SHORT COMMUNICATION

Uncontrolled blood pressure according to ambulatory blood pressure monitoring values in pregnant women is poorly predictable

Ewa Wojciechowska, Katarzyna Cienszkowska, Marta Ludwiczak, Piotr Sobieraj, Piotr Gryglas, Jacek Lewandowski

INTRODUCTION

The prevalence of hypertension-related disorders in pregnancy remains a significant clinical problem that contributes to an increase in maternal morbidity and mortality and influences the risk of future cardiovascular complications [1]. It is recommended to monitor blood pressure (BP) during pregnancy using office BP measurements (OBPM) with the support of outpatient measurements, which include home BP (HBPM) and ambulatory BP measurements (ABPM) [2]. ABPM is recognized as the best method for BP monitoring during pregnancy. Its role in management of hypertension in high-risk pregnant women is particularly emphasized [2, 3]. Experts do not indicate one specific algorithm for choosing the method for BP monitoring and the sequence and purposefulness of performing a specific type of BP measurement. Therefore, to define the role and importance of ABPM in relation to OBPM and HBPM, we decided to compare the results of these BP measurement methods in a group of women with high-risk pregnancies.

METHODS

Study group description

The study is a post-hoc analysis of data collected over 4 years (2015–2019) from 79 pregnant women referred to the clinic with a history of primary hypertension with eclampsia (89.9%) or pre-eclampsia (10.1%) in their previous pregnancy/pregnancies. All included women completed the study. The study was approved by the local ethics committee (no. AKBE/71/2018). The characteristics of pregnant women are presented in the Supplementary material.

Description of analyzed variables

Every fifth week of the study, subjects underwent ABPM and OBPM with the last visit scheduled in the 37th week of pregnancy. Before each visit, HBPM measurements were performed. All measurements were performed in accordance with recommendations [2]. For each of the BP measurement methods, arterial hypertension was diagnosed at the commonly accepted BP thresholds (details in the Supplementary material).

Statistical analysis

Continuous variables were presented as mean and standard deviation. Categorical variables were presented as numbers followed by percentages. The reliability of OBPM or HBPM for assessment of ABPM measurement was assessed using Cohen’s Kappa. In order to predict an abnormal ABPM result in BP measurement sets with well-controlled OBPM and HBPM values, mixed-effect logistic regression of all possible models including systolic and/or diastolic BP values from OBPM and/or HBPM as predictors was created. The model was evaluated in a randomly selected subset containing 80% of the measurement sets. The final model was selected on the basis of the lowest Akaike information criterion. Furthermore, accuracy of the model was evaluated in the remaining 20% of the data.

RESULTS AND DISCUSSION

During the trial, 706 office visits with BP measurements were performed, and finally,
640 (90.7%) complete sets of BP measurements were analyzed. Mean OBPM SBP/DBP was 134.0 (15.9)/83.7 (11.4) mm Hg, and HBPM SBP/DBP was 128.1 (16.6)/79.9 (11.3) mm Hg. Mean ABPM SBP/DBP values during 24-hour monitoring were 122.9 (13.1)/77 (9.9) mm Hg, during the activity period they were 126.9 (13.6)/80.9 (10.4) mm Hg, and at night 113.7 (13.8)/67.9 (9.9) mm Hg.

OBPM values ≥140 and/or 90 mm Hg were present in 239 (37.3%) sets of measurements. HBPM values ≥135 and/or 85 mm Hg occurred in 226 (35.3%) measurements. ABPM values ≥130 and/or 80 mm Hg during 24-hour or ≥135 and/or 85 mm Hg during the activity period or ≥120 and/or 70 mm Hg during night rest were present in 358 (55.9%) sets of measurements.

In 401 cases, OBPM was rated as well-controlled; 10 (2.5%) HBPM and 150 (37.4%) ABPM results were recognized as uncontrolled. In sets with well-controlled OBPM, 8 (2%) indicated a lack of BP control in both HBPM and ABPM. In 239 sets of measurements fulfilling the criteria for uncontrolled OBPM, 216 (90.4%) HBPM and 208 (87.0%) ABPM were classified as uncontrolled BP (Figure 1). Reliability of OBPM for assessment of controlled/uncontrolled ABPM results was weak (kappa 0.45).

HBPM

In 414 sets with well-controlled HBPM, there were 23 (5.6%) uncontrolled OBPM and 159 (38.4%) uncontrolled ABPM. In 17 (4.1%) sets, both OBPM and ABPM were uncontrolled. In 226 measurement sets fulfilling the criteria for uncontrolled HBPM, 216 (95.6%) OBPM and 199 (88.1%) ABPM were assessed as uncontrolled. Reliability of HBPM for assessment of controlled/uncontrolled ABPM was weak (kappa 0.44).

ABPM

In 282 well-controlled ABPM, 31 (11%) were uncontrolled in OBPM and 27 (9.6%) uncontrolled in HBPM. Both uncontrolled OBPM and HBPM were in 25 (8.9%) sets and uncontrolled OBPM or HBPM were in 8 sets (2.8%). In 358 sets of uncontrolled ABPM measurements, there were 208 (58.1%) uncontrolled OBPM and 199 (55.6%) uncontrolled HBPM. Both uncontrolled OBPM and HBPM were in 191 (53.3%) sets while 142 measurements were accompanied by well-controlled OBPM and HBPM.

**ABPM in relation to OBPM and HBPM**

Well-controlled hypertension according to both OBPM and HBPM was in 391 (61.1%) sets of measurements. Among them, there were 142 (22.2%) measurements indicating uncontrolled values according to ABPM. Both uncontrolled OBPM and HBPM were in 216 (33.8%) sets of measurements, and 33 (5.2%) fulfilled the criteria for uncontrolled hypertension in OBPM or HBPM. In subjects with uncontrolled hypertension both in OBPM and HBPM, 191 (88.4%) had uncontrolled hypertension in ABPM. In 33 sets of measurements with uncontrolled OBPM or HBPM, 25 (75.8%) fulfilled the criteria for uncontrolled ABPM.

**Prediction of uncontrolled ABPM in subjects with well-controlled values of both OBPM and HBPM**

In the training subset of the data with well-controlled values of both OBPM and HBPM, a model was selected for prediction of uncontrolled ABPM. The final logistic regres-
sion model included OBPM SBP, OBPM DBP, and HBPM DBP; the odds ratios for the prediction of uncontrolled ABPM were 1.09 (95% CI, 1.01–1.17), 1.52 (95% CI, 1.25–1.85), and 0.86 (95% CI, 0.72–1.02), respectively, for a 1 mm Hg increase. Using the remaining 20% of BP measurements we computed selected model accuracy equal to 0.592. These results suggest that high SBP and DBP in OBPM and low DPB in HBPM increase the likelihood of poor BP control in ABPM.

Using data from BP measurements in patients with high-risk pregnancy, we showed that the discrepancy between OBPM and HBPM may be considered as a relevant clinical problem. According to our results, physicians assessing BP control only using OBPM may overlook 37.4% of subjects with uncontrolled hypertension according to the ABPM control criterion. Surprisingly, using only HBPM values may result in under-recognition of 38.4% of subjects with ABPM values higher than expected. In our study, achieving ABPM target values of elevated BP treatment was associated with a low rate of uncontrolled OBPM (11%) and HBPM (9.6%) values. The evaluated model showed that physicians can predict uncontrolled ABPM values using data from OBPM and HBPM in fewer than two-thirds of sets of measurements.

Our results remain of special significance when compared to the current guidelines, indicating ABPM superiority in predicting pregnancy outcomes over routine BP measurement [4]. Many clinicians, using the results of studies evaluating the agreement between OBPM, HBPM, and ABPM using the Bland-Altman methodology, may be convinced that HBPM is closest to daily ABPM results. Actually, using the same data as in our study, we also confirmed that finding [5]. However, the assumption that HBPM can be used interchangeably with ABPM is incorrect as shown by Hodgkinson et al. [6] in the systematic review of 20 studies. In their analysis, pooled sensitivity and specificity of OBPM for ABPM were 74.6% (95% CI, 60.7%–84.8%) and 74.6% (95% CI, 47.9%–90.4%), respectively. Pooled sensitivity of HBPM for OBPM and ABPM was 85.7% (95% CI, 78%–91%) and 62.4% (95% CI, 48%–75%).

We did not find similar analyses concerning differences in OBPM, HBPM, and ABPM values, thus our results should be considered new. However, our study has several limitations. Due to the relatively small sample size and study design, we were not able to evaluate how the discrepancy between OBPM, HBPM, and ABPM impacts the outcome of pregnancy. Also, the day and night period schedule set in ABPM reports may not reflect the day-and-night cycle of our study participants.

In conclusion, our results indicate that good BP control in OBPM or HBPM does not mean achieving controlled BP in ABPM. In addition, based on the results of both OBPM and HBPM, we are unable to predict the result of ABPM. Therefore, especially considering the advantages in terms of predicting pregnancy outcomes, ABPM should be the standard for BP monitoring in pregnant women.

Supplementary material
Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

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REFERENCES