Contribution of hypertension to severe maternal morbidity

Jane Hitti, MD; Laura Sienas, MD; Suzan Walker, RN; Thomas J. Benedetti, MD, MHA; Thomas Easterling, MD

BACKGROUND: Maternal mortality and severe maternal morbidity are growing public health concerns in the United States. The Centers for Disease Control and Prevention Severe Maternal Morbidity measure provides insight into processes underlying maternal mortality and may highlight modifiable risk factors for adverse maternal health outcomes.

OBJECTIVE: The primary objective of this study was to evaluate the association between hypertensive disorders and severe maternal morbidity at a regional perinatal referral center. We hypothesized that women with preeclampsia with severe features would have a higher rate of severe maternal morbidity compared to normotensive women. We also assessed the proportion of severe maternal morbidity diagnoses that were present on admission, in contrast to those arising during the delivery hospitalization.

STUDY DESIGN: In this retrospective cross-sectional analysis, we assessed rates of severe maternal morbidity diagnoses (eg, renal insufficiency, shock, and sepsis) and procedures (eg, transfusion and hysterectomy) for all 7025 women who delivered at the University of Washington Medical Center from Oct. 1, 2013, through May 31, 2017. Severe maternal morbidity was determined from prespecified *International Classification of Diseases* diagnosis and procedure codes; all diagnoses were confirmed by chart review. Present-on-admission rates were calculated for each diagnosis through hospital administrative data provided by the Vizient University Health System Consortium. Maternal demographic and clinical characteristics were compared for women with and without severe maternal morbidity. The χ^2 and Fisher exact tests were used to determine statistical significance. Odds ratios and 95% confidence intervals were calculated for the associations between maternal demographic and clinical characteristics and severe maternal morbidity.

RESULTS: Of 7025 deliveries, 284 (4%) had severe maternal morbidity; 154 had transfusion only, 27 had other procedures, and 103 women had 149 severe maternal morbidity diagnoses (26 women had multiple diagnoses). Severe preeclampsia occurred in 438 deliveries (6.2%). Notably, hypertension was associated with severe maternal morbidity in a dose-dependent fashion, with the strongest association observed for preeclampsia with severe features (odds ratio, 5.4; 95% confidence interval, 3.9—7.3). Severe maternal morbidity was also significantly associated with preeclampsia without severe features, chronic hypertension, preterm delivery, pregestational diabetes, and multiple gestation. Among women with severe maternal morbidity, over one third of preterm births were associated with maternal hypertension. American Indian/Alaskan Native women had significantly higher severe maternal morbidity rates compared to other racial/ethnic groups (11.7% vs 3.9% for Whites, $P < .01$). Overall, 39.6% of severe maternal morbidity diagnoses were present on admission.

CONCLUSION: Hypertensive disorders in pregnancy are strongly associated with severe maternal morbidity in a dose-dependent relationship, suggesting that strategies to address rising maternal morbidity rates should include early recognition and management of hypertension. Prevention strategies focused on hypertension might also impact medically indicated preterm deliveries. The finding of increased severe maternal morbidity among American Indian/Alaskan Native women, a disadvantaged population in Washington State, underscores the role that socioeconomic factors may play in adverse maternal health outcomes. As 39% of severe maternal morbidity diagnoses were present on admission, this measure should be risk-adjusted if used as a quality metric for comparison between hospitals.

Key words: diabetes, hypertension, multiple gestation, preeclampsia, preterm birth, quality improvement, renal insufficiency, severe maternal morbidity

Introduction

Maternal morbidity and mortality continue to rise in the United States, with severe maternal morbidity (SMM) affecting >50,000 women in 2014.[1] The Centers for Disease Control and Prevention (CDC) SMM measure,[1,2] adopted by the Alliance for Innovation on Maternal Health, provides insight into processes underlying maternal mortality. The SMM measure includes specific diagnoses (eg, renal failure, shock and sepsis) and procedures (eg, transfusion and hysterectomy) that indicate adverse maternal health outcomes,[3] thus highlighting opportunities to decrease peripartum morbidity and mortality.[4] This is particularly true for hypertensive disorders in pregnancy, which are strongly associated with maternal morbidity and mortality and are often amenable to medical intervention.[5]

The SMM measure is derived from specific *International Classification of Diseases* (*ICD*), *Ninth Revision* (*ICD-9*) and *International Statistical Classification of Diseases, 10th Revision* (*ICD-10*) discharge diagnosis and procedure codes from delivery hospitalizations.[1-3] Notably, this measure does not adjust for preexisting conditions; it includes diagnoses present at hospital admission, as well as those arising during the delivery hospitalization. A recent publication found that >40% of SMM cases had opportunities for improvement in care.[4] It is important to understand the relative proportion of specific SMM diagnoses present on admission, as compared to those arising during the delivery hospital stay. This information could better focus prevention strategies and determine how much these efforts should be directed toward the delivery hospitalization as compared to antenatal care.

AJOG at a Glance

Why was this study conducted?
This study was conducted to evaluate the association between hypertensive disorders in pregnancy and other maternal clinical diagnoses with severe maternal morbidity (SMM) at a single perinatal regional referral center. We also assessed what proportion of specific SMM diagnoses were present at hospital admission.

Key findings
Women with SMM were significantly more likely to have hypertension (38% vs 17%) and preterm delivery (53% vs 19%) compared to women without SMM. Hypertension was associated with SMM in a dose-dependent fashion. Over one third of preterm deliveries among women with SMM were associated with hypertension. Overall, 39% of SMM diagnoses were present at admission, prior to delivery.

What does this add to what is known?
There may be opportunities to reduce SMM by focusing on maternal preexisting conditions such as hypertensive disorders. In turn, a reduction in SMM might reduce preterm delivery for hypertension or maternal medical indications. Since SMM diagnoses are frequently present on admission, this measure reflects maternal acuity of illness prior to the delivery hospitalization as well as intrapartum and early postpartum management.

Regional tertiary-care perinatal centers provide a unique setting to evaluate maternal morbidity. These specialized centers typically have a disproportionate number of deliveries with SMM because of regional referral patterns that result in transfer of high-acuity patients from local hospitals to a higher level of care. The increased maternal acuity at a regional perinatal center allows the detection of associations that might not be evident in a less acute patient population. In effect, the selection bias toward high patient acuity acts as a magnifying lens to discern potentially important correlates of maternal morbidity and mortality. The primary objective of this study was to evaluate the contribution of preeclampsia with severe features to SMM at a regional perinatal center. We hypothesized that women with preeclampsia with severe features would have a higher SMM rate compared to normotensive women. We also assessed the proportion of specific SMM diagnoses that were present on admission, in contrast to those arising during the delivery hospitalization.

Materials and Methods

We conducted a retrospective cross-sectional analysis of risk factors for SMM among all 7025 deliveries at the University of Washington Medical Center from Oct. 1, 2013, through May 31, 2017, excluding pregnancy terminations and ectopic pregnancies. The University of Washington Labor and Delivery Service is the academic perinatal referral center for a 5-state region (Washington, Wyoming, Alaska, Montana, Idaho) with a land mass of 1,063,258 square miles and approximately 143,800 deliveries annually.[6] The University of Washington delivery service has very high patient acuity; in 2016, this service ranked second in mean Admission All Patients Refined Diagnosis Related Groups Severity of Illness scores among 118 academic medical centers in the Vizient University Health System Consortium. The University of Washington Institutional Review Board approved the study protocol.

SMM was defined by the CDC criteria.[1–3] Specific SMM diagnosis categories were identified by prespecified *ICD-9* (Oct. 1, 2013, through Sept. 30, 2015) or *ICD-10* (Oct. 1, 2015, through May 31, 2017)[3] codes and validated by

medical record review. The specific SMM diagnosis categories included acute renal failure, adult respiratory distress, amniotic fluid embolism, anesthesia complications, aneurysm, cardiac arrest, cerebrovascular disorders, disseminated intravascular coagulation (DIC), eclampsia, embolism, pulmonary edema, sepsis, shock, and Sickle cell crisis. Cases in which chart review found erroneous *ICD* coding were reclassified as not having SMM diagnosis. The specific SMM procedure codes included cardioversion, hysterectomy, tracheostomy, transfusion, and ventilation. Women who met the CDC SMM definition were divided into 3 mutually exclusive subsets: (1) the SMM diagnosis group, composed of all women with any SMM diagnosis (could also have transfusion or other procedure); (2) the SMM procedure group, which included women with other SMM procedures (could also have transfusion but not SMM diagnoses); and (3) the transfusion-only group. Other relevant clinical diagnoses such as multiple gestation, diabetes, and hypertension were determined by *ICD-9* or *ICD-10* discharge diagnosis coding. Women with hypertension were classified into 4 mutually exclusive groups according standard definitions[7]: preeclampsia with and without severe features (could include women with chronic hypertension and super-imposed preeclampsia), chronic hypertension (without super-imposed preeclampsia), and gestational hypertension.

We compared demographic and clinical characteristics for women with and without any SMM, using the χ^2 or Fisher exact test for statistical significance. Odds ratios (OR) and 95% confidence intervals (CI) were used to estimate the strength of the associations between maternal demographic and clinical characteristics and SMM. For the subset of women with SMM diagnoses, we determined the proportion of cases that had the specific SMM diagnosis present on admission, using hospital administrative data provided by Vizient. Data analysis was completed in Excel 2016 (Microsoft Corporation, Redmond, WA) and Epi Info™ (Centers for Disease Control and Prevention, Atlanta, GA).[8]