

# Value of ambulatory blood pressure measurement in diagnosing hypotension in hypertensive diabetic patients with medication-controlled BP

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## Abstract

**Background:** Hypotension is a common clinical finding in diabetic patients on anti-hypertensive medications. In the absence of clearly defined and documented hypotensive episodes, clinicians are faced with the challenge of modifying antihypertensive medication in potentially symptomatic diabetic patients.

**Objective:** To determine the value of ambulatory blood pressure monitor (ABPM) in diagnosing hypotensive episodes in hypertensive diabetic patients with medication-controlled blood pressure.

**Patients and methods:** The records of all hypertensive diabetic patients with medication-controlled were obtained between 2017 and 2018. Patients' demographic data, comorbid conditions, hypotensive symptoms and echocardiography results were obtained and compared to office-based blood pressure and ABPM.

**Results:** Of 926 patients screened in the department of medicine outpatient clinics, 231 patients had diabetes and hypertension and were taking antihypertension medications, so only 86 patients were recruited. Using 24 h ABPM, hypotensive events were documented in 65 (75.6%) patients without correlated hypotensive symptoms in the patient sheet. Patients who had hypotensive episodes recorded by ABPM tended to have these between 5 and 10 a.m. and were significantly older – 60.71 versus 58.76 ( $P = .022$ ) – and more likely to have lower ejection fractions by echocardiography 46.31 versus 62.85 (EF) ( $P < .001$ ).

**Conclusion:** In treated hypertensive diabetic patients with antihypertensive medication, ABPM may be beneficial in capturing bouts of asymptomatic (silent) hypotension readings that occur in the out-of-hospital setting. Diabetic patients with controlled hypertension based on office reading showed a significant number of asymptomatic hypotensive readings detected with ambulatory BP monitoring that can have a role in following up such patients.

## Keywords

Diabetes hypertension, ambulatory blood pressure monitor, asymptomatic hypotension

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## Introduction

Diabetes mellitus (DM) is common worldwide. According to a recent report from the International Diabetes Federation (IDF),<sup>1</sup> an estimated 383 million people suffer from diabetes globally. The highest prevalence occurs in North America and the Caribbean (11%), followed by the Middle East and North Africa (9.2%). In Saudi Arabia in 2013, the prevalence of diabetes in adults between age 20–79 years was 23.9% and the associated mortality was 122.5/100,000 population.<sup>1</sup>

Hypertension is a common independent risk factor for cardiovascular disease, such as stroke, congestive

heart failure, and coronary heart disease and kidney disease. Diabetes mellitus (DM) is frequently comorbid with hypertension, adding significantly to the overall morbidity and mortality.<sup>2</sup> Likewise, hypertension significantly increases the risk of vascular complications in patients with DM.<sup>3</sup> Thus, accurate diagnosis and

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reliable assessment of hypertension are crucial in high-risk persons, such as diabetics, in whom a decrease of systolic pressure by even 1 mmHg indicates an important reduction in hypertensive-related morbidity and mortality.<sup>4,5</sup> As such, excellent control of hypertension in diabetic patients is mandatory to avoid or at least delay the associated complications. This is traditionally achieved by prescribing lifestyle modification and anti-hypertensive medications. However, strict blood pressure (BP) control can result in clinical hypotension, an important finding to document on clinical follow-up secondary to the significant and detrimental sequelae.

In common practice, hypotension is detected in the office setting based on BP readings and symptoms including postural dizziness and headache. While these symptoms are non-specific, in the appropriate clinical setting, they can be considered suggestive for hypotension. Concerns arise as other common comorbidities of DM may mimic the symptoms of hypotension. For example, in diabetic patients on anti-hypertensive medications, hypotension may be confused with the symptoms of autonomic dysfunction or hypoglycemia.<sup>6-9</sup> Consequently, office BP readings present an important tool in accurately detecting hypotension. However, in diabetic hypertensive patients with normal office-based BP readings, clinicians are faced with the challenge of modifying anti-hypertensive medication in potentially symptomatic diabetic patients.

The aim of this study is to determine the value of ambulatory blood pressure measurement (ABPM) in diagnosing hypotension in hypertensive diabetic patients with medication-controlled BP.

## Methods

This is a prospective study of patients with DM and controlled hypertension followed up at the outpatient clinics of King Abdulaziz University Hospital, Jeddah, Saudi Arabia between 2017 and 2018. Patients included in this study were diabetic, aged 25–80 years, had medication-controlled hypertension, and gave their consent to participate. As the aim of the study is to address patients without advance disease, we excluded the following cases: patients with advance renal disease; plasma creatinine level  $> 300 \mu\text{mol/L}$ ; end-stage heart failure, decompensated liver cirrhosis; end-stage pulmonary disease; advanced-stage non-cardiovascular disease (solid organ cancer, evolved dementia, leukemia); severe uncontrolled hyperglycemia or diabetic ketoacidosis, documented hypoglycemia and a severe decrease in ejection fraction (EF) less than 20% by echocardiography. The study was approved by the Ethics Research Committee of King Abdulaziz University.

In addition to demographic data and medical history (co-morbid conditions and medication use), baseline data collection included hypotensive symptoms, especially during orthostasis. The patients' BP readings were documented during routine office visits and during ABPM. Results of laboratory investigations, including a complete blood count, fasting blood sugar (FBS), glycated hemoglobin (HbA1C), thyroid function, liver enzymes, serum creatinine, serum electrolytes, 12-h fasting plasma lipid levels (total cholesterol, triglycerides, and low-density and high-density lipoprotein) were also documented. All laboratory tests were performed using standard laboratory techniques of King Abdulaziz university hospital.

## Blood pressure monitoring

ABPM values were recorded for all patients. We monitored BP according to standard protocols. A cuff of appropriate size for the arm circumference was attached to the non-dominant arm and the medical procedure was explained to the patient. Participants were instructed that the monitored arm had to be kept stationary during the 1- to 2-min period required to obtain readings and that the monitor would automatically repeat measurement in the case if the initial attempt was unsuccessful. A test BP reading was recorded for each participant at the time of fitting. The monitor was programmed to obtain readings as follows: every 30 min from 7 a.m. to 11 p.m. and every 60 min from 11 p.m. to 7 a.m. Each participant was provided with a data sheet to any hypotensive symptoms (dizziness, blurred vision, light headedness, syncope or near syncope attacks). A separate sheet was used to record their activities during the period of study and were instructed to record bedtime and arousal times. Similarly, participants were requested to document their meal and medication times. Monitors were removed after 24 h and the data were downloaded using the proprietary software. Daytime and night-time periods were defined in a time-dependent manner. Daytime analysis required 10 or more readings, whereas night-time analysis required at least 5 readings.

## Definitions

Hypotensive symptoms include dizziness, blurred vision, light headedness, syncope or near syncope attacks. Diabetes was defined as a fasting blood glucose  $\geq 7 \text{ mmol/L}$  or current use of any antidiabetic medication. Hypertension was defined as a systolic blood pressure  $\geq 140 \text{ mmHg}$  or diastolic blood pressure  $\geq 90 \text{ mmHg}$  or current use of any anti-hypertensive medication. Controlled hypertension was defined as a

systolic and diastolic pressure of 110–139 mmHg and 60–85 mmHg, respectively, while hypotension was defined as a systolic BP and diastolic values of <100 mmHg and <50 mmHg, respectively.

### Statistical analysis

The data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, US). Descriptive statistics were calculated for all variables. The independent T test and the one-way ANOVA were used to measure the differences in mean between different groups. Results are expressed as frequency (percent) mean (standard deviation [SD]) and interquartile range.

### Results

Of 926 patients screened in the department of medicine outpatient clinics, 231 patients had diabetes and hypertension and were taking antihypertension medications. We recruited 86 patients. Women comprised 52.3% of the sample ( $n = 45$ ). Mean age 60.2 years SD 10.4 (range, 31–86 years) there was no difference in age between males and females  $P = .26$

Hypotensive events were documented in 65 patients (75.6%) without any correlated symptoms in the patient observation sheet. Of these, 38 were women (58.5%). Table 1 shows the mean (SD) BP readings at rest as well as maximum and minimum BP values. Most patients were managed on angiotensin receptor blockers (ARBs) followed by beta blockers (Table 2). Hypotensive events were most commonly detected between 5 and 10 a.m. based on ABPM. The mean (SD) hemoglobin, sodium, potassium, and creatinine of the patients were within normal limits (Table 3).

Females were more likely to have a higher heart rate of 104.4 (SD 24.2) versus 95.3 (SD12.5) ( $P = 0.06$ ). Females were also more likely to have hypotensive episodes, 38 versus 27 ( $P = 0.39$ ). Patients with hypotensive events were significantly older – 60.7 SD11.3 and 58.7 SD7.1, respectively ( $P = 0.22$ ) and more likely to have a lower EF than those without hypotensive episodes 46.3 (SD27.7) versus 62.8 (SD7.8), respectively ( $P < 0.001$ ). Similarly, patients who had hypotensive episodes were more likely to have significantly lower resting blood pressure 82.4 (SD.11.6) and 92.4 (SD 10.4), respectively ( $P = 0.001$ ) (Table 1).

Patients on angiotensin-converting enzyme (ACE) inhibitor or ARBs had a higher EF than those prescribed other classes of anti-hypertensive medication 60 (SD 21) versus 41.8 (SD 29), respectively ( $P = 0.01$ ). However, there was no significant difference in EF between patients on beta blockers and those on other classes of anti-hypertensive agents ( $P = 0.38$ ). Similarly

**Table 1.** Mean blood pressure measurements and heart rate of the patients using ABPM.

Variable	Mean (SD)	Range
Resting systolic BP (mmHg)	143.0 (17.0)	110–192
Resting diastolic BP (mmHg)	84.8 (12.0)	57–110
Maximum systolic BP (mmHg)	158.6 (20.0)	91–204
Minimum systolic BP (mmHg)	109.0 (17.6)	75–181
Maximum diastolic BP (mmHg)	97.0 (14.0)	29–124
Minimum diastolic BP (mmHg)	55.0 (11.0)	35–95
Maximum HR	100.0 (20.0)	14–174
Minimum HR	61.0 (13.0)	29–96

BP: blood pressure; SD: standard deviation.

**Table 2.** Distribution of antihypertensive medications in the sample.

Antihypertension medication	Frequency (percent)
Beta blocker	27 (31.4)
Calcium channel blocker	24 (27.9)
Angiotensin converting enzyme inhibitor	22 (22.5)
Angiotensin receptor blocker	28 (32.6)
Thiazide diuretic	14 (16.3)

**Table 3.** Results of paraclinical investigations.

Variable <sup>a</sup>	Mean (SD)	Range
Hemoglobin (mg/dL)	13.0 (1.7)	7.00–16.5
Sodium (mmol/L)	135.3 (2.2)	13.0–151.0
Potassium (mmol/L)	4.0 (0.4)	3.1–5.2
Creatinine ( $\mu$ mol/L)	87.1 (4.2)	43.0–232.0
FBS (mmol/L)	7.4 (2.5)	4.5–17.3
HbA1c (%)	7.6 (1.9)	5.3–14.6

FBS: fasting blood sugar; HbA1c: glycated hemoglobin; SD: standard deviation.

<sup>a</sup>References ranges: Creatinine (53–115  $\mu$ mol/L), FBS (7), HbA1c (4–6.1), hemoglobin (14.0–17.5 g/dL), potassium (3.5–4.8 mmol/L), sodium (136–142 mmol/L).

patients on ACE or ARBs had significantly lower serum creatinine of 84.7 (SD29.4) and 91.2 (SD46.3) ( $P = 0.04$ ), respectively, compared to the other groups. There was numeric but non-significant difference in the day- or night-time occurrence of hypotensive episodes ( $P = 0.11$ ).

### Discussion

Our analysis indicated that 75.6% of our hypertensive diabetic patients with medication-controlled BP treated at the outpatient clinics of King Abdulaziz University Hospital experienced hypotensive events. This is much

higher than the 42.3% reported in a study by El Bakkali et al.<sup>10</sup> The disparity between our findings and those of the previous authors might be explained by the methodological differences. In that study, the authors reported average BP readings based on office BP measurements, whereas the present study is more thorough in the use of average ABPM values. Consequently, we were able to report BP fluctuations, decreasing the concern for missed hypotensive episodes compared to a protocol that measured only isolated office BP measurements.

In the current study, patients who demonstrated hypotensive events were significantly older and more likely to have a lower EF than those who did not have hypotensive episodes. Apart from neurodegenerative disorders (Parkinson's disease, multiple system atrophy, or autonomic neuropathies)<sup>11</sup> and chronic heart disease,<sup>12,13</sup> hypotension has been associated with aging.<sup>14,15</sup> In addition, both hypertension<sup>16</sup> and diabetes<sup>17</sup> conditions may contribute to impaired orthostatic homeostasis.

While patients on ARBs had a significantly higher EF than those on other classes of antihypertensive medication, as the echocardiography reports shows, our investigation did not determine the presence of other cardiovascular comorbidities, such as congestive heart failure (CHF) or ischemic heart disease. According to one report,<sup>18</sup> the use of a combination of ACE inhibitor and either a diuretic, mineral corticoid receptor antagonist, or nitrate in the treatment of CHF patients increases the risk of transient arterial hypotension. In patients with CHF, the risk of myocardial infarction is associated with the detection of systolic arterial hypotension episodes and the magnitude of diastolic arterial hypotension.<sup>18</sup> Thus, 24-h BP monitoring can substantially increase the detection rate of potentially dangerous BP fluctuations in patients with multiple comorbidities.

Although strict control of hypertension is recommended in diabetic patients to decrease microvascular and macrovascular complications,<sup>19–21</sup> physicians are faced with the challenge of treating hypertensive diabetic patients who also have an increased risk of developing orthostatic hypotension secondary to the associated diabetic autonomic neuropathy.<sup>22</sup> Furthermore, the risk of death in diabetic patients is increased in the advent of orthostatic hypotension.<sup>22</sup> Other reports have reported that the risk of orthostatic hypotension in diabetes can be decreased by achieving good glycemic control, as there is evidence that diabetic patients with poor glycemic control—as demonstrated by elevated HbA1C levels—are vulnerable to orthostatic hypotension.<sup>23,24</sup>

To the best of our knowledge, this is the first study to determine the value of ABPM in diagnosing

hypotensive episodes in diabetic patients with medication-controlled BP. It is an eye opening message to treating physicians that it is more than a single office reading that determined the patient response to anti-hypertensive medication and using ABPM is of value in this content. While the results indicate that ABPM may be beneficial in guiding physicians' management of hypertensive diabetic patients with medication-controlled BP, its limitations cannot be overlooked. First, the results have to be interpreted with caution owing to the small sample size. Second, our study design did not permit us to identify our patients' activities during hypotensive events. This is significant as hypotensive events have been reported in a previous report<sup>25</sup> to be closely related to patients' daily activities, especially in the elderly.

## Conclusion

In hypertensive diabetic patients on anti-hypertensive medication, office BP readings may be inadequate in determining BP control as bouts of hypotension may occur in the out-of-hospital setting. This study is a first step in identifying the importance of diagnosing hypotensive events using ABPM in hypertensive diabetic patients with medication-controlled BP. However, the limitations of this study are smaller in number and single center data collection, needing larger studies with more rigorous methods should be conducted, including using a controlled group, before relevant conclusions can be drawn.

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## Contributorship

None.

## Declaration of conflicting interests

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**References**

1. International Diabetes Federation. IDF diabetes atlas: sixth edition, [www.idf.org/diabetesatlas/download-book](http://www.idf.org/diabetesatlas/download-book) (accessed 20 July 2014).
2. Seo MH, Lee WJ, Park CY, et al. Management of blood pressure in patients with type 2 diabetes mellitus: a nationwide survey in Korean. *Diabetes Metab J* 2011; 35: 348–353.
3. Tyrberg M, Melander A, Lövestam-Adrian M, et al. 2007. *Retinopathy in subjects with impaired fasting glucose: the NANSY-Eye baseline report*. Jul 21.
4. Mancia G, De BG, Dominiczak A, et al. Management of arterial hypertension of the European society of hypertension, European Society of Cardiology. 2007 Guidelines for the Management of Arterial Hypertension: the task force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2007; 25: 1105–1187.
5. Blood Pressure Lowering Treatment Trialists' Collaboration. Effects of different blood pressure-lowering regimens on major cardiovascular events in individuals with and without diabetes mellitus: results of prospectively designed overviews of randomized trials. *Arch Intern Med* 2005; 165: 1410–1419.
6. Nayak UB, Acharya V, Jain H, et al. Clinical assessment of the autonomic nervous system in diabetes mellitus and its correlation with glycemic control. *Indian J Med Sci* 2013; 67: 13–22.
7. Vinik AI and Erbas T. Diabetic autonomic neuropathy. *Handb Clin Neurol* 2013; 117: 279–294.
8. Farrell C and Moran J. Comparison of comorbidities in patients with pre-diabetes to those with diabetes mellitus type 2. *Ir Med J* 2014; 107: 72–74. Mar
9. Purnell TS, Joy S, Little E, et al. Patient preferences for noninsulin diabetes medications: a systematic review. *Diabetes Care* 2014; 37: 2055–2062. Jul
10. El Bakkalil M, Benjelloun H, Rkain H, et al. A cross-sectional study evaluating orthostatic hypotension in normotensive and hypertensive patients with diabetes mellitus. *J Cardiovasc Dis* 2013; 1: 4–7.
11. Low PA and Singer W. Management of neurogenic orthostatic hypotension: an update. *Lancet Neurol* 2008; 7: 451–458.
12. Vaddadi G, Lambert E, Corcoran SJ, et al. Postural syncope: mechanisms and management. *Med J Aust* 2007; 187: 299–304.
13. Gorelik O, Almozino-Sarafian D, Litvinov V, et al. Seating-induced postural hypotension is common in older patients with decompensated heart failure and may be prevented by lower limb compression bandaging. *Gerontology* 2009; 55: 138–144.
14. Gupta V and Lipsitz LA. Orthostatic hypotension in the elderly: diagnosis and treatment. *Am J Med* 2007; 120: 841–847.
15. Hiitola P, Enlund H, Kettunen R, et al. Postural changes in blood pressure and the prevalence of orthostatic hypotension among home-dwelling elderly aged 75 years or older. *J Hum Hypertens* 2009; 23: 33–39.
16. Shin C, Abbott RD, Lee H, et al. Prevalence and correlates of orthostatic hypotension in middle-aged men and women in Korea: the Korean Health and Genome Study. *J Hum Hypertens* 2004; 18: 717–723.
17. Dimitropoulos G, Tahrani AA and Stevens MJ. Cardiac autonomic neuropathy in patients with diabetes mellitus. *World J Diabetes* 2014; 5: 17–39.
18. Serov VA, Shutov AM, Serova DV, et al. Prognostic value of detection of arterial hypotensive episodes in patients with chronic heart failure. *Ter Arkh* 2014; 86: 8–12.
19. Mudaliar S. New frontiers in the management of type 2 diabetes. *Ind J Med Res* 2007; 125: 275–296.
20. Clement M, Bhattacharyya O and Conway JR. Is tight glycemic control in type 2 diabetes really worthwhile? Yes. *Can Fam Physician* 2009; 55: 580, 582, 584, 586, 588.
21. Tandon N, Ali MK and Narayan KM. Pharmacologic prevention of microvascular and macrovascular complications in diabetes mellitus: implications of the results of recent clinical trials in type 2 diabetes. *Am J Cardiovasc Drugs* 2012; 12: 7–22.
22. Figueroa JJ, Basford JR and Low PA. Preventing and treating orthostatic hypotension: as easy as A, B, C. *Cleve Clin J Med* 2010 May; 77: 298–306.
23. Wu JS, Yang YC, Lu FH, et al. Population-based study on the prevalence and risk factors of orthostatic hypotension in subjects with pre-diabetes and diabetes. *Diabetes Care* 2009; 32: 69–74.
24. Briasoulis A, Silver A, Yano Y, et al. Orthostatic hypotension associated with baroreceptor dysfunction: treatment approaches. *J Clin Hypertens* 2014; 16: 141–148.
25. Palmi V, Jonsson MD, Lewis A, et al. Hypotensive responses to common daily activities in institutionalized elderly: a potential risk for recurrent falls. *Arch Intern Med* 1990; 150: 1518–1524.