

Understanding and comparing practices of managing patients with hypertensive disorders of pregnancy in urban China and the United States



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ARTICLE INFO

Keywords:

Hypertensive disorders
Management
Preeclampsia
Pregnancy
China

ABSTRACT

Objectives: To describe patient outcomes, management of hypertensive disorders of pregnancy, and evaluate provider knowledge of practice guidelines at a tertiary care center in urban China.

Study design: Retrospective chart review of patients admitted between September 2017 and March 2018 with a diagnosis of any hypertensive disorder at Zhongnan Hospital of Wuhan University Medical Center in China. Healthcare providers including physicians, midwives, nurses and medical students were surveyed. Patient outcomes were compared to those at the University of Chicago, USA.

Main outcome measures: Prevalence of hypertensive disorders of pregnancy, comparative rates of medication administration, mode of delivery, and other pregnancy characteristics were abstracted. Responses regarding definitions, treatment and outcomes of hypertension were analyzed using survey data.

Results: Among 2834 patients, the prevalence of hypertensive disorders at the Zhongnan Hospital was 7.1%, with a 6.4% prevalence of preeclampsia. Compared to hypertensive women from the University of Chicago, hypertensive patients at Zhongnan Hospital were more likely to be older and weigh less but had higher rates of antihypertensive drug administration and delivery via cesarean section. Infants born at Zhongnan Hospital were less likely to be admitted to the neonatal intensive care unit. Survey respondents demonstrated poor knowledge of preeclampsia diagnoses and first line treatments for severe hypertension in pregnancy.

Conclusions: Although several clinical characteristics of preeclampsia were similar between hospitals, the rates of cesarean section were higher in China. Provider knowledge was most lacking in areas about diagnostic criteria and medication use for preeclampsia. Future studies are needed to explore these differences.

1. Introduction

Hypertensive disorders of pregnancy (HDP) are common medical complications of pregnancy and include gestational hypertension, chronic hypertension, preeclampsia and superimposed preeclampsia. Preeclampsia has been well documented to be one of the most common causes of maternal morbidity and mortality, and accounts for 14% of maternal deaths worldwide [1]. The burden of disease associated with HDP appears to disproportionately affect developing regions of the world, both in increased incidence and maternal mortality [2].

In the United States, hypertensive disorders of pregnancy occur in approximately 10% of pregnancies, with preeclampsia diagnosed in approximately 3% of pregnancies [3,4]. There is limited literature on pregnant women in China with HDP. The prevalence of HDP in China

has been described as high as 11% in Jiaying areas of Zhejiang province of China between 1995 and 2000 [5]. A recent retrospective study in 2011 found the prevalence to be more comparable to that in the United States at 5.22%, though with wide geographic variation. In central China the prevalence of HDP was reported to be 1.23% while in Northern China the prevalence was 7.44% [6]. While these discrepancies may be related to the economic growth and development of certain cities over the past two decades, region specific prevalence is important to design interventions to reduce the burden of disease. Prior studies at Renmin Hospital of Wuhan University have found a 3% prevalence of preeclampsia among nulliparous and otherwise healthy patients [7]. This is comparable to estimates of the prevalence of preeclampsia in the United States [8]. However, the exclusion of patients with multiple gestations, a medical history of diabetes, or a body mass

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<https://doi.org/10.1016/j.preghy.2019.07.007>

Received 28 February 2019; Received in revised form 20 July 2019; Accepted 22 July 2019

Available online 23 July 2019

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index of 30 or more in this review indicates that the true prevalence of preeclampsia may be much higher, as these are all risk factors for preeclampsia [7].

Little published data is available about the management of HDP in China, including items such as antihypertensive use, gestational age, and mode of delivery. In one retrospective review at Wuhan, outcomes of patients with severe preeclampsia were compared over time. When compared to women with severe preeclampsia during an early period (1985–1997), women with severe preeclampsia in a later period (1998–2010) were less likely to have postpartum hemorrhage or fetal distress but far more likely to have HELLP (hemolysis, elevated liver enzymes, low platelet count) syndrome, placental abruption, heart dysfunction, preterm deliveries, and delivery by cesarean section. The rate of cesarean section deliveries among patients with severe preeclampsia was found to be as high as 88% between 1998 and 2010 [9]. This increased rate of cesarean section may correspond with the higher rate of placenta accreta observed in China (1.2%) as compared to the United States (0.2%) [10]. With the expansion to a generalized two-child policy in 2015, it is expected that repeat cesarean sections in China will continue to rise and subsequently may potentially contribute to continued increasing placenta accreta prevalence [11].

Given the paucity of data available, this study explores the prevalence of hypertensive disorders of pregnancy in China, including healthcare practice patterns and knowledge of understanding and managing hypertensive disorders.

2. Methods

2.1. Study cohorts

A retrospective chart review of women who delivered between September 2017 and March 2018 at Zhongnan Hospital of Wuhan University was performed. Institutional Review Board (IRB) approval was obtained from the University of Chicago (IRB#18-0437) as well as through the Ethics Committee at Wuhan University. Zhongnan Hospital is an urban tertiary-center affiliated with the Wuhan University School of Medicine, a nationally ranked institution. The hospital serves as a catchment center for many of the community hospitals in the surrounding area. The labor and delivery floor at Zhongnan Hospital is staffed by midwives as well as resident and attending physicians, with nearly 5000 deliveries each year.

Data was retrospectively collected on any patient with a diagnosis of a hypertensive disorder of pregnancy (chronic hypertension, gestational hypertension, preeclampsia, superimposed preeclampsia, and eclampsia) that presented to labor and delivery during the study period. Diagnosis of a hypertensive disorder was confirmed by study physicians. Hypertensive disorders were defined according to the American College of Obstetricians and Gynecologists (ACOG) guidelines [12]. Preeclampsia without severe features was defined as the presence of elevated blood pressures with proteinuria. The most common method of diagnosing proteinuria among patients at Zhongnan Hospital was a urine dipstick of protein 2+ or more. Mild hypertension without proteinuria was defined as gestational hypertension and in the absence of proteinuria, preeclampsia with severe features was defined according to ACOG. The characteristics of each patient's delivery were noted, including mode of delivery, timing of admission and discharge, the use of any anti-hypertensive medications, antenatal steroids and seizure prophylaxis agents. Objective measurements related to end organ perfusion and the diagnosis of proteinuric hypertensive diseases were noted, including liver function tests, creatinine, platelet count, urinalysis and the highest recorded systolic and diastolic blood pressure prior to delivery.

This data was then compared with an ongoing prospective study (ADOPTe) at University of Chicago, IL, USA. ADOPTe is an ongoing prospective placental biobanking study which is approved by the Institutional Review Board (IRB) at the University of Chicago (IRB#14-0977). All participants provided written informed consent prior to

initiation of study procedures. Subjects presenting to the University of Chicago Family Birth Center between January 2015 and March 2017 were included in this analysis which included patients with a normal pregnancy and patients with hypertensive disorders of pregnancy. Patient demographics were collected from their medical records and included clinical information about the antepartum, intrapartum and postpartum periods. Maternal data was abstracted from the electronic medical record and entered into a REDCap (Research Electronic Data Capture) database. Complete information about the study design of ADOPTe has been previously described [13].

2.2. Survey assessment

In addition to data abstraction, healthcare provider knowledge was assessed with a 31-item survey (Supplementary Appendix 1). The survey focused on three specific areas, namely diagnostic criteria of hypertensive disorders of pregnancy, management of these diseases per guidelines, and beliefs regarding the practices at Zhongnan Hospital compared to other hospitals in China. The questions were translated into standard Chinese through two bilingual research personnel. Paper surveys were then distributed at departmental grand rounds and on labor floors among any providers (nurses, midwives, physicians, or medical students) affiliated with the Obstetrics and Gynecology department at Zhongnan Hospital. Completed surveys were collected by the research team at the end of grand rounds or by the end of the shift.

2.3. Statistical analysis

No *a priori* power calculation was performed. Instead, charts of all patients who presented to Wuhan University Zhongnan Hospital over a seven-month period were enrolled. Patients in Chicago were identified through daily survey of the labor and delivery board and enrolled in a prospective ongoing cohort study [13].

Patient characteristics are reported as median (interquartile range [IQR]) or proportions and frequencies based on variable type. Normality of continuous data was assessed with the Shapiro-Wilk test. Differences in both patient and healthcare provider characteristics between cohorts were assessed with the use of a Mann-Whitney or Kruskal-Wallis test, depending on the number of groups being compared. Categorical data was compared with a chi-square or Fisher's Exact test, as appropriate. Survey responses were categorized as correct, unsure, or incorrect. The proportion of providers who answered each question correctly was compared between physicians and non-physicians (which included midwives, nurses, medical students and participants who listed 'other' or did not specify their role) using a chi-square (or Fisher's Exact) test. All two-sided p-values < 0.05 were considered statistically significant. SAS 9.4 (SAS Institute Inc., Cary, NC) was utilized for analysis.

3. Results

3.1. Chart review

A total of 2834 patients delivered at Zhongnan Hospital during the seven-month period. The prevalence of hypertensive disorders over the study period was 7.1%, with a 6.4% prevalence of preeclampsia. Of the 202 patients diagnosed with a hypertensive disorder of pregnancy, there were 149 cases of preeclampsia, 33 cases of superimposed preeclampsia, and 20 cases of non-proteinuric hypertensive disorders (gestational or chronic hypertension).

3.2. Patient characteristics at Zhongnan hospital

Overall, 54.5% of patients with an HDP were nulliparous. Among all patients the median of the highest measured systolic blood pressure was 162 mmHg (IQR 152–177) and highest diastolic blood pressure was 106

Table 1
Characteristics and Outcomes of Wuhan University Zhongnan Hospital Patients Based on Diagnosis.

	All Patients N = 202	Non-proteinuric Hypertensive Disorders* N = 20	Superimposed PE N = 33	PE N = 149	P-Value
Age, years	31.60 (28.13, 35.85)	30.74 (27.27, 36.67)	34.07 (31.60, 36.02)	30.91 (27.83, 35.53)	0.03
Weight, kilograms	75 (69, 82)	71 (69, 85)	79.5 (70, 82)	75 (69, 81)	0.33
Nulliparous	110 (54.46)	10 (50.00)	13 (39.39)	87 (58.39)	0.13
Gestational age at admission, weeks	36.57 (34.57, 38.29)	38.50 (37.71, 39.07)	36.57 (34.57, 37.43)	36.29 (34.29, 38.29)	0.0003
History of chronic hypertension	28 (13.86)	1 (5.00)	23 (69.70)	4 (2.68)	<0.0001
History of preeclampsia	3 (1.49)	0 (0)	0 (0)	3 (2.01)	0.58
Highest systolic blood pressure	162.0 (152.0, 177.0)	143.5 (138.5, 152.0)	170.0 (160.0, 183.0)	163.5 (153.5, 178.0)	<0.0001
Highest diastolic blood pressure	106.0 (100.0, 115.0)	93.5 (90.0, 101.0)	112.0 (103.0, 119.0)	106.0 (100.5, 114.0)	<0.0001
Proteinuria	136 (67.33)	9 (45.00)	17 (51.52)	110 (73.83)	0.004
Received Prenatal Care	197 (97.52)	20 (100.00)	33 (100.00)	144 (96.64)	0.76
Number of Prenatal Care Visits	9 (7, 10)	9 (8, 9)	9 (7, 11)	9 (6, 10)	0.41
Hospital Length of Stay, days	5.0 (4.0, 6.0)	4.0 (3.5, 5.5)	4.0 (3.0, 5.0)	5.0 (4.0, 7.0)	0.01
Delivery to Discharge, days	4.0 (3.0, 4.0)	3.0 (3.0, 4.0)	3.0 (3.0, 4.0)	4.0 (3.0, 5.0)	0.03
Gestational Age of delivery, weeks	36.86 (34.86, 38.43)	38.79 (37.79, 39.21)	36.71 (34.57, 37.43)	36.57 (34.57, 38.43)	0.0001
Preterm delivery < 37 weeks	103 (50.99)	3 (15.00)	19 (57.58)	81 (54.36)	0.003
Mode of Delivery					0.37
Vaginal	21 (10.40)	4 (20.00)	3 (9.09)	14 (9.40)	
Cesarean Section	181 (89.60)	16 (80.00)	30 (90.91)	135 (90.60)	
Maternal Complications					
Abruption	5 (2.48)	0 (0)	1 (3.03)	4 (2.68)	0.75
Stroke	0 (0)	0 (0)	0 (0)	0 (0)	—
Acute Renal Failure	0 (0)	0 (0)	0 (0)	0 (0)	—
Antihypertensive Use	160 (79.21)	6 (30.00)	30 (90.91)	124 (83.22)	<0.0001
Labetalol	13 (6.44)	0 (0)	5 (15.15)	8 (5.37)	0.06
Nifedipine	23 (11.39)	1 (5.00)	3 (9.09)	19 (12.75)	0.66
Methyldopa	0 (0)	0 (0)	0 (0)	0 (0)	—
Others	154 (76.24)	5 (25.00)	29 (87.88)	120 (80.54)	<0.0001
Magnesium Sulfate	81 (40.10)	1 (5.00)	16 (48.48)	64 (42.95)	0.003
Neonatal Outcomes					
Neonatal weight, grams	2665 (2130, 3155)	3270 (2980, 3470)	2690 (2120, 3080)	2615 (2080, 2990)	0.0001
Live Baby	194 (96.04)	19 (95.00)	30 (90.91)	145 (97.32)	0.14
NICU Admission	25 (12.38)	0 (0)	3 (9.09)	22 (14.77)	0.14

*Non-proteinuric hypertension includes patients with antepartum chronic or gestational hypertension. Abbreviations: PE = preeclampsia; NICU = Neonatal Intensive Care Unit;

(100–115) mmHg. The majority of deliveries were cesarean, with only 10.4% of patients having vaginal deliveries. Gestational age at admission, gestational age at delivery and birthweight was significantly lower in preeclampsia than non-proteinuric hypertension with a higher rate of preterm birth <37 weeks among patients with preeclampsia. NICU admissions were not statistically different. Table 1 shows patient characteristics among all patients and patients with various types of hypertension.

3.3. Comparison of patients at Zhongnan hospital and the University of Chicago

Compared to women from the University of Chicago, patients with an HDP at Zhongnan Hospital were more likely to be older (median 31.6 vs 28.0 years), weigh less (median 165.4 vs 206.0 lb), and have higher diastolic blood pressures (median 106.0 vs 97.0 mmHg; all $p < 0.0001$). Chinese patients also had higher rates of antihypertensive drug administration (79.2% vs 42.1%) and delivery via cesarean section (89.6% vs 45.1%). Hypertensive patients at Zhongnan Hospital had a longer length of hospital stay from delivery to discharge (median 4 vs 3 days), while infants were less likely to be admitted to the neonatal intensive care unit (12.4% vs 45.1%; Table 2).

3.4. Outcomes among patients with preeclampsia with severe features

Among preeclamptic patients, a higher proportion were diagnosed with severe features in the Zhongnan Hospital cohort compared to the University of Chicago (72.8% vs 33.9%). Patients diagnosed with preeclampsia with severe features at Zhongnan Hospital were less likely to have elevated liver function tests (5.4% vs 22.8%). No statistically significant difference was observed between groups in the rates of

thrombocytopenia or pulmonary symptoms. Patients at the University of Chicago received labetalol more frequently as an antihypertensive (71.7% vs 7.5%) and patients with severe features were more likely to receive magnesium for seizure prophylaxis (89.8% vs 49.0%) compared to patients at Zhongnan Hospital. The rates of preterm delivery were similar in both cohorts, however delivery by cesarean section was significantly high in the Zhongnan cohort (92.5%) as compared to the University of Chicago cohort (59.1%), while neonatal intensive care unit admission was significantly lower (15.7% vs 63.8%; Table 3). The birthweight was higher among babies born at Zhongnan Hospital as compared to those born at the University of Chicago (median 2515 vs 2290 g).

3.5. Survey results

A total of 70 surveys were given out and 56 responses were collected from attendings, fellows, residents, midwives, nurses and medical students (response rate 80%). Given the diversity of the respondents, two groups were created for the purposes of analysis; namely physicians, including residents, fellows, and attending faculty, and non-physicians, including nurses, midwives, and medical students. One respondent did not indicate their role and was excluded from analysis. Survey respondents have largely worked with pregnant patients for zero to four years, representing over 60% of the physician group and 80% of the non-physician group (Table 4).

When assessing provider knowledge at Zhongnan, roughly 20–30% of respondents demonstrated a lack of understanding of the risk factors of developing preeclampsia and the maternal and fetal effects of the disease. Moreover, questions about specific criteria for diagnosing preeclampsia, with or without severe features, or the definition of persistent hypertension, were answered incorrectly by more than 70%

Table 2
Comparing Outcomes Between Hypertensive Women at Zhongnan Hospital and the University of Chicago.

	Wuhan University Zhongnan Hospital N = 202	University of Chicago Medical Center N = 375	P-Value
Age, years	31.6 (28.1, 35.9)	28.0 (23.0, 34.0)	<0.0001
Weight, lbs	165.4 (152.1, 180.8)	206.0 (176.0, 245.0)	<0.0001
Nulliparous	110 (54.46)	187 (49.87)	0.29
History of chronic hypertension	28 (13.86)	115 (30.67)	<0.0001
History of preeclampsia	3 (1.49)	49 (13.07)	<0.0001
Type of HDP at Delivery			
Chronic hypertension	1 (0.50)	74 (19.73)	<0.0001
Gestational hypertension	19 (9.41)	117 (31.20)	<0.0001
Preeclampsia (PE)	181 (89.60)	137 (36.53)	<0.0001
Severe PE	147 (72.77)	127 (33.87)	<0.0001
Superimposed PE	33 (16.34)	51 (13.60)	0.37
Highest systolic blood pressure, mmHg	162 (152, 177)	162 (149, 176)	0.24
Highest diastolic blood pressure, mmHg	106 (100, 115)	97 (91, 104)	<0.0001
Proteinuria	136 (67.33)	185 (49.33)	<0.0001
Hospital Length of Stay, days	5 (4, 6)	5 (4, 6)	0.44
Delivery to Discharge, days	4 (3, 4)	3 (2, 3)	<0.0001
Gestational Age of delivery, weeks	36.86 (34.86, 38.43)	38.14 (35.71, 39.43)	<0.0001
Preterm delivery < 37 weeks	103 (50.99)	124 (33.07)	<0.0001
Mode of Delivery			<0.0001
Vaginal	21 (10.40)	196 (52.27)	
Cesarean Section	181 (89.60)	169 (45.07)	
Instrument	0 (0)	8 (2.13)	
Maternal Complications			
Abruption	5 (2.48)	2 (0.53)	0.05
Acute Renal Failure	0 (0)	12 (3.20)	0.01
Antihypertensive Use	160 (79.21)	158 (42.13)	<0.0001
Labetalol	13 (6.44)	136 (36.27)	<0.0001
Nifedipine	23 (11.39)	39 (10.40)	0.72
Methyldopa	0 (0)	13 (3.47)	0.01
Others*	154 (76.24)	26 (6.93)	<0.0001
Magnesium Sulfate	81 (40.10)	128 (34.13)	0.16
Neonatal Outcomes			
Neonatal weight, grams	2665 (2130, 3155)	2935 (2310, 3410)	0.003
Live Baby	194 (96.04)	371 (98.93)	0.03
NICU Admission	25 (12.38)	169 (45.07)	<0.0001

Data is presented as n (%) or median (quartile 1, quartile 3). *The other most common medications included furosemide, hydrochlorothiazide, and nifedipine.

Abbreviations: HDP = hypertensive disorder of pregnancy, PE = preeclampsia; NICU = Neonatal Intensive Care Unit.

of respondents, both physician and non-physician providers (Fig. 1). Additionally, more than 50% of respondents (physicians and non-physicians combined) incorrectly identified the diagnosis of preeclampsia (84%), whether preeclampsia patients should be confined to bed rest (68%), first line treatments for hypertension (92%), and incorrectly identified the definitions for proteinuria (61%) and severe features of preeclampsia (77%).

When questions were divided between practicing physicians and non-physician members of the health care team, only a few responses showed statistical significance. Notably, physicians were more likely to answer questions on medication usage correctly as compared to non-physicians. Additionally, physicians were more likely to answer the questions on the definition of chronic hypertension and the etiology of preeclampsia correctly. No other statistically significant differences were observed between the proportion of physicians and non-physicians who answered correctly on other questions (Fig. 1).

Table 3
Comparing the Prevalence and Delivery Outcomes of Patients with Preeclampsia with Severe Features.

	Wuhan University Zhongnan Hospital N = 147	University of Chicago N = 127	P-value
Severe BP (SBP > 160 or DBP > 110 mmHg)	111 (75.51)	101 (79.53)	0.43
Thrombocytopenia (< 100,000)	9 (6.12)	11 (8.66)	0.42
RUQ Pain or Transaminase (AST or ALT > 2 times the normal)	8 (5.44)	29 (22.83)	<0.0001
Elevated Creatinine	4 (2.72)	12 (9.45)	0.02
Pulmonary Edema	11 (7.48)	5 (3.94)	0.21
Cerebral/Visual Symptoms	26 (17.69)	45 (35.43)	0.001
Antihypertensive Use			
Labetalol	11 (7.48)	91 (71.65)	<0.0001
Nifedipine	20 (13.61)	27 (21.26)	0.09
Methyldopa	0 (0)	6 (4.72)	0.01
Others*	130 (88.44)	12 (9.45)	<0.0001
Magnesium sulfate for seizure prophylaxis	72 (48.98)	114 (89.76)	<0.0001
Gestational age at delivery, weeks	36.00 (34.00, 37.86)	34.14 (31.14, 37.57)	0.03
Preterm delivery < 37 weeks	91 (61.90)	86 (67.72)	0.32
Cesarean Delivery	136 (92.52)	75 (59.06)	<0.0001
Birth weight	2515 (1940, 2890)	2290 (1410, 2995)	0.04
NICU Admission	23 (15.65)	81 (63.78)	<0.0001

Data is presented as n (%). Abbreviations: BP = blood pressure, SBP = systolic blood pressure, DBP = diastolic blood pressure, ALT = alanine transaminase, AST = aspartate transaminase, NICU = neonatal intensive care unit. *The other most common medications included furosemide, hydrochlorothiazide, and nifedipine.

Table 4
Demographics of Healthcare Providers.

	Physicians N = 30	Non-Physicians* N = 25	P-Value
Role in the healthcare team			<0.0001
Midwife	0 (0)	3 (12.00)	
Nurse	0 (0)	6 (24.00)	
Resident Physician	14 (46.67)	0 (0)	
Attending Physician	16 (53.33)	0 (0)	
Medical Student	0 (0)	15 (60.00)	
Other	0 (0)	1 (4.00)	
Highest level of education completed			0.29
College degree	7 (23.33)	9 (36.00)	
Graduate degree	23 (76.67)	15 (60.00)	
Other	0 (0)	1 (4.00)	
Years working with pregnant patients			0.25
0–4 years	19 (63.33)	20 (83.33)	
4–8 years	6 (20.00)	2 (8.33)	
8–12 years	4 (13.33)	1 (4.17)	
12–16 years	0 (0)	1 (4.17)	
16 + years	1 (3.33)	0 (0)	

*This includes midwives, nurses, medical students and participants who listed ‘other’ or did not specify their role.

Perceptions regarding the prevalence of hypertensive disorders of pregnancy at Zhongnan Hospital revealed a varied picture. Most providers agreed or were neutral regarding the perception that the prevalence of preeclampsia at Zhongnan was comparable to the national average, and whether the rate of maternal complications from preeclampsia was comparable to the national average, with nearly half of non-physician providers answering “neutral” to these statements and physicians being evenly divided between agreement and disagreement (Fig. 2). Approximately 45% of physicians believed patients were no

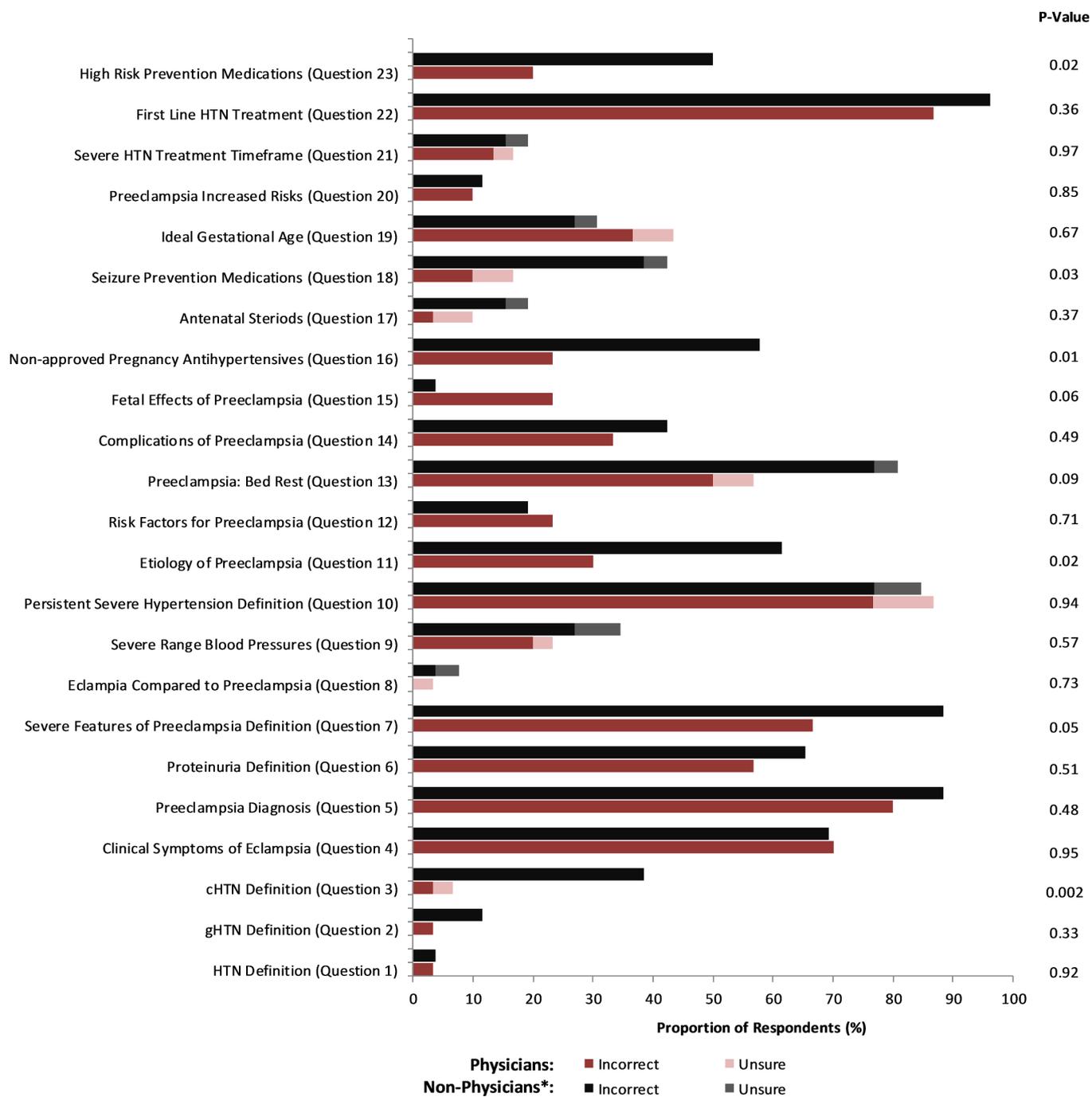


Fig. 1. Healthcare Provider Education Survey Results. Results of the knowledge survey among healthcare providers are reported in Fig. 1. Responses were categorized as correct, incorrect or unsure. The proportion of respondents who were incorrect or unsure are reported, stratified by provider role. Roles include either physicians or non-physicians (including midwives, nurses, medical students and participants who listed ‘other’ or did not specify their role). The question number for each item corresponds to the survey question in Supplementary Appendix 1.

more likely to deliver via cesarean section at Zhongnan Hospital than the national average, whereas nearly 45% of non-physician providers believed the opposite to be true. Of note, about 40% of respondents in both group reported neutrality to the statement “patients with preeclampsia are more likely to deliver by cesarean section at this hospital than the national average”. More than 50% of providers agreed or strongly agreed that the care of preeclamptic patients was standardized at Zhongnan Hospital.

4. Discussion

In this study we found that the prevalence of hypertensive disorders during pregnancy in China is similar to United States, but rates of cesarean section are high and knowledge of preeclampsia among healthcare providers is poor.

The prevalence of preeclampsia among patients at Zhongnan hospital was found to be 6.4%. Comparably, the incidence of preeclampsia is approximately 4.7% among hospitals in the United States between 2005 and 2014 [14]. It is possible that the higher proportion of preeclampsia with severe features observed among all hypertensive

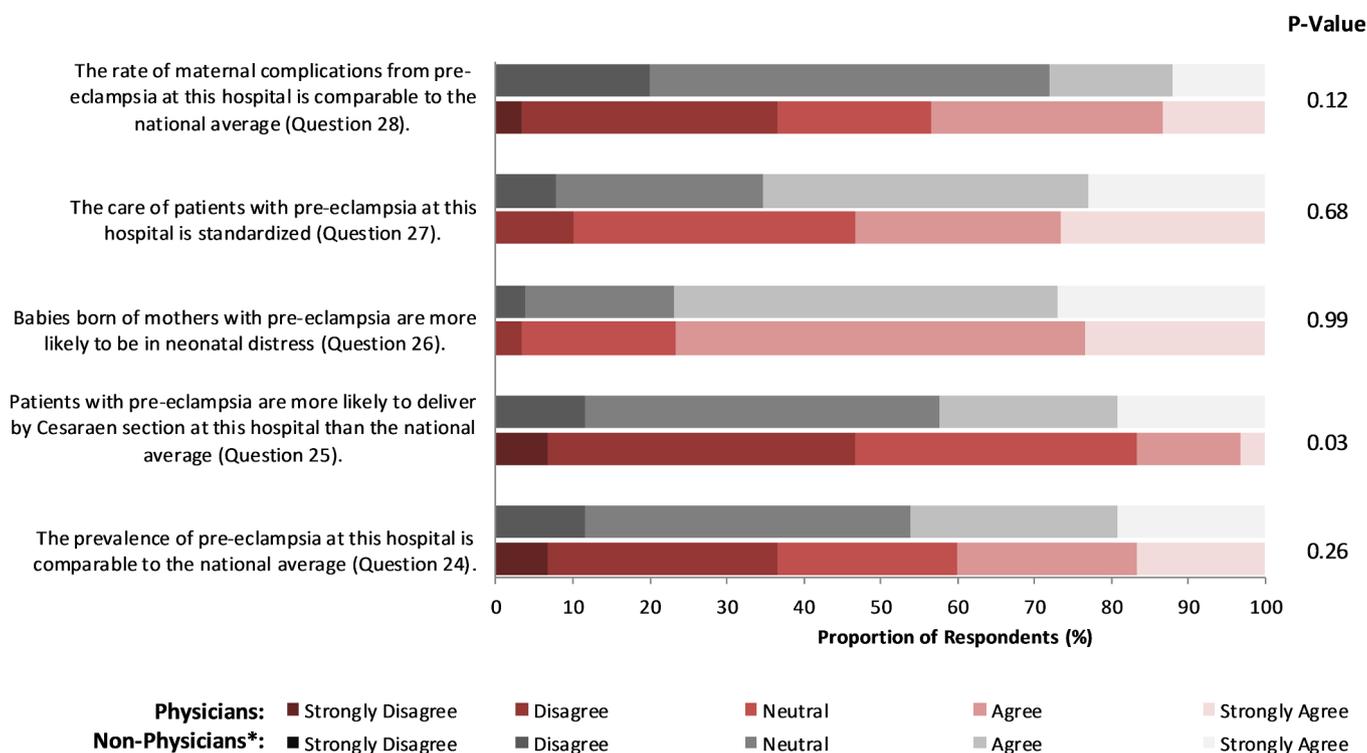


Fig. 2. Healthcare Perception Survey Results. Physicians and non-physicians (including midwives, nurses, medical students and participants who listed ‘other’ or did not specify their role) attitudes of the prevalence, treatment and outcomes of preeclampsia and their comparison to other hospitals are reported in Fig. 2. The question number for each item corresponds to the survey question in Supplementary Appendix 1.

disorders may be reflective of the hospital’s referral centers, though this would need further investigation. Among the two study populations, patients at the University of Chicago were younger and weighed more. The relative discrepancy in weight is compatible with generalized trends, with the average woman weighing 168 lb in the United States compared to the average woman weighing 123 lb in China [15,16]. This could potentially play a role in the increased incidence of patients with transaminitis in the University of Chicago cohort. Neonatal intensive care unit admission rates were also significantly different between the two institutions, with nearly three times as many admissions among the University of Chicago cohort. More specific measures of neonatal outcomes were unable to be captured, but the discrepancy in admission rates is likely explained by the criterion required for admission to a neonatal intensive care unit (NICU) rather than GA of delivery or birthweight. Among patients with preeclampsia with severe features at Zhongnan Hospital, the rates of preterm delivery were higher but the babies weighed more and rates of NICU admission was the same compared to all HDP at Zhongnan Hospital. In contrast, at the University of Chicago, patients with preeclampsia with severe features had higher rates of preterm birth, weighed less and had higher rates of NICU admission, suggesting that NICU admission in Chicago is driven by birthweight and gestational age.

Patients with hypertensive disorders at Zhongnan Hospital were also far more likely to receive anti-hypertensive medications as a part of antepartum management; however, most patients did not receive the usual first and second line of therapy but instead received diuretic agents such as furosemide. This could be due to lack of knowledge about diagnosis of preeclampsia, severe features and medication use. Survey results demonstrated that over 80% of survey respondents were unable to correctly identify first line anti-hypertensives such as labetalol, hydralazine or nifedipine. It is therefore possible that other agents are being used to treat blood pressures. Alternative medications such as hydrochlorothiazide or furosemide were frequently administered in labor, which are typically not recommended for control of hypertension in pregnancy or postpartum. Similarly, the rates of magnesium use in

Zhongnan Hospital was much lower in patients with preeclampsia with severe features and concordantly a significant number of respondents were unable to identify magnesium to prevent seizures in patients with preeclampsia. Interestingly, despite the much lower rate of magnesium among patients in the Zhongnan cohort, there were no statistically significant differences in maternal or fetal outcomes. A difference in outcomes would be difficult to demonstrate in this potentially under-powered observational study and requires further investigation. There was no statistically significant difference in overall magnesium administration between all hypertensive patients. Academic medical centers in China generally consider recommendations laid forth by the American College of Obstetricians and Gynecology (ACOG) to be the standard of care. Despite this, there are no known local or hospital-wide guidelines regarding the use of specific antihypertensive therapies or magnesium. It is possible that this lack of guidelines or knowledge may contribute to the results we observed.

The other significant difference in management between the two institutions was the mode of delivery. Studies of delivery in the United States have demonstrated a 53% cesarean section rate among patients with preeclampsia, consistent with the rate of 45% we observed at the University of Chicago. In patients with severe preeclampsia, the cesarean section rate is increased to 62% [17], again similar to the rates observed at the University of Chicago (59%). Previous retrospective cohort studies have identified no benefit to immediate cesarean delivery for maternal and infant outcomes among patients with severe preeclampsia [18]. However, the rate of cesarean section at Zhongnan Hospital was very high, approaching almost 95% among patients with severe preeclampsia. In a prior review of 39 hospitals in China, the overall cesarean delivery rate was 55% in tertiary hospitals [19] with rates as high as 88% reported among patients with severe preeclampsia [9]. Although the rates of cesarean delivery were high, we did not collect data on indications for cesarean section. Preeclampsia with severe features is not an absolute contraindication to a trial of induction of labor per ACOG recommendations, though this practice may not be observed among providers at Zhongnan Hospital. Additionally, it is

unknown what methods of induction of labor are used and whether there is a higher rate of failed induction. The level of acuity or presenting symptom of these patients may also be a contributing factor to the higher Cesarean rate. Further review on the decision-making process and medical management of inductions is needed. Other studies have noted that 20–25% of cesarean sections performed in China to be for non-indicated reasons, including maternal preference and cephalopelvic disproportion by pelvimetry. Conditions such as oligohydramnios, suspected macrosomia, preeclampsia, and third trimester bleeding were also often considered indication for cesarean delivery among the institutions reviewed [20]. The rate of deliveries by cesarean sections is correlated with increased risks of hemorrhage, endometritis, and placenta accreta in future pregnancies [20,21]. It is therefore imperative to identify appropriate indications for this mode of delivery in order to potentially reduce the associated morbid burden. Other methods of reducing the cesarean section rate include implementation of standardized review of the elective cesarean delivery rate and protocols for induction methods.

In this study there was a high “neutral” response rate among questions regarding the attitudes and beliefs of providers. This may be an indication that providers may not have a good sense of the national averages and institutional delivery rates by cesarean section. Most respondents had worked with pregnant patients for less than four years, indicating that we had captured a less experienced provider population, though this may accurately represent the majority of providers working on the wards. Of note, medical students in China spend limited time on the wards compared to students in the United States and residents spend a majority of the first two years performing bench research. It is therefore possible that this experience or lack thereof may translate into some of the understanding we reported in our survey.

All charts were reviewed by trained research staff and entered in a systematic fashion in electronic data forms, contributing to the strength of this study. The data forms were similar between Chicago and Zhognan Hospital, thus providing additional validity to the results. Additionally, the response rate was high (80%) and the survey was conducted in Chinese by the first author who is fluent in the local language.

Despite the important observations in this study, it is not without limitations. First, there is a lack of available data on the indications for cesarean section. We were unable to capture whether patients were undergoing induction of labor compared to conservative management progressing to spontaneous labor, or elective cesarean, which may shed light on some of the reasons for the high rate of delivery by cesarean section. Secondly, diagnoses were determined by charted outcomes, which can be incomplete in patients who were emergently transferred or had limited prenatal care. It is possible that inconsistencies in documentation may have affected our results. In addition, given the lack of knowledge about diagnosis of preeclampsia as seen in the survey, patients may have been misclassified. We did not collect raw data on all blood pressures of admitted patients to correctly classify these patients. Additionally, reasons for admission to the neonatal intensive care unit were not readily available, therefore we do not know how practice differences may affect the occurrence we observed in this study. When specifically addressing potential limitations associated with the survey, there is the possibility that cultural differences or terminology may have resulted in problems understanding the questions and their nuances. Further, it is possible that providers were unaware of national averages, therefore affecting their reporting of outcomes at their institution as compared to the nation. A similar survey was not implemented in Chicago to note differences between provider knowledge on diagnosis and management of preeclampsia. Further, survey observations were limited by provider perceptions of their institution as compared to the national average, which may not be consistent if studied.

5. Conclusions

The prevalence of preeclampsia at a tertiary care, urban hospital in China was found to be comparable to the prevalence of preeclampsia in a tertiary care hospital in the United States. Despite this, management of preeclampsia was significantly different between the two institutions including use of antihypertensive medications, magnesium, rates of cesarean section and NICU admissions. Provider knowledge overall was most lacking in areas requiring specific diagnostic criteria and use of antihypertensive medications. Detailed evaluation of education systems and providers' knowledge assessment may help identify areas for future investigations that may bridge these gaps in knowledge.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.preghy.2019.07.007>.

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