

Influence of Orthostatic Hypotension on Mortality Among Patients Discharged from an Acute Geriatric Ward

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BACKGROUND: Orthostatic hypotension (OH) is a common finding among older patients. The impact of OH on mortality is unknown.

OBJECTIVE: To study the long-term effect of OH on total and cardiovascular mortality.

PATIENTS AND METHODS: A total of 471 inpatients (227 males and 244 females), with a mean age of 81.5 years who were hospitalized in an acute geriatric ward between the years 1999 and 2000 were included in the study. Orthostatic tests were performed 3 times during the day on all patients near the time of discharge. Orthostatic hypotension was defined as a fall of at least 20 mmHg in systolic blood pressure (BP) and/or 10 mmHg in diastolic BP upon assuming an upright posture at least twice during the day. Patients were followed until August 31, 2004. Mortality data were taken from death certificates.

RESULTS: One hundred and sixty-one patients (34.2%) experienced OH at least twice. Orthostatic hypotension had no effect on all cause and cause specific mortality. Over a follow-up of 3.47 ± 1.87 years 249 patients (52.8%) had died 83 of whom (33.3%) had OH. Age-adjusted mortality rates in those with and without OH were 13.4 and 15.7 per 100 person-years, respectively. Cox proportional hazards model analysis demonstrated that male gender, age, diabetes mellitus, and congestive heart failure increased and high body mass index decreased total mortality.

CONCLUSIONS: Orthostatic hypotension is relatively common in elderly patients discharged from acute geriatric wards, but has no impact on vascular and nonvascular mortality.

KEY WORDS: orthostatic hypotension; elderly; mortality.

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Orthostatic hypotension (OH) is a common clinical finding in old people. Its prevalence ranges from 5% to 50%^{1,2} and may even encompass more than 67% among hospitalized old patients.³ The elderly are especially prone to various kinds of postural blood pressure (BP) drops because of both physiological and pathophysiological processes.⁴ A low body mass index,^{5,6} high BP, Parkinson disease, stroke, transient ischemic attacks, and diabetes mellitus are all associated with OH.⁷ Medications, volume depletion, immobility, and autonomic insufficiency may also contribute to OH.⁸ Its clinical consequences vary from lack of symptoms through lightheadedness, dizziness, falls, syncope, or even coronary and cerebrovascular events.⁹⁻¹² A few aspects of the clinical relevance of OH are under debate. One such issue relates to the effect of OH on the cognitive status of the elderly.¹³⁻¹⁶

The impact of OH on mortality is unclear; some claim that in certain circumstances OH even in lower than the consensus values might increase mortality,^{7,17,18} while others have not found any cause and effect at all.^{2,19}

We therefore decided to study the mortality rate among a cohort of patients who were evaluated for OH between the years 1999 and 2000 and were followed for 3.47 ± 1.87 years.

PATIENTS AND METHODS

Study Population

Between the years 1999 and 2000 we performed orthostatic tests on 502 consecutive patients who were hospitalized in an acute 25-bed geriatric ward in a community hospital serving an area of 250,000 citizens. 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. Most patients came from either private or sheltered homes where they led independent lives and had the standard health insurance applied by the law in Israel. Patients were studied during their convalescence, 3 days before their planned discharge from the hospital. The study was approved by the local Helsinki committee. As the study did not include any active intervention we obtained only an oral consent from the patients.

Patients were followed until August 31, 2004. Records on mortality were obtained from the day of the orthostatic test until the end of the follow-up period.

Data Collection

For each of the patients the following parameters were recorded; age, height, weight, body mass index (BMI), ethnicity or origin, reason for admission, diagnoses, and a list of the main drugs used.

Mortality data from the January 1, 1999 to August 31, 2004 were taken from the Bureau of Population Registry of the Ministry of Interior and the causes of death were taken from the medical records and death certificates.

Out of the 502 patients originally included in the study, 31 patients were lost to follow-up and therefore only 471 patients who had their entire database completed were enrolled in the present study. The baseline characteristics of those who were excluded were similar to the 471 patients who were included in the study.

None of the authors have any conflicts of interest to declare.

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BP Measurements and Orthostatic Test

Blood pressure and heart rate were measured with a device (Vital Signs Monitor 52 NTP model, Welch Allyn Protocol, Inc., Beaverton, OR) 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 beginning 3 days before planned discharge. The BP was measured in the supine position after at least 5 minutes of complete bed rest, and then after 2 minutes of standing. The BP was measured twice, 1 minute apart, in each position and the average of the 2 measurements was recorded.

Orthostatic hypotension was defined as a fall of at least 20 mmHg in systolic BP (SBP) and/or 10 mmHg in diastolic BP (DBP) upon assuming an upright posture at least twice during the day.³

Statistical Analysis

The results are reported as mean \pm SD. Age-adjusted mortality rates, expressed per 100 person-years of follow-up, were calculated according to OH status. Kaplan-Meier's curves were used for 1-way comparison of survival for OH and non-OH patients (while using log-rank and Wilcoxon tests for group's comparison). Survival of OH and non-OH patients was also compared using Cox proportional hazard regression model, adjusting for additional factors such as age, gender, diabetes mellitus, hypertension, BMI, ischemic heart disease (IHD), congestive heart failure (CHF), smoking, Parkinsonism, and medications used. In addition, 2 indicator variables were built to identify patients with more than 1 chronic disease and patients who consumed more than 1 type of medication. The results are presented as hazard ratios (HR) and 95% confidence intervals (CI). All independent variables, including all 2-way interactions were entered/withdrawn from the model according to stepwise method. The variable was entered into the model if it made a significant contribution at the .15 level of significance, and it was removed, if after subsequent addition of other variables to the model, it no longer made a contribution at the .05 level of significance. Age, BMI, SBP, and DBP were defined as continuous variables, diseases presence/medications use were define as dichotomous variables.

The proportional hazards assumptions were tested using Baseline Empirical Cumulative Hazards Function $\hat{H}_0(t)$. The influence of the same factors was also tested by using logistic regression models.

Continuous variables were compared by using the Student's *t*-test/analysis of variance, and categorical variables by using χ^2 test. Because of multiple comparisons, we applied Bonferroni correction for significance level. A *P*-value $< .0023$ indicated a significance level of .95.

RESULTS

Study Population

The study population included 471 patients (227 men) with a mean age of 81.5 years. Hypertension and IHD were the most common underlying diseases, and most patients used diuretics, angiotensin-converting enzyme inhibitors, and calcium antagonists. Of those 161 patients (34.2%) had OH at least

Table 1. Characteristics of Patients With and Without OH

Characteristics	Without OH	With OH	P-Value
	(n=310)	(n=161)	
	Mean \pm SD	Mean \pm SD	
Age (y)	81.4 \pm 6.9	81.7 \pm 6.7	.69
Gender (male/female)	139/171	88/73	.05
BMI (kg/m ²)	25.3 \pm 4.5	24.8 \pm 4.5	.26
Supine morning SBP (mmHg)	145 \pm 24	150 \pm 25	.03
Supine morning DBP (mmHg)	71 \pm 14	75 \pm 16	.008
Supine morning HR (beats/min)	77 \pm 14	76 \pm 14	.23
<i>Comorbid diseases</i>			
Hypertension	184 (59.4%)	111 (68.9%)	.045
Ischemic heart disease	176 (56.7%)	91 (56.5%)	1.0
Stroke	91 (29.2%)	59 (36.6%)	.12
Congestive heart failure	109 (35.3%)	38 (23.3%)	.01
Diabetes mellitus	88 (28.4%)	50 (31.1%)	.6
Chronic lung disease	69 (22.4%)	37 (23%)	.9
Parkinsonism	36 (11.7%)	24 (14.9%)	.4
Patients with more than 1 disease	203(65.5%)	112 (69.6%)	.37
<i>Medications used</i>			
Diuretics	114 (36.8%)	47 (29.2%)	.10
ACE inhibitors	102 (32.9%)	46 (28.6%)	.4
Calcium antagonists	90 (29%)	49 (30.4%)	.75
Nitrates	89 (28.7%)	42 (26.1%)	.59
β -blockers	52 (16.8%)	33 (20.5%)	.32
Sleeping pills	89 (28.7%)	39 (24.2%)	.33
Patients with more than 1 medication	167 (53.9%)	78 (48.4%)	.26

BMI, body mass index; OH, orthostatic hypotension; ACE, angiotensin converting enzyme; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.

twice during the initial evaluation. Patients who experienced and those who did not experience OH were similar in regard to age, BMI, history of IHD, diabetes mellitus, chronic lung disease, Parkinsonism, and medications (Table 1). Patients with OH had less CHF but were more likely to be hypertensive and had higher baseline supine BP levels than those without OH (Table 1). The most common reasons for admissions were stroke (24%), infections (18%), weakness (11%), CHF (5%), and syncope (3.6%). The prevalence of OH was unrelated to the reason for admission.

Mortality Rate

There were a total of 249 deaths in the entire cohort over a mean follow-up of 3.47 ± 1.87 years (range 1.6 to 5.34 years). The mortality rate was 15.3 per 100 person-years. Those who died and those who remained alive were similar in regard to age, baseline supine morning BP and heart rate, hypertension, stroke, chronic lung disease, and medications (Table 2). Those who died had lower BMI and were more likely to be men and to have IHD, CHF, diabetes mellitus, Parkinsonism, and more than 1 disease (Table 2).

The main causes for mortality were cardiovascular diseases, sepsis, and malignancy. Women died less from cardiovascular reasons (Hazard ratio [HR]=0.68; CI [0.47 to 0.98], *P*=.036). As for some patients we identified more than 1 cause of death we have 291 causes for 249 deaths. In 127 deaths (51%) cardiovascular causes were recorded, in 111 deaths (44.6%) sepsis was recorded and in 34 deaths (13.6%) malignancy was recorded.

Table 2. Characteristics of Survivors and Nonsurvivors

Characteristics	Alive	Died	P-Value
	(n=222) Mean ± SD	(n=249) Mean ± SD	
Age (y)	79.4 (6.5)	83.4 (6.6)	.4
Gender (male/female)	94/128	133/116	.02
BMI (kg/m ²)	26.3 (4.55)	24.2 (4.16)	.0001
Supine morning SBP (mm Hg)	148 (24.2)	145 (24.4)	.98
Supine morning DBP (mmHg)	72.8 (13.7)	71.5 (15.4)	.92
Supine morning HR (beats/min)	75.7 (13.7)	77.5 (13.6)	.18
<i>Comorbid diseases</i>			
Orthostatic hypotension	78 (35.1%)	83 (33.3%)	.67
Hypertension	142 (64%)	156 (63%)	.7
Ischemic heart disease	115 (52%)	153 (61%)	.03
Stroke	69 (31%)	83 (33%)	.6
Congestive heart failure	53 (24%)	94 (38%)	.0015
Diabetes mellitus	56 (25%)	84 (34%)	.04
Chronic lung disease	42 (19%)	64 (26%)	.1
Parkinsonism	17 (8%)	44 (18%)	.0014
Patients with more than 1 disease	130 (58.6%)	185 (74%)	.0004
<i>Medications used</i>			
Diuretics	69 (31%)	94 (38%)	.15
ACE inhibitors	66 (30%)	83 (33%)	.4
Calcium antagonists	68 (31%)	75 (30%)	.9
Nitrates	53 (24%)	80 (32%)	.05
β-blockers	48 (22%)	37 (15%)	.07
Sleeping pills	61 (27%)	70 (28%)	.9
Patients with more than 1 medication	115 (51.8%)	130 (52.2%)	.93

BMI, body mass index; OH, orthostatic hypotension; ACE, angiotensin converting enzyme; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.

Effect of OH on Mortality

Total mortality rate was the same in those who experienced and those who did not experience OH. Of those who had OH, 83 patients (52%) died, and of those who did not have OH 166 (54%) died during the follow-up period ($P=.7$). The age-adjusted mortality rate was 13.4 and 15.7 per 100 person-years in those with and those without OH, respectively. Of those who died, 83 (33.3%) had OH and of those who remained alive 78

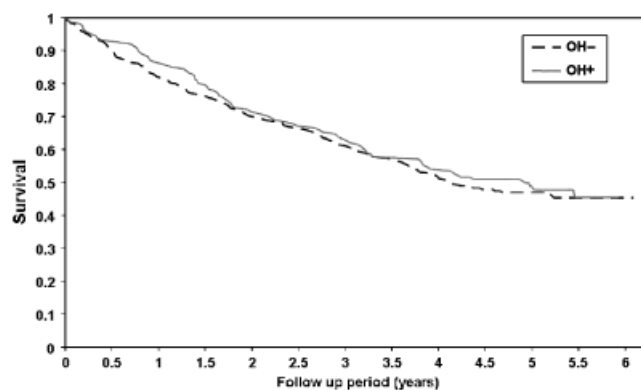


FIGURE 1. Probability of mortality by orthostatic hypotension (OH) status. (OH -, without OH; OH+, with OH). Kaplan-Meier curves for 3.47 years total mortality rate in association with OH. (Wilcoxon test, $P=.44$, Log-rank test, $P=.56$). Rows indicate the number of persons under observation at each time period.

Table 3. Factors Affecting Survival (Cox Proportional Hazards Model)

Variable	Hazard Ratio	95% Confidence Interval
Male gender*	1.54	1.14 to 2.05*
Diabetes mellitus*	1.58	1.15 to 2.15*
Age (1 y)	1.08	1.05 to 1.10†
BMI (1 kg/m ²)	0.90	0.88 to 0.94†
CHF	1.40	0.98 to 2.02
OH	0.96	0.72 to 1.28
Hypertension	1.22	0.84 to 1.79
IHD	0.98	0.67 to 1.40
Smoking	0.83	0.55 to 1.20
Stroke	0.97	0.72 to 1.30
Chronic lung disease	1.34	0.95 to 1.89
Parkinsonism	1.36	0.94 to 1.93
More than 1 disease	0.99	0.61 to 1.62
<i>Medications used</i>		
Diuretics	1.19	0.81 to 1.75
ACE inhibitors	0.92	0.60 to 1.35
Calcium antagonists	0.99	0.70 to 1.39
Nitrates	1.32	0.90 to 1.88
β-blockers	0.82	0.54 to 1.23
Sleeping pills	1.03	0.74 to 1.42
More than 1 medication	0.94	0.58 to 1.55

BMI, body mass index; CHF, congestive heart failure; OH, orthostatic hypotension; IHD, ischemic heart disease.

* $P \leq .005$; † $P < .0001$.

(35.1%) had OH (Table 2; $P=.67$). Kaplan-Meier survival analysis according to OH status showed a similar mortality in those with and without OH (Fig. 1; $P=.44$). Patients without OH died more than those with OH from CHF ($P=.009$). A multivariate Cox proportional hazards model analysis demonstrated that male gender, age and diabetes mellitus increased, and high BMI decreased total mortality (Table 3), whereas OH, hypertension, and other diseases or drug used had no effect on mortality (Table 3).

DISCUSSION

In our present study we did not find an increase in the 3.47-year risk of all cause and cause-specific mortality in patients who experienced OH while hospitalized in an acute geriatric ward. Orthostatic hypotension was diagnosed in 34.2% of our patients and was the same in those who died and in those who remained alive. This is a relatively high rate of OH reflecting a high-risk population with a high rate of concomitant diseases. Very few studies evaluated the impact of OH on mortality in elderly subjects.^{7,17,18} Masaki et al.¹⁷ found OH in 10.2% of the subjects older than 85 years. Luukinen et al.⁷ found OH in 30% of the subjects, but they examined the subjects on 2 separate days at an average interval of 3 months. Sasaki et al.¹⁸ found OH in 42% of the patients, but they examined patients with chronic renal failure. It is well known that the reproducibility of OH is low and the rate may vary during the day.^{3,20} Therefore more than 1 examination should be performed before a diagnosis of OH can be established. We performed orthostatic tests 3 times during the day and we included in the present analysis only those who exhibited OH at least twice. Some other studies that evaluated the effect of OH on mortality defined OH according to only 1 observation.^{7,17}

In our cohort, OH did not predict all-cause and cause-specific mortality. Several studies found that OH is an inde-

pendent predictor of mortality.^{7,17,18} In one study, diastolic OH after 1 minute and systolic OH after 3 minutes were associated with excess vascular death but not with nonvascular mortality.⁷ Masaki et al.¹⁷ found a significant relationship between OH and total mortality among 3,741 elderly Japanese men, but they did not evaluate cause-specific mortality. Sasaki et al.¹⁸ found that OH at the introductory phase of hemodialysis was an independent predictor of all-cause mortality.

Unlike these findings, 2 Finnish studies which also investigated community dwelling elders, found no correlation between OH and mortality.^{2,19} Similarly, Hossain et al.²¹ failed to show a higher mortality rate among nursing home residents with OH.²¹ The inconsistent results may be related to the type of subjects included in the various studies. Our cohort included very high-risk patients as the mortality rate was 15.3 per 100 person-years in comparison with only 3.86 to 11.2 per 100 person-years in some other studies.^{7,17,18,21,22} The patients in our cohort were very old, relatively sick, and probably less mobile than the subjects studied by others.^{7,17} As a result they were less exposed to the deleterious effects of OH like falls and their consequences. This may explain, at least in part, why OH did not affect mortality in our cohort.

Alternatively, the setting in which the orthostatic test was performed was unique, as our patients were recovering from an acute disease. This may affect the occurrence of OH and may explain the high frequency of OH found among our population.³ We cannot exclude the fact that some of our patients did not have OH after their discharge. The effect of hospitalization on OH was described in a small study in a rehabilitation unit. In this study OH was found upon admission in 37 old patients, but resolved in 23 on discharge.²³ If this is true, then some of our patients did not have OH in the long-run and therefore OH during hospitalization had no effect on long-term mortality. It may be worthwhile to divide patients with OH into 2 subgroups; those with episodic OH during acute illness and those with established OH who exhibit sustain OH on repeated examinations in the community.

It is possible that only established OH has a worse impact on mortality,^{24,25} whereas episodic OH, as in our cohort, has no effect on long-term mortality.

Unlike some other studies that assessed total mortality,^{17–19,21} we assessed also cause specific mortality and we did not observe any effect of OH on cardiovascular or noncardiovascular mortality. We did, however, observe the effect of age, gender and diabetes mellitus on survival. These findings are in accordance with data regarding survival in elderly patients.^{26–30} Therefore, we believe that our cohort of elderly patients, admitted to an acute medical ward, was a typical and a representative one.

Our study had several limitations because some patients were lost to follow-up and we do not have information regarding the influence of OH on nonfatal outcomes and whether the OH resolved after discharge. However, these limitations have no effect on the major observation that OH found in elderly patients discharged from acute geriatric wards has no impact on vascular and nonvascular mortality.

Summary and Conclusions

Orthostatic hypotension, found in elderly patients admitted to an acute geriatric ward, has no effect on all cause and cause specific mortality. Further large-scale studies are needed to

find out whether OH observed during hospitalization persists beyond discharge.

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