JACOBS PUBLISHERS

OPEN ACCESS

Jacobs Journal of Gerontology

Research article

Falls and Orthostatic Hypotension in Older Adults: Re-examining Limits

Alycia Cleinman MD*[1], Michael E. Griswold PhD[2], Eleanor M. Simonsick PhD[3], W. Mark Meeks MD[1], Katharine T Gregg MD[1], Luigi Ferrucci MD PhD[3], B. Gwen Windham MD MHS[1]

[1]*University of Mississippi Medical Center, Department of Medicine, Division of Geriatrics*

[2]*University of Mississippi Medical Center, Department of Data Science*

[3]*National Institute on Aging*

**Corresponding author:* *Dr. Alycia Cleinman, 2500 North State Street, Jackson MS 39216, Tel: (601) 984-5610; Fax: (601) 984-5783; Email: acleinman@umc.edu*

Received: *12-17-2016*

Accepted: *01-18-2017*

Published: *05-23-2017*

Objectives:

To assess associations between falls risk and [1] consensus-defined orthostatic hypotension (cOH), [2] standing blood pressure (BP) levels, [3] BP changes with standing, [4] combined standing BP levels and BP changes with standing.

Design:

Observational study of normative aging.

Setting:

Baltimore Longitudinal Study of Aging

Participants:

Participants >65 years with first visits evaluating orthostatic hypotension (OH) and self-reported falls (2004-2010).

Measurements: BP was measured supine and 3 minutes after standing. A drop in systolic BP (SBP) >20mmHg or a drop in diastolic BP (DBP) >10mmHg upon standing defined cOH. Participants self-reported the number of falls experienced in the previous 12 months.

Statistical Analysis:

Logistic and multinomial logistic regressions reporting odds ratios (OR) examined relations of falls to cOH, continuous standing SBP and DBP, or changes (drops) in BPs (SBP and DBP) upon standing in separate models. Models were adjusted for age, sex, race, impaired vision, use of anti-hypertensive medications, diabetes and use of anti-depressant medications. Modification of relations of SBP drops to falls by attained standing SBP were examined using interaction terms.

Results:

Among 400 participants (45% women; 30% black; mean age 74.8 years), 113 (28%) reported >1 fall; 19 (4.8%) had cOH. Risk of any fall was nearly 3 times greater with cOH compared to no cOH (OR=2.82, 95% CI: 1.01-7.87 p=0.048) and was 21% higher for each 5mmHg continuous SBP-drops even without cOH (OR=1.21, 1.00-1.47 p=0.047). Multiple falls were 4 times more likely with cOH compared to no cOH (OR=4.07, 1.06-15.59 p=0.041); risk was 36% greater for each 5mmHg continuous SBP drop(OR=1.36, 1.05-1.75 p=0.018). Attained SBP with standing was not associated with falls either alone (OR=1.01, 0.99-1.02) or in combination with SBP-drops (interaction OR=1.03, 0.96-1.09).

Conclusion

Postural SBP-drops that are much lower than current OH definition thresholds indicate increased falls risk in older adults, regardless of absolute SBP level. This has implications for standard clinical falls risk assessment and communication of falls risk to patients.

Keywords: Fall; Orthostatic Hypotension; Blood Pressure

Abbreviations:

OH: Orthostatic Hypotension;
SBP: Systolic Blood Pressure;
DBP: Diastolic Blood Pressure;
cOH: consensus Orthostatic Hypotension;
BP: Blood Pressure;
BLSA : Baltimore Longitudinal Study of Aging;
NIA :National Institute on Aging;
US : Unites States;
IRB : Institutional Review Board;
OR : Odds Ratios

Introduction

Complications from falls are the most common cause of injury-related death in older adults. Approximately one third of community-dwelling older adults reports falling annually [1,2]. Orthostatic hypotension (OH) occurs in 4-33% of older adults [1-3], increases with age, and is associated with falls. However, conflicting studies report positive associations [3], no associations [4-7] or associations with recurrent falls only and OH [8-10]. These discordant findings may stem from the use of different operational definitions of OH or not accounting for all aspects of resting and postural blood pressures.

Current guidelines recommend assessing postural blood pressure during falls risk assessments [11] with a decrease in systolic blood pressure (SBP) of >20mmHg or a decrease in diastolic blood pressure (DBP) of >10mmHg 3 minutes after moving from a supine to standing position defining OH [12]. This definition, hereafter referred to as consensus OH (cOH), includes only extreme thresholds and does not consider the level of the final standing blood pressure. Using cOH criteria, the risk of falling would be equivalent for two people who experienced 20mmHg drops in SBP, one who decreased from 150mmHg to 130mmHg and the other who decreased from 100mmHg to 80mmHg (i.e. the absolute resting and standing BP levels are ignored). In contrast, a decrease from 99mmHg to 80mmHg (a 19mmHg drop) would not be considered OH or a falls risk factor. Although several studies examined the relationship of OH to falls, studies of drops in SBP with standing that do not meet OH criteria or absolute levels of SBP after standing in relationship to falls are lacking. The optimal use of postural BP components to facilitate falls risk assessment and interventions can only be determined by fully evaluating the relationship of these components to falls risk. We hypothesized that falls history would be greater among those with decreases in blood pressure upon standing, especially among persons who attained a very low blood pressure upon standing.

The current study aims to assess associations between self-reported history of falls and [1] (cOH as currently defined in clinical practice, [2] standing BP after moving from a supine to standing position, [3] drops in BP upon standing across a continuum, and [4] combined information on the BP drop upon standing and attained standing BP.

Methods

Study Population

The Baltimore Longitudinal Study of Aging (BLSA) is an observational study of aging that began in 1958 using a volunteer cohort of healthy persons at baseline conducted by the Intramural Research Program of the National Institute on Aging (NIA). Participants are enrolled if they are >20 years old and healthy at study entry (e.g. no evidence of functional limitation, cognitive impairment or chronic debilitating disease including diabetes, stroke, heart disease and active cancer) but remain in the study if disease or debility develops. Participants, most of whom reside in the eastern US, are evaluated every one to four years depending on age, with participants 80 years or older seen annually. Clinically relevant information, including orthostatic blood pressure results, are reported to participants and their physicians with participant permission. All participants provided informed consent and study protocols were reviewed and approved by the Medstar Research Institute IRB. The current analysis includes only the first exam of participants aged >65 years with blood pressure measurements and a falls questionnaire between 2004 and 2010; return visits were not included since reports on orthostatic blood pressure readings from previous examinations could have impacted treatment and/or blood pressure measurements in the interval between visits, potentially biasing relationships of interest.

Data Collection

Falls Assessment

Participants were asked if they had fallen and landed on the ground or floor in the past 12 months. Those responding in the affirmative were queried on number of falls and related injuries, including fracture, head injury, sprain/strain, or bruising/bleeding. Recurrent falls were defined as two or more falls in the previous 12 months.

Blood Pressure and OH Measurements

Blood pressure was measured using a Welch Allyn oscillometric sphygmomanometer with appropriately sized cuffs following a standardized protocol. Participants rested in the supine position for five minutes in a dimly lit room. Blood pressure and heart rate were measured three times in each arm, with one-minute intervals between measurements. The average of the second and third measurements in the right arm (or left if unable to use right arm) was used for analysis. Heart rate was calculated by multiplying the manual count of heart beats in 20 seconds by three. Participants were then asked to stand for 3 minutes and a single standing blood pressure and heart rate were taken. This BP was the "Standing BP". Participants were asked if they felt dizzy or lightheaded with standing. The "drop" in BP was defined as supine BP minus standing BP for both systolic and diastolic values. Therefore, a positive "drop" in BP refers to a fall in BP and a negative "drop" refers to a rise in BP upon standing. Consensus OH (cOH) was defined as a decrease in SBP of >20mmHg or of >10mmHg in DBP 3 minutes after moving from the supine to standing position [12].

Comorbidities

Certified examiners conducted medical interviews to ascertain medical comorbidities, medications, and demographics. Medications were coded according to the World Health Organization's Anatomical Therapeutic Chemical classification, including anti-depressants, anxiolytics, psychotropics, muscle relaxers, anticholinergics, anti-hypertensives, and diuretics. Diabetes mellitus and hypertension were defined by self-report and medication usage. In addition, participants were classified as hypertensive if SBP was >140mmHg or DBP >90mmHg. Participants were classified as having impaired vision if they self-reported "moderate" or "extreme" difficulty or "stopped due to eyesight" on two standardized interview questions: "Because of your eyesight, how much difficulty do you have reading ordinary print in newspapers?" and "Because of your eyesight, how much difficulty do you have recognizing people you know from across a room?" [13].

Statistical Analysis

Participant characteristic comparisons across fall status were conducted using Fisher's exact tests for categorical data and nonparametric Wilcoxon tests for continuous data. Logistic and multinomial logistic regressions reporting odds ratios (OR) were used to examine OH relationships with any fall and the number of falls (0, 1, >2), respectively. Primary predictors included cOH, continuous standing SBP and DBP, and changes (drops) in BPs (SBP and DBP) upon standing. Interaction terms were used to examine potential effect-modifications of BP-drops across levels of attained standing BPs. Linear splines with a single knot at 0 were used to estimate nonlinear associations of drops versus rises in blood pressure, supported physiologically and via LOWESS smoothing model diagnostics. Models were adjusted for age, sex, race, impaired vision, use of anti-hypertensive medications, diabetes and use of anti-depressant medications. Use of non-anti-depressant central nervous system modifying medications (taken by 11%) was examined but was not associated with falls and did not affect relationships between primary predictors and falls. Analyses were performed using Stata Statistical Software Release 12.1 (StataCorp LP, College Station, TX).

Results

Among 400 participants 65 years or older with first visit data (45% women; 30% black; mean age of 74.8), 76 (19%) reported one fall within the past 12 months, and 37 (9%) reported two or more falls (Table 1). cOH was prevalent in 19 (5%). Among those with cOH, 10 (53%) reported falling within the past 12 months, compared to 103 (27%) of those without cOH (Table 1).

Falls and the Consensus Definition of Orthostatic Hypotension

cOH was associated with falls in unadjusted models (OR=3.00 (95% CI: 1.19, 7.59) p=0.020) with a slightly attenuated relationship in adjusted models (OR=2.82 (1.01, 7.87) p=0.048) (Table 2). Contrary to expectations, our data did not support the hypothesis that the relationship between cOH and falls would depend on the absolute level of SBP upon standing (OR=1.03 (0.96, 1.09) p=0.420).

Falls and Systolic Blood Pressure Measurements

Decreases in SBP with standing were also significantly associated with falls; for example, for every 5mmHg drop in SBP, the odds of falls increased (adjusted OR= 1.21 (1.00, 1.47) p=0.047) (Table 2). These findings translate into a 21%, 47%, and 117% increased odds of falling for drops in SBP of 5, 10, and 20mmHg with standing. Similar to cOH, final standing SBP did not affect the relationship between drops in SBP and falls

	Total	# Falls Within the Past Year			
Characteristics	**N=400**	**0 (n=287)**	**1 (n=76)**	**>2 (n=37)**	**p-value[a]**
Women	181 (45%)	119 (41%)	45 (59%)	17 (46%)	0.022
Age (years)					
65-75	240 (60%)	179 (62%)	42 (55%)	19 (51%)	0.253
75-80	79 (20%)	58 (20%)	14 (z18%)	7 (19%)	
>80	81 (20%)	50 (17%)	20 (26%)	11 (30%)	
Education	16.8 (2.73)	16.82 (2.67)	16.65 (2.62)	16.92 (3.41)	
High school	43 (11%)	30 (11%)	8 (11%)	5 (14%)	0.859
College	141 (36%)	99 (35%)	30 (40%)	12 (32%)	
Post-graduate	213 (54%)	156 (55%)	37 (49%)	20 (54%)	
Race					
White	252 (63%)	166 (58%)	56 (74%)	30 (81%)	0.016
Black	120 (30%)	97 (34%)	17 (22%)	6 (16%)	
Other	28 (7%)	24 (8%)	3 (4%)	1 (3%)	
Hypertension	204 (52%)	143 (50%)	41 (55%)	20 (56%)	0.719
Diabetes Mellitus	64 (16%)	49 (17%)	9 (12%)	6 (16%)	0.593
Antihypertensive medication	204 (59%)	147 (59%)	38 (58%)	19 (58%)	0.968
CNS modifying medication	37 (11%)	25 (10%)	7 (11%)	5 (15%)	0.579
Antidepressant medication	29 (8%)	15 (6%)	4 (6%)	10 (30%)	0.000
Poor vision	8 (2%)	4 (2%)	3 (4%)	1 (3%)	0.194
Consensus Orthostatic Hypotension	19 (5%)	9 (3%)	6 (8%)	4 (11%)	0.029
SBP Drop > 20 mmHg	10 (3%)	6 (2%)	2 (3%)	2 (5%)	0.345
DBP Drop > 10 mmHg	10 (3%)	4 (1%)	4 (5%)	2 (5%)	0.049
Systolic Blood Pressure (mmHg)					
Supine	121.7 (15.6)	120.9 (15.7)	123.0 (14.4)	125.4 (16.8)	0.096
Standing	125.6 (17.7)	125.4 (17.6)	127.0 (18.2)	123.8 (17.7)	0.546
Change from supine to standing	3.9 (12.45)	4.5 (11.5)	4.0 (14.98)	-1.6 (12.87)	0.157
Diastolic Blood Pressure (mmHg)					
Supine	64.6 (8.59)	64.8 (8.88)	63.9 (7.49)	64.7 (8.54)	0.765
Standing	69.2 (10.22)	69.6 (10.63)	68.3 (9.25)	67.0 (8.9)	0.500
Change from supine to standing	4.6 (7.32)	4.8 (7.26)	4.4 (7.77)	3.3 (6.83)	0.798

Values in table are N (%) for categorical and Mean (sd) for continuous variables.

CNS=Central nervous system medication

[a]P-values are derived from Fisher's Exact and Wilcoxon Rank Sum test for categorical and continuous variables, respectively

Table 1. Demographic Characteristics by Number of Falls.

(p=0.803 for interaction). Additionally, standing SBP was not associated with falls (adjusted OR=1.01 (0.99, 1.02) p=0.35) (Table 2).

	Odds Ratio of Reporting ≥1 Fall in Previous Year	
Primary Predictor	Unadjusted	Adjusted
Model 1: cOH	3.00 [1.19,7.59] 0.020	2.82 [1.01,7.87] 0.048
Model 2: SBP		
SBP Drop (5 mmHg)[(a)]	1.29 [1.09,1.54] 0.003	1.21 [1.00,1.47] 0.047
SBP Drop (10 mmHg)[(b)]	1.67 [1.19,2.36] 0.003	1.47 [1.01,2.16] 0.047
SBP Drop (15 mmHg)[(c)]	2.16 [1.29,3.63] 0.003	1.79 [1.01,3.17] 0.047
SBP Drop (20 mmHg)[(d)]	2.80 [1.41,5.58] 0.003	2.17 [1.01,4.66] 0.047
Standing SBP[(e)]	1.00 [0.99,1.01] 0.794	1.01 [0.99,1.02] 0.354
Model 3: DBP		
DBP Drop (1 mm Hg)[(f)]	1.06 [0.98,1.15] 0.167	1.08 [0.99,1.17] 0.097
DBP Drop (2 mm Hg)[(g)]	1.12 [0.95,1.31] 0.167	1.16 [0.97,1.38] 0.097
DBP Drop (5 mm Hgh)[(9)]	1.33 [0.89,1.98] 0.167	1.44 [0.94,2.22] 0.097
DBP Drop (10 mm Hg)[(i)]	1.76 [0.79,3.92] 0.167	2.08 [0.88,4.94] 0.097
Standing DBP[(j)]	0.99 [0.97,1.01] 0.234	1.00 [0.98,1.03] 0.841

Estimates in table are OR (95% CI) p-value, adjusted for age, sex, race, diabetes, anti-hypertensive use, anti-depressant use, and visual difficulty

(a) 5 unit drop in SBP within a participant (supine to standing)
(b) 10 unit drop in SBP within a participant (supine to standing)
(c) 15 unit drop in SBP within a participant (supine to standing)
(d) 20 unit drop in SBP within a participant (supine to standing)
(e) 1 unit increase in SBP across different participants
(f) 1 unit drop in DBP within a participant (supine to standing)
(g) 2 unit drop in DBP within a participant (supine to standing)
(h) 5 unit drop in DBP within a participant (supine to standing)
(i) 10 unit drop in DBP within a participant (supine to standing)
(j) 1 unit increase in DBP across different participants

Table 2. Associations of Reported Falls within the Last Year with Consensus Orthostatic Hypotension (cOH), Drops in Systolic Blood Pressure (SBP) Upon Rising, Standing SBP, Drops in Diastolic Blood Pressure (DBP) Upon Rising, and Standing DBP. Associations were observed for blood pressure drops even at levels lower than those in current cOH definitions.

Falls and Diastolic Blood Pressure Measurements

With each 2mmHg drop in DBP with standing, we observed a 16% increase in falls (adjusted OR=1.16 (0.97, 1.38) p=0.097), similar in degree of association as with SBP drop results, but weaker in support (Table 2). We saw no evidence that the absolute level of DBP upon standing was associated with falls (adjusted OR=1.00 (0.98, 1.03) p=0.841) (Table 2).

Recurrent Falls and Blood Pressure Measurements

Relationships between cOH and falls were more pronounced for recurrent fallers (adjusted OR=4.07 (1.06, 15.59) p=0.041) in adjusted multinomial models. Similarly, associations between drops in SBP and falls were more compelling among recurrent fallers (per 5mmHg drop: adjusted OR=1.36 (1.05, 1.75) p=0.018) (Table 3).

	Odds Ratio of Reporting Recurrent (≥2) Falls
Model 1: cOH	4.07 [1.06,15.59] 0.041
Model 2: SBP	
SBP 5 Unit Drop	1.36 [1.05,1.75] 0.018
SBP Standing	1.00 [0.98,1.03] 0.697
Model 3: DBP	
DBP 2 Unit Drop	1.17 [0.90,1.52] 0.247
DBP Standing	1.01 [0.97,1.05] 0.802

Estimates in table are OR (95% CI) p-value, adjusted for age, sex, race, anti-depressant use, diabetes, anti-hypertensive use, and visual difficulty

Table 3. Drops of Systolic Blood Pressure (SBP) and Consensus Orthostatic Hypotension (cOH) were Associated with Increased Odds of Having Recurrent Falls.

Conclusion

In this study, we found that fall risks were associated with much smaller drops in SBP upon standing than current consensus defined OH (20mmHg), particularly for recurrent fallers (>2 falls in the previous 12 months). Additionally, we observed this increase in reported falls across a continuum of SBP drops upon standing regardless of the final standing SBP level.

The inability to maintain SBP with standing may be indicative of underlying multi-system impairments consistent with frailty or, given the general good health of the BLSA population, a pre-frail state. Specifically, the inability to maintain blood pressure with positional changes may represent compromised compensatory reserves across multiple systems (e.g. cardiac, endocrine, neurologic) that are required to maintain homeostasis related to volume status, balance and posture. Decreased

reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems and increased vulnerability to adverse outcomes is a commonly used definition of the frailty syndrome [14-17]. Such impairments may result in postural drops in SBP, inability to optimally regulate arterial pressure, and subsequently contribute to increased risk of falling.

Contrary to our hypothesis, lower absolute standing blood pressure levels did not confer a greater risk of falls. A potential explanation for this finding could be that a person's homeostatic norm is less relevant for fall risk than perturbations (drops) from that norm; i.e. the body likes to be at whatever level it is accustomed (high or low), with heightened risk when those levels change and one is unable to maintain its homeostatic norm. We note however, that these findings could vary among subgroups with longstanding comorbidities. For example, persons with chronic hypertension may be more sensitive to levels and reductions in SBP upon standing [4]. Our study lacked adequate power to examine how risk varies across different comorbidity subgroups, but these questions would be worthwhile to address in a larger sample.

The etiology of falls in older adults is often multifactorial and most recommendations advise screening for and treating OH during falls risk assessments [11,18-20]. Management of OH along with other risk factors is an effective fall prevention strategy, but our findings suggest that risk may be heightened along the full continuum of blood pressure drops. Whether or not treatment of less severe drops in SBP reduces risk of falls is not known; however, measuring orthostatic vital signs routinely in clinic settings is a quick, inexpensive and non-invasive screen for OH, and management poses limited potential for harm. Some practical considerations include advising patients to rise slowly from seated or supine positions, to sit momentarily at the furniture edge before standing, avoid or minimize alcohol intake, remain hydrated, elevate the head of the bed during sleep, install grab bars in bathrooms, and avoid bending at the waist [11,21]. Clinicians can adjust or eliminate potentially provoking medications, such as alpha-blockers and clonidine [11,22,23] and anti-hypertensive medications including diuretics that contribute to volume depletion [11]. Lower body muscle tensing immediately after standing may attenuate postural BP drops and symptoms of dizziness [24]. Some patients may be advised to liberalize salt in the diet or in severe cases may be prescribed medications to raise BP, such as midodrine and fludrocortisone [11].

Limitations of this study included the cross-sectional design, prohibiting conclusions about causal relationships, a moderate sample size and a low prevalence of cOH. However, the 5% cOH sample prevalence is fully dependent on a cutoff value (20mmHg) which may be too stringent and miss persons at risk of falls due to SBP drops of lesser magnitudes. Using continuous SBP drops provides power from the entire sample and permits examinations of risk across the SBP continuum. BLSA participants typically represent a relatively healthy population and findings may not generalize to all populations, particularly more frail persons. We were unable to address postprandial BP measures or measures beyond 3 minutes of standing which may reveal additional cases of delayed cOH [20]. If unidentified delayed BP drops occurred, the association between BP drops or cOH and falls would likely be underestimated and our findings would represent conservative estimates. Lastly, though fall reports were retrospective, cOH assessment was independent of the falls questionnaire, so recall bias should not be differential by fall status. In addition, if previous falls were associated with OH and affected participants were evaluated and treated for OH prior to the clinic visit, the association of OH to falls would be underestimated.

In summary, these findings suggest that drops in SBP with postural change may increase fall risks in community-dwelling older adults, including drops in SBP that do not meet criteria for cOH. Relying on established thresholds for drops in blood pressure may result in failures to recognize older persons at risk of falling with SBP drops less than 20mmHg. We suggest clinicians educate patients about fall risks and ways to mitigate fall risks when patients exhibit drops in SBP with standing, including drops less than 20mmHg.

Acknowledgment

Funding Source: National Institute on Aging Intramural Research Training Program.

References

1. Low PA. Prevalence of orthostatic hypotension. Clin Auton Res. 2008, 18 Suppl 1: 8-13.

2. Rose KM, Tyroler HA, Nardo CJ, Arnett DK, Light KC et al. Orthostatic hypotension and the incidence of coronary heart disease: the Atherosclerosis Risk in Communities study. Am J Hypertens. 2000, 13(6 Pt 1): 571-578.

3. Rutan GH, Hermanson B, Bild DE, Kittner SJ, LaBaw F et al. Orthostatic hypotension in older adults. The Cardiovascular Health Study. CHS Collaborative Research Group. Hypertension. 1992, 19(6 Pt 1): 508-519.

4. Gangavati A, Hajjar I, Quach L, Jones RN, Kiely DK et al. Hypertension, orthostatic hypotension, and the risk of falls in a community-dwelling elderly population: the maintenance of balance, independent living, intellect, and zest in the elderly of Boston study. J Am Geriatr Soc. 2011, 59(3): 383-389.

5. Ganz DA, Bao Y, Shekelle PG, Rubenstein LZ et al. Will my patient fall? JAMA: the journal of the American Medical Association. 2007, 297(1): 77-86.

6. Liu BA, Topper AK, Reeves RA, Gryfe C, Maki BE et al. Falls among older people: relationship to medication use and orthostatic hypotension. J Am Geriatr Soc. 1995, 43(10): 1141-1145.

7. Ensrud KE, Nevitt MC, Yunis C, Hulley SB, Grimm RH et al. Postural hypotension and postural dizziness in elderly women. The study of osteoporotic fractures. The Study of Osteoporotic Fractures Research Group. Arch Intern Med. May 1992, 152(5): 1058-1064.

8. Graafmans WC, Ooms ME, Hofstee HM, Bezemer PD et al. Falls in the elderly: a prospective study of risk factors and risk profiles. American journal of epidemiology. 1996, 143(11): 1129-1136.

9. Ooi WL, Hossain M, Lipsitz LA. The association between orthostatic hypotension and recurrent falls in nursing home residents. Am J Med. 2000, 108(2): 106-111.

10. van Nieuwenhuizen RC, van Dijk N, van Breda FG, Scheffer AC, Korevaar JC et al. Assessing the prevalence of modifiable risk factors in older patients visiting an ED due to a fall using the CAREFALL Triage Instrument. Am J Emerg Med. 2010, 28(9): 994-1001.

11. Panel on Prevention of Falls in Older Persons AGS, British Geriatrics. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. Journal of the American Geriatrics Society. 2011, 59(1): 148-157.

12. Kaufmann H. Consensus statement on the definition of orthostatic hypotension, pure autonomic failure and multiple system atrophy. Clin Auton Res. 1996, 6(2): 125-126.

13. Hart PM, Chakravarthy U, Stevenson MR, Jamison JQ. A vision specific functional index for use in patients with age related macular degeneration. British Journal of Ophthalmology. 1999, 83(10): 1115-1120.

14. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med. 1992, 8(1): 1-17.

15. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing. 1997, 26(4): 315-318.

16. Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G et al. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. J Gerontol A Biol Sci Med Sci. 2004, 59(3): 255-263.

17. Hamerman D. Toward an understanding of frailty. Annals of internal medicine. 1999, 130(11): 945-950.

18. Tinetti ME, Baker DI, McAvay G, Claus EB, Garrett P et al. A multifactorial intervention to reduce the risk of falling among elderly people living in the community. N Engl J Med. 1994, 331(13): 821-827.

19. Tinetti ME, McAvay G, Claus E. Does multiple risk factor reduction explain the reduction in fall rate in the Yale FICSIT Trial? Frailty and Injuries Cooperative Studies of Intervention Techniques. Am J Epidemiol. 1996, 144(4): 389-399.

20. McInnes L, Gibbons E, Chandler-Oatts J. Clinical practice guideline for the assessment and prevention of falls in older people. Worldviews Evid Based Nurs. 2005, 2(1): 33-36.

21. Wieling W, Krediet CT, van Dijk N, Tschakovsky ME et al. Initial orthostatic hypotension: review of a forgotten condition. Clin Sci (Lond). 2007, 112(3): 157-165.

22. Fine SR, Ginsberg P. Alpha-adrenergic receptor antagonists in older patients with benign prostatic hyperplasia: issues and potential complications. J Am Osteopath Assoc. 2008, 108(7): 333-337.

23. Coupland NJ, Bailey JE, Wilson SJ, Horvath R, Nutt D et al. The effects of clonidine on cardiovascular responses to standing in healthy volunteers. Clin Auton Res. 1995, 5(3): 171-177.

24. Krediet CT, Go-Schon IK, Kim YS, Linzer M, Van Lieshout JJ et al. Management of initial orthostatic hypotension: lower body muscle tensing attenuates the transient arterial blood pressure decrease upon standing from squatting. Clin Sci (Lond). 2007, 113(10): 401-407.