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Ambulatory Blood Pressure Monitoring for Hypertension Diagnosis in Pregnancy: A Prospective Study in Saint-Louis, Senegal

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ABSTRACT

Background: *Hypertensive disorders in pregnancy affect 10-15% of pregnancies and account for 30% of maternal deaths and 20% of fetal mortality. Accurate blood pressure measurement is crucial for early diagnosis and management.*

Objective: *To evaluate the utility of 24-hour ambulatory blood pressure monitoring (ABPM) in diagnosing hypertension during pregnancy compared to conventional clinic measurements.*

Methods: *This prospective longitudinal study was conducted from July to December 2018 at the Regional Hospital Center of Saint-Louis, Senegal. Pregnant women ≥20 weeks' gestation were included. Clinic blood pressure measurements during prenatal visits were compared with 24-hour ABPM results.*

Results: *Thirty-one pregnant women were enrolled (mean age 32±5.9 years, 72% in third trimester). ABPM revealed hypertension in 9.7% (systolic) and 3.2% (diastolic) of patients over 24 hours. Clinic measurements detected systolic hypertension in only 6% at first prenatal visit. Among systolic hypertension cases detected by ABPM, 38% were masked hypertension (normal clinic BP, elevated ABPM). All diastolic hypertension cases were masked. Conversely, 50% of patients with elevated clinic BP were normotensive on ABPM (white-coat hypertension). Nocturnal hypertension was found in 25.8% (systolic) and 3.2% (diastolic) of patients. Fifty-two percent of patients were non-dippers.*

Conclusion: *ABPM detected significant masked hypertension (38% systolic, 100% diastolic) and white-coat hypertension (50%) unidentified by clinic measurements. These findings suggest ABPM could improve hypertension diagnosis accuracy in pregnancy, potentially preventing both under-treatment and over-treatment.*

Keywords

Ambulatory blood pressure monitoring, Pregnancy, Hypertension, Senegal.

Introduction

Hypertensive disorders of pregnancy (HDP) represent a major global health challenge, affecting 10-15% of pregnancies worldwide and contributing to 30% of maternal deaths and 20% of perinatal mortality [1,2]. These disorders encompass chronic hypertension, gestational hypertension, preeclampsia, and preeclampsia superimposed on chronic hypertension [3]. Early and accurate diagnosis is crucial for preventing severe complications including eclampsia, HELLP syndrome, placental abruption, and intrauterine growth restriction [4].

The diagnosis of hypertension in pregnancy relies primarily on blood pressure (BP) measurements during routine prenatal visits. However, clinic-based measurements may not accurately reflect the true BP profile due to the white-coat effect, masked hypertension, or temporal BP variations [5]. Ambulatory blood pressure monitoring (ABPM), which provides continuous BP measurements over 24 hours in the patient's usual environment,

has emerged as the gold standard for hypertension diagnosis in non-pregnant populations [6].

Recent evidence suggests ABPM may be particularly valuable in pregnancy due to the unique cardiovascular adaptations that occur. The physiological decrease in BP during the first two trimesters, followed by a gradual return to pre-pregnancy levels, creates challenges for accurate hypertension diagnosis using conventional clinic measurements [7,8]. Additionally, the circadian BP pattern (dipper/non-dipper status) during pregnancy has prognostic implications for both maternal and fetal outcomes [9].

Despite its potential benefits, ABPM remains underutilized in obstetric practice, particularly in low-resource settings. The objective of this study was to evaluate the diagnostic utility of ABPM compared to conventional clinic BP measurements in pregnant women and to assess the prevalence of masked and white-coat hypertension in this population.

Methods

Study Design and Setting

This prospective longitudinal study was conducted from July 1 to December 31, 2018, at the regional hospital center of Saint-Louis, Senegal, in collaboration with the Laboratory of application and research in health sciences (LARESS) at Gaston Berger University.

Participants

Pregnant women with gestational age ≥20 weeks attending routine prenatal care were eligible for inclusion. Exclusion criteria included multiple pregnancy, known fetal anomalies, and inability to tolerate ABPM device. Written informed consent was obtained from all participants.

Data Collection

A standardized questionnaire collected demographic characteristics, medical history, obstetric history, and clinical data. Clinic BP measurements were recorded during routine prenatal visits using validated automated devices with appropriate cuff sizes. Measurements were taken after 10 minutes of rest in the sitting position.

ABPM Protocol

ABPM was performed using validated EDAN devices with standard and large cuffs. The device was programmed to take measurements every 15 minutes during daytime and every 30 minutes during nighttime. Patients were instructed to maintain normal daily activities and complete an activity diary.

BP Definitions

- Clinic hypertension: systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg
- ABPM hypertension: ≥50% of readings above normal values 24-hour: systolic ≥125 mmHg, diastolic ≥80 mmHg

Daytime: systolic ≥135 mmHg, diastolic ≥85 mmHg
Nighttime: systolic ≥120 mmHg, diastolic ≥70 mmHg

- Masked hypertension: normal clinic BP, elevated ABPM
- White-coat hypertension: elevated clinic BP, normal ABPM
- Non-dipper: <10% nocturnal BP decline

Statistical Analysis

Data were analyzed using EPI INFO software. Descriptive statistics included frequencies, percentages, means, and standard deviations. Chi-square and Student's t-tests were used for comparisons. Statistical significance was set at $p<0.05$.

Results

Participant Characteristics

The mean maternal age was 32±5.9 years, with 52% aged 34-41 years. Most participants (71%) were of Wolof ethnicity and married (96.8%). The majority (72%) were in the third trimester of pregnancy with a mean gestational age of 28.5 weeks. Table 1 summarizes the baseline characteristics of the 31 enrolled participants.

Table 1: Baseline characteristics of study participants (n=31).

Characteristics	Nomber (%)	Mean ± SD
Maternal age (years)		32 ± 5.9
Age groups		
<25 years	4 (13)	
26-33 years	11 (35)	
34-41 years	16 (52)	
Ethnicity		
Wolof	22 (71)	
Toucouleur	2 (6.5)	
Other	7 (22.5)	
Marital status		
Married	30 (96.8)	
Single	1 (3.2)	
Gestational age (weeks)		**28.5 ± 4.8**
Trimester		
Second	9 (28)	
Third	22 (72)	
Gravidity		
Primigravida	7 (23)	
Paucigravida (2-3)	14 (45)	
Multigravida (4-5)	8 (26)	
Grand multigravida (>5)	2 (6)	

ABPM Results

The ABPM revealed hypertension in 9.7% of participants for systolic BP over 24 hours, compared to 6% detected by clinic measurements at the first prenatal visit. The Table 2 compares clinic BP measurements with ABPM findings.

Masked and White-coat Hypertension

The analysis revealed significant discordance between clinic and ABPM measurements. Among the 9.7% of patients with systolic hypertension detected by 24-hour ABPM, 38% had masked hypertension (normal clinic BP but elevated ABPM). All cases of diastolic hypertension detected by ABPM represented masked

hypertension. Conversely, 50% of patients with elevated clinic systolic BP at the first prenatal visit were normotensive on ABPM, indicating white-coat hypertension.

Table 2: Comparison of clinic blood pressure and ABPM findings.

BP Category	Clinic BP n (%)	ABPM 24-hour n (%)	ABPM Daytime n (%)	ABPM Nighttime n (%)
Systolic Hypertension				
First prenatal visit	2 (6)	3 (9.7)	0 (0)	8 (25.8)
Second prenatal visit	3 (10)			
Diastolic Hypertension				
First prenatal visit	0 (0)	1 (3.2)	2 (6.4)	1 (3.2)
Second prenatal visit	1 (6)			
Elevated BP (not meeting hypertension criteria)				
Systolic		12 (39)	6 (19)	6 (19)
Diastolic		7 (23)	8 (26)	6 (19)

BP: Blood pressure ABPM: Ambulatory blood pressure monitoring

Circadian BP patterns

ABPM revealed that 52% of participants were non-dippers, indicating impaired nocturnal BP decline. Nocturnal hypertension was more prevalent than daytime hypertension, particularly for systolic BP (25.8% vs 0%).

Pulse Pressure

Pulse pressure was normal in 100% of participants during daytime and 97% during nighttime, indicating low cardiovascular risk in this population.

Discussion

This study demonstrates the superior diagnostic capability of ABPM compared to conventional clinic BP measurements in pregnant women. The finding that 38% of systolic hypertension cases detected by ABPM were masked represents a significant diagnostic gap that could have important clinical implications.

Masked hypertension in pregnancy

The prevalence of masked hypertension in our study (38% for systolic, 100% for diastolic) is consistent with recent literature. Bello, et al. reported that approximately 33% of pregnant women with normal clinic BP were hypertensive on ABPM [10]. Similarly, Pechère, et al. found masked hypertension rates of 10-40% in various populations [11]. The higher rate of masked diastolic hypertension in our study (100%) suggests that diastolic BP may be particularly prone to being missed during routine clinic visits.

Masked hypertension during pregnancy has significant clinical relevance. These patients may appear normotensive during prenatal visits but actually have elevated BP that could lead to adverse outcomes. Studies have shown that masked hypertension is associated with increased risk of preeclampsia, particularly when nocturnal hypertension is present [12,13]. The identification of these cases through ABPM could enable earlier intervention and closer monitoring, potentially preventing progression to severe hypertensive complications.

White-coat Hypertension

The finding that 50% of patients with elevated clinic BP where normotensive on ABPM indicates a substantial white-coat effect. This is consistent with the reported prevalence of 30-70% in pregnant populations [14]. White-coat hypertension has important implications for clinical management, as it may lead to unnecessary antihypertensive treatment with potential adverse effects on maternal and fetal well-being.

Excessive BP reduction can compromise uteroplacental perfusion and fetal development [15]. Our findings suggest that ABPM could prevent overtreatment in a significant proportion of pregnant women initially diagnosed with hypertension based on clinic measurements alone.

Nocturnal hypertension and non-Dipper pattern

The high prevalence of nocturnal hypertension (25.8% systolic) and non-dipper pattern (52%) in our study population is particularly noteworthy. Nocturnal hypertension has been associated with increased cardiovascular risk in non-pregnant populations [16]. In pregnancy, loss of the normal nocturnal BP decline has been linked to increased risk of preeclampsia and adverse fetal outcomes [17,18].

The International Database on Ambulatory Blood Pressure (IDACO) registry has shown that nocturnal hypertension in normotensive patients during the day increases cardiovascular event risk by 48% [19]. While similar long-term outcome data in pregnancy are limited, the identification of non-dipper patterns through ABPM could have important prognostic implications for both immediate pregnancy outcomes and future cardiovascular risk.

Clinical implications

These findings have several important clinical implications:

- Diagnostic accuracy: ABPM provides more accurate BP assessment than clinic measurements, identifying both masked and white-coat hypertension that would be missed or misdiagnosed with conventional methods.
- Treatment decisions: ABPM could guide more appropriate treatment decisions, preventing both under-treatment of masked hypertension and over-treatment of white-coat hypertension.
- Risk stratification: The identification of nocturnal hypertension and non-dipper patterns could help identify high-risk pregnancies requiring closer monitoring.
- Resource allocation: In settings with limited resources, ABPM could be prioritized for women with borderline clinic BP readings or those at high risk for hypertensive complications.

Limitations

Several limitations should be considered when interpreting these results. The small sample size (n=31) limits the statistical power

and generalizability of findings. The study was conducted at a single center, which may not be representative of the broader population. Additionally, the lack of long-term follow-up prevents assessment of pregnancy outcomes and their correlation with ABPM findings.

The limited availability of ABPM devices and the need for patient education and compliance may also restrict the widespread implementation of this technology, particularly in resource-limited settings. Future studies with larger sample sizes and outcome data are needed to validate these findings and establish clear guidelines for ABPM use in pregnancy.

Future directions

Future research should focus on several key areas:

- **Outcome studies:** Large prospective studies correlating ABPM findings with pregnancy outcomes are needed to establish the clinical significance of masked and white-coat hypertension in pregnancy.
- **Cost-effectiveness:** Economic analyses comparing ABPM-guided care with conventional management could inform healthcare policy decisions.
- **Technology development:** Development of more accessible and user-friendly ABPM devices could facilitate broader implementation.
- **Guidelines development:** Evidence-based guidelines for ABPM use in pregnancy, including indications and interpretation criteria, are needed.

Conclusion

This study demonstrates that ABPM reveals significant masked hypertension (38% systolic, 100% diastolic) and white-coat hypertension (50%) that are unidentified by conventional clinic BP measurements during pregnancy. The high prevalence of nocturnal hypertension and non-dipper patterns suggests additional cardiovascular risk that may not be apparent from daytime clinic measurements alone.

These findings support the integration of ABPM into routine prenatal care, particularly for women with borderline clinic BP readings or those at high risk for hypertensive complications. While further research is needed to establish clear guidelines and validate these findings in larger populations, ABPM represents a valuable tool for improving the accuracy of hypertension diagnosis and management during pregnancy.

The potential to prevent both under-treatment of masked hypertension and over-treatment of white-coat hypertension could significantly improve maternal and fetal outcomes while optimizing healthcare resource utilization. As hypertensive disorders remain a leading cause of maternal mortality globally, the adoption of more accurate diagnostic methods like ABPM should be considered a priority in improving maternal health outcomes.

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