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Mortality and Morbidity During Delivery Hospitalization Among Pregnant Women With Epilepsy in the United States

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Abstract

IMPORTANCE—Between 0.3% and 0.5% of all pregnancies occur among women with epilepsy. Evidence suggests an increase in perinatal morbidity and mortality among women with epilepsy. However, these risks have not been quantified in large population-based samples.

OBJECTIVE—To report on the risk for death and adverse outcomes at the time of delivery for women with epilepsy in the United States.

DESIGN, SETTING, AND PARTICIPANTS—Retrospective cohort study of pregnant women identified through delivery hospitalization records from the 2007-2011 Nationwide Inpatient Sample. From this representative sample of 20% of all US hospitals, we obtained a weighted sample of delivery hospitalizations from 69 385 women with epilepsy and 20 449 532 women without epilepsy.

MAIN OUTCOMES AND MEASURES—Obstetrical outcomes including maternal death, cesarean delivery, length of stay, preeclampsia, preterm labor, and stillbirth.

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Study concept and design: MacDonald, Bateman, Hernández-Díaz.
Acquisition, analysis, or interpretation of data: All authors.
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RESULTS—Women with epilepsy had a risk of death during delivery hospitalization of 80 deaths per 100 000 pregnancies, significantly higher than the 6 deaths per 100 000 pregnancies found among women without epilepsy (adjusted odds ratio [OR], 11.46 [95% CI, 8.64-15.19]). Women with epilepsy were also at a heightened risk for other adverse outcomes, including preeclampsia (adjusted OR, 1.59 [95% CI, 1.54-1.63]), preterm labor (adjusted OR, 1.54 [95% CI, 1.50-1.57]), and stillbirth (adjusted OR, 1.27 [95% CI, 1.17-1.38]), and had increased health care utilization, including an increased risk of cesarean delivery (adjusted OR, 1.40 [95% CI, 1.38-1.42]) and prolonged length of hospital stay (>6 days) among both women with cesarean deliveries (adjusted OR, 2.13 [95% CI, 2.03-2.23]) and women with vaginal deliveries (adjusted OR, 2.60 [95% CI, 2.41-2.80]).

CONCLUSIONS AND RELEVANCE—Findings suggest that women with epilepsy are at considerably heightened risk for many adverse outcomes during their delivery hospitalization, including a more than 10-fold increased risk of death, and that increased clinical attention is imperative for these pregnancies.

Between 0.3% and 0.5% of all pregnancies occur among women with epilepsy.[1] The clinical management of pregnancies among women with epilepsy involves a careful balance of eliminating seizures while also minimizing adverse effects associated with antiepileptic drugs. To prevent seizures, consistent monitoring of antiepileptic drug levels, along with corresponding adjustments in dosage, is required throughout a pregnancy and after delivery.[2] The use of antiepileptic drugs themselves may also pose a risk because some birth defects (eg, oral clefts and neural tube defects) are more common after in utero exposure.[3]

However, the risks to pregnancies among women with epilepsy may extend even further. Individual studies have reported that women with epilepsy are at increased risk for outcomes such as gestational hypertension,[4,5] preeclampsia,[5-8] cesarean delivery,[7-11] and prolonged length of hospital stay.[10] Yet other studies[4-7,10] have failed to replicate these associations. A literature review[12] published by the American Academy of Neurology concluded that women with epilepsy were not at substantially increased risk of cesarean delivery, late pregnancy–related bleeding, or preterm labor. However, there was insufficient evidence to conclusively evaluate the risk for other complications such as preeclampsia or gestational hypertension, suggesting that more work is needed.

Assessing maternal mortality at delivery, which is a rare outcome, is often infeasible without large sample sizes. Based on a series of reports on maternal mortality in the United Kingdom,[13-17] the odds of mortality among women with epilepsy during the entire pregnancy and 42 days postpartum was estimated to be approximately 10-fold that of the general population.[18] A recent audit of maternal deaths in the United Kingdom and Ireland noted 14 deaths among women with epilepsy during pregnancy or within 42 days post partum between 2009 and 2012; the authors of this report[19] highlighted the need for more guidance, specifically in the prevention of maternal death among pregnant women with epilepsy.

With inadequate data on obstetrical outcomes, the magnitude of the risk of death and other adverse outcomes in this population remains dangerously unquantified and unappreciated by the obstetrical community. The aim of our study, therefore, is to identify whether pregnant

women with epilepsy are at increased risk for death and other adverse perinatal outcomes. We used the Nationwide Inpatient Sample, the largest all-payer inpatient care database in the United States, to obtain a large population-based sample of delivery-related hospital discharges among pregnant women with epilepsy.

Methods

Part of the Healthcare Cost and Utilization Project, the Nationwide Inpatient Sample is a federal-state-industry partnership sponsored by the Agency for Healthcare Research and Quality. The database is a 20% stratified sample of all US community hospitals as defined by the American Hospital Association. Representative hospitals are selected for inclusion based on 5 criteria: rural or urban location, number of beds, region, teaching status, and ownership. Approximately 7 million (unweighted) discharges from almost 1000 hospitals are recorded each year.[20] Discharge-level sampling weights based on the sampling scheme are available to obtain national estimates from all US community hospitals. Diagnoses and procedures conducted during a patient's stay are recorded using the International Classification of Diseases, Ninth Revision, Clinical Modification (*ICD-9-CM*) codes. There is no information on medication use, nor is there an ability to link between patient records (ie, analysis is strictly cross-sectional).

We analyzed data from the Nationwide Inpatient Sample during the period from 2007 to 2011. Using *ICD-9-CM* codes from a previously validated method,[21] we identified a cohort of women who delivered during their hospitalizations. From this cohort, we identified women with and women without recorded diagnoses of epilepsy (codes 345.0x-345.5x, 345.7x-345.9x, and 649.4x). Owing to the deidentified nature of the data set, our study was deemed exempt from review by the institutional review board at the Harvard T. H. Chan School of Public Health in Boston, Massachusetts (protocol IRB15-0069). Our study conforms to the data use agreement for the Nationwide Databases from the Healthcare Cost and Utilization Project.

Baseline Characteristics

Baseline characteristics were abstracted using *ICD-9-CM* codes (eTable in the Supplement) and included having multiple births, a previous cesarean delivery, preexisting diabetes mellitus, chronic renal disease, preexisting hypertension, depression, alcohol or substance abuse, and psychiatric disorders. From the data set variables, we directly abstracted maternal age, primary payer, race (white, black, Hispanic, Asian or Pacific Islander, Native American, or other), and income quartile of the patient's zip code. Hospital characteristics were obtained directly from the data set and included hospital region, location, bed size, and teaching status. We also calculated quartiles of the annual number of deliveries per hospital.

Maternal and Fetal Outcomes

Maternal outcomes were primarily chosen to reflect outcomes previously associated or hypothesized to be associated with epilepsy. As a summary measure for overall maternal morbidity, we used the Centers for Disease Control and Prevention severe maternal morbidity composite outcome[22] to provide a summary measure of overall maternal

morbidity. Other specific outcomes included maternal death (death as the recorded hospital disposition), cesarean delivery, induction of labor, length of stay (in days and in percentages with stays longer than 6 days) among cesarean and vaginal deliveries, pregnancy-related hypertension (gestational hypertension or preeclampsia), gestational hypertension alone, and preeclampsia alone. From the identified *ICD-9-CM* codes, we calculated the incidence of eclampsia codes among women with preeclampsia during the hospitalization. Other maternal outcomes included antepartum hemorrhage, postpartum hemorrhage due to atony and not due to atony, severe postpartum hemorrhage, gestational diabetes, preterm labor (<37 weeks), premature rupture of membranes, and chorioamnionitis. Fetal outcomes included poor fetal growth, excessive fetal growth, fetal distress, fetal abnormalities, and stillbirth.

Statistical Analyses

Odds ratios (ORs) and 95% CIs were calculated for all binary maternal and fetal outcomes using logistic regression. Odds ratios were adjusted for variables reflecting baseline demographic characteristics and included maternal age, race, quartile of median household income for patient's zip code, hospital location (urban or rural), hospital region, and year. Variables with more than 5% missing values were assigned a missing indicator level. Statistical tests were 2 sided with $P < .05$ indicating statistical significance. Discharge-levels sampling weights available in the database ("discwt" variable) were applied to obtain national estimates representing discharges from all US community hospitals. All statistical analyses were conducted using SAS version 9.3 (SAS Institute Inc).

Sensitivity Analyses

In an attempt to understand the ultimate causes of maternal deaths, models were further adjusted for common causes of maternal mortality: hemorrhage and preeclampsia (in addition to the standard adjustment covariates already mentioned).[23] Assuming we are adjusting for common causes of maternal mortality and these obstetrical complications, findings would indicate whether the association between epilepsy and maternal mortality is mediated through these complications.

To evaluate the robustness of our epilepsy diagnosis, which was based on codes, and rule out the possibility of eclampsia seizures being recorded as epilepsy, we conducted a sensitivity analysis in a restricted cohort of pregnant women with pregnancies uncomplicated by hypertensive disorders (preeclampsia, eclampsia, or gestational hypertension), with the rationale being that the majority of nonepileptic seizures would be excluded in this group.

Finally, to eliminate the possibility that nonepileptic seizures were being incorrectly coded under the *ICD-9-CM* code 345.9x ("epilepsy, unspecified"), we redefined our criteria for epilepsy by removing this code. The obstetrical risks were re-quantified for this restricted group of women with epilepsy.

Results

A total of 4 190 599 delivery-related hospital discharges were included in our study population. Of these, 14 151 were women with epilepsy. After applying the Nationwide Inpatient Sample sampling weights to obtain national estimates for the United States, we found that the source population became 69 385 women with epilepsy and 20 449 532 women without epilepsy (20 518 917 discharges total). Results did not change after including sampling weights, and so only weighted results are presented. Because information on race was missing for more than 5% of women, a missing indicator level was added for this variable.

Baseline Characteristics

Baseline characteristics are presented in Table 1. The mean age at delivery for both subgroups of women was 27 years (27.1 years for women with epilepsy vs 27.6 years for women without epilepsy). Women with epilepsy were more likely than women without epilepsy to have Medicaid as their primary payer (51.6% vs 42.9%) and to be at the lowest quartile of median household income by zip code (33.0% vs 27.1%). Women with epilepsy were less likely than women without epilepsy to be Hispanic (14.1% vs 19.2%) or Asian/Pacific Islander (1.4% vs 4.3%). The proportion of multiple births was similar between the 2 groups (1.7% of women with epilepsy vs 1.8% of women without epilepsy). Women with epilepsy were more likely than women without epilepsy to have had a previous cesarean delivery (18.6 vs 16.1%) and to have chronic conditions such as diabetes mellitus (2.1% vs 0.9%), chronic renal disease (0.7% vs 0.2%), preexisting hypertension (4.1% vs 1.9%), depression (6.2% vs 1.9%), alcohol or substance abuse (5.4% vs 1.5%), and psychiatric disorders (9.1% vs 1.7%) as recorded during delivery hospitalization.

Hospital Characteristics

Hospital characteristics are presented in Table 2. The hospital characteristics of region, location, bed size, and annual number of deliveries did not differ substantially between women with epilepsy and women without epilepsy. Women with epilepsy were slightly more likely than women without epilepsy to stay at a teaching hospital (54.5% vs 47.6%).

Maternal Mortality

The frequency of death at delivery hospitalization was 80 deaths per 100 000 pregnancies for women with epilepsy and 6 deaths per 100 000 pregnancies for women without epilepsy. After adjusting for maternal age, race, household income for patient’s zip code, hospital location, hospital region, and year, we found that this corresponded to a more than 10-fold increased risk of death for women with epilepsy compared with women without epilepsy (adjusted OR, 11.46 [95% CI, 8.64-15.19]) (Table 3; eFigure 1 in the Supplement).

Other Obstetrical Outcomes

Frequencies and ORs of obstetrical outcomes are presented in Table 3 (eFigures 1 and 2 in the Supplement). Overall, using the Centers for Disease Control and Prevention severe maternal morbidity composite outcome, we found that women with epilepsy were more

likely than women without epilepsy to experience severe maternal morbidity of any sort (adjusted OR, 2.53 [95% CI, 2.44-2.63]).

Specifically, women with epilepsy were more likely than women without epilepsy to undergo a cesarean delivery (adjusted OR, 1.40 [95% CI, 1.38-1.42]) and to undergo induced labor (adjusted OR, 1.14 [95% CI, 1.12-1.16]). Hospital stays of more than 6 days were more likely for women with epilepsy than for women without epilepsy even after stratification by mode of delivery (cesarean delivery: adjusted OR, 2.13 [95% CI, 2.03-2.23]; vaginal delivery: adjusted OR, 2.60 [95% CI, 2.41-2.80]), and the mean length of stay was slightly longer for women with epilepsy than for women without epilepsy (cesarean delivery: 4.0 days vs 3.6 days; vaginal delivery: 2.5 days vs 2.2 days).

Women with epilepsy were more likely than women without epilepsy to have pregnancy-related hypertension (adjusted OR, 1.30 [95% CI, 1.27-1.33]). Specifically, women with epilepsy and women without epilepsy had a similar risk of gestational hypertension (adjusted OR, 0.96 [95% CI, 0.92-1.00]), but women with epilepsy were more likely than women without epilepsy to have preeclampsia (adjusted OR, 1.59 [95% CI, 1.54-1.63]). Among preeclamptic patients, women with epilepsy were more likely than women without epilepsy to have seizures superimposed on preeclampsia (adjusted OR, 5.18 [95% CI, 4.65-5.77]). Women with epilepsy were more likely than women without epilepsy to experience antepartum hemorrhage (adjusted OR, 1.38 [95% CI, 1.31-1.45]). They were also more likely than women without epilepsy to experience postpartum hemorrhage both related to atony (adjusted OR, 1.14 [95% CI, 1.08-1.20]) and not related to atony (adjusted OR, 1.38 [95% CI, 1.28-1.50]), as well as severe postpartum hemorrhage (adjusted OR, 1.76 [95% CI, 1.61-1.93]). Women with epilepsy were more likely than women without epilepsy to experience gestational diabetes (adjusted OR, 1.11 [95% CI, 1.07-1.15]), deliver prematurely (adjusted OR, 1.54 [95% CI, 1.50-1.57]), experience premature rupture of membranes (adjusted OR, 1.07 [95% CI, 1.03-1.11]), and develop chorioamnionitis (adjusted OR, 1.17 [95% CI, 1.11-1.23)].

Compared with women without epilepsy, women with epilepsy had fetuses that were more likely to experience poor growth (adjusted OR, 1.68 [95% CI, 1.61-1.75]) and less likely to experience excessive growth (adjusted OR, 0.73 [95% CI, 0.69-0.77]), suggesting a shift of the fetal growth curve to the left. Women with epilepsy were more likely than women without epilepsy to have an infant who experienced fetal distress (adjusted OR, 1.04 [95% CI, 1.02-1.06]), had a recorded fetal abnormality (adjusted OR, 1.68 [95% CI, 1.60-1.77]), and were stillborn (adjusted OR, 1.27 [95% CI, 1.17-1.38]).

Sensitivity Analyses

Controlling for hemorrhage and preeclampsia in an attempt to explore whether these outcomes mediate the association between epilepsy and maternal mortality did not dramatically alter the effect estimate for death (adjusted OR, 9.65 [95% CI, 7.27-12.81]). Analyses for epilepsy code validation found that after the exclusion of pregnancies complicated by preeclampsia, eclampsia, and gestational hypertension, the adjusted ORs of the examined outcomes did not dramatically change (maternal mortality: adjusted OR, 9.81 [95% CI, 6.84-14.07]). In addition, the risk for death using the restricted criteria for epilepsy

diagnosis (excluding code 345.9x) was not substantially altered (adjusted OR, 9.77 [95% CI, 7.13-13.39]), nor was the effect of other examined outcomes.

Discussion

Women with epilepsy were at significantly higher risk than women without epilepsy for a variety of obstetrical complications at delivery. This was evidenced by their higher risk on the severe maternal morbidity composite outcome, as well as in the examination of individual complications. The most dramatic finding was a more than 10-fold increased risk of maternal death. Women with epilepsy were also more likely than women without epilepsy to experience preeclampsia, preterm labor, hemorrhage, and chorioamnionitis. Compared with women without epilepsy, women with epilepsy had a longer length of hospital stay, were more likely to deliver via cesarean delivery, and were more likely to undergo induced labor. Babies born to women with epilepsy were at a higher risk of stillbirth, poor intrauterine growth, preceding fetal distress, and congenital abnormalities. However, despite their heightened risk of complications, we did not observe evidence that women with epilepsy are routinely triaged to high-risk medical centers. Women with epilepsy delivered at hospitals of similar size in terms of number of beds and annual deliveries, although they were slightly more likely than women without epilepsy to stay at a teaching hospital.

The 10-fold increased risk of dying during delivery hospitalization is in line with one previous estimate for maternal mortality during the entire pregnancy and 42 days post partum.[18] However, unlike the previous estimate, the findings from the present study relate to mortality occurring only during the delivery hospitalization. As such, our absolute risk estimate for maternal mortality would be lower if one considered the time before delivery and in the post partum after hospital discharge, both for women with epilepsy and for women without epilepsy. It should be noted, however, that while the risk is substantially heightened on the multiplicative scale, maternal death during delivery is still very rare even among women with epilepsy (80 deaths per 100 000 pregnancies).

With our data, we can only hypothesize the ultimate causes of death during delivery among women with epilepsy. Part of the increased risk may be mediated by the higher prevalence of potentially life-threatening obstetrical complications such as preeclampsia and postpartum hemorrhage. While the effect estimate did not drastically change after controlling for postpartum hemorrhage and preeclampsia, we are aware of the possibility for selection bias to be introduced after the adjustment of intermediates.[24,25] Thus, we are unable to comment decisively on the role that these adverse obstetrical outcomes played on the risk of mortality among women with epilepsy. Alternatively, the deaths may have occurred because of complications directly related to seizures; for example, the patient may have gone into status epilepticus or experienced aspiration of fluids during a seizure. The rate of sudden unexpected death among persons with epilepsy has been reported to be nearly 24 times that of the expected rate among the general population,[26] and thus sudden unexpected death could be a possible explanation for the increased risk. Regardless of the specific cause, the point that women recorded as having epilepsy have an increased risk of mortality remains a clinically relevant message suggesting that increased attention should be paid. Future

research is needed to determine the specific causes of mortality and how interventions might improve outcomes.

The risk for other outcomes generally confirms those identified in previous studies of women with epilepsy, although our large sample size allows us to make more precise estimates. Similar to prior studies, we observe an increased risk of preeclampsia,[5-8] longer lengths of hospital stay,[10] and inductions.[8] We observe a 40% increase in the risk for cesarean delivery, which would translate into an additional 7400 cesarean deliveries per 100 000 deliveries among women with epilepsy compared with the general population. Similarly, our risk estimate for preterm labor among women with epilepsy would translate into an added 3700 cases of premature labor and delivery per 100 000 pregnancies among women with epilepsy. A higher risk for preterm labor has been found in some studies[7,27] but not in others.[4,9,28-30] Risk of antepartum hemorrhage and postpartum hemorrhage, including severe bleeding, was significantly increased among women with epilepsy, contrary to previous reports of smaller sample sizes.[9,29]

In our data, 3.7% of the fetuses in women with epilepsy and 2.1% of fetuses in women without epilepsy had poor growth recorded in maternal records. A significant increase in risk for poor growth has been reported before.[31,32] The small increased risk found for fetal distress (4%) was also consistent with previous studies that had not supported a significantly increased risk.[9,28,30] Finally, we note a significant 27% increased risk for stillbirth among offspring born to mothers with epilepsy, a magnitude similar to that found in previous work.[7]

Our study relied on the use of *ICD-9-CM* codes to identify women with epilepsy and thus is subject to the limitations of these codes. There are few recent data validating *ICD-9* epilepsy codes.[33-35] Therefore, it is possible that women who experience seizures due to nonepileptic causes (eg, hypertensive disorders during pregnancy) may be misclassified as having epilepsy in their discharge record. To address this, we conducted 2 sensitivity analyses. First, we excluded women recorded as having hypertensive disorders. Doing so excluded the majority of nonepileptic seizure cases and reduced the possibility of misclassification in the epilepsy codes. Despite this exclusion, we found that the risk for maternal mortality and the measures of morbidity associated with epilepsy in the main analysis remained high, suggesting that misclassification did not solely drive the effect of epilepsy. The second sensitivity analysis addressed concerns regarding code 345.9x (“epilepsy unspecified”) incorrectly containing women with non-epileptic seizures. After excluding this code from the criteria for defining epilepsy, we found that there was little change in the effect of epilepsy on any of the outcomes. Together, these sensitivity analyses demonstrate the robustness of our findings to potential errors in misclassification and suggest a true effect of epilepsy.

Other limitations of our study should also be recognized. First, we cannot be sure that differential reporting did not occur. Specifically, it is possible that outcomes that did not affect maternal care were not recorded in the discharge record, potentially leading to an underestimation[36] or an overestimation of ORs. For example, baseline chronic conditions may not have been reported unless they affected the current care of the patient, thus

potentially causing an underestimation of their prevalence. In addition, epilepsy cases may be monitored more closely, such that the probability of reported baseline chronic conditions may be higher for women with epilepsy than for women without epilepsy. While this may also be possible for our main obstetrical outcomes, the majority of our main outcomes are conditions or procedures that are routinely assessed in the course of the delivery hospitalization (eg, preeclampsia, induction, and cesarean delivery), and thus surveillance bias is less likely. Second, information about medications is not included in the data set, and thus we are unable to analyze the effect of treatment and seizure control. Future research is needed to clarify the effect of the use of specific antiepileptic drugs on the risk of complications at delivery. Third, the deidentified nature of the data prevented us from linking maternal and fetal records. Thus, outcomes like birth weight, Apgar scores, neonatal death, and admission to the neonatal intensive care unit are unavailable.

Conclusions

To our knowledge, the present study represents one of the largest population-based studies to date describing the outcomes of women with epilepsy during time of delivery. Epilepsy is relatively infrequent; therefore, the sample size required to assess rare outcomes like maternal death is quite large and not easy to obtain. However, we present the results of approximately 20 million weighted delivery discharges, approximately 69 000 of which pertained to women with epilepsy. As a product of its stratified sampling design, this data set is not only large but uniquely representative of discharges in all community hospitals across the United States, thus providing an accurate picture of the status of women with epilepsy throughout the country.

With approximately half a million women with epilepsy of reproductive age in the United States[12] and 25 000 offspring born to these women annually,[37] there is considerable need to understand the risks of pregnancy in this population. The disproportionate burden of maternal morbidity and mortality among women with epilepsy suggests that these are high-risk patients who may be best cared for in medical centers with subspecialty expertise in neurology, maternal-fetal medicine, and critical care. For some obstetrical conditions, triage to high-risk medical centers has been suggested as a method to improve outcomes.[38] Future studies should explore whether this may also be the case for women with epilepsy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Baseline Characteristics of Women With and Women Without Epilepsy at Delivery

Characteristic[a]	Women, No. (%)[b]	
	With Epilepsy (n = 69 385)	Without Epilepsy (n = 20 449 532)
Age, mean (SE), y	27.09 (0.08)	27.61 (0.07)
Primary payer		
Medicaid	35 753 (51.6)	8 759 914 (42.9)
Private	26 609 (38.4)	10 245 234 (50.2)
Other	6935 (10.0)	1 410 288 (6.9)
Race		
White	34 952 (50.3)	8 773 734 (42.9)
Black	9965 (14.4)	2 374 693 (11.6)
Hispanic	9784 (14.1)	3 925 859 (19.2)
Asian or Pacific Islander	983 (1.4)	874 292 (4.3)
Native American	575 (0.8)	149 622 (0.7)
Other	2298 (3.3)	832 397 (4.1)
Missing	10 826 (15.6)	3 518 935 (17.2)
Median household income for patient's zip code[c]		
1st Quartile	22 395 (33.0)	5 433 119 (27.1)
2nd Quartile	18 039 (26.6)	5 078 085 (25.3)
3rd Quartile	15 884 (23.4)	4 935 520 (24.6)
4th Quartile	11 489 (16.9)	4 597 336 (22.9)
Multiple birth	1181 (1.7)	374 342 (1.8)
Previous cesarean delivery	12 925 (18.6)	3 301 423 (16.1)
Preexisting diabetes mellitus	1484 (2.1)	188 721 (0.9)
Chronic renal disease	490 (0.7)	50 550 (0.2)
Preexisting hypertension	2818 (4.1)	398 068 (1.9)
Depression	4313 (6.2)	387 482 (1.9)
Alcohol or substance abuse	3741 (5.4)	306 859 (1.5)
Psychiatric disorders[d]	6341 (9.1)	347 348 (1.7)

[a] Outcomes are not mutually exclusive.

[b] Because of a small degree of missing data, percentages may not exactly reflect the denominators provided. Data weighted using sampling weights to achieve nationally representative estimates.

[c] Exact amount varies by year. In 2011, the first quartile was from $1 to $37 999, the second quartile was from $38 000 to $47 999, the third quartile was from $48 000 to $63 999, and the fourth quartile was $64 000 or more.

[d] Includes anxiety, adjustment, eating, mood, personality, and psychotic disorders.

Table 2

Characteristics of Hospitals Where Women With and Women Without Epilepsy Delivered Their Babies

Characteristics	Women, No. (%)[a]	
	With Epilepsy (n = 69 385)	Without Epilepsy (n = 20 449 532)
Region		
Northeast	11 729 (16.9)	3 320 917 (16.2)
Midwest	15 243 (22.0)	4 387 922 (21.5)
South	28 815 (41.5)	7 778 763 (38.0)
West	13 598 (19.6)	4 961 930 (24.3)
Location		
Rural	7991 (11.7)	2 301 370 (11.4)
Urban	60 405 (88.3)	17 932 948 (88.6)
Bed size[b]		
Small	6807 (10.0)	2 161 299 (10.7)
Medium	16 375 (23.9)	5 175 845 (25.6)
Large	45 213 (66.1)	12 897 175 (63.7)
Teaching hospital	37 245 (54.5)	9 621 974 (47.6)
Annual average deliveries[c]		
1st Quartile	1710 (2.5)	540 794 (2.6)
2nd Quartile	7087 (10.2)	2 036 117 (10.0)
3rd Quartile	15 248 (22.0)	4 662 893 (22.8)
4th Quartile	45 340 (65.3)	13 209 727 (64.6)

[a] Because of a small degree of missing data, percentages may not exactly reflect the denominators provided. Data weighted using sampling weights to achieve nationally representative estimates.

[b] The definition of the number of beds that qualifies as small, medium, or large depends on the region, location, and teaching/nonteaching designation.

[c] Less than 285 deliveries in the first quartile, from 285 deliveries or less to less than 720 deliveries in the second quartile, from 720 deliveries or less to less than 1739 deliveries in the third quartile, and 1739 or more deliveries in the fourth quartile (unweighted).

Table 3

Obstetrical Outcomes Among Women With and Women Without Epilepsy at Delivery Hospitalization

Outcome[a]	Women, No. (%)[b]		OR (95% CI)	
	With Epilepsy (n = 69 385)	Without Epilepsy (n = 20 449 532)	Crude	Adjusted[c]
Death	56 (0.080)	1294 (0.006)	12.66 (9.68-16.56)	11.46 (8.64-15.19)
Severe maternal morbidity	588 (4.2)	70 754 (1.7)	2.53 (2.44-2.62)	2.53 (2.44-2.63)
Cesarean delivery	28 132 (40.5)	6 763 068 (33.1)	1.38 (1.36-1.40)	1.40 (1.38-1.42)
Induction of labor	14 339 (20.7)	3 709 883 (18.1)	1.18 (1.15-1.20)	1.14 (1.12-1.16)
LOS, mean (SE), d				
Cesarean delivery	4.0 (0.07)	3.6 (0.02)	NA	NA
Vaginal delivery	2.5 (0.03)	2.2 (0.01)	NA	NA
Length of stay >6 d				
Cesarean delivery	1865 (6.6)	217 853 (3.2)	2.14 (2.04-2.24)	2.13 (2.03-2.23)
Vaginal delivery	745 (1.8)	88 360 (0.6)	2.83 (2.63-3.05)	2.60 (2.41-2.80)
Pregnancy-related hypertension	7268 (10.5)	1 611 070 (7.9)	1.37 (1.34-1.40)	1.30 (1.27-1.33)
Gestational hypertension	2703 (3.9)	779 016 (3.8)	1.02 (0.99-1.06)	0.96 (0.92-1.00)
Preeclampsia	4629 (6.7)	849 877 (4.2)	1.65 (1.60-1.70)	1.59 (1.54-1.63)
Seizures among preeclamptic patients	394 (8.5)	14 981 (1.8)	5.18 (4.67-5.75)	5.18 (4.65-5.77)
Antepartum hemorrhage	1464 (2.1)	312 428 (1.5)	1.39 (1.32-1.47)	1.38 (1.31-1.45)
Postpartum hemorrhage				
Due to atony	1626 (2.3)	438 978 (2.1)	1.09 (1.04-1.15)	1.14 (1.08-1.20)
Not due to atony	621 (0.9)	132 911 (0.6)	1.38 (1.28-1.50)	1.38 (1.28-1.50)
Severe postpartum hemorrhage	490 (0.7)	84 587 (0.4)	1.71 (1.57-1.87)	1.76 (1.61-1.93)
Gestational diabetes	3981 (5.7)	1 168 111 (5.7)	1.01 (0.97-1.04)	1.11 (1.07-1.15)
Preterm labor	7716 (11.1)	1 510 382 (7.4)	1.57 (1.53-1.61)	1.54 (1.50-1.57)
Premature rupture of membranes	2791 (4.0)	779 315 (3.8)	1.06 (1.02-1.10)	1.07 (1.03-1.11)
Chorioamnionitis	1351 (1.9)	361 402 (1.8)	1.10 (1.05-1.17)	1.17 (1.11-1.23)
Poor fetal growth	2533 (3.7)	432 779 (2.1)	1.75 (1.68-1.82)	1.68 (1.61-1.75)

Outcome[a]	Women, No. (%)[b]		OR (95% CI)	
	With Epilepsy (n = 69 385)	Without Epilepsy (n = 20 449 532)	Crude	Adjusted[c]
Excessive fetal growth	1330 (1.9)	534 267 (2.6)	0.73 (0.69-0.77)	0.73 (0.69-0.77)
Fetal distress	10 374 (15.0)	2 924 175 (14.3)	1.06 (1.03-1.08)	1.04 (1.02-1.06)
Fetal abnormalities, any	1605 (2.3)	285 826 (1.4)	1.67 (1.59-1.76)	1.68 (1.60-1.77)
Stillbirth	577 (0.8)	125 543 (0.6)	1.36 (1.25-1.48)	1.27 (1.17-1.38)

Abbreviations: LOS, length of stay; NA, not applicable; OR, odds ratio.

[a] Outcomes are not mutually exclusive.

[b] Because of a small degree of missing data, percentages may not exactly reflect the denominators provided. Data weighted using sampling weights to achieve nationally representative estimates.

[c] Adjusted for maternal age, race, quartile of median household income for patient's zip code, hospital location, hospital region, and year.