OBSTETRICS

Severe maternal morbidity in a large cohort of women with acute severe intrapartum hypertension

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BACKGROUND: Hypertensive diseases of pregnancy are associated with severe maternal morbidity and remain common causes of maternal death. Recently, national guidelines have become available to aid in recognition and management of hypertension in pregnancy to reduce morbidity and mortality. The increased morbidity related to hypertensive disorders of pregnancy is presumed to be associated with the development of severe hypertension. However, there are few data on specific treatment or severe maternal morbidity in women with acute severe intrapartum hypertension as opposed to severe preeclampsia.

OBJECTIVE: The study aimed to characterize maternal morbidity associated with women with acute severe intrapartum hypertension, and to determine whether there was an association between various first-line antihypertensive agents and posttreatment blood pressure.

STUDY DESIGN: This retrospective cohort study of women delivering between July 2012 and August 2014 at 15 hospitals participating in the California Maternal Quality Care Collaborative compared women with severe intrapartum hypertension (systolic blood pressure >160 mm Hg or diastolic blood pressure >105 mm Hg) to women without severe hypertension. Hospital Patient Discharge Data and State of California Birth Certificate Data were used. Severe maternal morbidity using the Centers for Disease Control and Prevention criteria based on International Classification of Diseases—9 codes was compared between groups. The efficacy of different antihypertensive medications in meeting the 1-hour posttreatment goal was determined. Statistical methods included distribution appropriate univariate analyses and multivariate logistic regression.

RESULTS: There were 2252 women with acute severe intrapartum hypertension and 93,650 women without severe hypertension. Severe maternal morbidity was significantly more frequent in the women with severe hypertension (8.8%) compared to the control women (2.3%) ($P < .0001$). Severe maternal morbidity rates did not increase with increasing severity of blood pressures ($P = .90$ for systolic and .42 for diastolic). There was no difference in severe maternal morbidity between women treated (8.6%) and women not treated (9.5%) ($P = .56$). Antihypertensive treatment rates were significantly higher in hospitals with a level IV neonatal intensive care unit (85.8%) compared to a level III neonatal intensive care unit (80.2%) ($P < .001$), and in higher-volume hospitals (84.5%) compared to lower-volume hospitals (69.1%) ($P < .001$). Severe maternal morbidity rates among severely hypertensive women were significantly higher in hospitals with level III neonatal intensive care unit level compared to hospitals with a level IV neonatal intensive care unit (10.6% vs 5.7%, respectively; $P < .001$), and significantly higher in low—delivery volume hospitals compared to high—delivery volume hospitals (15.5% vs 7.6%, respectively; $P < .001$). Only 53% of women treated with oral labetalol as first-line medication met the posttreatment goal of nonsevere hypertension, significantly less than those treated with intravenous hydralazine, intravenous labetalol, or oral nifedipine (68%, 71%, and 82%, respectively) ($P = .001$). Severe intrapartum hypertension remained untreated in 17% of women.

CONCLUSION: Women with acute severe intrapartum hypertension had a significantly higher risk of severe maternal morbidity compared to women without severe hypertension. Significantly lower antihypertensive treatment rates and higher severe maternal morbidity rates were seen in lower—delivery volume hospitals.

Key words: hypertension, severe maternal morbidity, severe preeclampsia

It is well known that preeclampsia and other hypertensive diseases of pregnancy are associated with severe maternal morbidity including stroke, eclampsia, hemolysis, elevated liver enzymes, low platelet count (HELLP) syndrome, renal failure, and disseminated intravascular coagulation (DIC)[1,2] and are a common cause of maternal death in the United States.[3,4] Furthermore, more than half of maternal deaths due to hypertensive disease were deemed preventable.[5,6] Because the increased morbidity related to hypertensive disorders of pregnancy is in part presumed to be associated with the development of severe hypertension, national and international guidelines, bundles, and toolkits to aid in timely recognition and management of hypertension in pregnancy to reduce perinatal morbidity and mortality have been available for at least 3 years.[1,7-13] Moreover, although there are multiple small randomized controlled trials comparing 1 antihypertensive agent to another to control acute severe antenatal hypertension, these studies generally focused on immediate treatment results and did not evaluate the impact on severe maternal morbidity.[14] Therefore, the aims of this study were to characterize current management patterns in a large cohort of women with acute severe intrapartum maternal hypertension; to determine the specific severe maternal morbidity associated with intrapartum severe hypertension compared to that in women without severe hypertension; and to determine efficacy of different first-line antihypertensive agents in meeting posttreatment blood pressure goals.

Materials and Methods

We conducted a retrospective cohort study of all women delivering between

Cite this article as: Kilpatrick SJ, Abreo A, Greene N, et al. Severe maternal morbidity in a large cohort of women with acute severe intrapartum hypertension. Am J Obstet Gynecol 2016;215:91.e1-7.

0002-9378/$36.00

http://dx.doi.org/10.1016/j.ajog.2016.01.176

July 2012 and August 2014 at 15 hospitals participating in both the Active Track of the California Maternal Quality Care Collaborative (CMQCC) and the CMQCC's Preeclampsia Collaborative, comparing women with acute severe intrapartum hypertension to women without severe hypertension. CMQCC's mission is to reduce maternal and perinatal morbidity and mortality, principally by gathering, reviewing, and organizing pregnancy-related data from a variety of sources to be used for quality improvement research and initiatives. These data functions occur within the California Maternal Data Center. Active Track hospitals provide automatic uploading of Patient Discharge Data monthly, and also manually upload supplemental data from chart review. All records are linked to the Birth Certificate Data from the State of California. The purpose of CMQCC's Preeclampsia Collaborative was to engage obstetric hospitals to improve timely diagnosis and treatment of women with preeclampsia by using the CMQCC Preeclampsia Toolkit.[8] Data submitted included blood pressures, treatment drug, time of treatment, blood pressure response to treatment, demographic data, and maternal morbidity. In addition, hospital delivery volume and neonatal intensive care unit (NICU) level of care were collected.

We compared women with severe hypertension, defined as systolic blood pressure (SBP) >160 mm Hg or diastolic blood pressure (DBP) >105 mm Hg that was confirmed within 1 hour, to women without severe hypertension. DBP >105 mm Hg was used because this was the definition of severe diastolic hypertension used initially by CMQCC and supported by data in the literature.[1,8] Women without severe hypertension, all remaining women who delivered at the same hospitals in the same time period, are hereafter called the control group. For the severely hypertensive women, only data from the first episode of confirmed severe hypertension and treatment for that episode were submitted to the Preeclampsia Collaborative and used, such that each woman had only 1 hypertensive episode studied. Hypertensive episode data included antihypertensive drug, pretreatment blood pressure, and posttreatment blood pressure within 1 hour of treatment, reasons for no treatment if not treated, and type of hypertensive disease. Types of hypertensive diseases were eclampsia, severe preeclampsia, superimposed preeclampsia, gestational hypertension, and "other" when the patient did not meet the usual criteria for any of the prior 4 categories. Variables compared between groups included demographics (age, prepregnancy body mass index [BMI], race/ethnicity, insurance), pregnancy characteristics (plurality, delivery route, gestational age at delivery), hospital-level factors, and severe maternal morbidity. The hospital-level factors that we included were American Association of Pediatrics (AAP) NICU level[15] as a proxy for maternal level of care, and annual birth volume.

Severe maternal morbidity (SMM) was determined from the Centers for Disease Control and Prevention (CDC) Callaghan criteria based on International Classification of Diseases—9 (ICD-9) codes.[16-18] The CDC Callaghan criteria included the following ICD-9 diagnoses: DIC, acute renal failure, pulmonary edema, adult respiratory distress syndrome, transfusion, puerperal cerebrovascular event, and ventilation.[16,18] (A complete list of CDC ICD-9 codes for SMM are provided on the CDC website.[17]) In addition, we collected abruption and postpartum hemorrhage based on ICD-9 discharge codes. It was not possible to determine whether the SMM occurred before or after treatment for severe hypertension.

Within the group of women with acute severe hypertension, we compared those treated to those not treated, in terms of demographics, pregnancy characteristics, medication used, hospital-level factors, and occurrence of severe maternal morbidity. In addition, the efficacy, defined as achieving blood pressure <160/105, of different first-line antihypertensive medications used for controlling severe blood pressure was compared in the treated group. Finally, we compared SMM rate and treatment rate among 3 tiers of severe blood pressure using a χ^2 and a trend test. The 3 tiers were determined from natural cut points in a histogram of blood pressure ranges. Statistical methods for all analyses included distribution appropriate univariate analyses (χ^2 test, analysis of variance, and t test). We constructed multivariate logistic regression with specific perinatal outcomes including the CDC Callaghan morbidity criteria as the dependent variables, and treated vs not treated as the independent predictors of interest. Where appropriate, we constructed hierarchical models to account for between-hospital differences. We used SAS 9.3 (SAS Institute, Cary, NC) for all analyses, and set the significance (α) level at $P < .05$. Finally, Stanford University provided a determination of non—human subjects research.

Results

There were 2252 women with acute severe intrapartum hypertension and 93,650 women without severe hypertension who delivered at 1 of the 15 participating hospitals during our time frame. Demographics and pregnancy characteristics are presented in Table 1. Obesity, maternal age >35 years, and multiple gestation were significantly more common in women with severe hypertension compared to controls ($P <$ .0001). Of particular interest, 50.4% of the severely hypertensive women compared to 8.0% of the control women delivered prematurely, with 14.3% vs 1.6% delivering before 32 weeks' gestation, respectively ($P < .0001$). The distribution of underlying hypertension disease type for all women with severe hypertension was the following: severe preeclampsia, 65%; superimposed preeclampsia, 25%; other, 6%; gestational hypertension, 3%; and eclampsia, 1%.

Severe maternal morbidity was significantly more frequent in the women with severe hypertension (8.8%) compared to the control women (2.3%) ($P < .0001$) (Table 2). As also shown in Table 2, all morbidities except stroke were significantly more frequent in the severely hypertensive women ($P <$ .0001). Of note, although stroke was rare in both groups of women, there was a