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Hypertension

ORIGINAL ARTICLE

Diagnosis and Monitoring of White Coat Hypertension in Pregnancy: an ISSHP Consensus Delphi Procedure

Sonia Johnson,* Sanne Gordijn,* Stefanie Damhuis, Wessel Ganzevoort, Mark Brown, Peter von Dadelszen, Laura A. Magee,† Asma Khalil†; on behalf of the ISSHP

BACKGROUND: There is no accepted definition or standardized monitoring for white coat hypertension in pregnancy. This Delphi procedure aimed to reach consensus on out-of-office blood pressure (BP) monitoring, and white coat hypertension diagnostic criteria and monitoring.

METHOD: Relevant international experts completed three rounds of a modified Delphi questionnaire. For each item, the predefined cutoff for group consensus was ≥70% agreement, with 60% to 70% considered to warrant reconsideration at the subsequent round, and <60% considered insufficient to warrant consideration.

RESULTS: Of 230 experts, 137 completed the first round and 114 (114/137, 83.2%) completed all three. For out-of-office BP monitoring, there was consensus that home BP monitoring (HBPM) should be chosen; instructions given, pairs of BP values taken, opportunity given for women to qualify values they do not regard as valid, and BP considered evaluated when ≥25% of values are above a cutoff. For HBPM, BP should be taken at least 2 to 3 d/wk, at minimum in the morning; however, many factors may affect frequency and timing. Experts endorsed a clinic BP <140/90 mm Hg as normal. While not reaching consensus, most agreed that HBPM values should be lower than clinic BP. Among those, HBPM <135/85 mm Hg was considered normal. There was consensus that white coat hypertension warrants: HBPM at least 1 d/wk before 20 weeks, 2 to 3 d/wk after 20 weeks or if persistent hypertension develops, and symptom monitoring (ie, headache, visual symptoms, and right upper quadrant/epigastric pain).

CONCLUSIONS: Consensus-based diagnostic criteria and monitoring strategies should inform clinical care and research, to facilitate evaluation of out-of-office BP monitoring on pregnancy outcomes. **(*Hypertension*. 2022;79:993–1005. DOI: 10.1161/HYPERTENSIONAHA.121.18356.)** • **Supplemental Material**

Key Words: blood pressure ■ consensus ■ gestational age ■ headache ■ hypertension ■ preeclampsia ■ pregnancy

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Hypertension in pregnancy is defined as a systolic blood pressure (sBP) ≥140 mm Hg or a diastolic blood pressure (dBP) ≥90 mm Hg in the clinic setting. The 2018 International Society for the Study of Hypertension in Pregnancy (ISSHP) guidelines recommend that high BP detected in clinic be confirmed by out-of-office BP measurement, 24-hour ambulatory BP monitoring (ABPM) or home BP monitoring (HBPM). This differentiates chronic hypertension from white coat hypertension (WCH) for which BP is elevated in clinic but normal at home, which is important to avoid overtreatment.[1,2]

However, WCH is not benign and has an estimated prevalence almost as high as true hypertension in pregnancy.[3] For women with WCH (vs. normotensive pregnancy), a recent systematic review and meta-analysis of 12 studies (4830 women) illustrated higher risks of preeclampsia (5-fold), preterm birth

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NOVELTY AND RELEVANCE

What Is New?

Diagnostic criteria and monitoring strategies for white coat hypertension.
Expansion on current out-of-office home blood pressure monitoring protocols.

What Is Relevant?

Potential clinical pathway to be evaluated in future research for the appropriate care of women with white coat hypertension in pregnancy using home blood pressure monitoring
Awareness of the intermediate risk of white coat hypertension in pregnancy outcomes

Clinical/Pathophysiological Implications?

Our proposed pathway for white coat hypertension, including diagnostic criteria and monitoring strategies, should inform further research on pregnancy outcomes and, subsequently, be integrated into clinical practice alongside existing guidelines.

Nonstandard Abbreviations and Acronyms

ABPM	ambulatory blood pressure monitoring
BUMP	Blood Pressure Self-monitoring in Pregnancy
dBP	diastolic blood pressure
HBPM	home blood pressure monitoring
ISSHP	International Society for the Study of Hypertension in Pregnancy
sBP	systolic blood pressure
SGA	small for gestational age
WCH	white coat hypertension

(3-fold), and small-for-gestational-age (SGA) infants (2.5-fold), with risks lower than for women with chronic or gestational hypertension.[4] However, substantial heterogeneity in BP measurement protocols and diagnostic criteria was identified, associated with large variation in the prevalence of WCH, from 3% to 4% to as high as 62%.[4]

The COVID-19 pandemic has catalyzed a shift in routine antenatal care from clinic to women's homes. While BP self-monitoring has been common for many years,[5] large randomized trials have been investigating its effectiveness and cost-effectiveness in pregnancy compared with usual clinic care.[6–8] The use of HBPM has also been long-recognized to have advantages over ABPM. It can capture longitudinal BP, is well tolerated as it does not interfere with sleep, has better reproducibility, is more widely available, and can use many BP monitors validated in pregnancy.[9,10] The majority of devices available to the general public are accurate in pregnancy.[11] However, while many clinical practice guidelines identify BP self-monitoring as useful, recognize WCH in pregnancy and regard a normal self-monitored BP as <135/85 mm Hg, there is no standard BP self-monitoring protocol beyond commonly recommending use of an automated device validated for use in pregnancy.[12]

The aim of this Delphi procedure was to reach consensus on out-of-office BP monitoring, diagnostic criteria for WCH, and monitoring of women so diagnosed.

METHODS

The authors declare that all supporting data are available within the article and its Supplemental Material.

Delphi Study Design

A modified Delphi consensus methodology was applied to an electronic, 3-round questionnaire.[13] The Delphi procedure allows a panel of experts to address a research question that cannot be answered with certainty using empirical evidence, and minimize biases, such as a strong and vocal opinion leader who can influence other group-based methodologies. Delphi is an iterative technique involving a series of structured questionnaires, presented to participating experts in rounds. There are preset criteria for inclusion and exclusion of items in subsequent rounds, when the group results are presented anonymously, and options refined until consensus is reached.

Ethical approval was obtained from the University Medical Centre of Groningen (METc 2020/440). All participants provided informed consent before commencing the first round, and they were reminded of their right to withdraw before each subsequent round.

Panel Selection

Eligibility for participation was based on meeting at least one of three inclusion criteria. First, expertise in WCH or HBPM, based on a relevant publication record as lead or senior author, including on published guidelines. Relevant publications were identified through 2 PubMed searches (using the terms, WCH and pregnancy, followed by home blood pressure and pregnancy) and through Research Gate. Second, we identified membership in the ISSHP or affiliated scientific organisations, such as the Macdonald Obstetric Medicine Society, the International Society of Obstetric Medicine, the Society of Obstetric Medicine Australian and New Zealand and World Gestosis, among others. Third, we asked invitees for suggestions of others with relevant expertise in the area. Potentially eligible participants were sent an invitational email

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that emphasized our interest in hearing from experts, and our selection criteria (as above).

The intended sample size was 100 to 150 participants, to balance selection of true experts with a sufficiently large and diverse body of participants to be representative of the pregnancy hypertension care community, internationally. As such, a wide geographic range of practice regions was sought to maximize the generalizability of the results for an international setting.

Delphi Rounds

Based on a literature review on WCH and HBPM,[1,2,4,6,14,15] the first round was structured into 3 domains: (1) out-of-office BP measurement protocol, including specific questions about HBPM or ABPM, such as frequency and timing of measurement, additional monitoring parameters, and diagnostic thresholds for true hypertension, as well as symptom monitoring; (2) WCH diagnosis, for chosen out-of-office BP monitoring modalities; and (3) WCH monitoring, including frequency of BP measurement in WCH or if it develops into persistent hypertension and additional monitoring other than BP.

Response options were either multiple choice or a 5-point Likert scale (with 1 as very unimportant and 5 as very important). The predefined cutoff for group consensus on an item or group of related answers was ≥70%.[16] Items with 60% to 69% agreement were considered worthy of reconsideration in the next round. Items with <60% agreement were considered to reflect no consensus and were not considered further unless rewording was believed to be necessary. During each round, participants could provide feedback on existing items or suggest additional ones; this information was used to clarify, adjust, or add items to subsequent rounds. For survey templates, see Text S1.

All expert panel members provided their demographic characteristics, clinical and academic background. Participants were asked to indicate whether they had experience with the use of ABPM and if not, they did not receive this section of the questionnaire.

Items for which there was consensus in the first round were presented to the panel for confirmation in the second round. Items with significant (60%–70%) agreement were reconsidered in the second round, following rephrasing or refinement of the existing question and response options (ie, presenting the 3 answers that had achieved the highest degree of consensus for that question), or addition of a new question to provide clarification, as appropriate following feedback. Items with no consensus were presented in the subsequent round for agreement to exclude.

Data Collection and Analyses

Data was collected through online questionnaires and captured in RedCap version 9.1.0 (Vanderbilt University, Nashville, TN). Every participant received a unique token-secured link. Participants who did not respond received reminder emails after ≈2 and 4 weeks before scheduled questionnaire closure. Experts were excluded from subsequent rounds if they did not complete the current round. Analyses were performed using SPSS Statistics version 26.0 (IBM, Armonk, NY), and votes of all panel members were considered equally.

RESULTS

Participants

Two hundred thirty experts were invited to participate. One hundred sixty-six joined the first round and 137 completed it (137/230; 59.6%). One hundred eighteen (118/137, 86.1%) completed the second round and 114 (114/137, 83.2%) completed all rounds (Figure S1).

The demographic and background characteristics of the participants are described in Table 1. On average, experts were just over 50 years of age, female and male in equal measure, and from a broad geographic distribution, with the exception of South America and Africa which were underrepresented. Most respondents were obstetricians (two-thirds of whom were maternal medicine specialists) or obstetric internists, and specialist consultants or academic Professors. Most respondents reported practicing in tertiary obstetric units where the vast majority had access to HBPM, but also frequently to 24-hour ABPM or serial measurement of BP measurements in a medical unit. Among those with access to HBPM, half reported that the BP devices used were validated for use in pregnancy/preeclampsia, but one-third indicated that the institution does not provide the device; to review HBPM values, the majority of respondents reported using pen and paper, with far fewer using the memory function of the BP device, emailed values, or a mobile app. Just over half of survey respondents reported having published papers on pregnancy hypertension or BP monitoring specifically, almost uniformly as a principal author.

Experts felt most confident in the management of true hypertension in pregnancy (60.6% very confident; 38.0% confident), compared with management of WCH (24.8% very confident; 41.6% confident), or knowledge of WCH (30.7% very confident; Figure S2).

Out-of-Office BP Measurement Protocol

Table 2 shows that in the first round, experts agreed almost unanimously that HBPM should be the first line method for out-of-office BP monitoring. There was uniform agreement that: women should receive instructions about how to undertake HBPM, each BP recording should be taken in pairs, and the heart rate provided by devices does not have to be recorded, and women should be able to indicate if they feel that their BP measurement was not a true reflection of their BP. It was agreed that BP should be considered abnormal based on a proportion (suggested to be ≥25%) of BP values above a set value, as either the diagnostic threshold for hypertension or the target BP agreed; other commonly used approaches to summarizing BP were not endorsed, such as trends over time.

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Table 1. Demographic and Baseline Characteristics of 137 Respondents (Mean±SD or n [%] Unless Otherwise Stated)

Characteristic	Respondents (n=137)
Age, y*	51.0±10.9
Gender	
Female	75 (54.7)
Male	62 (45.3)
Region of practice	
Europe	54 (39.4)
Asia	31 (22.6)
Australia/New Zealand	26 (19.0)
North America	21 (15.3)
South America	4 (2.9)
Africa	1 (0.7)
Speciality	
Obstetrics: maternal medicine	57 (41.6)
General obstetrics and gynaecology	28 (20.4)
Obstetric internal medicine	27 (19.7)
Obstetrics: fetal medicine	8 (5.8)
General practitioner	2 (1.5)
Research nurse/midwife	1 (0.7)
Other	14 (10.2)
Level of experience	
Specialist/consultant	58 (42.6)
Professor	44 (32.4)
Associate/assistant professor	25 (18.4)
Other†	9 (6.6%)
Level of care	
Tertiary obstetric center	104 (75.9)
General/routine obstetric center (secondary)	20 (14.6)
Primary care	6 (4.4)
Other	7 (5.1)
Institution uses out-of-office BP	117 (85.4)
Method/s	
HBPM	110 (80.3)
24-hour ABPM	52 (38.0)
Serial measurements at medical unit	49 (35.8)
Blood pressure machine at pharmacy	21 (15.3)
Other	3 (2.2)
If HBPM used, BP monitor is validated in pregnancy	(n=110)
Yes	54/110 (49.1)
Do not provide devices	36/110 (32.7)
No	7/110 (6.4)
Do not know the device	13/110 (11.8)
If HBPM used, mechanism for recording/transmitting BP	
Pen and paper	83 (60.6)
Memory of device	27 (19.7)
Summarized and sent by email	23 (16.8)
Mobile app	20 (14.6)
Sent by message	11 (8.0)
Other	10 (7.3)
Published papers in WCH, HBPM or hypertension in pregnancy	77 (56.2)
Principal investigator, first, second or last author	73/77 (94.8)

(*Continued*)

Table 1. Continued

BP indicates blood pressure; HBPM, home BP monitoring; and WCH, white coat hypertension.

*n=132 respondents provided information about their age.

†Other included: specialty trainee/registrar/resident (N=3), general practitioner (N=2), nonclinical investigator/researcher (N=1), research nurse or midwife (N=1), and other unspecified (N=2).

Consensus was reached on HBPM frequency for well-controlled chronic hypertension (at least 2–3 days per week) and timing (at least once daily in the morning on monitoring days), with almost uniform endorsement that there were factors that should influence monitoring schedules for individual women (Table 2). Consensus was reached on factors that should influence HBPM frequency (ie, hypertensive disease in pregnancy type, risk of preeclampsia current BP control, and use of antihypertensive medication), and those that should not (ie, gestational age, patient factors, distance from health care facility). There was consensus that the time of day for BP measurement should be influenced by patient factors (such as daily schedule) and timing of antihypertensive medication, and should not be influenced by gestational age or concurrent conditions; no consensus was reached for whether timing should differ by hypertensive disease in pregnancy type.

If ABPM is chosen for BP measurement, there was consensus that women should use a diary to report sleep and waking times, and clinicians should use mean 24-hour ABPM to evaluate BP measurements, taking sBP ≥135 and dBP≥85 mm Hg as abnormal, regardless of gestational age (Table 2).

WCH Diagnosis

Table 3 shows that in a first round knowledge question, just over half of respondents knew that white coat effect means that BP is higher in clinic (versus out-of-office), regardless of the BP level, while only one-third knew that white coat effect could apply to any hypertensive disease in pregnancy (and not just chronic hypertension). Very few respondents thought that white coat effect and WCH were the same, but almost half of respondents agreed with the statement that defined white coat effect as BP that is high in clinic but normal at home (ie, WCH).

In the first round, respondents endorsed a diagnosis of hypertension based on clinic sBP ≥140 mm Hg and a dBP ≥90 mm Hg (Table 3). After the second round, no consensus was reached for the cutoff for hypertension based on abnormal HBPM measurements, so for the third round, a question was added about whether HBPM (versus clinic)

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Table 2. Out-of-Office BP Measurement Protocol*

Item	Round in which issue was included		
	1	2	3
	(N=137)	(N=118)	(n=114)
Out-of-office BP measurement approach			
HBPM is method of first choice	128 (93.4%)	113 (95.8%)	…
The following should NOT be first line			
ABPM	64 (46.7%)	100 (84.7%)	…
Serial BP at a medical unit	84 (61.3%)	110 (93.2%)	…
BP machine at a pharmacy	118 (86.1%)	114 (96.6%)	…
All of the above	…	98 (83.1%)	…
HBPM: general recommendations			
Women should be given relevant instructions	136 (99.2%)	…	…
A pair of BP readings should be taken	92 (67.2%)	109 (92.4%)	…
Heart rate does not have to be recorded	49 (35.8%)	78 (66.1%)	87 (76.3%)
Women should be able to comment on self-measured BP they feel does not reflect their true BP	…	110 (93.2%)	…
Proportion of high BP values should be standard to describe self-measured BP	…	72 (61.0%)	89 (78.1%)
Proportion that is abnormal (high)*	…	…	25%
The following should NOT be standard when describing self-measured BP values			
Trend in BP values over time	…	63 (53.4%)	96 (84.2%)
Average of all BP values	…	77 (55.9%)	91 (79.8%)
Proportion of BP values that are severely elevated	…	76 (64.4%)	96 (84.2%)
Most common BP value	…	90 (76.3%)	109 (95.6%)
Proportion BP values below acceptable level	…	98 (83.1%)	107 (93.9%)
All of the above	…	…	74 (64.9%)
HBPM: frequency of BP monitoring			
For well-controlled, chronic hypertension			
1 day per week	22 (16.1%)	11 (9.3%)	…
2–3 days per week	42 (30.7%)	68 (57.6%)	…
4–5 days per week	3 (2.2%)	…	…
7 days per week	21 (15.3%)	26 (22.0%)	…
Individualized	23 (16.8%)	13 (11.0%)	…
At least 2–3 days per week	…	…	106 (93.0%)
Frequency should not be the same for all women	132 (96.4%)	116 (98.3%)	…
Factors that should influence frequency			
Risk of preeclampsia	98 (71.5%)	115 (97.5%)	…
Type of HDP	107 (78.1%)	115 (97.5%)	…
Current BP control	115 (83.9%)	115 (97.5%)	…
Use of antihypertensive medication	97 (70.8%)	115 (97.5%)	…
Factors that should not influence frequency			
Gestational age	58 (42.3%)	85 (72.0%)	…
Patient factors	72 (52.6%)	100 (84.7%)	…
Distance from health care facility	88 (64.2%)	105 (89.0%)	…
All of the above	…	72 (61.0%)	…
HBPM: Time of day for BP monitoring			
For women well-controlled, chronic hypertension			
Once/day in morning	14 (10.2%)	31 (26.3%)	
Midday or afternoon only	5 (3.6%)	…	

(*Continued*)

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Table 2. Continued

Item	Round in which issue was included		
	1	2	3
	(N=137)	(N=118)	(n=114)
Evening only	7 (5.1%)	…	
Night-time only	2 (1.5%)	…	…
Multiple times/day if possible	33 (24.1%)	10 (8.5%)	…
Individualized	45 (32.8%)	29 (24.6%)	…
Twice/day in morning and evening	…	48 (40.7%)	…
At least once a day in the morning	…	…	100 (87.7%)
Timing should not be same for all women	116 (84.7%)	107 (90.7%)	…
Factors that should influence timing			
Patient factors (eg, schedule)	86 (62.8%)	84 (71.2%)	…
Timing of antihypertensive(s)	85 (62.0%)	84 (71.2%)	…
Factors that should NOT influence timing			
Gestational age	105 (76.6%)	114 (96.6%)	…
Concurrent conditions	76 (55.5%)	105 (89.0%)	…
All of the above	…	93 (78.8%)	…
Factors for which impact on timing has no consensus			
HDP type (including preeclampsia)	62 (45.3%)	48 (40.7%)	…
24-hour ABPM	(N=137)	(N=91)	(N=68)
Should use diary to report sleep and waking times	34 (24.8%)	77 (84.6%)	…
Mean 24-hr BP should be standard for ABPM	50 (36.5%)	55 (60.4%)	59 (86.8%)
The following should NOT be standard for ABPM			
Mean night-time BP	101 (73.7%)	87 (95.6%)	59 (86.8%)
Night-time dip in BP (≥10% drop)	107 (78.1%)	87 (95.6%)	59 (86.8%)
Mean daytime BP	90 (65.7%)	63 (69.2%)	59 (86.8%)

ABPM indicates ambulatory BP monitoring; BP, blood pressure; HBPM, home BP monitoring; and HDP, hypertensive disorder of pregnancy.

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BP measurements should be regarded as being lower, as they are considered to be for nonpregnant subjects.[15,17] While no consensus was reached, the majority (almost two-thirds) of respondents agreed with this statement, and among them, hypertension was regarded as a home sBP ≥135 mm Hg or dBP ≥85 mm Hg. Views on BP criteria for elevated BP were similar for mean daytime ABPM (Table 3) and lower for mean night-time ABPM (ie, sBP ≥125 or dBP ≥75 mm Hg at <20 weeks, and sBP ≥120 or dBP ≥75 mm Hg at ≥20 weeks; Table S1). Overall, WCH was defined as a clinic sBP ≥140 mm Hg and a dBP ≥90 mm Hg and HBPM or 24-hr ABPM sBP <135 mm Hg or dBP <85 mm Hg, with the latter value based on those who believed BP should be lower at home.

WCH Monitoring

Table 4 shows that with the addition of a new question in round three, there was consensus that for women with WCH specifically, BP monitoring should occur at least one day per week at <20 weeks and 2 to 3 days per week at ≥20 weeks; however, if persistent hypertension develops, monitoring frequency should be 2 to 3 days per week.

Most participants agreed that women with WCH require additional monitoring beyond BP. Consensus was reached for monitoring of symptoms (Table 4). Headache, visual disturbances, and right upper quadrant/epigastric abdominal pain should be recorded. Most respondents did not endorse monitoring of chest pain/dyspnea or an increase in edema, but consensus was not reached. Respondents endorsed not recording other symptoms of altered mental state, sudden weight gain, heartburn, nausea/vomiting, fatigue, and dizziness. In round 1, the relative importance of symptoms was recorded; only headache and visual symptoms reached consensus as being important/very important. No other symptoms were viewed as important. Consensus was reached for not monitoring any of: proteinuria at home, angiogenic factors, preeclampsia laboratory tests, and tests of fetal well-being (Table 4). While not reaching consensus, the majority of respondents felt that women with WCH did not warrant an increased number of routine antenatal appointments.

Table 3. Diagnostic Criteria for Abnormal Out-of-Office BP in Pregnancy*

Item	Round in which issue was included		
	1	2	3
	(N=137)	(N=118)	(n=114)
Knowledge about WCH and white coat effect			
White coat effect means BP is higher in clinic (vs out-of-office), no matter what BP level is in clinic office	80 (58.4%)	…	…
White coat effect means that BP is high in clinic, but normal at home	61 (44.5%)	…	…
White coat effect can apply to any HDP	46 (33.6%)	…	…
White coat effect refers only to chronic hypertension	3 (2.2%)	…	…
White coat effect and WCH are the same	7 (5.1%)	…	…
Criteria for diagnosis of hypertension			
For clinic BP measurement			
sBP ≥140 mm Hg	117 (85.4%)	115 (97.5%)	
dBP ≥90 mm Hg	115 (83.9%)	115 (97.5%)	
For HBPM measurements			
HBPM should be lower than in clinic BP	…	…	72 (63.2%)
Systolic			
≥130 mm Hg	16 (11.7%)	8 (6.8%)	…
Of those who thought HBPM should be lower than in clinic	…	…	10/72 (13.9%)
≥135 mm Hg	43 (31.4%)	46 (39.0%)	…
Of those who thought HBPM should be lower than in clinic	…	…	58/72 (80.6%)
≥140 mm Hg	68 (49.6%)	64 (54.2%)	…
Of those who thought HBPM should be lower than in clinic	…	…	NA
Other	…	…	4/72 (5.6%)
Diastolic			
≥80 mm Hg	16 (11.7%)	0	…
Of those who thought HBPM should be lower than in clinic	…	…	…
≥85 mm Hg	53 (38.7%)	54 (45.8%)	…
Of those who thought HBPM should be lower than in clinic	…	…	66/72 (91.7%)
≥90 mm Hg	68 (49.6%)	64 (54.2%)	…
Of those who thought HBPM should be lower than in clinic	…	…	3/72 (4.2%)
Other	…	…	3/72 (4.2%)
24-hour ABPM	(N=137)	(N=91)	(N=68)
Mean 24-h ABPM threshold at <20 wk			
Systolic BP threshold			
≥130 mm Hg	20 (14.6%)	53 (58.2%)	…
≥135 mm Hg	11 (8.0%)	16 (17.6%)	55 (80.9%)
≥140 mm Hg	11 (8.0%)	22 (24.2%)	…
Diastolic BP threshold			
≥80 mm Hg	17 (12.4%)	48 (52.7%)	…
≥85 mm Hg	14 (10.2%)	17 (18.7%)	55 (80.9%)
≥90 mm Hg	15 (10.9%)	26 (28.6%)	…
Mean 24-h ABPM threshold at ≥20 wk			
Systolic BP threshold			
≥130 mm Hg	18 (13.1%)	44 (48.4%)	…
≥135 mm Hg	12 (8.8%)	20 (22.0%)	55 (80.9%)
≥140 mm Hg	14 (10.2%)	27 (29.7%)	…
Diastolic BP threshold			
≥80 mm Hg	17 (12.4%)	41 (45.1%)	…
≥85 mm Hg	12 (8.8%)	22 (24.2%)	55 (80.9%)
≥90 mm Hg	18 (13.1%)	28 (30.8%)	…

ABPM indicates ambulatory BP monitoring; BP, blood pressure; dBP, diastolic BP; HBPM, home BP monitoring; HDP, hypertensive disorder of pregnancy; NA, not applicable; sBP, systolic BP; and WCH, white coat hypertension.

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Table 4. Monitoring of WCH in Pregnancy*

Item	Round in which issue included			
	1	2	3	
	(N=137)	(N=118)	(n=114)	
BP monitoring frequency				
Before 20 wk' gestation				
1 day per week	51 (37.2%)	57 (48.3%)	…	
2–3 days per week	42 (30.7%)	40 (33.9%)	…	
7 days per week	16 (11.7%)	13 (11.0%)	…	
Individualized	17 (12.4%)	8 (6.8%)	…	
At least 1 day per week	…	…	103 (90.4%)*	
After 20 wk' gestation				
1 day per week	4 (2.9%)			
2–3 days per week	37 (27.0%)	71 (60.2%)	…	
4–5 days per week	9 (6.6%)	8 (6.8%)	…	
7 days per week	14 (10.2%)	28 (23.7%)	…	
Individualized	11 (8.0%)	11 (9.3%)	…	
At least 2–3 days per week	…	…	101 (88.6%)*	
If persistent hypertension develops				
Before 20 wk of gestation				
1 day per week	23 (16.8%)	23 (19.5%)	…	
2–3 days per week	44 (32.1%)	48 (40.7%)	…	
4–5 days per week	8 (5.8%)	-	…	
7 days per week	31 (22.6%)	41 (34.7%)	…	
Individualized	14 (10.2%)	6 (5.1%)	…	
At least 2–3 days per week	…	…	…	
After 20 wk of gestation				
1 day per week	3 (2.2%)	…	…	
2–3 days per week	16 (11.7%)	33 (28.0%)	…	
7 days per week	24 (17.5%)	53 (44.9%)	…	
Individualized	18 (13.1%)	12 (10.2%)	…	
At least 2–3 days per week	…	…	101 (88.6%)*	
Additional monitoring for WCH	121 (88.3%)	93 (78.8%)*		
Home symptom monitoring is recommended	84 (61.3%)	76 (64.4%)	110 (96.5%)	
Symptoms that should be recorded				
Headaches	114 (83.2%)	116 (98.3%)*	Importance (round 1)†	4 (73.7%)
Visual disturbances	109 (79.6%)	116 (98.3%)*		4 (73.0%)
Right upper quadrant pain	87 (63.5%)	109 (92.4%)		1 (63.5%)
Epigastric pain	90 (65.7%)	109 (92.4%)		1 (65.6%)
Symptoms that should not necessarily be recorded				
Chest pain	72 (52.6%)	…	Importance (round 1)†	1 (47.5%)
Dyspnoea	75 (54.7%)	72 (61.0%)		1 (45.2%)
Altered mental state	89 (65.0%)	85 (72.0%)		1 (35.0%)
Sudden weight gain	80 (58.4%)	83 (70.3%)		1 (41.5%)
Increase in edema	73 (53.3%)	79 (66.9%)		1 (46.7%)
Heartburn	106 (77.4%)	108 (91.5%)		1 (22.7%)
Nausea and vomiting	66 (48.2%)	90 (76.3%)		1 (51.8%)
Fatigue	106 (77.4%)	110 (93.2%)*		1 (22.6%)
Dizziness	79 (57.7%)	90 (76.3%)		1 (42.3%)
All of the above	…	53 (44.9%)	NA	

(*Continued*)

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Table 4. Continued

Item	Round in which issue included		
	1	2	3
	(N=137)	(N=118)	(n=114)
Approaches not recommended			
Measurement of angiogenic factors	117 (85.4%)	…	…
Regular preeclampsia laboratory testing in absence of suspected preeclampsia	106 (77.4%)	…	…
Home proteinuria testing	97 (70.8%)	…	…
Increased N routine appointments	80 (58.4%)	68 (57.6%)	76 (66.7%)
Additional fetal assessments†	67 (48.9%)	74 (62.7%)	84 (73.7%)
Increased N routine appointments and additional fetal assessments	…	…	68 (59.6%)

BP indicates blood pressure; NA, not applicable; and WCH, white coat hypertension.
*Additional fetal assessment by ultrasound or cardiotocography.
†Likert scores (1=minimum importance, 5=maximum importance).

Survey respondents raised additional issues of interest to them that were not addressed by this Delphi, including use of aspirin and antihypertensive therapy in women with WCH. (For details of the free-text contributions, see Table S2)

Figure summarizes our findings in a proposed pathway for out-of-office BP monitoring in pregnancy, in support of diagnosing women with WCH, and managing those with persistent hypertension. For a tabular summary of consensus findings, see Table S3

DISCUSSION

Summary of Findings

In this 3-round modified Delphi procedure involving 137 international experts, we reached consensus on HBPM as the modality of first choice for out-of-office BP monitoring when an abnormal office reading (≥140/90 mm Hg) is detected. A monitoring strategy was established, including that pairs of BP values should be taken, the frequency (2–3 days/wk) and timing (at minimum, in the morning) of BP measurements and factors that should influence them, and at least 25% of HBPM values should exceed a given threshold before being considered abnormal.

While consensus was not reached, the majority of respondents agreed that HBPM should be lower than clinic BP (agreed to be normal at <140/90 mm Hg), and among those respondents, there was consensus that normal was <135/85 mm Hg. This was the same consensus-based cutoff for mean 24-hour ABPM if that method were chosen.

Despite their expertise, our respondents were more comfortable diagnosing and managing true hypertension than WCH, by their own self-assessment. Answers to our knowledge-based questions suggested some confusion between white coat effect and WCH. Nevertheless, when WCH was diagnosed, less frequent BP monitoring (1 d/wk) was considered acceptable at <20 weeks, unless persistent hypertension developed. Also, BP monitoring should be accompanied by home symptom monitoring, particularly of headache and visual symptoms considered to be most important, but also right upper quadrant/epigastric pain.

Strengths and Limitations

A key strength of our study was use of the well-established Delphi procedure,[18,19] with modifications employed to maximize the opportunity for consensus, such as rephrasing of questions or addition of clarification questions, such as when responses conflicted with previous answers. We enrolled a large and diverse group of experts, by snowballing recruitment through organizations and through other experts; we documented clinical and academic experience, and checked for expertise in specialized areas, such as with ABPM, before activating relevant questions. This process aimed to avoid bias, also minimized by our low attrition rate across the 3 rounds. Our respondents practiced over a broad geography; while not surprising given the surge in HBPM during the global COVID-19 pandemic, the broad consensus achieved suggests that there may be less contextualization of out-of-office BP monitoring and WCH care than anticipated.

Limitations include that the Delphi output quality is a reflection of the contemporary interpretation of the underlying body of scientific knowledge which may change over time. As such, the summary of expert opinion constitutes a lower level of research evidence, compared with randomized trials or other prospective study designs. Presenting consensus results in follow-up rounds means participants may have exhibited Group think, whereby an individual changes their own initial beliefs and agree with the majority's views to emphasize

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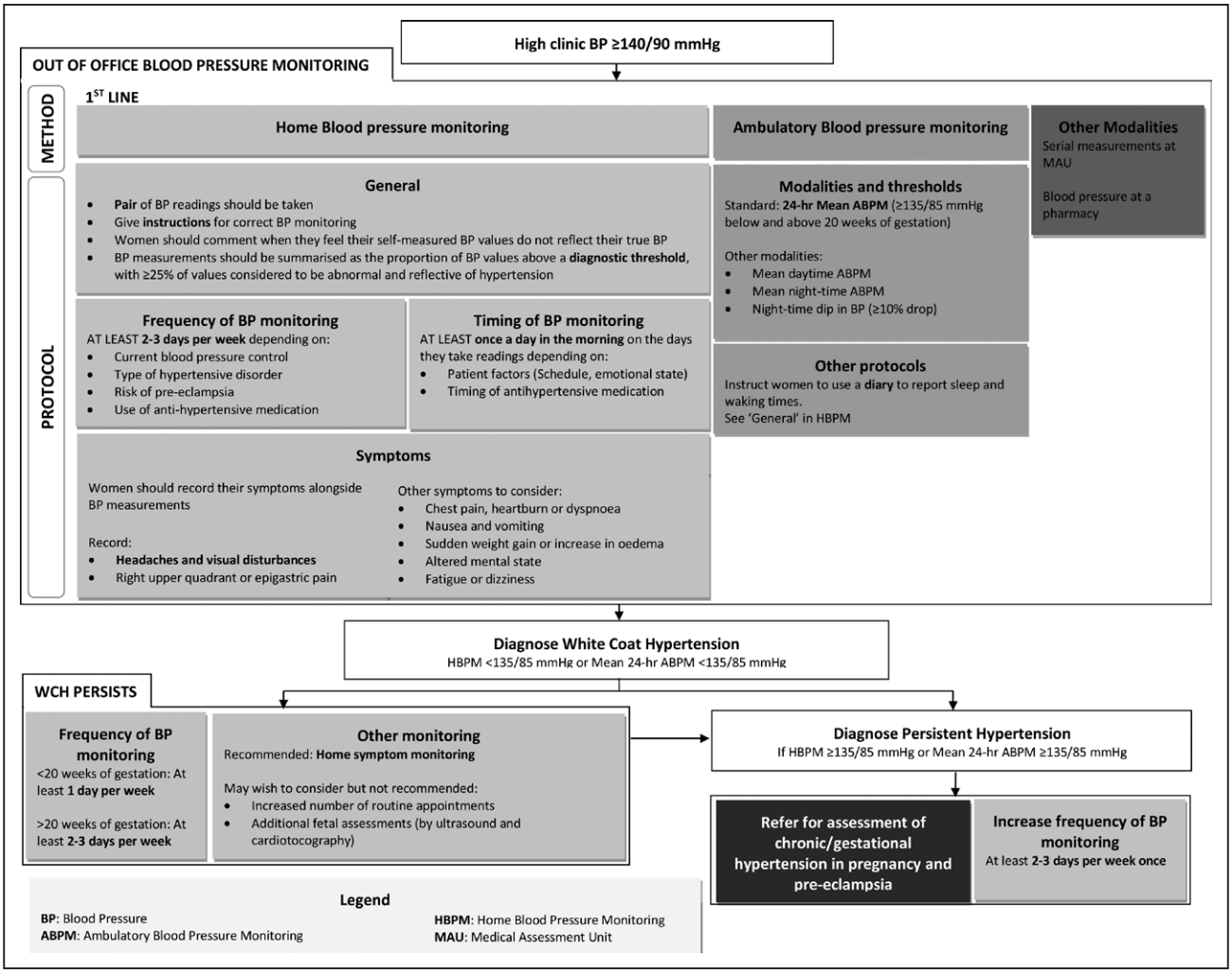

Figure. Pathway of diagnosis and management of white coat hypertension (WCH), based on Delphi consensus.
ABPM indicates ambulatory BP monitoring; BP, blood pressure; HBPM, home BP monitoring; and MAU, Medical Assessment Unit.

group unanimity.[20] The effect was minimized by the fact that respondents completed the questionnaire independently and were masked to individual expert opinion that could steer the group in a specific direction. Despite our efforts to recruit globally, South America and Africa were underrepresented; however, rather than a lack of interest, this may reflect a lack of availability or implementation, or a lower research priority for out-of-office BP monitoring in these regions, compared with Europe, North America, and Australasia.

Interpretation of the Study Findings and Comparison With Published Literature

A diagnosis of WCH is predicated on out-of-office BP monitoring. Our consensus-based HBPM monitoring strategy is similar to the HBPM protocol for the BUMP (Blood Pressure Self-Monitoring in Pregnancy) trials of HBPM for diagnosis and management of outpatient pregnancy hypertension[21]; in these trials, women at high-risk of or with established pregnancy hypertension were provided with instructions for HBPM, asked to take 2 BP readings each time, and their BP monitoring plan was based on <135/85 mm Hg as being normal. Women with normal BP were asked to monitor BP 3 times/wk, consistent with our consensus of 2 to 3 times/wk. Also, women with elevated BP were asked to monitor daily, consistent with our findings that frequency should increase based on current BP control (or use of antihypertensive medication, type of pregnancy hypertension, or risk of preeclampsia). While BP device was not explored in our Delphi, women in the BUMP trials were provided with a BP device validated for use in pregnancy and preeclampsia, consistent with international guidelines that do not specify HBPM or ABPM protocols.

Our study suggests that a normal BP by HBPM is <135/85 mm Hg, based on the views of a majority of all respondents, and consensus among those who believe that home BP should be lower than clinic

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BP. This is consistent with a cutoff for normality of <135/85 mm Hg by mean 24-hour ABPM if chosen as the method for out-of-office BP monitoring. Why we were just short of reaching consensus for a normal home BP may relate in part to insufficient evidence, as summarized by a subsequent systematic review of eight studies (758 women), that found no evidence of a systematic difference between home and clinic BP measurements.[22] While home (versus clinic) readings were ≤1.2 mm Hg different, and the prevalence of WCH was 6% to 13%, home (versus clinic) BP differences were much larger among hypertensive women (mean of 8–16 mm Hg systolic and 4–7 mm Hg diastolic lower at home; 6 studies, 130 women), although the number of hypertensive participants in early pregnancy was low (N=31), and between-study heterogeneity was very high.

Diagnosing WCH when clinic BP is ≥140/90 mm Hg, but out-of-office BP is <135/85 mm Hg is supported by 2018 ISSHP guidelines for HBPM in pregnancy and guidance for outside pregnancy.[1,23] However, a mean 24-hour ABPM <135/85 mm Hg is higher than the 2018 ISSHP recommendation to use <126/76 mm Hg, as well as the awake average BP of <132/79 mm Hg, or the sleep average BP <114/66 mm Hg before 22 weeks.[1] While all ISSHP values are lower than outside pregnancy and cutoffs have shown wide variation,[4,15] these results suggest that maternity care providers desire a threshold for abnormal BP out-of-office that is harmonized across methods for ease of implementation. It is worth noting that our study did not address the detection of severe ranges of BP. According to the ISSHP, clinic BP readings (>160/110 mm Hg) require urgent treatment regardless of the type of hypertensive disorder.[1] BUMP trials have employed lower thresholds (≥150/100 mm Hg) in out-of-office BP monitoring.[21]

Despite the expertise of our respondents, even they showed sub-optimal understanding of the difference between white coat effect and WCH, terms that have been used interchangeably and in error in pregnancy literature. White coat effect is a BP difference between the clinic and the patient's usual environment, which can occur in both normotensive and hypertensive patients[24]; it is not associated with adverse pregnancy outcomes.[16] In contrast, WCH is an elevated BP in clinic which is normal at home, and a condition that is performed pregnancy and tends to manifest early.[2,25] WCH is associated with a higher risk of cardiovascular disease outside pregnancy,[24] and in pregnancy, with an increased risk of preeclampsia, preterm birth, and small-for-gestational age infants.[4] It is not yet possible to identify those women with WCH at particular risk of developing preeclampsia or other complications but there is potential to do so using biomarkers of endothelial dysfunction,[26,27]

Finally, we reached consensus that women with WCH require additional monitoring beyond HBPM, and specifically home symptom monitoring, for cerebrovascular and hepatic symptoms. While chest pain and dyspnea are independently predictive of adverse maternal outcome among hypertensive pregnancy (in general)[28] or preeclampsia specifically,[29] these symptoms were not endorsed as important or necessary to record in WCH monitoring. Guidelines do not currently advise on specific monitoring strategies for women with WCH (versus normotensive or hypertensive women). Our findings suggest that further guidance is required, as experts reported greater confidence when managing true hypertension, compared with WCH. Based on the association between WCH and a heightened risk of preeclampsia and small-for-gestational age babies, we had expected experts to support an increased number of routine appointments and additional fetal assessments, but this was not the case. Explanations may be the need for better evidence on the prognosis of WCH, an awareness of the increased demands that additional assessments could place on health care resources, particularly without evidence that outcomes are improved, or beliefs based on personal experience. We are aware of three trials (BUMP1, BUMP2, and SAFE@HOME) that are evaluating the cost-effectiveness of HBPM in pregnancy.[6,7]

Perspectives

Our Delphi study has highlighted the importance of a standardized protocol for WCH in pregnancy to prevent overtreatment of women without true hypertension while remaining alert of the potential for adverse outcomes and preeclampsia development in this intermediate risk condition. There are unanswered questions. What is the prevalence and natural history of a standardized definition of WCH in pregnancy, including more complex pregnancies? Can we predict adverse pregnancy outcomes among women with WCH?[30] Are interventions, such as aspirin to prevent preeclampsia, useful? How should the BP of WCH be managed optimally postpartum? How can we increase awareness of the intermediate risk of the condition?

Conclusions

These consensus-based diagnostic criteria and monitoring strategies should inform prospective studies to facilitate evaluation of out-of-office BP monitoring on pregnancy outcomes. Our pathway may then be integrated into standardized clinical practice or integrated into future guidance based on higher levels of evidence to remain up to date and informative in the clinical setting.[16]

ARTICLE INFORMATION

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A. Khalil has a patent on HAMPTON, a software for home blood pressure monitoring in pregnancy. L.A. Magee is the president of the International Society for the Study of Hypertension in Pregnancy (ISSHP). The other authors report no conflicts.

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