Orthostatic Hypotension in Acute Geriatric Ward
Is It a Consistent Finding?

Avraham Weiss, MD; Ehud Grossman, MD; Yichayau Beloosesky, MD; Joseph Grinblat, MD

Background: Orthostatic hypotension (OH) is a common finding among older patients. We designed a study to examine the prevalence and consistency of OH during the day.

Methods: A total of 502 inpatients (241 men and 261 women) with a mean age of 81.6 years were included in the study. Orthostatic tests were performed 3 times during the day, 30 minutes after meals. In 13 patients only 2 sets of measurements were obtained, and they were omitted from some of the calculations. Orthostatic hypotension was defined as a fall of at least 20 mm Hg in systolic blood pressure and/or 10 mm Hg in diastolic blood pressure on assuming an upright posture.

Results: Three hundred thirty-two (67.9%) of 489 patients experienced OH at least once during the day. Of these, 170 patients (34.8% of the 489) had OH at least twice (persistent OH) and 162 patients (33.1%) experienced OH only once (variable OH). Diastolic OH was more prevalent than systolic OH (57.3% vs 43.4%; $P<.001$). The intraindividual consistency of OH was low ($\kappa=0.2$). Orthostatic hypotension was observed less frequently during the evening than during the morning and afternoon ($P<.05$ vs morning and $P=.003$ vs afternoon). The difference between meals' constituents (light vs heavy meals) did not affect the prevalence of OH.

Conclusions: Orthostatic hypotension is very common in the elderly, and diastolic OH is more common than systolic OH. The prevalence of OH is the lowest during the evening, and meals do not increase the prevalence of OH. The intraindividual consistency of OH during the day is poor. Thus, in elderly patients, more attention should be paid to diastolic OH and the diagnosis should be based on repeated measurements.

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ORTHOSTATIC hypotension (OH) is a relatively common finding among the elderly, occurring in 5% to 50% of those patients.1-13 Because of age-related physiologic changes in the cardiovascular system and a blunted response to the recruitment of the sympathetic system, older people tend to be more vulnerable to orthostatic stress than younger ones.5 Some conditions, such as hypertension, diabetes mellitus, low blood volume, and use of medications, may even further impair the ability of the elderly to cope with this stress.5,7,10,16

Patients with OH have difficulties walking,8,17 are more susceptible to falls, with their consequences,17-22 experience more frequent dizziness and syncope5,23-27; tend to develop coronary events and transient ischemic attacks or strokes,5,6,19,20, have poor prognosis if they are diabetic and hypertensive,6; have decreased quality of life,30,31; and might have a higher mortality rate.11,32 Hence, the diagnosis of OH is important for the treatment of elderly patients and is based on blood pressure (BP) measurements in both the supine and the upright positions. Several studies evaluated the reproducibility of OH.33,34 However, data from these studies yielded conflicting results. It remained unclear whether OH is affected by diurnal changes or is consistent throughout the day.

We, therefore, designed a study to determine the consistency of OH in elderly patients throughout the day.

METHODS

STUDY POPULATION

During a 2-year period (January 1, 1999, to December 31, 2000), 1852 patients were admitted to our acute 25-bed geriatric ward. Of these, 502 consecutive patients were enrolled in this study.

Patients were included in the study if they were at least 60 years old, able to get out of bed alone or with minor assistance, and able to stand up for at least 5 minutes. Patients were
BLOOD PRESSURE MEASUREMENTS

Blood pressure and heart rate were measured with a device (Vital Signs Monitor 52 NTP model, Welch Allyn Protocol, Inc, Beaverton, Ore) that was checked every day for accuracy against a mercury sphygmomanometer.

Measurements were taken in the supine and the standing positions 3 times a day, 30 minutes after meals: between 8 and 9 AM after breakfast; between 1 and 2 PM after lunch; and between 5 and 6 PM after dinner. Because of technical problems, repeated physical examinations, we obtained only an oral consent from the patients.

Definition of OH

Orthostatic hypotension was defined as a fall of at least 20 mm Hg in systolic BP (SBP) and/or 10 mm Hg in diastolic BP (DBP) on assuming an upright posture, as suggested by the Consensus Committee of the American Autonomic Society and the American Academy of Neurology.35 We defined OH according to BP changes and not according to symptoms.

DATA COLLECTION

For each of the patients, the following variables were recorded: age, height, weight, body mass index, ethnicity or origin, reason for admission, diagnoses, and list of the main drugs used.

In addition, laboratory results of complete blood cell count and serum levels of glucose, urea, creatinine, sodium, potassium, thyrotropin, vitamin B12, and folic acid were recorded.

STATISTICAL ANALYSIS

Results are reported as mean ± SD. Patients were divided into 3 groups: persistent OH for those who exhibited OH at least twice during the day, variable OH for those who exhibited OH only once during the day, and no OH for those without OH.

The difference in OH rate between morning, afternoon, and evening was tested by McNemar test. The difference between frequency of systolic and diastolic OH was tested by McNemar test for morning, afternoon, and evening. Test-retest consistency of OH was determined by means of the κ coefficient. To estimate the consistency, we also analyzed whether the orthostatic BP response in the morning could predict the additional responses during the day. We therefore used the χ² test to estimate the risk for at least 1 finding of OH in the afternoon or evening among 3 subgroups: those who experienced OH, those who had BP fall in the nonorthostatic range, and those who experienced no orthostatic BP fall in the morning.

The effect of sex on OH was tested in 2 ways. To assess if there was a difference at least 1 time during the day, we used the Mantel-Haenszel test for all 3 times. To find the time of day with the largest difference, we used the χ² test for morning, afternoon, and evening separately. Values of P < .05 were considered significant.

RESULTS

PATIENTS’ CHARACTERISTICS

The study population included 502 patients (241 men and 261 women) with a mean age of 81.6 years. Women had a higher baseline supine SBP than men (150 ± 25/72 ± 15 mm Hg vs 143 ± 23/72 ± 14 mm Hg; P = .002) and were less likely than men to be smokers (4.6% vs 32%; P < .001). Other baseline characteristics were similar between men and women. Hypertension and ischemic heart disease were the most common underlying diseases, and most patients used diuretics, angiotensin-converting enzyme inhibitors, and calcium antagonists. The main clinical characteristics, drugs used, and reasons for hospitalizations are given in Table 1.

PREVALENCE OF OH

Three hundred thirty-two (67.9%) of 489 patients experienced OH at least once per day. Of these, 170 patients (34.8%) had OH at least twice (persistent OH) and 162 patients (33.1%) experienced OH only once (variable OH). Diastolic OH was more prevalent than systolic OH (P < .05). Two hundred eighty-eight (57.4%) of 502 patients experienced diastolic OH (DBP decline ≥10 mm Hg) at least
Orthostatic hypotension is a common disorder in the elderly. In the present study, 34.8% of the patients had persistent OH and 33.1% had variable OH. We studied sick hospitalized patients, and our results may not be applicable to outpatients. However, our patients were studied before their discharge, and the reason for admission was only slightly and not significantly higher than the reason for admission, whereas it was related to smoking ($P = .02$) and use of antiarrhythmic agents ($P = .01$), $\alpha$-blockers ($P = .02$), and anticholinergic agents ($P < .001$).

**The Effect of Sex on Orthostatic BP Response**

Supine BP levels were higher in women than in men (Table 3; $P < .05$). Orthostatic BP fall was significantly greater in men than in women (Table 3; $P < .05$). During the afternoon, the prevalence of OH was higher in men than in women (Table 4; $P < .05$). Adjustment for smoking and use of $\alpha$-blockers that affect orthostatic BP response eliminated the differences between sexes.

**Consistency of OH**

The intraindividual consistency of OH was low ($\kappa$ coefficient=0.2). The consistency was poor also for systolic and diastolic OH ($\kappa$ coefficient=0.29 and 0.16, respectively). However, orthostatic BP response during the morning predicted OH during the day. Among 192 patients who experienced OH in the morning, 135 (70.3%) had persistent OH, whereas among 133 patients with no orthostatic BP fall, only 53 (39.8%) had persistent OH (Table 5; $P < .001$).

**The Effect of Time of Day and Lunch on Orthostatic BP Response**

Supine BP was the lowest during the afternoon (Table 6; $P < .001$). Orthostatic BP fall was significantly greater during the afternoon, after lunch (the main, heavy meal of the day), than during the morning and the evening (Table 6; $P < .001$), but the rate of OH in the afternoon was only slightly and not significantly higher than the rate during the morning. Orthostatic hypotension was observed less frequently during the evening than during the morning and the evening (Table 6; $P < .05$ vs morning and $P = .003$ vs afternoon). Among those who experienced OH in the afternoon, 22.3% had no OH in the evening, whereas among those who experienced OH in the evening, only 14.1% had no OH in the afternoon ($P < .05$).

**Comment**

Orthostatic hypotension is a common disorder in the elderly. In the present study, 34.8% of the patients had persistent OH and 33.1% had variable OH. We studied sick hospitalized patients, and our results may not be applicable to outpatients. However, our patients were studied before their discharge, and the reason for admission was only slightly and not significantly higher than the reason for admission, whereas it was related to smoking ($P = .02$) and use of antiarrhythmic agents ($P = .01$), $\alpha$-blockers ($P = .02$), and anticholinergic agents ($P < .001$).
important component in the regulation of postural changes in DBP. Patients with contracted blood volumes and hyperadrenergic states tended to have an increase in DBP while standing. It is possible that our patients had well-balanced blood volume and had low adrenergic tone and therefore exhibited a high prevalence of diastolic OH. Alternatively, it is possible that elderly sick patients have reduced arterial sensitivity to the compensatory effect of the sympathetic nervous system. Indeed, diastolic OH was not associated with symptoms, but since diastolic OH may better predict vascular death than systolic OH, and since this phenomenon is common in the elderly, we suggest that there should be greater focus on postural diastolic BP changes.

Since OH is common and may explain symptoms of dizziness and recurrent falls, it is important to assess the consistency of this finding. Several studies found poor day-to-day reproducibility of the diagnosis of OH. In the present study, we found that the intraindividual consistency during the day is relatively poor, as the values were quite low. This poor consistency may be due to the multiple medications used by the studied population. Recently, Puisieux et al also found, in a small group of patients, remarkable within-day variability in postural BP change. Unlike our findings, Youde et al

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<th>Table 3. Blood Pressure (BP) and Heart Rate (HR) During the Day by Sex</th>
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<td><strong>Time of Day</strong></td>
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<td><strong>Men</strong></td>
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*P < .05 vs men.

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<th>Table 4. Rates of Orthostatic Hypotension (OH) by Sex</th>
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<td><strong>No. (%) of Patients</strong></td>
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<td><strong>No. (%) of Patients</strong></td>
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<td><strong>Supine BP, mm Hg</strong></td>
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*P < .05 vs morning and evening.
†P = .003 vs afternoon, ‡P < .05 vs morning.

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<th>Table 6. Postural Response and Rate of Orthostatic Hypotension (OH) During the Day</th>
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<td><strong>No. (%) of Patients</strong></td>
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*P < .05 vs morning and evening.
†P = .003 vs afternoon, ‡P < .05 vs morning.
found consistency in postural changes in BP within days and across days. However, they studied only a small group of 22 relatively healthy and not very old patients. Despite the relatively poor consistency, our results showed that the postural BP changes in the morning could predict, to some extent, the response during the rest of the day. Among those with OH in the morning, 70% had persistent OH (at least 1 additional OH during the day), whereas among those with no BP fall in the morning, only 39.8% had persistent OH.

Because older subjects tend to have lower BP after food intake,44-47 we assumed that OH might be more prevalent after lunch. We therefore compared the postural BP response in the early afternoon shortly after lunch with the response in the morning and evening. Supine BP was lower and the postural BP fall was more remarkable after lunch, but the prevalence of OH was the same as in the morning. Thus, the main meal lowered BP and accentuated the postural drop in BP, but the magnitude of the BP drop was mild and did not increase the rate of OH. Other investigators also failed to show increased prevalence of OH after a meal.13,34 Other possible causes, in addition to food intake, for the large within-day variability may be related to drug intake or diurnal hormonal changes.

Ooi et al33 and Puisieux et al34 found that OH was more prevalent in the morning before breakfast than during the rest of the day. We found that OH was less prevalent during the evening. During the evening, supine BP was similar to that of the morning, but the postural drop in BP and the prevalence of OH were significantly less in comparison with the findings during the morning and afternoon. This observation cannot be explained by diurnal hormonal variation, since the elevated morning levels of catecholamines and corticotropin should increase BP levels and prevent postural BP drop. Thus, some other factors should play a role in the diurnal variability of OH. Sodium reabsorption is important to maintain BP levels and prevent OH. Circadian variations in renal sodium handling may contribute to the variability of the orthostatic syndrome, as suggested by Pechere-Bertschi et al.28 Alternatively, slow adaptive mechanisms such as increased muscle tone after activities throughout the day may increase the “pumping up” of venous blood toward the heart, thereby attenuating postural BP fall.9,50

In conclusion, we found that OH is very common in the elderly and that diastolic OH is more common than systolic OH. The intraindividual consistency of OH during the day is poor, even though morning OH can, to some extent, predict subsequent responses during the day. Lunch slightly accentuates the postural fall in BP, but not the prevalence of OH. The prevalence of OH is the lowest during evening. Thus, more attention should be paid to diastolic OH and the diagnosis should be based on repeated measurements during the day.

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