publicly available; approximates a 20% stratified sample of discharges from U.S. community hospitals, excluding rehabilitation and long-term acute care hospitals; and is weighted to be nationally representative (5). The NIS data are collected cross-sectionally and include diagnostic and procedure codes occurring during hospitalization from the International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM), but the data do not provide information about the timing of events within the hospitalization. We first identified hospitalizations of women aged 12 to 55 years during 2017 to 2019. Using a standard algorithm, we then identified those during which a stillbirth or live birth occurred (6). The algorithm uses ICD-10-CM diagnostic and procedure codes pertaining to delivery and diagnosis-related group delivery codes to identify deliveries (Supplement Table 1, available at Annals.org), excluding pregnancies with abortive outcomes and molar and ectopic pregnancies.

Outcomes

We identified in-hospital cardiac arrest using ICD-10-CM diagnosis codes for cardiac arrest (I46.2, I46.8, and I46.9), postprocedural cardiac arrest after cardiac or other surgery (I97.120 and I9.121), intraoperative cardiac arrest during cardiac or other surgery (I97.710 and I97.711), cardiac arrest due to anesthesia during pregnancy (O29.112, O29.113, and O29.119), or ventricular fibrillation (I49.01), or the procedure code for performance of cardiac output (single, manual; 5A12012). We determined survival to hospital discharge using discharge disposition.

Patient-, Hospital-, and Community-Level Characteristics

Patient-, hospital-, and community-level characteristics are included in the NIS database as recorded during the hospitalization. Patient age in years at hospital admission is based on maternal birth and admission dates. The HCUP classified patients of Hispanic origin as Hispanic and classified non-Hispanic patients by their reported race (7). It categorized race and ethnicity as Hispanic, Asian or Pacific Islander, Black, Native American, White, or other. Because of small sample sizes, we created the group “another non-Hispanic race,” combining HCUP’s race categories for Native American and other. Payer indicates the expected primary payer for the hospitalization and was categorized as private, Medicare

or Medicaid, or other (self-pay, no charge, or other). The HCUP categorized median household income for the patient's ZIP code into quartiles. Rurality was derived from the National Center for Health Statistics urban–rural classification for the patient's county of residence and was classified as metropolitan, micropolitan, or rural (nonmetropolitan and nonmicropolitan) (8). The HCUP obtained teaching hospital status and census region from the American Hospital Association Annual Survey. Because the HCUP does not classify rural hospitals according to teaching status, nonteaching hospitals include all rural hospitals and nonteaching urban hospitals. We calculated annual delivery volume for each hospital and divided hospitals into low (<1000), medium (1000 to 2000), and high (>2000) annual delivery volumes (9). The HCUP calculates length of stay by subtracting the admission date from the discharge date. Disposition of the patient at discharge was classified as routine, transfer to short-term hospital, other transfer (such as skilled-nursing or immediate care facility), home health care, against medical advice, or died.

We identified underlying medical conditions, obstetric outcomes, and severe maternal complications using ICD-10-CM diagnosis and procedure codes (Supplement Table 1). Underlying medical conditions included asthma, acquired heart disease, congenital heart disease, chronic hypertension, chronic kidney disease, diabetes mellitus, pulmonary hypertension, mental health disorders, systemic lupus erythematosus, substance use disorder, and tobacco use disorder. Obstetric outcomes included multiple gestation, stillbirth, and cesarean delivery. Severe maternal complications were based on the Centers for Disease Control and Prevention's 21 indicators of severe maternal morbidity grouped into diagnoses (air or thrombotic embolism, acute myocardial infarction, acute heart failure or pulmonary edema, acute renal failure, acute respiratory distress syndrome, amniotic fluid embolism, aortic aneurysm or dissection, disseminated intravascular coagulation [DIC], puerperal cerebrovascular disorders, severe anesthesia complications, sepsis, shock, and sickle cell disease with crisis) and procedures or interventions (blood product transfusion, hysterectomy, temporary tracheostomy, conversion of cardiac rhythm, and mechanical ventilation) (6). Other severe maternal complications included arrhythmia, severe hypertensive disorders of pregnancy (severe preeclampsia; eclampsia; and hemolysis, elevated liver enzymes, low platelet count [HELLP] syndrome), status asthmaticus, and peripartum cardiomyopathy (4, 10).

Statistical Analysis

We calculated the weighted annual rate of cardiac arrest per 100 000 delivery hospitalizations and associated 95% CI. Pooling data from 2017 to 2019, we examined patient-, hospital-, and community-level characteristics; obstetric outcomes; length of stay; and discharge disposition by cardiac arrest status. We assessed differences by examining 95% CIs. Among delivery hospitalizations with cardiac arrest, we calculated the annual weighted percentage of survival to hospital discharge, the weighted prevalence of co-occurring severe maternal complications (described above) by complication, and survival to hospital discharge by complication. To evaluate survival by hospital-level characteristics, we calculated the weighted percentage of survival to hospital discharge by annual hospital delivery volume and teaching hospital status. We also calculated the cardiac arrest rate per 1000 deliveries with amniotic fluid embolism, a known cause of maternal cardiac arrest (11).

All analyses were done using SAS, version 9.4 (SAS Institute). We used SAS survey procedures and weighting to account for complex sampling in the NIS, including hospital-level clustering (Supplement Methods, available at Annals.org). This activity was consistent with applicable federal law and Centers for Disease Control and Prevention policy (see, for example, 45 C.F.R. §46, 21 C.F.R. §56, 42 U.S.C. §241[d], 5 U.S.C. §552[a], and 44 U.S.C. §3501 et seq.).

Role of the Funding Source

No funding was received for this work.

RESULTS

Among 10 921 784 delivery hospitalizations, we identified 1465 cardiac arrests. All delivery hospitalizations with cardiac arrest had complete information on survival. Supplement Table 2 (available at Annals.org) outlines missingness of patient-, hospital-, and community-level characteristics; length of stay; and discharge disposition.

The overall rate of cardiac arrest during 2017 to 2019 was 13.4 events (95% CI, 11.9 to 14.9 events) per 100 000 delivery hospitalizations and did not change during the study period (Figure 1). In total, 1005 (68.6% [CI, 63.2% to 74.0%]) of the 1435 women with cardiac arrest during delivery hospitalization survived to hospital discharge. Survival remained stable during the study period (Figure 2) and did not vary by annual hospital delivery volume or teaching hospital status (Supplement Figure, available at Annals.org).

Table 1 presents the patient-, hospital-, and community-level characteristics at baseline, both overall and stratified by the presence of a cardiac arrest code. Compared with patients hospitalized without cardiac arrest, those hospitalized with a cardiac arrest code were older; more likely to be Black; and more likely to have Medicare or Medicaid and underlying medical conditions, including chronic hypertension, mental health disorders, substance use disorder, and acquired heart disease.

Table 2 presents obstetric outcomes, length of stay, and discharge disposition, both overall and stratified by the presence of a cardiac arrest code. The median length of stay among delivery hospitalizations with a cardiac arrest code was 5.1 days (IQR, 5.0 days), versus 2.0 days (IQR, 0.1 days) for those without (Table 2). Among delivery hospitalizations with cardiac arrest, 49% ended with a routine hospital discharge disposition.

Table 3 presents the distribution of documented cardiac arrests during delivery hospitalization, by diagnoses and procedures or interventions. Acute respiratory distress syndrome was the most common co-occurring diagnosis (56.0% [CI, 50.2% to 61.7%]) (Table 3). Among co-occurring procedures or interventions examined, mechanical ventilation was the most common (53.2% [CI, 47.5% to 59.0%]). Survival to hospital discharge after cardiac arrest was lower with co-occurring DIC without or with transfusion (50.0% [CI, 35.8% to 64.2%] or 54.3% [CI, 39.2% to 69.5%], respectively). There were 357.7 cardiac arrests (CI, 277.3 to 438.0 cardiac arrests) per 1000 deliveries where amniotic fluid embolism was documented.

DISCUSSION

During 2017 to 2019, cardiac arrest occurred in approximately 1 in 9000 U.S. delivery hospitalizations, and two thirds of these patients survived to hospital discharge. The rate of cardiac arrest and subsequent survival to hospital discharge remained stable during this 3-year period. Cardiac arrest was disproportionately more likely to occur in patients who were older, were Black, had Medicare or Medicaid, or had underlying medical conditions. Although acute respiratory distress syndrome was the most common co-occurring diagnosis, cardiac arrest rates were high among hospitalizations where a diagnosis of amniotic fluid embolism was noted. Survival to hospital discharge after cardiac arrest was lowest with co-occurring DIC. However, we could not determine causality or identify whether co-occurring severe maternal complications preceded or followed cardiac arrest. We also could not distinguish the causes of cardiac arrests, including whether they were pregnancy-related complications or other underlying causes among pregnant women.

The rates of cardiac arrest during delivery hospitalization and survival to hospital discharge both remained stable during the study period but may have been higher than previously published estimates. During 1998 to 2011, cardiac arrest occurred in 1 in 12000 admissions for delivery (1), compared with 1 in 9000 delivery hospitalizations in our study using the same data source. The same earlier study reported an overall survival rate of 58.9% after cardiac arrest during hospital delivery in 1998 to 2011 (1), whereas we found that 68.6% of patients survived to hospital discharge after cardiac arrest. The transition from ICD-9-CM to ICD-10-CM that occurred in 2015 creates challenges in comparing estimates (12). However, the higher rate of cardiac arrest may be related to the observed increased prevalence over time of characteristics associated with cardiac arrest, such as hypertensive disorders in pregnancy (13), heart disease (14), and hemorrhage (15). Survival after in-hospital cardiac arrest in the general adult U.S. population has also improved over time, increasing from 16.9% in 2000 to 26.7% in 2019 (16).

In our study, cardiac arrest was more common among delivery hospitalizations of patients who were older, were Black, had Medicare or Medicaid, or had underlying medical conditions. This is consistent with existing literature on maternal cardiac arrest (1, 17–19). Although such risk factors as hypertensive disorders in pregnancy disproportionately affect Black patients (13), 1 study found that racial/ethnic differences in severe maternal morbidity persisted after accounting for comorbid conditions, cesarean delivery, and other factors (20). Strategies to address maternal cardiac arrest implemented with an equity lens may reduce disparities in maternal outcomes by addressing upstream factors associated with cardiac arrest incidence and management. For women with underlying medical conditions, prepregnancy counseling and coordinated care with a team of specialists could reduce severe complications (18). Clinical tools, such as the California Maternal Quality Care Collaborative’s algorithm for symptomatic or high-risk pregnant and postpartum women (21), and education to raise awareness about urgent maternal warning signs (22) may increase recognition of cardiovascular complications and improve management.

Responding to maternal cardiac arrest is time-sensitive and complex (23). Although response to in-hospital cardiac arrest for pregnant women is similar to that for the general

adult population (24), managing maternal cardiac arrest has additional considerations (for example, the effect of aortocaval compression on resuscitation). Guidance from the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine outlines levels of maternal care and states that level III and IV facilities have the capabilities, including the personnel and equipment, to most appropriately care for persons with maternal cardiac conditions (for example, an onsite intensive care unit for obstetric patients with primary or comanagement by a maternal–fetal medicine team) (25). Effective response often requires coordination of care across specialties, in addition to access to equipment for basic life support, defibrillation, and airway management and specialized equipment specific to maternal cardiac arrest (for example, emergency cesarean delivery tray) (11, 26). There may be opportunities for increasing knowledge about maternal cardiac arrest or improving cardiopulmonary resuscitation technique for pregnant people (27). Studies have shown that simulation-based training on advanced cardiac life support combining a standardized curriculum and intense deliberate practice significantly increased adherence to clinical guidelines (28, 29).

This study is subject to several limitations. First, delivery hospitalizations, cardiac arrest, and maternal medical conditions were identified using claims codes and are subject to inherent challenges and coding errors, and ICD-10-CM codes for cardiac arrest among pregnant patients have not been validated. We also did not have information about the primary indication for hospitalization (that is, a hospitalization for delivery in which a cardiac arrest occurred vs. a hospitalization for cardiac arrest that necessitated a delivery) or the temporality of events occurring during the delivery hospitalization (that is, the timing of the cardiac arrest relative to the delivery or other maternal complications). However, we suspect that the cause of the arrest is likely a more important driver of survivability than the sequential order of the delivery versus the cardiac arrest. Second, we could not assess trends in cardiac arrest before 2017 because of the coding transition from ICD-9-CM to ICD-10-CM beginning in the fourth quarter of 2015. Third, we did not have information on prenatal care, family and personal history of cardiovascular disease, neurologically intact survival after cardiac arrest, or fetal or neonatal outcomes. Thus, we could not evaluate survival by patient- or community-level characteristics because of the limited number of deaths among delivery hospitalizations with cardiac arrest. Finally, this study did not include cardiac arrest occurring outside delivery hospitalizations and does not represent all maternal cardiac arrests.

Cardiac arrest affected an estimated 1 in 9000 delivery hospitalizations, higher than previously published estimates. More information is needed on specific drivers of cardiac arrest frequency, including race and ethnicity; underlying medical conditions; and other patient-, hospital-, and community-level characteristics. Although nearly 7 in 10 women with cardiac arrest during delivery hospitalization survived to hospital discharge, survival was lowest among patients with co-occurring DIC. Implementing clinical guidelines, ensuring that pregnant people receive risk-appropriate care, and addressing potential knowledge deficits in maternal cardiac arrest and cardiopulmonary resuscitation technique for pregnant people may improve maternal outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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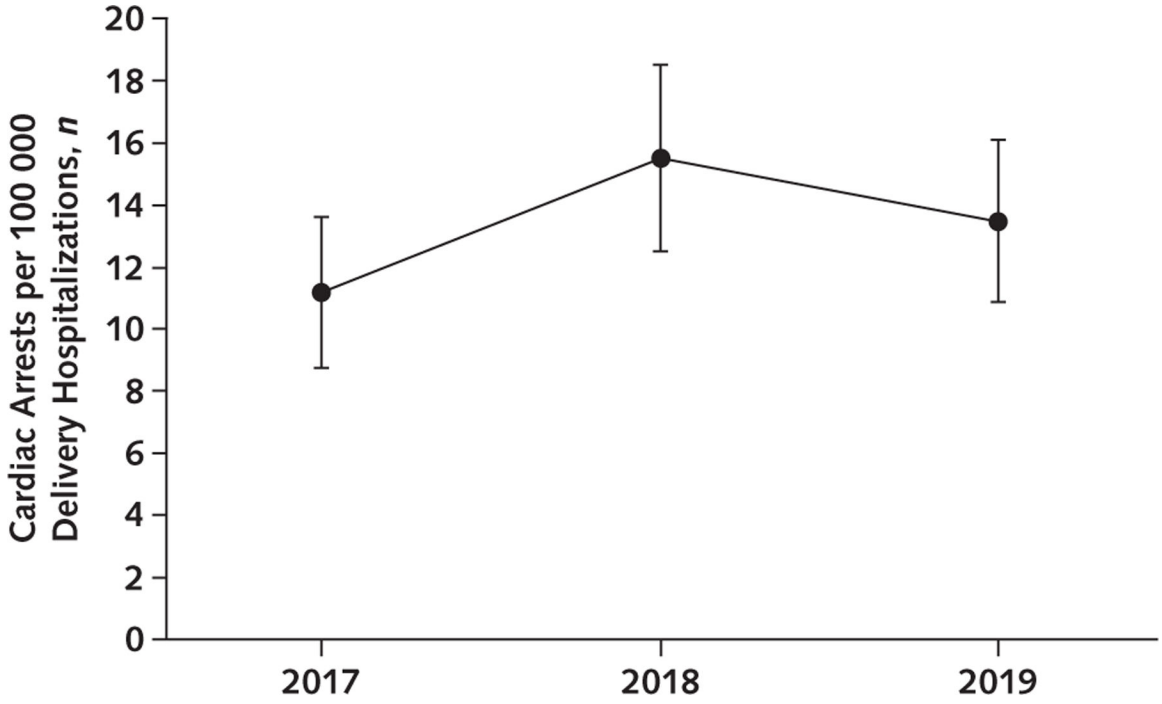

Figure 1. Rate of documented cardiac arrest during delivery hospitalization (per 100 000 delivery hospitalizations), by year.

Data are from the National Inpatient Sample (weighted n = 10 921 784). Overall rate during 2017–2019 was 13.4 events (95% CI, 11.9–14.9 events) per 100 000 delivery hospitalizations.

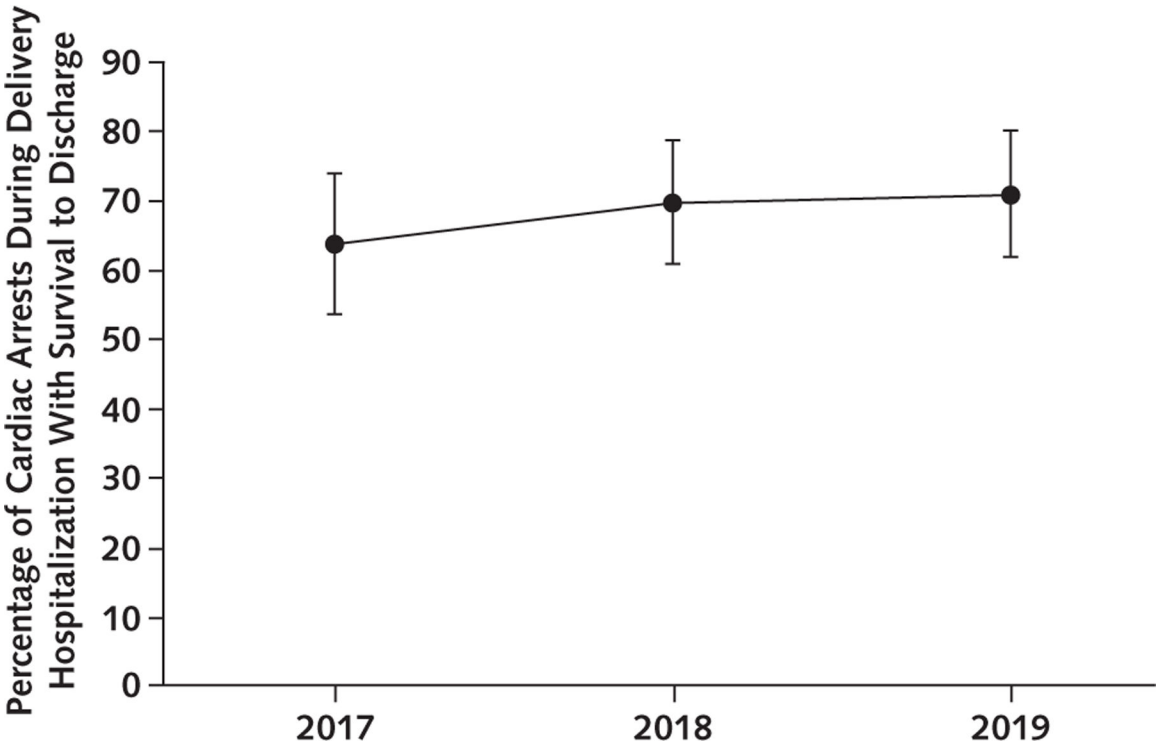

Figure 2. Proportion of survival to hospital discharge after documented cardiac arrest during delivery hospitalization, by year.

Data are from the National Inpatient Sample (weighted $n = 1465$). Overall survival to hospital discharge after cardiac arrest during 2017–2019 was 68.6% (95% CI, 63.2% to 74.0%).

Table 1.

Patient-, Hospital-, and Community-Level Characteristics, by Documented Cardiac Arrest During Delivery Hospitalization*

Characteristic	Total (*n* = 10 921 784)		Cardiac Arrest (*n* = 1465)		No Documented Cardiac Arrest (*n* = 10 920 319)	
	Patients, *n*	Percentage (95% CI)†	Patients, *n*	Percentage (95% CI)†	Patients, *n*	Percentage (95% CI)†
Patient characteristics						
Median maternal age (Q1, Q3), *y*	10 921 784	28.4 (24.2, 32.5)	1465	31.1 (26.5, 35.8)	10 920 319	28.4 (24.2, 32.5)
Race/ethnicity						
Non-Hispanic Asian/Pacific Islander	657 529	6.3 (5.9–6.6)	115	8.1 (5.0–11.3)	657 414	6.3 (5.9–6.6)
Non-Hispanic Black	1 588 355	15.1 (14.7–15.5)	405	28.6 (23.4–33.9)	1 587 950	15.1 (14.7–15.5)
Hispanic	2 186 989	20.8 (20.2–21.4)	280	19.8 (15.0–24.6)	2 186 709	20.8 (20.2–21.4)
Another Non-Hispanic race‡	563 430	5.4 (5.1–5.6)	80	5.7 (3.0–8.4)	563 350	5.4 (5.1–5.6)
Non-Hispanic White	5 514 981	52.5 (51.8–53.2)	535	37.8 (32.1–43.5)	5 514 446	52.5 (51.8–53.2)
Payer						
Medicare/Medicaid	4 709 708	43.2 (42.5–43.8)	775	53.1 (47.3–58.8)	4 708 933	43.2 (42.5–43.8)
Private insurance	5 615 161	51.5 (50.8–52.1)	610	41.8 (36.0–47.5)	5 614 551	51.5 (50.8–52.1)
Self-pay/other	583 095	5.3 (5.2–5.5)	75	5.1 (2.6–7.7)	583 020	5.3 (5.2–5.5)
Rurality (county-level)§						
Metropolitan	9 430 042	86.6 (86.2–87.0)	1255	85.7 (81.7–89.7)	9 428 787	86.6 (86.2–87.0)
Micropolitan	875 499	8.0 (7.8–8.3)	105	7.2 (4.2–10.1)	875 394	8.0 (7.8–8.3)
Rural	587 133	5.4 (5.2–5.6)	105	7.2 (4.2–10.1)	587 028	5.4 (5.2–5.6)
National quartile of median household-level income for patient ZIP code‖						
Q1	3 016 334	27.9 (27.2–28.5)	480	33.1 (27.7–38.5)	3 015 854	27.9 (27.2–28.5)
Q2	2 754 128	25.4 (25.0–25.9)	410	28.3 (23.2–33.4)	2 753 718	25.4 (25.0–25.9)
Q3	2 681 533	24.8 (24.4–25.2)	350	24.1 (19.1–29.1)	2 681 183	24.8 (24.4–25.2)
Q4	2 369 949	21.9 (21.2–22.6)	210	14.5 (10.4–18.6)	2 369 739	21.9 (21.2–22.6)
Underlying medical conditions						
Asthma	570 790	5.2 (5.1–5.3)	145	9.9 (6.5–13.3)	570 645	5.2 (5.1–5.3)
Diabetes mellitus¶	138 845	1.3 (1.2–1.3)	50	3.4 (1.3–5.5)	138 795	1.3 (1.2–1.3)
Chronic hypertension	307 815	2.8 (2.8–2.9)	200	13.7 (9.8–17.5)	307 615	2.8 (2.8–2.9)

Characteristic	Total (n = 10 921 784)		Cardiac Arrest (n = 1465)		No Documented Cardiac Arrest (n = 10 920 319)	
	Patients, n	Percentage (95% CI)†	Patients, n	Percentage (95% CI)†	Patients, n	Percentage (95% CI)†
Chronic kidney disease	29 180	0.3 (0.3–0.3)	115	7.8 (4.8–10.9)	29 065	0.3 (0.3–0.3)
Acquired heart disease**	21 095	0.2 (0.2–0.2)	90	6.1 (3.4–8.9)	21 005	0.2 (0.2–0.2)
Congenital heart disease	11 795	0.1 (0.1–0.1)	15	1.0 (0.0–2.2)	11 780	0.1 (0.1–0.1)
Pulmonary hypertension	2680	0.0 (0.0–0.0)	40	2.7 (0.9–4.6)	2640	0.0 (0.0–0.0)
Systemic lupus erythematosus	15 540	0.1 (0.1–0.1)	–	††	15 535	0.1 (0.1–0.1)
Mental health disorder	848 555	7.8 (7.6–7.9)	265	18.1 (13.6–22.6)	848 290	7.8 (7.6–7.9)
Substance use disorder	291 690	2.7 (2.6–2.7)	135	9.2 (5.9–12.5)	291 555	2.7 (2.6–2.7)
Tobacco use disorder	1 207 744	11.1 (10.8–11.3)	245	16.7 (12.5–20.9)	1 207 499	11.1 (10.8–11.3)
Hospital characteristics						
Region						
Northeast	1 740 900	15.9 (15.2–16.7)	195	13.3 (9.4–17.2)	1 740 705	15.9 (15.2–16.7)
Midwest	2 309 002	21.1 (20.4–21.9)	280	19.1 (14.7–23.5)	2 308 722	21.1 (20.4–21.9)
South	4 288 031	39.3 (38.2–40.3)	570	38.9 (33.3–44.5)	4 287 461	39.3 (38.2–40.3)
West	2 583 851	23.7 (22.8–24.5)	420	28.7 (23.4–34.0)	2 583 431	23.7 (22.8–24.5)
Teaching hospital‡‡						
Yes	7 803 252	71.4 (70.7–72.2)	1140	77.8 (73.0–82.6)	7 802 112	71.4 (70.7–72.2)
No	3 118 532	28.6 (27.8–29.3)	325	22.2 (17.4–27.0)	3 118 207	28.6 (27.8–29.3)
Annual delivery volume						
Low (<1000 deliveries)	1 963 580	18.0 (17.4–18.6)	200	13.7 (9.7–17.6)	1 963 380	18.0 (17.4–18.6)
Medium (1000–2000 deliveries)	2 440 195	22.3 (21.3–23.3)	345	23.5 (18.5–28.6)	2 439 850	22.3 (21.3–23.3)
High (>2000 deliveries)	6 518 009	59.7 (58.5–60.9)	920	62.8 (57.1–68.5)	6 517 089	59.7 (58.5–60.9)

Q = quartile.

*Data are from the National Inpatient Sample. Numbers are weighted and may vary due to missing data.

†Unless indicated in row header as median (Q1, Q3).

‡Includes Native American and other races not specified (7).

§Metropolitan includes metropolitan counties with populations of ≥50 000. Rural includes all nonmetropolitan and nonmicropolitan counties (8).

‖For 2017, Q1 is $1–$43 999, Q2 is $44 000–$55 999, Q3 is $56 000–$73 999, and Q4 is ≥$74 000. For 2018, Q1 is $1–$45 999, Q2 is $46 000–$58 999, Q3 is $59 000–$78 999, and Q4 is ≥$79 000. For 2019, Q1 is $1–$47 999, Q2 is $48 000–$60 999, Q3 is $61 000–$81 999, and Q4 is ≥$82 000.

¶Not including gestational diabetes.

**Includes chronic ischemic heart disease and valvular heart disease.

††The Agency for Healthcare Research and Quality's data use agreement prohibits reporting estimates based on <11 observations.

‡‡Because the Healthcare Cost and Utilization Project does not classify rural hospitals according to teaching status, nonteaching hospitals include all rural hospitals and those urban hospitals that are nonteaching hospitals.

Table 2.

Obstetric Outcomes, Length of Stay, and Discharge Disposition, by Documented Cardiac Arrest During Delivery Hospitalization*

Characteristic	Total (*n* = 10 921 784)		Cardiac Arrest (*n* = 1465)		No Documented Cardiac Arrest (*n* = 10 920 319)	
	Patients, *n*	Percentage (95% CI)†	Patients, *n*	Percentage (95% CI)†	Patients, *n*	Percentage (95% CI)†
Obstetric outcomes						
Multiple gestation	223 085	2.0 (2.0–2.1)	75	5.1 (2.6–7.6)	223 010	2.0 (2.0–2.1)
Stillbirth	78 555	0.7 (0.7–0.7)	135	9.2 (5.9–12.5)	78 420	0.7 (0.7–0.7)
Cesarean delivery	3 504 503	32.1 (31.9–32.2)	1230	84.0 (79.8–88.2)	3 503 273	32.1 (31.9–32.2)
Median length of stay (Q1, Q3), *d*						
Discharge disposition‡	10 921 784	1.8 (1.3, 2.6)	1465	3.9 (1.2, 9.0)	10 920 319	1.8 (1.3, 2.6)
Routine	10 760 614	98.5 (98.4–98.7)	710	48.5 (42.7–54.3)	10 759 904	98.5 (98.4–98.7)
Transfer to short-term hospital	13 990	0.1 (0.1–0.1)	120	8.2 (5.0–11.3)	13 870	0.1 (0.1–0.1)
Other transfer	5500	0.1 (0.0–0.1)	125	8.5 (5.3–11.7)	5375	0.0 (0.0–0.1)
Home health care	126 235	1.2 (1.0–1.3)	50	3.4 (1.3–5.5)	126 185	1.2 (1.0–1.3)
Against medical advice	12 855	0.1 (0.1–0.1)	0	–	12 855	0.1 (0.1–0.1)
Died	680	0.0 (0.0–0.0)	460	31.4 (26.0–36.8)	220	0.0 (0.0–0.0)

Q = quartile.

*Data are from the National Inpatient Sample. Numbers are weighted and may vary due to missing data.

†Unless indicated in row header as median (Q1, Q3).

‡Routine includes “discharged to home or self care (routine discharge),” “court/law enforcement,” “discharged to home or self care with a planned acute care hospital inpatient readmission,” and “discharged/transferred to court/law enforcement with a planned acute care hospital inpatient readmission.” Transfer to short-term hospital includes “discharged/transferred to a short-term hospital for inpatient care,” “discharged/transferred to a designated Cancer Center or Children’s Hospital,” “discharged/transferred to a federal health care facility,” “discharged/transferred to a critical access hospital,” “discharged/transferred to a short term general hospital for inpatient care with a planned acute care hospital inpatient readmission,” “discharged/transferred to a designated Cancer Center or Children’s Hospital with a planned acute care hospital inpatient readmission,” “discharged/transferred to a federal health care facility with a planned acute care hospital inpatient readmission,” and “discharged/transferred to a critical access hospital with a planned acute care hospital inpatient readmission.” Other transfer includes “hospice-medical facility,” “discharged/transferred to a hospital-based Medicare approved swing bed,” “discharged/transferred to an inpatient rehabilitation facility including rehabilitation distinct part unit of a hospital,” “discharged/transferred to a Medicare certified long term care hospital, “discharged/transferred to a nursing facility certified by Medicaid, but not certified by Medicare,” “discharged/transferred to a psychiatric hospital or psychiatric distinct part unit of a hospital,” “discharged/transferred to a designated disaster alternative care site,” “discharged/transferred to another type of institution not defined elsewhere,” “discharged/transferred to a skilled nursing facility with Medicare certification with a planned acute care hospital inpatient readmission,” “discharged/transferred to a facility that provides custodial or supportive care with a planned acute care hospital inpatient readmission,” “discharged/transferred to a hospital-based Medicare approved swing bed with a planned acute care hospital inpatient readmission,” “discharged/transferred to an inpatient rehabilitation facility including rehabilitation distinct part units of a hospital with a planned acute care hospital inpatient readmission,” “discharged/transferred to a Medicare certified long term care hospital with a planned acute care hospital inpatient readmission,” “discharged/transferred to a nursing facility certified under Medicaid but not certified under Medicare with a planned acute care hospital inpatient readmission,” “discharged/transferred to a psychiatric hospital or psychiatric distinct part unit of a hospital with a planned acute care hospital inpatient readmission,” and “discharged/transferred to another type of health care institution not defined elsewhere with a planned acute care hospital inpatient readmission.” Home health care includes “discharged/transferred to home under care of organized home

health service organization," "home IV provider," "hospice-home," and "discharged/transferred to a home under care of organized home health service organization with a planned acute care hospital inpatient readmission."

Table 3.

Distribution of Documented Cardiac Arrests During Delivery Hospitalization*

Severe Maternal Complication	Prevalence of Co-occurring Severe Maternal Complication (*n* = 1465)		Survival to Hospital Discharge (*n* = 1005)	
	Patients, *n*	Percentage (95% CI)	Patients, *n*	Percentage (95% CI)
Diagnoses				
Acute respiratory distress syndrome	820	56.0 (50.2–61.7)	610	74.4 (67.7–81.1)
Shock	550	37.5 (32.0–43.1)	375	68.2 (59.4–77.0)
Acute renal failure	375	25.6 (20.6–30.6)	270	72.0 (61.5–82.5)
Amniotic fluid embolism	245	16.7 (12.5–21.0)	140	57.1 (43.3–71.0)
Acute heart failure	240	16.4 (12.2–20.6)	185	77.1 (65.2–89.0)
Disseminated intravascular coagulation without transfusion	240	16.4 (12.1–20.6)	120	50.0 (35.8–64.2)
Severe preeclampsia, eclampsia, HELLP syndrome	225	15.4 (11.2–19.5)	175	77.8 (65.6–89.9)
Arrhythmia	180	12.3 (8.5–16.0)	140	77.8 (64.3–91.3)
Sepsis	175	11.9 (8.3–15.6)	105	60.0 (43.7–76.3)
Air or thrombotic embolism	140	9.6 (6.1–13.0)	105	75.0 (58.8–91.2)
Severe anesthesia complications†	135	9.2 (5.9–12.5)	135	100.0 (100.0–100.0)
Peripartum cardiomyopathy	115	7.8 (4.8–10.9)	100	87.0 (73.2–100.0)
Puerperal cerebrovascular disorders	80	5.5 (2.9–8.1)	55	68.8 (46.0–91.5)
Acute myocardial infarction	65	4.4 (2.1–6.8)	50	76.9 (54.0–99.8)
Procedures/interventions				
Mechanical ventilation	780	53.2 (47.5–59.0)	560	71.8 (64.7–78.9)
Hysterectomy	285	19.5 (14.8–24.1)	205	71.9 (59.7–84.1)
Both transfusion and disseminated intravascular coagulation	230	15.7 (11.4–20.0)	125	54.3 (39.2–69.5)
Transfusion without disseminated intravascular coagulation	215	14.7 (10.6–18.7)	165	76.7 (64.1–89.4)
Temporary tracheostomy	110	7.5 (4.5–10.5)	100	90.9 (78.9–100.0)
Conversion of cardiac rhythm	75	5.1 (2.6–7.6)	45	60.0 (35.3–84.7)

HELLP = hemolysis, elevated liver enzymes, low platelet count.

*Data are from the National Inpatient Sample. Numbers are weighted. Estimates for aortic aneurysm or dissection and status asthmaticus are not presented to comply with the Agency for Healthcare Research and Quality's data use agreement, which prohibits reporting estimates based on <11 observations. No cases of sickle cell crisis were identified among delivery hospitalizations with cardiac arrest.

†Including cardiac arrest due to anesthesia during pregnancy.