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Orthostatic blood pressure recovery patterns in suspected syncope in the emergency department

Veera K van Wijnen,[1] Dik Ten Hove,[1] Reinold O B Gans,[1] Wybe Nieuwland,[2] Arie M van Roon,[1] Jan C Ter Maaten,[1] Mark P M Harms[1]

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[1]Department of Internal, Emergency and Vascular Medicine, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands
[2]Department of Cardiology, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

Correspondence to
Dr Mark P M Harms, Department of Internal, Emergency and Vascular Medicine, University Medical Center Groningen, University of Groningen, Groningen 9713 GZ, The Netherlands; m.p.m.harms@umcg.nl

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ABSTRACT

Introduction Orthostasis is a frequent trigger for (pre)syncope but some forms of orthostatic (pre)syncope have a worse prognosis than others. Routine assessment of orthostatic BP in the ED can detect classic orthostatic hypotension, but often misses these other forms of orthostatic (pre)syncope. This study aimed to determine the frequency of abnormal orthostatic BP recovery patterns in patients with (pre)syncope by using continuous non-invasive BP monitoring.

Methods We performed a prospective cohort study in suspected patients with (pre)syncope in the ED of a tertiary care teaching hospital between January and August 2014. Orthostatic BP was measured during the active lying-to-standing test with Nexfin, a continuous non-invasive finger arterial pressure measurement device. Orthostatic BP recovery patterns were defined as normal BP recovery, initial orthostatic hypotension, delayed BP recovery, classic orthostatic hypotension and reflex-mediated hypotension.

Results Of 116 patients recruited, measurements in 111 patients (age 63 years, 51% male) were suitable for analysis. Classic orthostatic hypotension was the most prevalent abnormal BP pattern (19%), but only half of the patients received a final diagnosis of orthostatic hypotension. Initial orthostatic hypotension and delayed BP recovery were present in 20% of the patients with (pre)syncope of whom 45% were diagnosed as unexplained syncope. Reflex-mediated hypotension was present in 4% of the patients.

Conclusion Continuous non-invasive BP measurement can potentially identify more specific and concerning causes of orthostatic (pre)syncope. Correct classification is important because of different short-term and long-term clinical implications.

Key messages

What is already known on this subject

► Classic orthostatic hypotension may be diagnosed with traditional orthostatic BP measurement. However, initial orthostatic hypotension, delayed BP recovery and reflex-mediated hypotension, forms of orthostasis that are more frequently associated with falls and mortality, are often missed using standard orthostatic BP testing.

What this study adds

► This prospective cohort study used a continuous, non-invasive BP monitoring to determine the frequency of abnormal orthostatic BP recovery patterns. While classic orthostatic hypotension was most prevalent in suspected patients with (pre)syncope, initial orthostatic hypotension and delayed BP recovery were present in a considerable number of patients. Continuous non-invasive BP measurement can potentially identify more specific and concerning causes of (pre)syncope.

INTRODUCTION

Suspected (pre)syncope in the ED is a difficult clinical problem and many patients are discharged without a diagnosis (17%–33%).[1] Orthostasis is a frequent trigger for (pre)syncope, but it is underappreciated that there are several forms of orthostatic (pre)syncope, associated with different underlying problems and degree of risk.[2] Initial orthostatic hypotension, delayed BP recovery, classic orthostatic hypotension and reflex-mediated hypotension are all recognised causes for (pre)syncope and falls, but delayed BP recovery and classic orthostatic hypotension present a higher risk because of the association with cardiovascular morbidity and mortality.[3]

Classic orthostatic hypotension is a common (4%–24%) cause of (pre)syncope and can be detected during routine orthostatic BP measurement.[1] However, the inability of the oscillometric orthostatic BP measurement to measure rapid BP changes limits further evaluation of other forms of orthostatic (pre)syncope. Moreover, the high rate of unexplained syncope justifies new evaluation strategies.[1]

Continuous non-invasive BP measurement can differentiate between abnormal orthostatic BP recovery patterns. Continuous non-invasive finger arterial pressure measurement is based on dynamic (pulsatile) unloading of the finger arterial walls using an inflatable finger cuff with built-in photoelectric plethysmograph.[4] From the finger waveform, heart beats are detected and systolic, diastolic and mean pressure and pulse rate are output in a beat-to-beat mode. The device has extensively been validated as a reliable method to track orthostatic changes in BP.[4]

As orthostasis is a frequent trigger for (pre)syncope, we aimed to determine the frequency of different orthostatic BP recovery patterns in patients with (pre)syncope in the ED that cannot be captured with intermittent measurements such as those with standard oscillometric BP cuffs.

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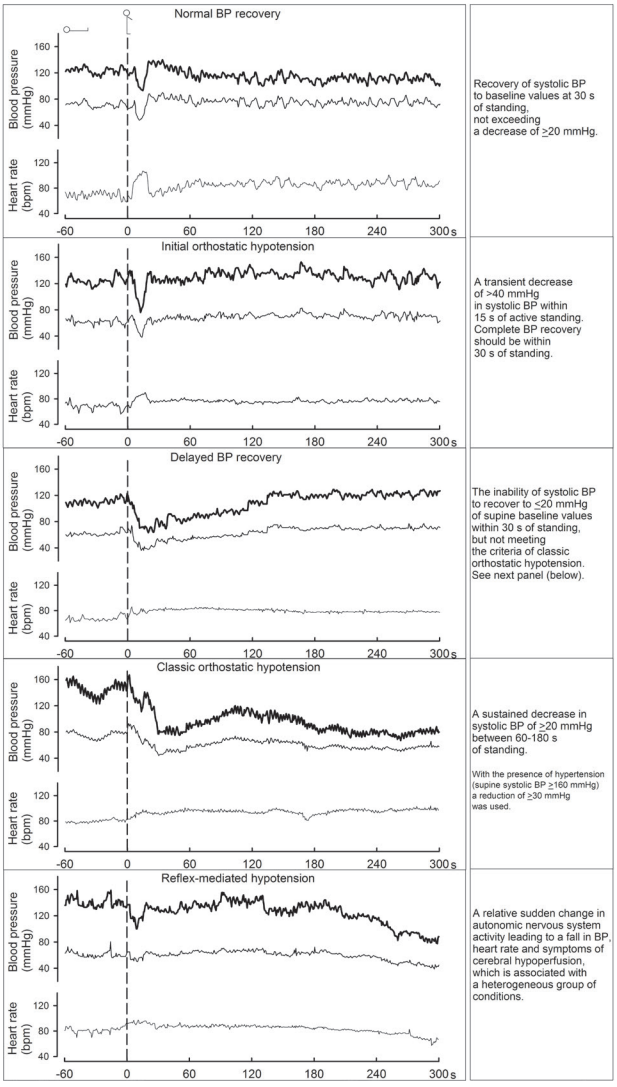

Figure 1 Definitions and illustrations of five distinct orthostatic BP recovery patterns on standing. Continuous non-invasive BP measurement during active lying-to-standing test in five suspected patients with (pre)syncope. Illustrated are the last 60 s in supine position and 300 s of standing. Systolic and diastolic BP and HR are shown.

METHODS

Setting

This prospective cohort study was conducted in the ED of a tertiary care teaching hospital, the University Medical Center Groningen, between January and August 2014.

Participants

All consecutive suspected patients with (pre)syncope older than 18 years visiting the ED Monday to Friday during regular working hours (08:00–18:00) were eligible. Patients were referred by ambulance emergency services, by general practitioner, by specialists or self-referred within 1 hour after the (pre) syncope episode. Patients were excluded if they were not able to stand for 5 min, were haemodynamically unstable (systolic BP <90 mm Hg), in need of immediate treatment or if informed consent was impaired by a cognitive disorder.

Syncope was defined as a transient loss of consciousness due to transient global cerebral hypoperfusion characterised by rapid onset, short duration and spontaneous complete recovery.[1] Presyncope was defined as the feeling of almost losing consciousness with similar prodromal symptoms as in syncope. Patients with presyncope are as likely as patients with syncope to experience critical interventions or adverse events like bradydysrhythmia and haemorrhage.[5 6]

Procedures and variables

After initial evaluation by the attending physician, patients were approached to participate in the study. Verbal informed consent was obtained from all patients. The orthostatic BP measurement was performed with Nexfin (BMEYE, Edwards Lifesciences, Irvine, California, USA), a continuous non-invasive finger arterial pressure measurement device. The finger cuff, a height correction unit which corrects for movements of the finger when the hand is not kept at heart level, and the wrist-worn unit are connected to a primary unit which holds the air pump, electronics and computer. At the start of the orthostatic BP measurement, patients were lying in supine position; the Nexfin wrist-worn unit was placed around the wrist and the appropriately sized finger cuff was placed around the middle finger. BP was measured continuously during 5 min of supine rest and 5 min after active standing up. Subsequently patients were asked whether they experienced any symptoms during standing, such as light-headedness, dizziness or blurred vision. Further details on the device and active stand protocol are available in the online Supplementary file 1. The orthostatic BP recovery patterns were defined according to a recent review (figure 1).[2]

Attending physicians in the ED work according to the syncope guideline of the European Society of Cardiology.[1] No specific criteria with regard to the diagnosis were given to the attending physicians. The attending physician was unaware of conclusive information obtained with continuous non-invasive BP measurement because this was not available at the time of the visit. The attending physician's final diagnosis was obtained from the discharge letter. Patient's demographic features, comorbidities and medication were also obtained from the discharge letter. These features were chosen because of the known association with abnormal orthostatic BP recovery patterns.[7]

The primary outcome of the study was the frequency of the different abnormal orthostatic BP recovery patterns. Secondary outcome was a comparison of the orthostatic BP patterns with the final diagnosis of the (pre)syncopal episode in the ED discharge letter.

RESULTS

One hundred and sixteen patients consented to participate. Measurements were suitable for analysis in 111 patients (median age 63±30 years, 51% male). Five measurements were excluded due to poor quality signal (artefacts) or signal interruptions. Sixty-six (59%) patients were referred because of syncope and 45 (41%) patients because of presyncope. Fifty-seven per cent of the 111 patients had a normal BP recovery, 7% had initial orthostatic hypotension, 13% delayed BP recovery, 19% classic orthostatic hypotension and 4% had reflex-mediated hypotension (table 1). Haemodynamic profiles of the different patterns are presented in figure 2.

Seven out of 45 (16%) patients classified by the attending physician as vasovagal syncope had classic orthostatic hypotension with continuous BP measurement (table 2). In patients classified as orthostatic hypotension by the attending physician, 11/18 (61%) had a positive test for classic orthostatic hypotension. In patients with a delayed BP recovery, 6/14 (43%) were

Table 1 Patient's characteristics based on the orthostatic BP recovery patterns

	All patients (n=111)	Normal BP recovery (n=63)	Initial orthostatic hypotension (n=8)	Delayed BP recovery (n=14)	Classic orthostatic hypotension (n=21)	Reflex-mediated hypotension (n=5)
Demographics						
Male, n (%)	56 (51)	30 (48)	3 (38)	8 (57)	11 (52)	4 (80)
Age, in years	63 (30)	59 (37)	62 (42)	73 (21)	62 (27)	66 (45)
Medical history, n (%)						
Hypertension	36 (32)	18 (29)	1 (12)	10 (71)	6 (29)	1 (20)
Myocardial infarction	14 (13)	8 (13)	–	4 (29)	1 (5)	1 (20)
Atrial fibrillation	20 (18)	7 (11)	3 (38)	5 (36)	5 (24)	–
Diabetes mellitus	15 (14)	9 (14)	1 (12)	2 (14)	3 (14)	–
Medication, n (%)						
Beta blocker	31 (28)	20 (32)	2 (25)	4 (29)	5 (24)	–
ACE-inhibitor	20 (18)	12 (19)	–	3 (21)	4 (19)	1 (20)
Angiotension II antagonist	14 (13)	4 (6)	2 (25)	5 (36)	2 (10)	1 (20)
Calcium antagonist	18 (16)	6 (10)	2 (25)	6 (43)	3 (14)	1 (20)
Diuretics	27 (24)	18 (29)	–	5 (36)	4 (19)	–
Symptoms of orthostatic intolerance, n (%)						
During orthostatic test	42 (38)	18 (29)	3 (38)	5 (36)	11 (52)	5 (100)
History of (pre)syncope	77 (69)	44 (70)	5 (62)	9 (64)	16 (76)	3 (60)
Admission, n (%)	21 (19)	8 (13)	1 (12)	6 (43)	4 (19)	2 (40)

The dichotomous values are given in number of patients (n) with %. Age: median with IQR.

classified as unexplained syncope. The presumed aetiology of the cardiac causes were cardiac ischaemia (n=1) and arrhythmia (n=9). Arrhythmia was further subdivided into non-sustained ventricular tachycardia (n=1), ventricular fibrillation followed by implantable cardioverter defibrillator-discharge (n=1), bradycardia with atrioventricular block (n=3) and atrial flutter/atrial fibrillation (n=4). The management of patients with presyncope and syncope, respectively, consisted of admission (16% vs 21%), referral to an outpatient department (49% vs 20%), referral to the general practitioner (11% vs 9%) or no specific management (24% vs 50%).

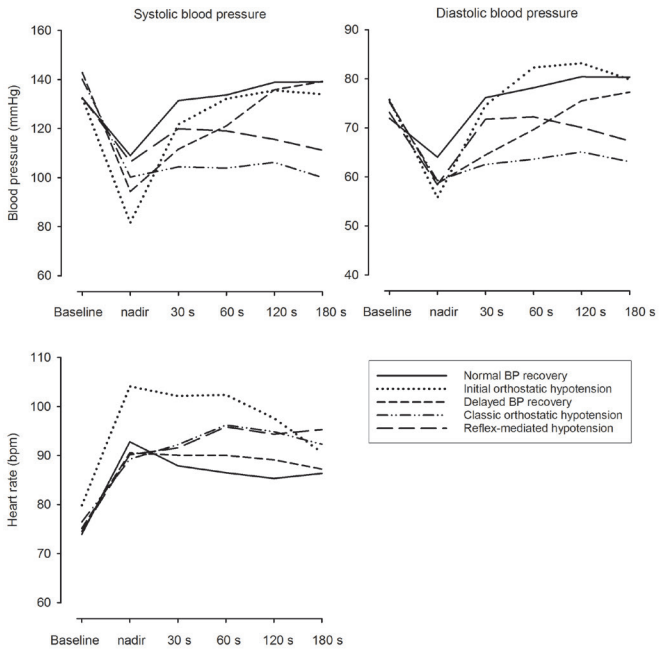

Figure 2 Haemodynamic profiles of the different orthostatic BP recovery patterns. Continuous non-invasive orthostatic BP measurement in 111 patients with (pre)syncope. Median BP and HR values are presented at baseline, nadir, 30, 60, 120 and 180 s after standing up. Orthostatic BP recovery patterns are classified as normal BP recovery (n=63), initial orthostatic hypotension (n=8), delayed BP recovery (n=14), classic orthostatic hypotension (n=21) and reflex-mediated hypotension (n=5).

DISCUSSION

In this study, we found that 43% of the patients with (pre) syncope had an abnormal orthostatic BP recovery pattern. Classic orthostatic hypotension (19%) was most frequently detected, followed by delayed BP recovery (13%), initial orthostatic hypotension (7%) and reflex-mediated hypotension (4%). The aim of this study was to describe the frequency of abnormal orthostatic BP recovery patterns that cannot be captured by oscillometric BP measurement.

Current research in the ED is directed towards risk stratification associated with syncope.[8 9] Thereby, two important elements are considered: risk of death and life-threatening events and risk of recurrence and physical injury.[1] With increasing age, syncope secondary to underlying cardiovascular disease becomes more common.[10] Besides structural heart disease as a major risk factor for sudden cardiac death and overall mortality, classic orthostatic hypotension is associated with a twofold higher risk of death owing to the severity of comorbidities.[1] Based on recent studies, similar risks are prevalent in subjects with delayed BP recovery.[3] Furthermore, to prevent recurrences, correct identification of the cause of the (pre)syncopal episode and appropriate treatment and advices are important.

Classic orthostatic hypotension was the most prevalent abnormal orthostatic BP recovery pattern on continuous monitoring, with a three times higher prevalence than in the general population.[11] In this study, only 61% of patients classified as having orthostatic hypotension by the attending physician had a positive continuous BP test for classic orthostatic hypotension, while 48% of patients with a positive test for classic orthostatic hypotension received a different working diagnosis from the attending physician. There are several factors that can explain this difference. Either the diagnosis was given without

Table 2 Syncope classification by attending physician versus orthostatic BP recovery pattern

Diagnosis by attending physician, n(%)	All patients (n=111)	Normal BP recovery (n=63)	Initial orthostatic hypotension (n=8)	Delayed BP recovery (n=14)	Classic orthostatic hypotension (n=21)	Reflex-mediated hypotension (n=5)
Vasovagal reflex syncope	45 (41)	31 (69)	1 (2)	3 (6)	7 (16)	3 (7)
Situational reflex syncope	9 (8)	5 (56)	1 (11)	2 (22)	1 (11)	–
Orthostatic hypotension	18 (16)	4 (22)	–	1 (6)	11 (61)	2 (11)
Cardiac syncope	10 (9)	6 (60)	2 (20)	2 (20)	–	–
Unexplained syncope	29 (26)	17 (59)	4 (14)	6 (21)	2 (6)	–

Classification of the cause of syncope diagnosed by the attending physician. The attending physician performed his usual syncope evaluation in the ED. Conclusive information about the orthostatic BP recovery patterns was not available at the time of diagnosis.

performing orthostatic BP measurement or measurement result was not taken into account or the test was not performed correctly or it was inaccurate. The prevalence of classic orthostatic hypotension as the cause of syncope in the literature lies between 4% and 24% and probably depends on whether the test has been performed (accurately) and the age of the population.[12] Correctly classifying classic orthostatic hypotension is important because of the short-term risk of recurrences and falling and long-term association with cardiovascular morbidity and mortality.[3 10 13] Classic orthostatic hypotension can be caused by primary or secondary autonomic failure, it can be drug induced (eg, vasodilators, antidepressants) or caused by volume depletion.[1] Treatment and advice are dependent on the underlying cause.[13]

It is only recently that delayed BP recovery has been recognised as a cause of unexplained falls and (pre)syncope and has been associated with similar short-term and long-term risks as classic orthostatic hypotension.[3 10] In the present syncope guidelines by the European Society of Cardiology and by ACC/AHA/HRS, delayed BP recovery, as a variant of orthostatic hypotension, is not mentioned.[1 14] In our population, 43% of the patients with delayed BP recovery were classified as unexplained syncope. Compared with those with classic orthostatic hypotension, patients with delayed BP recovery were older, had higher prevalence of hypertension and had a higher admission rate. Delayed BP recovery can be seen as a physical sign of subclinical impaired physiology.[3] Therefore, we suggest that (older) patients presenting to the ED with a history of orthostatic (pre)syncope shortly after standing up, but with a negative oscillometric orthostatic BP measurement, be referred to a syncope unit to detect the underlying cause.[15]

Initial orthostatic hypotension was present in eight (7%) patients in our study. This is a common (3%–10%) but unrecognised cause of syncope usually seen in younger patients.[16] The clinical diagnosis is based on a typical history of (pre)syncope directly on standing and no classic orthostatic hypotension during oscillometric orthostatic BP measurement.[17] The diagnosis becomes 100% certain with detection of initial orthostatic hypotension during continuous non-invasive BP measurement and recognisable symptoms. Recognition by the physician is important because management is simple and effective, that is, get up slowly and clench the buttocks (counterpressure manoeuvres).[16 17] When these manoeuvres abort recognisable symptoms in the patient, the diagnosis is confirmed.[17]

LIMITATIONS

The number of patients within the different orthostatic BP recovery patterns is relatively small. Nonetheless, this study was observational and primarily intended to determine the frequency of several forms of orthostatic (pre)syncope. Furthermore, continuous BP measurements were only performed during workdays. Nevertheless, the classification of syncope by the attending physician (table 2) was similar to other studies performed in the ED.[1] Although we found that many patients with (pre)syncope had indeed an abnormal BP pattern, further assumptions about potential misdiagnosis by the attending physician could not be made, because this was not part of the study protocol. Moreover, we did not observe orthostatic BP measurements by the attending physicians and can therefore not state whether this was performed correctly or whether orthostatic testing was absent. Currently, we are investigating whether continuous orthostatic BP measurement in the ED is of added value in addition to extensive history taking.

CONCLUSION

Continuous non-invasive BP measurement can potentially identify more specific and concerning causes of (pre)syncope than separate oscillometric measurements. Correct classification is important because of the short-term and long-term clinical implications.

Contributors VKvW, DTH, WN, JCTM and MPMH conceived the study and designed the study protocol. JCTM acquired the waiver from the Institutional Review Board. VKvW and DTH performed the measurements and VKvW, DH, MPMH and AMvR performed the analysis. ROBG critically revised the manuscript. All authors contributed to the final draft of the manuscript.

Competing interests None declared.

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