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Postpartum Length of Stay and Risk for Readmission among Women with Preeclampsia

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Abstract

OBJECTIVE: How hospital length of stay after delivery for women with preeclampsia is associated with risk for readmission is unknown. The objective of this study was to evaluate risk for 60-day hypertension-related postpartum readmission based on length of stay after delivery.

Methods: The 2014 Healthcare Cost and Utilization Project's (HCUP) Nationwide Readmissions Database was used to analyze risk for readmission for a hypertension-related diagnosis within 60 days from cesarean delivery hospitalization for women with preeclampsia who underwent cesarean delivery. Risk for readmission was evaluated based on postoperative length of stay as well as demographic, hospital, and other obstetric factors. Population weights were applied to create national estimates. Multivariable analyses were performed with adjusted risk ratios (aRR) and corresponding 95% confidence intervals as measures of effect. Mean and median hospital charges based upon postoperative length of stay were also evaluated. Time from delivery hospitalization to readmission was calculated.

Results: In 2014, 65,401 women with preeclampsia underwent cesarean delivery. Of these, 1,016 women (1.6%) were readmitted for a hypertension-related diagnosis. 921 of the 1,016 readmissions occurred within 10 days of discharge (90.6%). In adjusted analyses, postoperative

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CONTRIBUTION TO AUTHORSHIP

All authors fulfilled all conditions required for authorship and have approved of this submission. Specifically, Drs. Friedman and Wen conceived the study question and study design. Dr. Wen, Dr. Friedman and Ms. Xu drafted the manuscript. Drs. Attenello, Mack, Goffman, and D'Alton made substantial contributions to the conception and design of the study as well as interpretation of the data. They also made substantial contributions in drafting the article and revising it critically.

DISCLOSURE OF INTERESTS

Dr. Wright has served as a consultant for Tesaro and Clovis Oncology. The other authors did not report any potential conflicts of interest.

DETAILS OF ETHICS APPROVAL

Given that the Nationwide Readmissions Database is publicly available and identified the Columbia University Institutional Review Board (IRB) granted a waiver for this analysis (application number AAAR5341).

LOS 5 to 7 days and >7 days compared to LOS <3 days were associated with decreased risk of 60-day hypertension-related readmission (aRR 0.59 95% CI 0.45, 0.78; aRR 0.53 95% CI 0.29, 1.00, respectively). When the cohort was restricted to women with severe preeclampsia or eclampsia, LOS 5 to 7 days was associated with decreased risk of 60-day hypertension-related readmission in both unadjusted and adjusted analyses compared to LOS <3 days (RR 0.34, 95% CI 0.18, 0.65; aRR 0.29, 95% 0.18, 0.46, respectively). Median delivery hospitalization charges were \$26,512. Compared to LOS <3 days, mean and median charges increased significantly for patients with LOS 4, 5 to 7, and >7 days.

Conclusions: Longer postoperative length of stay during cesarean delivery hospitalizations was associated with decreased risk for postpartum hypertension-related readmission. Most readmissions occurred soon after discharge. These findings support that post-delivery management may play a role in likelihood of women requiring subsequent readmission for complications related to preeclampsia after discharge.

INTRODUCTION

Hospital readmission rates are increasingly being used as an indicator of quality of care with the goal of identifying at-risk patients and reducing readmission risk(1–4). For obstetric patients, hypertension and preeclampsia are a leading indication for postpartum readmission. (5) Preeclampsia complicates 3–6% of pregnancies in the US and is associated with risk for severe maternal morbidity(6–8) including when readmission occurs after a delivery hospitalization. There is limited data from clinical trials on management of postpartum hypertension.(7) The American College of Obstetricians and Gynecologists (ACOG) Task Force on Hypertension in Pregnancy recommends maintenance of blood pressure in a safe range postpartum and that blood pressure be monitored in the hospital or on an equivalent outpatient basis 72 hours postpartum and again 7 to 10 days after delivery. (7)

How hospital length of stay after delivery for women with preeclampsia is associated with risk for readmission for a hypertension-related diagnosis is unknown. An analysis from the Nationwide Readmissions Database found that women with hypertensive disorders of pregnancy are at increased for readmission and these readmissions are associated with significant hospital costs.(9) It is possible that women with preeclampsia who have longer lengths of stay after delivery may be at lower risk for readmission. Longer postpartum stays could allow for monitoring of concerning symptoms, initiation or titration of blood pressure medication, and optimization of pain control minimizing the need for non-steroidal anti-inflammatory drugs. A potential downside of longer postpartum stays may be increased utilization of resources. An additional knowledge gap regarding obstetric readmissions is when such re-hospitalizations occur; knowing the temporal distribution of pre-eclamptic readmissions could be of value in optimizing postpartum care.

Given that the relationship between hospital length of stay after delivery for women with preeclampsia and risk of hypertension-related readmission is not well characterized, the two purposes of this study were to: (i) evaluate risk for 60-day hypertension-related postpartum readmission based on postpartum length of stay, and (ii) evaluate when these risk factors occur relative to delivery hospitalization discharges.

METHODS

Data Source

This analysis was performed using the 2014 Healthcare Cost and Utilization Project's (HCUP) Nationwide Readmissions Database (NRD). The NRD is an all-payer database derived from state-level data capable of tracking patients across hospitalizations within individual states. The NRD contains weights that allow estimates for the 35 million discharges that occur in the United States annually.(10–12) Given that the 2014 version of the NRD includes the hospitalization day that a procedure is performed, postoperative or post-procedure days prior to discharge can be calculated. Public, community, and academic centers are included in the NRD, as are patients with private, public, and no insurance. In 2014, 22 states contributed data to the NRD accounting for 51% of US residents. The Columbia University and University of Southern California institutional review boards granted exemptions for use of this database given that the NRD is de-identified and publically available.

Study Population

Hospitalizations where women underwent cesarean delivery (74.x) complicated by mild (642.4x), superimposed (642.7x), or severe preeclampsia/eclampsia (642.5x, 642.6x) were identified using International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) procedure and diagnosis codes respectively. Women aged 15 to 54 years were included. Cesarean (as opposed to vaginal) deliveries were analyzed given that postoperative day for cesarean could be tracked within the 2014 NRD. Because vaginal deliveries in this database are not associated with a specific hospital day and procedure code, postpartum length of stay could not be calculated. The primary outcome of interest was a hypertension-related readmission within 60 days from delivery hospitalization discharge classified by a primary readmission diagnosis of a hypertensive disorder (mild, severe, or superimposed preeclampsia, gestational hypertension, chronic hypertension) or stroke. We were interested in outcomes where optimization of hypertension management prior to discharge may reduce risk of readmission. While the postpartum period is typically defined as 6 weeks postpartum, we wanted to determine if risk extended beyond this period. To identify stroke, the CDC severe maternal morbidity ICD-9-CM coding algorithm for puerperal cerebrovascular disorders was used.(9)

The primary exposure of interest was postoperative length of stay calculated categorically from day of cesarean to day of discharge: <3 days, 3 days, 4 days, 5-7 days, and >7 days; we utilized multiple categories to determine if small differences in stay length were associated with readmission risk. The overall duration of hospitalization is provided by HCUP in the NRD. Postoperative length of stay was calculated by subtracting the day of cesarean from the overall delivery hospitalization length. Readmissions were identified using methodology provided by HCUP in the NRD. In the case of multiple readmissions occurring within 60 days only the first readmission was analyzed. We characterized the proportion of readmissions occurring by the following time periods: 1-10 days after discharge, 11-30 days after discharge, and 31-60 days after discharge. Because the NRD includes data on a year-by-year basis and readmissions are not tracked across years, only hospitalizations where

discharge occurred from January 1st through October 31st 2014 were included. November and December discharges were not included because readmissions for the subsequent 60 days could not be fully ascertained.

Patient and Hospital Demographics

Demographic, medical, obstetric, and hospital factors from the NRD were included in the analysis. Patient demographic factors included maternal age (15-19, 20-24, 25-29, 30-34, 35-39, and 40-54 years), payer information (Medicaid, Medicare, private, self-pay, no charge, and other), median household income quartile based on ZIP code, and patient location based on the NCHS Urban-Rural Classification Scheme for Counties (central, fringe, counties in metropolitan areas with population >250,000, counties in metropolitan areas with population 50,000-250,000, micropolitan, and neither metropolitan nor micropolitan).(12) Maternal conditions included diabetes and the presence of cardiac conditions including adult congenital heart disease, valvular disorders, and chronic conditions. Obstetric risk factors for readmission included postpartum endometritis and postpartum hemorrhage. Finally, hospital risk factors included bed size (small, medium, large) and teaching status (metropolitan non-teaching, metropolitan teaching, non-metropolitan). Bed size classification was defined using region of the U.S., the urban-rural designation of the hospital, and teaching status.(12)

Statistical Analysis

Primary analysis—Univariable relationships between hospital, demographic and obstetric factors and the risk for 60-day hypertension-related readmission were analyzed using unadjusted log-linear regression analyses. Multivariable log-linear regression analyses utilizing a Poisson distribution were used to assess the relationship between postoperative length of stay and 60-day hypertension-stroke readmissions. We fit two multivariable models for the primary outcome: (i) the first model included all women with preeclampsia during cesarean delivery hospitalizations, and (ii) the second model included only women with severe preeclampsia/eclampsia. Unadjusted and adjusted risk ratios (RR) and 95% confidence intervals (CI) were used to estimate magnitudes of risk for hypertension and stroke readmissions respectively for univariable and multivariable models. Because patients undergoing prolonged antepartum hospitalizations could be a priori at risk for readmission and because longer antepartum hospitalizations could be associated with unmeasured factors associated with readmission, we conducted a sensitivity analysis restricted to women undergoing cesarean delivery within the first two days of admission and repeated the adjusted analyses for (i) all women with preeclampsia, and (ii) only women with severe preeclampsia.

Hospital charges analysis—Data on hospital charges is available in the NRD. Hospital charges associated with both the index delivery hospitalization and readmissions were evaluated. Charges associated with cesarean delivery and postoperative length of stay were calculated based on the same categories as in the primary analysis: <3 days, 3 days, 4 days, 5-7 days, and >7 days. Charges associated with 60-day hypertension-related readmissions were also calculated. Both mean and median charges were calculated with 95% confidence intervals. Because prolonged antepartum hospitalizations prior to delivery could increase

hospital charges apart from postpartum length of stay, we conducted a sensitivity analysis restricted to women with preeclampsia undergoing cesarean delivery within the first two days of admission. All charge data was adjusted for inflation to represent 2016 dollars. All analysis was conducted in SAS 9.4 (Cary, NC) with a predetermined level of significance set to $p < 0.05$.

RESULTS

From January 1 to October 31 2014, 65,399 cesarean deliveries complicated by preeclampsia met inclusion criteria and were included in the analysis. Severe preeclampsia/eclampsia was the most common diagnosis (42.4%, $n=27,750$), followed by mild (39.7%, $n=25,963$) and superimposed (17.9%, $n=11,686$) preeclampsia. Patients were most likely to be discharged postoperative day (POD) 3 ($n=25,223$, 39%), followed by POD 4 ($n=17,655$, 27%), and POD 2 ($n=13,839$, 21%). 11% of patients were discharged POD 5 to POD 7 ($n=8,684$), and 2% of patients were discharged after POD 7 ($n=1,208$). Demographic data by preeclampsia diagnosis (mild, superimposed, severe) is demonstrated in Table 1. Patients with superimposed preeclampsia were older, more likely to have Medicaid insurance, more likely to be from a ZIP code in the lowest quartile for income, and to deliver at a hospital with a large bed size (all $p < 0.05$).

Overall, 1.6% of women with preeclampsia were readmitted for a hypertension-related indication within 60 days of discharge ($n=1,016$) including 2.0% of women with superimposed preeclampsia ($n=231$), 1.6% of women with severe preeclampsia or eclampsia ($n=451$), and 1.3% of women with mild preeclampsia ($n=334$). 90.6% ($n=921$) of discharges occurred 1-10 days after discharge, compared to 8.2% ($n=83$) 11 to 30 days after discharge, and 1.2% ($n=12$) 31-60 days after discharge. In unadjusted analyses, patients with severe preeclampsia or eclampsia and superimposed preeclampsia were respectively 28% and 53% more likely to have a 60-day hypertension-related readmission comparison to mild preeclampsia (risk ratio (RR) 1.28, 95% CI 1.04, 1.58; RR 1.53, 95% CI 1.20, 1.96, $p < 0.01$) (Table 2). With postoperative LOS < 3 days as a reference, longer postoperative stays (3 days) were not significantly associated with readmission risk. Patients 35-39 years old were significantly more likely to be readmitted with age 25-29 years as a reference (RR 1.45 95% CI 1.12, 1.89). Medical and obstetric risk factors including pregestational diabetes, maternal cardiac conditions, endometritis, and postpartum hemorrhage were not found to be significantly associated with hypertension-related readmission. Delivering at a metropolitan teaching hospital was associated with a 30% higher risk of readmission compared to delivering at a metropolitan non-teaching hospital (RR 1.30, 95% CI 1.03, 1.63).

In comparison to univariable analysis, longer hospital stays were associated with lower risk of readmission in the adjusted analysis. For the entire preeclamptic cohort, postoperative lengths of stay 5 to 7 days and > 7 days compared to LOS < 3 days were associated with decreased risk (aRR 0.59 95% CI 0.45, 0.78; aRR 0.53 95% CI 0.29, 1.00, respectively). Other significant factors included age 35 to 39 compared to age 25 to 29 years (aRR 1.52, 95% CI 1.27, 1.83) and severe preeclampsia/eclampsia and superimposed preeclampsia compared to mild preeclampsia (aRR 1.34 95% CI 1.16, 1.55; aRR 1.44 95% CI 1.21, 1.72, respectively). In the second model restricted only to patients with severe preeclampsia/

eclampsia, LOS 5 to 7 days was associated with decreased risk of 60-day hypertension-related readmission in both unadjusted and adjusted analyses (RR 0.34, 95% CI 0.18, 0.65; aRR 0.29, 95% CI 0.18, 0.46, respectively). In the adjusted analysis for severe preeclampsia, other factors associated with decreased risk of readmission included in metro counties with populations of 50 to 250,000 or >250,000 compared to central counties and delivering at a medium or large hospital compared to a small hospital (Table 3).

In the first sensitivity analysis restricted to women with preeclampsia who delivered by cesarean within the first two days of hospital admission, compared to LOS <3 days, adjusted risk for readmission was lower with LOS 4 days (aRR 0.75, 95% CI 0.61, 0.94), LOS 5 to 7 days (aRR 0.46, 95% CI 0.34, 0.62), and >7 days (aRR 0.39, 95% CI 0.19, 0.79) (Supplemental Table 1). Risk of readmission was not statistically significantly different for women with postoperative LOS 3 days compared to <3 days. In the second sensitivity analysis restricted only to women with severe preeclampsia, postoperative length stays of 3 days (aRR 0.65, 95% CI 0.48, 0.88), 4 days (aRR 0.67, 95% CI 0.49, 0.92), 5 to 7 days (aRR 0.16, 95% CI 0.09, 0.28), and >7 days (aRR 0.40, 95% CI 0.12, 0.78) were associated with decreased adjusted risk for readmission compared to stays of <3 days (Supplemental File 2).

For all preeclamptic hospitalizations mean and median charges were \$34,190.00 and \$26,512.00, respectively (95% CI \$32,681.64, \$35,697.84, 95% CI \$25,345.58, \$27,679.10 respectively). For all patients, LOS <3 days was associated with mean and median charges of (\$27,699.00 95% CI \$25,874.09, \$29,524.40 and \$22,428, 95% CI \$21,290.80, \$23,654.82 respectively). Mean and median charges increased significantly for patients with LOS 4, 5 to 7, and >7 days (Table 4). When the analysis was restricted to patients that delivered within the first two days, LOS <3 days was similarly associated with lowest charges, with charges increasing for LOS 3, 4, 5 to 7, and >7 days. Mean and median charges for readmissions were \$23,466.00 and \$24,696.00 (95% CI \$28,792.50, \$31,379.29, 95% CI \$23,526.15, \$25,865.41 respectively).

DISCUSSION

Main Findings

This analysis found that longer lengths of stay during cesarean delivery hospitalizations complicated by preeclampsia were associated with decreased risk for postpartum hypertension-related readmission. These findings support that post-delivery management may play a role in likelihood of women requiring subsequent readmission for complications related to preeclampsia after discharge. Longer postpartum length of stay may represent an opportunity to initiate or titrate oral blood pressure medications, to diagnose and manage end organ involvement related to preeclampsia prior to discharge, and to optimize pain control and minimize use of outpatient non-steroidal anti-inflammatory drugs. Reducing readmissions may play an important role in strategies to address rising (13) postpartum severe maternal morbidity rates given that severe range hypertension is associated with stroke (14) and postpartum readmissions for preeclampsia are associated with a range of other morbidity. Given that the majority of readmissions occurred soon after discharge, short-term follow up after discharge may represent a useful adjunct to titrate blood pressure

medication and identify patients who require re-hospitalization and are at risk for severe morbidity.

Strengths and Limitations

An important consideration raised by the hospital charges component of this analysis is that longer postpartum stay involves increased resource utilization. Prolonged hospital stays require increased staffing and decrease bed availability, and hospital charges in our analysis increased with longer length of stay. Relative costs of preventing admissions may be reduced if subsequent research can determine which women are at highest risk for readmission and most likely to benefit from prolonged hospitalization. Future research is indicated to perform a detailed cost analysis of competing strategies related to postpartum length of stay for this patient population. Given that our analysis used administrative data and did not include information on blood pressure parameters, clinical management including use and dose of antihypertensives, outpatient management, and individual detailed patient clinical history, it is likely that risk could be more fully characterized with subsequent analyses that utilize clinical data. Having more granular data could also provide the basis for predictive models that identify patients at particularly high risk for readmission. That teaching compared to non teaching hospitals had higher readmission supports that there are unmeasured factors associated with readmission not captured in our analysis. Another important consideration in interpreting this study is that given that this is an administrative database study inadequate case mix adjustment is possible; if patients at higher risk a priori for readmission underwent longer index postpartum stays, our analysis would be biased towards underestimating potential readmission risk reduction. Indeed, in our sensitivity analysis restricted to patients delivering within the first two days larger effect sizes in reduced readmission risk were noted. Another limitation is that this database was not able to determine the specific hypertensive indication for readmission. We could not determine whether a patient was indicated for symptomatology, blood pressure control, eclampsia, or another set of findings. Finally, our study was limited to cesarean deliveries. Readmission risk and outcomes data may differ for vaginal delivery hospitalizations. While a sufficiently sized readmissions database that includes day of delivery for vaginal delivery hospitalizations was not available for this analysis, future studies focusing on these hospitalizations are indicated to determine if similar risk is present.

Interpretation

Readmission rates are increasingly being used as an indicator of quality of care with reimbursements tied to reducing risk.(1–4) Initiatives like the Centers for Medicaid and Medicare Services' Hospital Readmissions Reduction Program (HRRP) decrease reimbursement based on unplanned 30-day readmissions.(15, 16) While HRRP does not currently target postpartum hypertensive readmissions,(15–17) it is conceivable that payers could use similar reimbursement schemes related to postpartum readmission in the future. The potential role of reimbursement reductions alongside costs for extended hospitalizations and improved outpatient postpartum follow up will likely factor in to institutional decision making on managing postpartum preeclampsia. The degree to which optimal outpatient management can provide equivalent outcomes to prolonged inpatient postpartum management is an important focus for future comparative effectiveness research. Similarly,

research is needed as to whether early inpatient treatment of borderline severe-range blood pressure with continued outpatient management reduce risk for readmission and need for longer inpatient stays.

Strengths of this study include a large nationally representative database designed to analyze hospital readmissions, allowing adjusted estimates of readmission based on postoperative length of stay after cesarean. The validity of our findings on readmission risk was enhanced by the fact that both the primary and the sensitivity analyses demonstrated similar results. Limitations of the study include shortcomings inherent to administrative data, which provide a broad overview of population-based risk, but lack clinical management details that are of importance in particular to management of preeclampsia. In addition to not being able to evaluate inpatient blood pressure parameters we were also unable to account for outpatient management factors such as outpatient office visits, home nurse visits, and use and titration of antihypertensive medications. Other limitations of the database include that we were limited to discharges January through October in 2014 given that postpartum readmissions from November and December could not be fully ascertained, that the database is state-based, so that if a patient was readmitted in a state different from that in which the delivery hospitalization occurred they would not be able to be linked, that we evaluated hospital charges as opposed to actual costs, that vaginal deliveries were not included in the analysis, and that use of non-steroidal anti-inflammatory drugs cannot be analyzed.

Conclusion

In conclusion, this study provides a novel epidemiologic assessment of postpartum hospitalization length and risk for readmission. To optimize care for women with preeclampsia while managing costs, subsequent research is needed to determine which clinical practices are associated with decreased risk of readmission, to what degree outpatient management can be improved to reduce risk for readmission, and which women may be most likely to benefit from longer postpartum hospitalization. In particular, state-level obstetric safety collaboratives may be particularly well suited to ascertain which patient and clinical management factors are most important in reducing risk for readmissions and associated adverse outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Demographics of preeclamptic cohort

	Mild (n,%)		Severe (n,%)		Superimposed (n,%)	
Postoperative Length of Stay						
<3 days	7,199	27.7%	4,346	15.7%	2,294	19.6%
3 days	11,207	43.2%	9,674	34.9%	4,342	37.2%
4 days	5,653	21.8%	8,882	32.0%	3,120	26.7%
5 to 7 days	1,687	6.5%	4,164	15.0%	1,625	13.9%
>7 days	217	0.8%	685	2.5%	306	2.6%
Age						
15-19 years old	1,709	6.6%	2,098	7.6%	201	1.7%
20-24 years old	5,512	21.2%	6,063	21.9%	1,356	11.6%
25-29 years old	7,090	27.3%	7,334	26.4%	2,658	22.8%
30-34 years old	6,659	25.7%	6,737	24.3%	3,564	30.5%
35-39 years old	3,706	14.3%	4,145	14.9%	2,831	24.2%
40-54 years old	1,287	5.0%	1,373	5.0%	1,076	9.2%
Payer Information						
Medicare	226	0.9%	287	1.0%	229	2.0%
Medicaid	10,591	40.9%	11,989	43.3%	5,556	47.7%
Private Insurance	13,994	54.0%	14,136	51.1%	5,475	47.0%
Self-pay	297	1.2%	377	1.4%	131	1.1%
No Charge	10	0.0%	16	0.1%	3	0.0%
Other	790	3.1%	857	3.1%	243	2.1%
Hospital Location						
Central counties	7,120	27.5%	8,685	31.3%	3,482	29.9%
Fringe counties	6,920	26.7%	7,215	26.0%	2,976	25.5%
Counties in metro areas >250,000	5,558	21.4%	5,796	20.9%	2,669	22.9%
Counties in metro areas 50-250,000	2,180	8.4%	2,339	8.4%	928	8.0%
Micropolitan	2,406	9.3%	2,098	7.6%	875	7.5%
Not metro/micropolitan	1,755	6.8%	1,587	5.7%	731	6.3%
Median Income by ZIP Code						
Income Quartile 1 st	7,512	28.9%	8,259	29.8%	4,190	35.9%
Income Quartile 2 nd	6,906	26.6%	7,160	25.8%	3,062	26.2%
Income Quartile 3 rd	6,042	23.3%	6,467	23.3%	2,344	20.1%
Income Quartile 4 th	5,251	20.2%	5,590	20.1%	1,940	16.6%
Missing	251	1.0%	275	1.0%	150	1.3%
Hospital Bed Size						
Small	3,833	14.8%	3,370	12.1%	1,352	11.6%
Medium	7,711	29.7%	7,566	27.3%	2,920	25.0%
Large	14,417	55.5%	16,815	60.6%	7,415	63.5%
Hospital Teaching Status						
Metro non-teaching	6,222	24.0%	5,364	19.3%	2,150	18.4%

	Mild (n,%)		Severe (n,%)		Superimposed (n,%)	
Metro teaching	16,838	64.9%	20,838	75.1%	8,861	75.8%
Non-metro	2,902	11.2%	1,548	5.6%	675	5.8%
Diabetes	1,132	4.4%	1,281	4.6%	1,536	13.1%
Endometritis	332	1.3%	463	1.7%	160	1.4%
Maternal cardiac condition	113	0.4%	204	0.7%	126	1.1%
Postpartum hemorrhage	929	3.6%	1,499	5.4%	430	3.7%

Table 2:

Unadjusted and adjusted risk for readmission for all patients with preeclampsia

	Unadjusted RR, 95% CI		Adjusted RR, 95% CI	
Postoperative Length of Stay				
<3 days	Reference		Reference	
3 days	1.18	0.92, 1.50	1.11	0.94, 1.31
4 days	1.07	0.82, 1.40	0.93	0.77, 1.12
5 to 7 days	0.75	0.51, 1.09	0.59	0.45, 0.78
>7 days	0.70	0.31, 1.59	0.53	0.29, 1.00
Preeclampsia				
Mild preeclampsia	Reference		Reference	
Severe preeclampsia	1.28	1.04, 1.58	1.34	1.16, 1.55
Superimposed preeclampsia	1.53	1.20, 1.96	1.44	1.21, 1.72
Age				
15-19 years old	0.79	0.48, 1.28	0.93	0.69, 1.25
20-24 years old	0.82	0.61, 1.1	0.81	0.66, 1.00
25-29 years old	Reference		Reference	
30-34 years old	1.04	0.81, 1.34	1.10	0.92, 1.31
35-39 years old	1.45	1.12, 1.89	1.52	1.27, 1.83
40-54 years old	1.36	0.94, 1.96	1.32	1, 1.73
Payer information				
Medicare	1.57	0.78, 3.18	1.45	0.88, 2.38
Medicaid	1.01	0.84, 1.22	1.10	0.96, 1.27
Private insurance	Reference		Reference	
Self-pay	0.51	0.16, 1.6	0.36	0.15, 0.92
No Charge	n/a	n/a	n/a	n/a
Other	0.69	0.35, 1.34	0.96	0.64, 1.43
Patient location				
Central counties	Reference		Reference	
Fringe counties	0.89	0.71, 1.13	0.93	0.78, 1.09
Counties in metro areas >250k	0.84	0.66, 1.08	0.82	0.69, 0.98
Counties in metro areas 50-250k	0.75	0.51, 1.1	0.76	0.58, 0.99
Micropolitan	0.70	0.46, 1.07	0.77	0.56, 1.05
Not metro/micropolitans	0.92	0.6, 1.4	0.92	0.68, 1.24
Median Income by ZIP Code				
Income Quartile 1 st	0.98	0.76, 1.26	1.14	0.93, 1.39
Income Quartile 2 nd	0.79	0.61, 1.04	0.93	0.76, 1.14
Income Quartile 3 rd	0.90	0.68, 1.17	0.98	0.81, 1.2
Income Quartile 4 th	Reference		Reference	
Diabetic	0.99	0.67, 1.44	0.89	0.68, 1.16
Maternal cardiac condition	0.95	0.31, 2.96	0.70	0.28, 1.72
Endometriitis	0.43	0.14, 1.33	0.55	0.25, 1.17

	Unadjusted RR, 95% CI		Adjusted RR, 95% CI	
Postpartum hemorrhage	0.78	0.48, 1.26	0.88	0.63, 1.22
Hospital Bed Size				
Small	Reference		Reference	
Medium	0.92	0.68, 1.26	0.92	0.75, 1.13
Large	0.96	0.73, 1.28	0.95	0.79, 1.15
Hospital Teaching Status				
Metro non-teaching	Reference		Reference	
Metro teaching	1.30	1.03, 1.63	1.12	0.95, 1.32
Non-metro	1.15	0.75, 1.79	1.21	0.86, 1.71

The adjusted model included all of the variables listed in this table. *RR*, risk ratio. *CI*, confidence interval

Table 3:

Unadjusted and adjusted risk for readmission restricted to patients with severe preeclampsia

	Unadjusted RR, 95% CI			Adjusted RR, 95% CI		
Postoperative Length of Stay	RR	95% CI	p-value	RR	95% CI	p-value
<3 days		Reference			Reference	
3 days	0.99	0.67, 1.47	0.98	0.95	0.73, 1.25	0.73
4 days	1.03	0.69, 1.53	0.88	1.01	0.77, 1.34	0.92
5 to 7 days	0.34	0.18, 0.65	<0.01	0.29	0.18, 0.46	<0.01
>7 days	0.50	0.15, 1.63	0.25	0.43	0.17, 1.1	0.08
Age	RR	95% CI	p-value	RR	95% CI	p-value
15-19 years old	0.98	0.53, 1.80	0.95	1.24	0.84, 1.82	0.27
20-24 years old	0.89	0.58, 1.36	0.59	0.88	0.65, 1.19	0.40
25-29 years old		Reference			Reference	
30-34 years old	1.05	0.71, 1.55	0.81	1.19	0.91, 1.56	0.21
35-39 years old	1.48	0.99, 2.21	0.05	1.60	1.21, 2.13	<0.01
40-54 years old	1.19	0.65, 2.19	0.57	1.35	0.87, 2.12	0.18
Payer information	RR	95% CI	p-value	RR	95% CI	p-value
Medicare	1.43	0.46, 4.51	0.54	1.67	0.76, 3.68	0.20
Medicaid	0.94	0.71, 1.24	0.64	1.05	0.85, 1.31	0.63
Private insurance		Reference			Reference	
Self-pay	1.05	0.33, 3.30	0.93	0.74	0.29, 1.87	0.53
No Charge	n/a	n/a	n/a	n/a	n/a	n/a
Other	0.82	0.33, 2.00	0.66	1.36	0.83, 2.21	0.22
Patient location	RR	95% CI	p-value	RR	95% CI	p-value
Central counties		Reference			Reference	
Fringe counties	1.02	0.73, 1.42	0.91	0.97	0.76, 1.24	0.82
Counties in metro areas >250k	0.68	0.45, 1.01	0.06	0.60	0.45, 0.8	<0.01
Counties in metro areas 50-250k	0.64	0.35, 1.18	0.15	0.57	0.37, 0.87	<0.01
Micropolitan	0.85	0.46, 1.55	0.59	0.94	0.61, 1.46	0.79
Not metro/micropolitan	0.77	0.37, 1.59	0.48	0.65	0.39, 1.08	0.10
Median Income by ZIP Code	RR	95% CI	p-value	RR	95% CI	p-value
Income Quartile 1 st	0.96	0.66, 1.41	0.85	1.21	0.9, 1.62	0.22
Income Quartile 2 nd	0.77	0.51, 1.17	0.22	0.87	0.64, 1.19	0.39
Income Quartile 3 rd	1.09	0.74, 1.60	0.67	1.22	0.92, 1.62	0.17
Income Quartile 4 th		Reference			Reference	
Diabetes	0.90	0.46, 1.76	0.76	0.72	0.43, 1.19	0.20
Endometritis	0.28	0.04, 2.00	0.20	0.34	0.08, 1.35	0.13
Index PPH	0.65	0.32, 1.32	0.24	0.88	0.55, 1.39	0.57
Hospital Bed Size	RR	95% CI	p-value	RR	95% CI	p-value
Small		Reference			Reference	
Medium	0.61	0.40, 0.95	0.03	0.59	0.44, 0.79	<0.01
Large	0.68	0.47, 1.00	0.05	0.66	0.51, 0.85	<0.01

Hospital Teaching Status	Unadjusted RR, 95% CI			Adjusted RR, 95% CI		
	RR	95% CI	p-value	RR	95% CI	p-value
Metro non-teaching		Reference			Reference	
Metro teaching	1.36	0.94, 1.95	0.10	1.24	0.96, 1.62	0.10
Non-metro	1.33	0.64, 2.77	0.44	1.23	0.7, 2.16	0.47

The adjusted model included all of the variables listed in this table. *RR*, risk ratio. *CI*, confidence interval.

Table 4.

Charges for delivery hospitalizations complicated by preeclampsia by length of stay

Length of stay	Mean	95% CI		Median	95% CI	
All	\$34,190.00	\$32,681.64	\$35,697.84	\$26,512.00	\$25,345.58	\$27,679.10
<3 days	\$27,699.00	\$25,874.09	\$29,524.40	\$22,428.00	\$21,209.93	\$23,645.82
3 days	\$29,455.00	\$28,135.24	\$30,774.79	\$25,199.00	\$24,050.38	\$26,348.53
4 days	\$35,152.00	\$33,079.06	\$37,224.30	\$28,113.00	\$26,102.62	\$30,123.68
5 to 7 days	\$46,020.00	\$43,203.29	\$48,837.02	\$37,408.00	\$34,742.27	\$40,073.17
>7 days	\$118,316.00	\$98,536.64	\$138,095.74	\$67,597.00	\$60,651.45	\$74,542.72