ORIGINAL ARTICLE

Prevalence of orthostatic hypotension in the unselected ambulatory population of persons aged 65 years old and above

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Abstract

Background. The diagnostic recommendation for orthostatic hypotension (OH) is to measure blood pressure during the first 3 min after getting up from a lying position. There are no clear definitions as to the amount of time that the patient should lie down before this, and the number of measurements to be taken in lying and standing positions. The aim of this study was to identify the optimal time to measure blood pressure when lying and standing. Methods. This was a prospective study of 99 patients aged 65 years and above in an urban primary care clinic. Blood pressure was measured at 1 min intervals over 10 min in the lying position and 7 min standing. Results. OH was found in 37 patients (37.4%). Of these, 56.8% were identified in the 1st minute, 67.6% after 2 min and 83.8% after 3 min of standing. In all cases, participants with OH were asymptomatic. In the lying position, blood pressure stabilized after 7 min, but when the 7th minute was used as a reference for OH many cases were lost. Conclusion. To optimize the identification of OH, blood pressure should be measured at 1 min intervals over the first 3 min after standing up. The amount of time that patients should lie down before blood pressure is measured standing up still has to be determined.

Key Words: 65 years and above, orthostatic hypotension, primary care

Introduction

The definition of orthostatic hypotension (OH) has changed over recent decades. In 1996, the Consensus Statement on the Definition of Orthostatic Hypotension was published (1). In this statement, OH was diagnosed as a drop in systolic blood pressure of at least 20 mmHg or in diastolic blood pressure of at least 10 mmHg within 3 min of standing. In 2011, a consensus statement was published (2) in which a new definition was added to the existing ones: a drop in systolic pressure of 30 mmHg if hypertension is recorded while lying down. In addition, two types of OH were defined: initial OH in which a drop in systolic pressure of 30 mmHg if hypertension is recorded while lying down. When the drop in blood pressure occurs more than 3 min after standing or tilting the table.

The prevalence of OH in populations aged 65 years old and above ranges from a relatively low rate of 6.9% (3) to 27–38% in most studies (4–7). An association was found between OH and an increased prevalence of significant medical problems including falls (8,9), syncope (9), cardiac events (10,11), atrial fibrillation (12), heart failure (13,14), stroke (15) and mortality (3,11,16–18). Thus, proper identification of OH is of great medical significance.

The variance in the prevalence rates for OH is related, at least in part, to the method of measurement. In a study of the practices of nurses who measured blood pressure, the measurement time ranged from immediately following standing to as much as
30 min later (19). Other studies also demonstrated large gaps in the timing of blood pressure measurement after standing. These differences appear to stem from a lack of clarity as to the existing definitions: measuring within 3 min of standing could mean immediately or it could mean during the 3rd minute after standing. There is also variance in parameters such as the time for which the patient should lie down before blood pressure is measured, the timing of measurement after standing and the number of measurements that should be carried out. It is possible that, in some studies in which standing blood pressure was measured only once, cases of OH were missed (3,9,11,20–26).

Whether or not blood pressure should be measured later than 3 min after standing is also unresolved. In a study of patients in an emergency room, OH was identified in most of the subjects (83.5%) within 3 min of standing (27), but OH can also appear later on.

The aim of the present study was to determine the optimal timing for measurement of OH where the majority of cases are identified and measurement time is kept to a minimum.

Methods

This was an observational study of patients aged 65 years or more in the Ashdod D primary care clinic of Maccabi Health Services, Israel, where there are 524 patients in this age group. Patients who came to the clinic were asked if they would like to participate in the study. Inclusion criteria were men and women 65 years old and above who were independent in ambulation. Exclusion criteria included patients who could not lie on their back for 10 consecutive minutes, patients who could not stand on their own or with help for 7 consecutive minutes, patients with a severe tremor that prevented blood pressure measurement with an automatic instrument, and patients with cognitive impairment that could render them incapable of providing informed consent to take part in the study.

The procedures were in accordance with the ethical standards of the responsible institutional committee on human experimentation and with the Helsinki Declaration of 1975 (as revised in 1983). The Helsinki committee of Maccabi Health Services approved the study (approval 32/2012). Those eligible patients who agreed to participate in the study signed informed consent. Information on their health condition and medications that they were taking was recorded from their medical charts. The Charlson Co-morbidity Index was used to assess co-morbidity (28). The participants underwent a brief in-person interview in which information was obtained about their socioeconomic status and their medications were verified. At that time, height and weight were also measured.

Following the interview, the cuff of the blood pressure device was adjusted to the patient and the automatic Scholar III 507 EL monitor (manufacturer: CSI - Criticare Systems, Inc.) was calibrated. The cuff was then placed on the patient’s arm and the patient lay down flat with the hands along the body axis. From the moment that the patient lay down, blood pressure was measured every minute for 10 min. After the 10th measurement, the patient was asked to stand up with his or her supported hand horizontal to the body. The first blood pressure measurement was then taken within 1 min of standing and was repeated at 1 min intervals another six times. During the measurement, the patient was asked about OH-related symptoms, such as dizziness or weakness.

Definitions

In this study we used the following diagnostic criteria:

- **Systolic OH (OHS):** a drop of 20 mmHg or more standing compared to the last measurement lying down.
- **Diastolic OH (OHD):** a drop of 10 mmHg or more standing compared to the last measurement lying down.
- **“Any OH” (systolic or diastolic OH):** a drop of 20 mmHg or more in systolic pressure or 10 mmHg or more in diastolic pressure compared to the last measurement lying down.

Sample size calculation

The sample size calculation was based on the assumption that blood pressure stabilizes 7 min after a change in posture in 90% of the patients. To test this hypothesis compared to the alternative hypothesis that blood pressure stabilizes in less than 80% of the patients, with a power of 80% and significance at 5%, and assuming that the correlation between the first and last measurements is \( r = 0.75 \), the sample size would have to be at least 89 participants. Assuming a missing value rate of 10%, there would have to be at least 98 recruits to the study.

Data analyses

Data analyses were conducted using the SPSS software (version 21). The subjects were divided into two groups: “any” orthostatic hypotension positive (OHP) and orthostatic hypotension negative (OHN). Fisher’s exact tests or chi-squared tests were used for categorical variables and \( t \) tests or analysis of variance (ANOVA) for continuous variables. Differences in blood pressure values between the various time-points were analyzed using paired \( t \) tests. The level of statistical significance was set at \( p < 0.05 \) (two-sided).
Results

Characteristics of the study population

The study was conducted between September 2012 and April 2013. In all, 99 patients agreed to take part in the study and met the inclusion criteria.

The mean age was 73.6 ± 5.3 years with a range from 65 to 89 years. Women comprised 49.5% of the study population.

Prevalence of orthostatic hypotension

“Any” OH was diagnosed in 37 subjects (37.4%), 25 (25.3%) had OHS and 21 (21.2%) had OHD. None of the patients with OH was symptomatic (had a history of dizziness, etc.).

Comparison between the orthostatic hypotension positive and negative groups

Table I shows comparative data between the OHP and OHN groups. Other than a lower percentage of women in the OHP group (37.8% vs 58.0%, p = 0.052), there were no significant differences between the groups.

Table II shows the various patterns of blood pressure measurements, after standing, in the two groups. The systolic blood pressure dropped in the OHN group from 135.5 ± 16.1 mmHg in the last minute of lying to 134.5 ± 18.9 mmHg after the 1st minute of standing up. The mean systolic blood pressure value in the 2nd minute after standing (137.0 ± 17.5 mmHg) was higher than in the last minute lying (135.5 ± 16.1 mmHg) and continued to increase up to the 7th minute after standing (none of the differences was statistically significant).

In contrast, the systolic blood pressure dropped in the OHP group after standing, from 137.0 ± 16.4 mmHg to 122.7 ± 20.2 mmHg. The blood pressure trended upwards during the course of standing, but at no stage did it reach the level measured after the 10th minute of lying down. The blood pressure was 132.8 ± 16.8 mmHg in the 7th minute of standing.

In the OHN group, the diastolic blood pressure rose from 69.3 ± 9.2 mmHg in the last minute of lying to 73.8 ± 10.4 mmHg in the 1st minute after standing and then remained high in comparison to...
Table II. Blood pressure fluctuations over 17 measurements with 1 min intervals in the orthostatic hypotension (OH) negative and positive groups.

<table>
<thead>
<tr>
<th>Time of measurement</th>
<th>OH negative (62 participants)</th>
<th>OH positive (37 participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Systolic BP (mmHg)</td>
<td>Diastolic BP (mmHg)</td>
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<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>1 min of lying</td>
<td>144.2 ± 19.0</td>
<td>73.3 ± 11.2</td>
</tr>
<tr>
<td>2 min of lying</td>
<td>139.3 ± 18.2</td>
<td>71.5 ± 10.6</td>
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<tr>
<td>3 min of lying</td>
<td>137.8 ± 17.4</td>
<td>70.4 ± 10.2</td>
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<tr>
<td>4 min of lying</td>
<td>137.4 ± 17.9</td>
<td>71.2 ± 10.1</td>
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<td>5 min of lying</td>
<td>135.7 ± 17.1</td>
<td>70.1 ± 9.7</td>
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<tr>
<td>6 min of lying</td>
<td>137.2 ± 16.5</td>
<td>70.2 ± 10.4</td>
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<tr>
<td>7 min of lying</td>
<td>135.6 ± 16.4</td>
<td>69.8 ± 8.8</td>
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<td>8 min of lying</td>
<td>136.5 ± 16.5</td>
<td>70.9 ± 9.3</td>
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<tr>
<td>9 min of lying</td>
<td>136.8 ± 15.9</td>
<td>69.7 ± 9.7</td>
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<tr>
<td>10 min of lying</td>
<td>135.5 ± 16.1</td>
<td>69.3 ± 9.2</td>
</tr>
<tr>
<td>1 min of standing</td>
<td>134.5 ± 18.9</td>
<td>73.8 ± 10.4</td>
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<tr>
<td>2 min of standing</td>
<td>137.0 ± 17.5</td>
<td>74.9 ± 10.4</td>
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<td>3 min of standing</td>
<td>138.6 ± 16.0</td>
<td>74.4 ± 10.5</td>
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<td>4 min of standing</td>
<td>139.0 ± 16.3</td>
<td>74.8 ± 10.5</td>
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<td>5 min of standing</td>
<td>139.0 ± 16.1</td>
<td>75.4 ± 10.1</td>
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<td>6 min of standing</td>
<td>139.5 ± 14.4</td>
<td>74.5 ± 9.9</td>
</tr>
<tr>
<td>7 min of standing</td>
<td>140.0 ± 15.8</td>
<td>74.5 ± 10.4</td>
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Blood pressure (BP) data are shown as mean ± SD.
Ref., reference.
<p value calculated compared with the 10th minute of lying.

Blood pressure measurement while standing

Figure 1 shows that 56.8% of all cases of OH were identified in the 1st minute after standing, 67.6% in the 2nd minute and 83.8% in the 3rd minute. Figure 2 shows the number of cases of OH that would have been identified if the blood pressure had been measured at only one of the time-points. Thus, if blood pressure had been measured at the 2nd minute alone, only 32.4% of all cases of OH would have been identified.

Figure 3 shows the percentage of “unique” cases of OH that would have been identified if there had been only one measurement. “Unique” cases were defined as those in which only one measurement been identified. In contrast, in the OHP group, the diastolic blood pressure dropped from 71.9 ± 8.4 mmHg to 67.9 ± 10.8 mmHg in the 1st minute after standing and then rose in the 2nd minute and continued to rise until the 7th minute, when a second drop was recorded, to 69.6 ± 9.1 mmHg.

Blood pressure measurement while standing

Figure 1 shows that 56.8% of all cases of OH were identified in the 1st minute after standing, 67.6% in the 2nd minute and 83.8% in the 3rd minute. Figure 2 shows the number of cases of OH that would have been identified if the blood pressure had been measured at only one of the time-points. Thus, if blood pressure had been measured at the 2nd minute alone, only 32.4% of all cases of OH would have been identified.

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showed a drop in blood pressure that met the criteria for the diagnosis of OH. In all, there were 14 unique cases of OHS and 10 of OHD. This graph shows that if we had skipped over the first measurement we would have missed six (24.0%) of the patients with OHS and three (14.3%) with OHD. If blood pressure had not been measured at the 2nd or 3rd minute after standing, we would have missed two (8.0%) and three (12.0%) of the OHS cases, respectively. Another interesting finding is that in the measurement after 7 min of standing, three (14.3%) cases of “unique” OHD were identified.

The precision of the Scholar III 507 IL Monitor, which was used for blood pressure measurements in the present study, is ≥ 2 mmHg. Accordingly, we determined that lying blood pressure stabilized when the change in blood pressure was not greater than 2 mmHg between any particular minute measurement lying down and the measurement at any minute-interval measurement up to the last one. Table II shows that systolic blood pressure “stabilized” in the OHN group after the 4th minute lying down and diastolic blood pressure stabilized in this group after the 3rd minute lying down. In contrast, systolic and diastolic blood pressure stabilized only after the 7th and 2nd minutes lying down, respectively, in the OHP group. Thus, we suggest that it may be enough to measure blood pressure for 7 min after lying down rather than 10 min. When the blood pressure measurement in the 7th minute after lying down was taken as the reference point, 17 cases of OHS, 19 cases of OHD and 28 cases of “any” OH were identified. At the same time, 12 cases of OHS, six cases of OHD and 13 cases of “any” OH that were identified when blood pressure was measured in the 10th minute lying down, were missed using the measurement at the 7th minute as the reference point. Yet, using the 7th minute measurement, four cases of OHS, four cases of OHD and four cases of “any” OH were identified that were missed using the measurement at the 10th minute as the reference point.

**Discussion**

In the present study, conducted among adults age 65 years old and above living in the community, the prevalence rate for OH was 37.4%. This result is a little higher than the findings in most studies in similar populations (6,9,18,29), in which the prevalence ranged from 20% to 34%. Some community studies found even lower prevalence rates. Thus, in the study by Applegate et al. (30), in the population of the Systolic Hypertension in the Elderly Program (SHEP), the prevalence of OH was only 17.3%, but only systolic blood pressure was measured in that study. In another study, conducted among American
men of Japanese descent, the Honolulu Heart Program (3), a prevalence of 6.9% was found for OH. In that study, blood pressure was measured only once, after 3 min standing. In the study by Walczak (21) among individuals aged 65 years old and above in a day-care center, in which blood pressure was measured once at 2 min after standing, the prevalence of OH was 28%. In another study, among patients aged 65 years old and above in a primary care clinic (24), in which blood pressure was measured only once at 5 min after standing, the prevalence of OHS was 13% and OHD was 18%. The common characteristic of all studies with lower prevalence rates for OH was that only systolic blood pressure was measured, or blood pressure was measured only once.

In the present study, blood pressure was measured seven times, minute after minute, during the first 7 min after standing. If we had measured blood pressure only once, at the 1st minute after standing, we would have identified only 21 (56.8%) of the 37 cases of OH and the prevalence would have been 21.2% (Figure 2).

Based on Figures 2 and 3, skipping any measurement point would reduce the precision in case identification for OH. However, in the present study more than 80% of the cases of OH were identified over the course of the first 3 min of standing. These results are similar to the findings of Cohen et al., who found that 83.5% of all cases of OH was identified within 3 min of standing (27). Since in daily practice in today's overloaded clinics the duration and number of measurements need to be limited to a minimum, it would appear that three measurements over the first 3 min after standing may be sufficient. On the other hand, in a significant number of patients OH may appear after a longer period of standing (5–7 min) (24,31,32). Thus, in patients at high risk for OH (advanced age, treatment with relevant drugs, presence of dizziness, syncope, hypertension, heart failure, Parkinson's disease or other predisposing factors for OH), it may be worthwhile to evaluate blood pressure for a longer time than the traditional period of 3 min.

Another aim of this study was to determine the optimal amount of time that patients should lie down before standing. In previous studies, the time before standing ranged from 1 min (22) to 20 min (10,21). The mean time for lying was 5 min (9,18,24,27,33–36) or 10 min (6,20,25,37,38).

The number of measurements while lying also varied from study to study. In most cases, blood pressure was measured once before standing (3,6,9,11,18,20–25,27,29,33–36), while in other studies blood pressure was measured more than once (4,5,10,25,38–40).

In the present study, blood pressure in the OHP group stabilized after 7 min lying down, but when this point was used as the reference for the calculation of OH, many cases of systolic and diastolic OH were missed and “new” cases of OH were “discovered”. The explanation for this phenomenon is fluctuations in blood pressure in each specific case. In one of the cases, for example, OHS was found at the 7th minute lying down, but not at the 10th minute. Systolic blood pressure was 151 mmHg at the 7th minute lying down and 147 mmHg at the 10th minute lying down, while in the 1st minute after standing up it was 128 mmHg. However, cases with inconsistent results between the two definitions of OH (1,2) were found not only among participants with supine hypertension. For example, in one case systolic blood pressure lying down was 132 mmHg at the 7th minute, 121 mmHg at the 10th minute and 106 mmHg after standing up.

Thus, while on the one hand reducing the amount of lying time led to a loss of some cases of OH, on the other it led to the identification of new cases. That being the case, it would not be possible, on the basis of the findings of the present study, to make recommendations as to the specific amount of time that the patient should lie down before standing up.

In light of the differences between previous studies in measurements lying down and based on the findings of the present study, one can raise the question as to the true rate of OH in the population. In addition, if the previous studies that investigated associations between OH and morbidity and mortality used non-uniform criteria in terms of time lying down as well as the timing and number of blood pressure measurements after getting up, can we have confidence in the results of those studies?

In the present study, there was an increase in the number of cases of OH at the 7th minute standing up. One explanation for this finding may be that the participants were familiar with the study protocol and knew that they were reaching the end of the measurements. It is possible that emotional changes related to the end of the study affected blood pressure in the last measurement. In the OHP group, an increase of 2.3 ± 6.8 mmHg was observed in systolic blood pressure between the 5th and 6th minutes and a decrease of 1.6 ± 7.9 mmHg between the 6th and 7th minutes of standing (p = 0.03). In this group, there was a decrease in diastolic blood pressure of 0.5 ± 5.1 mmHg and 2.8 ± 9.6 mmHg between the 5th and 6th and the 6th and 7th minutes of standing, respectively. These differences were not statistically significant (p = 0.21).

In the OHN group, these differences were different. The increase in systolic blood pressure between the 5th and 6th and the 6th and 7th minutes was 0.7 ± 7.5 mmHg and 0.4 ± 8.4 mmHg, respectively (p = 0.6). The diastolic blood pressure decreased by 0.9 ± 4.2 mmHg between the 5th and 6th minutes and did not change (0.0 ± 4.4 mmHg) between the 6th and 7th minutes of standing.
(p = 0.44). Therefore, one can assume that people with and without OH react differently to emotional stimuli.

Interestingly, 44 of the 99 participants (44.4%) had supine hypertension (systolic blood pressure ≥ 140 mmHg at the 10th minute lying down). In 12 of the 44 participants (27.3%) with supine hypertension OH was diagnosed, and in six of them (13.6%) in more than one measurement. Patients with supine hypertension may have normal blood pressure on standing, which is a good sign, although often neglected in the clinic. These patients, although classified as having OH, demonstrate dysautonomia in the supine position, but not upon standing. In this case, 24 h ambulatory blood pressure monitoring should be mandatory and may be helpful in tailoring therapy to the patient.

All participants with OH in this study were asymptomatic. The clinical significance of asymptomatic OH is not fully clear, and probably does not lead to a poor prognosis including increased mortality (41). On the other hand, assessment of OH is especially important in symptomatic patients, and if confirmed, further extensive evaluation, including cardiac assessment and 24 h blood pressure monitoring, should be performed (42). In such patients, beat-to-beat technology and the head-up tilt test, which are more robust for the assessment of OH than usual lying/standing blood pressure measurement (43), should be used.

This study has several limitations. First, although we recruited subjects based on sample size calculations, the final number of participants was relatively small. Second, we did not have data regarding whether usual medications were taken before performing blood pressure measurement. Third, during the course of the study we did not record the hour in which the measurement was made. In the study by Weiss et al. (39), a higher prevalence of OH was found in the morning and afternoon, and a lower prevalence was found in the evening hours. In contrast, Gabbet and Gass (44) found that orthostatic responses do not change over the course of the day, week, month or year. We also did not record the amount of time that passed between meals and measurements. In the past, an association was found between meals and OH (45,46).

Finally, in busy clinics, it is difficult to measure the blood pressure over a protracted period. Therefore, we decided to measure blood pressure over 7 min of standing only. However, since in some cases OH can appear later, this time restriction is a limitation of the study.

In conclusion, the results of our study confirm previous findings that OH is common. Over 80% of OH cases were diagnosed within the first 3 min of standing. In order to avoid missing some of these cases, blood pressure should be measured three times over the course of these 3 min, once every minute.

To ensure consistency in future studies, it is important to determine an exact point of time to measure blood pressure lying down before measuring it after standing up.

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