OBSTETRICS

Prevalence, trends, and outcomes of chronic hypertension: a nationwide sample of delivery admissions

Brian T. Bateman, MD; Pooja Bansil, MPH; Sonia Hernandez-Diaz, MD, DrPH; Jill M. Mhyre, MD; William M. Callaghan, MD, MPH; Elena V. Kuklina, MD, PhD

OBJECTIVE: We sought to define the prevalence, trends, and outcomes of primary and secondary chronic hypertension in a population-based sample of deliveries.

STUDY DESIGN: An estimated 56,494,634 deliveries were identified from the 1995 through 2008 Nationwide Inpatient Sample. The association of primary and secondary chronic hypertension with adverse fetal and maternal outcomes was evaluated using regression modeling and adjusted population-attributable fractions were calculated.

RESULTS: During the study period, the prevalence of primary and secondary hypertension increased from 0.90% in 1995 through 1996 to 1.52% in 2007 through 2008 (P for trend $< .001$) and from 0.07% to 0.24% (P for trend $< .001$), respectively. The population-attributable fraction for chronic hypertension was considerable for many maternal adverse outcomes, including acute renal failure (21%), pulmonary edema (14%), preeclampsia (11%), and in-hospital mortality (10%).

CONCLUSION: Primary and secondary chronic hypertension were both strongly associated with adverse pregnancy outcomes and accounted for a substantial fraction of maternal morbidity. Prioritizing research efforts in this area is needed.

Key words: chronic hypertension, epidemiology, obstetric complications

Cite this article as: Bateman BT, Bansil P, Hernandez-Diaz S, et al. Prevalence, trends, and outcomes of chronic hypertension: a nationwide sample of delivery admissions. Am J Obstet Gynecol 2012;206:134.e1-8.

Chronic hypertension is a relatively common comorbidity in pregnancy[1-3] and a well-established risk factor for a number of adverse perinatal outcomes, including preterm birth,[4,5] perinatal death,[5-8] and intrauterine growth restriction,[4,5] as well as adverse maternal outcomes, including preeclampsia,[4,5,9,10] stroke,[8,11,12] acute renal failure,[8,11] pulmonary edema,[8,11] and maternal death.[8,11] Although the majority of chronic hypertension among pregnant women is due to primary hypertension, about 10% of cases occur secondary to other medical conditions, such as diabetes mellitus, chronic renal disease, thyroid disease, and collagen vascular disease.[13]

★ EDITORS' CHOICE ★

There are few population-based studies examining the impact of chronic hypertension on obstetric outcomes in the United States[8,11]; this is particularly true for chronic hypertension that is secondary to or associated with other conditions. As the prevalence of advanced maternal age[14] and obesity[15] increase among childbearing women in the United States, both primary and secondary chronic hypertension are likely to become an increasingly common obstetric conditions.

The purpose of this study is 3-fold: (1) to examine nationwide trends in the prevalence of primary and secondary chronic hypertension during delivery hospitalizations in the United States; (2) to assess the effect of primary and secondary chronic hypertension on fetal and maternal obstetric complications; and (3) during the most recent years in the study period, to estimate the contribution of primary and secondary chronic hypertension to the burden of select fetal and maternal complications in the United States.

Materials and Methods

Hospital discharge data were obtained from the Nationwide Inpatient Sample (NIS), part of the Healthcare Cost and Utilization Project, a federal-state-industry partnership sponsored by the

From the Division of Obstetric Anesthesia, Department of Anesthesia, Critical Care, and Pain Medicine, Massachusetts General Hospital, Harvard Medical School (Dr Bateman), and the Department of Epidemiology, Harvard School of Public Health (Dr Hernandez-Diaz), Boston, MA; the Divisions of Heart Disease and Stroke Prevention (Ms Bansil and Dr Kuklina) and Reproductive Health (Dr Callaghan), National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA; and the Department of Anesthesiology, University of Michigan Health System, Ann Arbor, MI (Dr Mhyre).

Received Aug. 24, 2011; revised Oct. 11, 2011; accepted Oct. 31, 2011.

The authors report no conflict of interest.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Reprints: Brian T. Bateman, MD, Division of Obstetric Anesthesia, Department of Anesthesia, Critical Care, and Pain Medicine, Massachusetts General Hospital, Harvard Medical School, 55 Fruit St., Boston, MA 02114. BBateman@partners.org.

0002-9378/free • © 2012 Mosby, Inc. All rights reserved. • doi: 10.1016/j.ajog.2011.10.878

For Editors' Commentary, see Table of Contents

TABLE 1
Patient characteristics, comparing those with and without chronic hypertension

Characteristic	With chronic hypertension (N = 731,694), n (%)	Without chronic hypertension (N = 55,762,940), n (%)	*P*[a] value
Age, y			
<20	23,094 (3.2)	6,236,678 (11.2)	< .001
20–34	478,006 (65.3)	41,889,300 (75.1)	
≥35	230,594 (31.5)	7,637,061 (13.7)	
Primary payer			
Public[b]	258,620 (35.4)	21,254,523 (38.2)	< .001
Private (including HMO)	432,453 (59.3)	30,752,962 (55.3)	
Other (including self-pay)	38,693 (5.3)	3,596,175 (6.5)	
Multiple birth			
Yes	18,384 (2.5)	919,225 (1.7)	< .001
No	713,304 (97.5)	54,843,715 (98.3)	
Previous cesarean delivery			
Yes	156,303 (21.4)	7,374,516 (13.2)	< .001
No	575,391 (78.6)	48,388,423 (86.8)	
Pregestational diabetes			
Yes	48,263 (6.6)	364,907 (0.7)	< .001
No	683,431 (93.4)	55,398,031 (99.3)	
Chronic renal disease			
Yes	6614 (0.9)	84,866 (0.2)	< .001
No	725,080 (99.1)	55,678,074 (99.8)	
Collagen vascular disease			
Yes	4482 (0.6)	49,520 (0.1)	< .001
No	727,212 (99.4)	55,713,420 (99.9)	
Pheochromocytoma			
Yes	[c]	[c]	.32
No	[c]	55,762,940 (100.0)	
Hyperplasia of renal artery			
Yes	[c]	[c]	.05
No	[c]	[c]	
Hyperaldosteronism			
Yes	158 (0.02)	558 (0.001)	< .001
No	731,537 (99.9)	55,762,382 (100.0)	
Cushing syndrome			
Yes	[c]	412 (0.001)	< .001
No	[c]	55,762,529 (100.0)	
Thyroid disorders			
Yes	29,810 (4.1)	772,032 (1.4)	< .001
No	701,885 (95.9)	54,990,908 (98.6)	
Maternal coarctation of aorta			
Yes	130 (0.02)	684 (0.001)	< .001
No	731,565 (99.9)	55,762,257 (100.0)	

HMO, health maintenance organization; *RSE*, residual standard error.

[a] χ^2; [b] Including Medicaid and Medicare; [c] Number too small to report stable estimate (n ≤10 and/or RSE >0.30).

Bateman. Chronic hypertension: a nationwide sample of delivery admissions. Am J Obstet Gynecol 2012.

Agency for Healthcare Research and Quality. The NIS is a 20% stratified sample of all US community hospitals as defined by the American Hospital Association: nonfederal, short-term, general, and specialty hospitals whose facilities are open to the public. To create a sample that is maximally representative of all US community hospital admissions, hospital are selected for inclusion in the NIS based on 5 characteristics: rural/urban location, number of beds, region of the country, teaching status, and ownership. The NIS includes all discharges from the sampled hospitals and includes between 5-8 million discharges from an average of 1000 hospitals each year.[16] Further information about the methodology used to create the dataset is available at http://www.hcup-us.ahrq.gov/nisoverview.jsp.

Our analysis included all delivery hospitalizations of women aged ≥15 years from 1995 through 2008; those who had abortions, ectopic pregnancies, or molar pregnancies were excluded from the analyses. Delivery hospitalizations were identified using a validated approach that selects admissions with relevant diagnosis-related groups and *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnosis/procedure codes, as previously described.[17] In addition, *ICD-9-CM* codes were used to classify hospitalizations with chronic hypertension, associated comorbidities, and maternal and fetal outcomes (Appendix).

Data management and statistical analyses were conducted using SAS (SAS Inc, Cary, NC) and SAS-callable SUDAAN software (version 9.2, RTI International, Research Triangle, NC) to account for the stratified sampling design used to collect the hospital discharge data. We used χ^2 tests with a significance level of .05 to compare the distribution of deliveries with and without chronic hypertension by sociodemographic and hospital characteristics and maternal comorbidities. For purposes of analysis, secondary hypertension was defined as chronic hypertension in association with conditions that can cause hypertension through either vascular or endocrinologic mechanisms including pregestational diabetes, chronic renal disease, collagen vascular disease (including systemic lupus erythematous, scleroderma, and other diffuse diseases of connec-