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

Short title: Unpredictable blood pressure values in pregnancy

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INTRODUCTION

The prevalence of hypertension-related disorders in pregnancy remain a significant clinical problem that contributes to the 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 monitoring BP 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 of BP monitoring and the sequence and purposefulness of performing a specific type of BP measurements. 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 the group of women with high risk pregnancy.

METHODS

Study group description

The study is a post-hoc analysis of data collected over a period of 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 a 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 Supplementary material).

Statistical analysis

Continuous variables are presented as mean and standard deviation. Categorical variables are presented as number followed by percentage. 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 measurements sets with well-controlled OBPM and HBPM values, mixed-effect logistic regression all possible models including SBP and/or DBP values from OBPM and/or HBPM as predictors was created. Model was evaluated in randomly selected subset containing 80% of the measurements sets. Final model was selected on the basis of the lowest Akaike Information Criterion. Further, accuracy of the model was evaluated in 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 measurement were analysed. Mean OBPM SBP/DBP was 134.0 (15.9)/83.7 (11.4) mm Hg, 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 activity period were 126.9 (13.6)/80.9 (10.4) mm Hg, and in the 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 activity period or ≥120 and/or 70 mm Hg during night rest were present in 358 (55.9%) sets of measurements.

OBPM

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

HBPM

In 414 sets with well-controlled HBPM there was 23 (5.6%) uncontrolled OBPM and 159 (38.4%) uncontrolled ABPM. In 17 (4.1%) sets both OBPM and ABPM were uncontrolled. Among 226 measurements sets fulfilling criteria of uncontrolled HBPM, 216 (95.6%) of OBPM and 199 (88.1%) of ABPM were assessed as uncontrolled. Reliability of HBPM for assessment of controlled/uncontrolled ABPM result 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%). Among 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 were in 391 (61.1%) sets of measurements. Among them there was 142 (22.2%) measurements indicating uncontrolled values according to ABPM. Uncontrolled both OBPM and HBPM were in 216 (33.8%) sets of measurements and 33 (5.2%) fulfilled criteria of uncontrolled hypertension in OBPM or HBPM. Among 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 criteria of 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 model was selected for prediction of uncontrolled ABPM. Final logistic regression 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 remaining 20% of BP measurements we computed selected model accuracy equal 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 of BP measurements in high-risk pregnancy we showed that discrepancy between OBPM and HBPM may be considered as relevant clinical problem. According to our results, physician assessing BP control only using OBPM may overlook 37.4% subjects with uncontrolled hypertension according to ABPM control criterion. Surprisingly, using only HBPM values may result in under-recognition of 38.4% subjects with higher than expected ABPM values. In our study, the achievement of ABPM target values of elevated BP treatment was associated with low rate of uncontrolled OBPM (11%) and HBPM (9.6%) values. Evaluated model, showed that in less than 2/3 sets of measurements physician using data from OBPM and HBPM is able to predict uncontrolled ABPM values.

Our results remain of special significance when compared to the current guidelines, indicating ABPM superiority for prediction of pregnancy outcome 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 the current manuscript we also confirmed that finding [5]. However, the assumption that HBPM can be used interchangeably with ABPM is incorrect as showed by Hodginson at el. [6] in the systematic review of 20 studies. In their analysis pooled sensitivity and specificity of OBPM for ABPM was 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 analysis concerning differences in OBPM, HBPM and ABPM values, thus our results should be considered as new.

However, our study has several limitations. Due to relatively small sample size and study design we were not able to evaluate how discrepancy between OBPM, HBPM and ABPM impacts outcome of the pregnancy. Also, day and night period schedule set in ABPM reports may not reflect day-and-night cycle of participants of our study.

In conclusion, our results indicate that good BP control in OBPM or HBPM does not mean achievement of 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 monitoring of BP in pregnant women.

Supplementary material

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

Article information

Conflict of interest: None declared.

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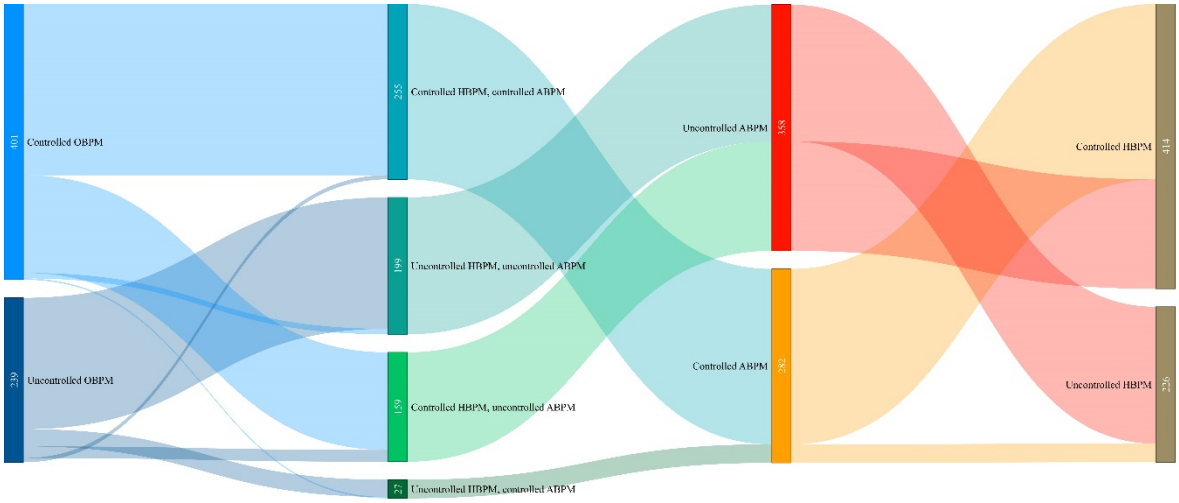

Figure 1. Dependency between controlled/uncontrolled values of OBPM, HBPM, ABPM in analyzed group of 640 sets of blood pressure measurements.

Abbreviations: ABPM, ambulatory blood pressure measurements; HBPM, home blood pressure measurements; OBPM, office blood pressure measurements