



A poor performance in comprehensive geriatric assessment is associated with increased fall risk in elders with hypertension: a cross-sectional study

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Abstract

Background Fall and serious fall injuries have become a major health concern for elders. Many factors including blood pressure and anti-hypertensive medication application were reported as hazards of fall. The purpose of this study was to determine if age related systemic functional decline related with increased fall risks in elderly patients with hypertension. **Methods** A total of 342 elderly hypertension patients (age 79.5 ± 6.7 years, male 63.8%) were recruited to the study. Comprehensive geriatric assessment (CGA), including measurements about activity of daily living (ADL), nutrition, cognition, depression, numbers of prescription medication and number of clinical diagnosis, was conducted to evaluate the physical and mental status of each participants. Fall risk was evaluated by Morse fall scale, Tinetti performance oriented mobility assessment (POMA) and history of fall in the recent year. Participants were grouped into tertiles according to CGA score. Correlation between CGA and fall risk was analyzed through SPSS 18.0. **Results** Participants with higher CGA score were likely to be older, had a lower body mass index (BMI), and a higher prevalence of cardiovascular disease, chronic obstructive pulmonary disease (COPD), cerebrovascular disease and osteoarthritis. Participants in higher tertile of CGA score got increased prevalence of fall risk than those in lower tertile ($P < 0.01$ T3 vs. T1, $P < 0.01$ T3 vs. T2). Correlation analysis and regression analysis showed significant association between CGA and Morse fall scale ($P < 0.001$), as well as CGA and POMA ($P < 0.001$). Meanwhile, CGA components also showed co-relationships with increase fall risks. After adjusting age, BMI, benzodiazepine use, cardiovascular disease, cerebrovascular disease, COPD and osteoarthritis, both history of fall in the recent year and rising Morse fall scale were significantly associated with ADL impairment (OR: 2.748, 95%CI: 1.598–4.725), (OR: 3.310, 95%CI: 1.893–5.788). Decreased Tinetti POMA score was associated with Mini-Mental State Examination (MMSE) (OR: 4.035, 95%CI: 2.100–7.751), ADL (OR: 2.380, 95%CI: 1.357–4.175) and shortened MNA form (MNA-SF) impairment (OR: 2.692, 95%CI: 1.147–6.319). **Conclusions** In elderly adults with hypertension, impaired physical and mental function is associated with increased fall risk. Further study is required to investigate possible mediators for the association and effective interventions.

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1 Introduction

Fall and its adverse consequences, such as hip fractures, traumatic brain injury, rise morbidity and mortality and have a significant societal impact in term of lost productivity, deteriorating quality of life, and increased healthcare

cost.^[1,2] The Chinese elders were reported at a 18% annual incidence of falls.^[3] In the developed world, falls and fall-related complications has raised as the fifth leading cause of death.^[4,5] Falls have become a major health concern for elders.

Many factors contribute to fall risks. Although it was reported that relationship between blood pressure and adverse outcomes are in the form of “J-shaped” curve, optimal levels are still unclear in older adults.^[6,7] Blood pressure management is a key solution reducing myocardial infarction and stroke risk.^[8,9] However, antihypertensive medication related fall risks and serious fall injuries have an effect on function and mortality similar to that of cardiovascular events.^[10]

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Meanwhile, functional independence measure was reported to be as useful as Morse Fall Scale, a widely used tool to assess the fall risks, suggesting that a patient is at a high risk if fall.^[11] Both number and pattern of chronic conditions is related to increased risk of fall.^[12] Another study showed that nutritional status can be an independent predictor of fall for community-dwelling elders.^[13] Comprehensive geriatric assessment is definite as a multidimensional interdisciplinary diagnostic process focused on determining a frail elderly person's medical, psychological and functional capability.^[14]

In this study, we determined whether declined performance of comprehensive geriatric assessment is associated with increased risk of fall in elderly patients with hypertension.

2 Methods

2.1 Participants and study design

A total of 342 elderly hypertension patients (age: 79.5 ± 6.7 years, male: 63.8%) were recruited to the study from January 2013 to July 2014 at Zhejiang Hospital. Eligibility criteria for the current study included age older than 65 years old, in-hospital status, without recently acute cerebrovascular events and uncontrolled malignant tumor, single and multiple organ failure. Participants with hypertension had clinically diagnosed with essential hypertension according to classifications on blood pressure in the 2010 Chinese guidelines for the management of hypertension.^[15]

There is a clear record for every study subject on their demographic characteristics and clinical information, especially about hypertension duration, treatment and blood pressure on the day of admission. All participants were evaluated with comprehensive geriatric assessment. Meanwhile, balance and risk of fall were assessed through Tinetti performance oriented mobility assessment (POMA) and Morse fall scales. Relationship between functional decline reflected from CGA (comprehensive geriatric assessment) and fall risk were analyzed. This study was approved by the Research Ethics Committee of Zhejiang Hospital.

2.2 Morse fall scales

The most common type of falls was anticipated physiological falls, in a prevalence of 78%.^[16] It is also the one which would offer the greatest opportunity for intervention when patients are at high risk. Other types of falls include accidental falls (14%) and unanticipated physiological falls (8%). Morse fall scale is designed to identify patients at risk

for anticipated physiological falls. Patient who get a score over 45 in this scale was considered to be in a risk of fall.

2.3 POMA

We also use Tinetti POMA scale to assess the gait with seven components (initiation of gait, step length, step symmetry, step continuity, path, trunk and walking stance; maximum 12 points) and balance abilities of participants with nine components (sitting balance, arises, attempts to arise, immediate standing balance, standing balance, nudged, eyes closed, turning 360 degrees, and sitting down; maximum 16 points).^[17] Each subscale was measured as abnormal = 0 or normal = 1; in some cases adaptive = 1 and normal = 2. The total score is associated with different levels of fall risks, from low risk (25–28) to medium or high risk (0–24).

2.4 Comprehensive geriatric assessment

The CGA was performed at the day of admission. Here we developed a CGA based on variables selected a priori. It concludes the major assessment of functional status, cognition, co-morbidity, nutrition and numbers of prescribed medications before admission. Specifically, we assessed functional status as the level of dependence in activities of daily living (ADL) using the Barthel Index.^[18] The cognitive status was evaluated by the Mini-Mental State Examination (MMSE),^[19] and the 15-item Geriatric Depression Scale (GDS).^[20] The shortened MNA form (MNA-SF) was used to assess the nutritional status.^[21] Five types or more clinical diagnosis was considered as co-morbidity. Poly-pharmacy was defined as five or more medications used on hospital admission. Then, we designed a CGA score comprised by the six variables (Table 1). Impairment of each scale was defined as one point. The CGA score ranged from 0 to 6. According to the scores on the CGA, participants were classified into tertiles. Cutoff points defining tertiles of the CGA score were 0–1 for the lower one, 2–3 for the middle one, 4–6 for the higher tertile.

2.5 Statistical analysis

Differences in sociodemographic and clinical variables across tertiles of the CGA score were tested with a *P* for Chi-square test and body mass index (BMI) with One-Way ANOVA. The comparison between CGA tertiles and impairment in Morse fall scale, POMA, as well as any history of fall in the recent year was summarized with chi-square test. Chi-square test was also selected to analyze the differences between CGA components and fall risk assessing elements. As a secondary analysis, scores of each assessment were treated as continuous variables. The correlation

Table 1. Components of CGA score.

	Range	Score
ADL (Barthel index)		
Independent	> 95	0
Dependent	≤ 95	1
MNA-SF		
Normal	> 11	0
Malnutrition	≤ 11	1
MMSE		
Normal	> 24	0
Dementia	≤ 24	1
GDS		
Normal	< 6	0
Depression	≥ 6	1
Co-morbidity (No. of clinical diagnosis)		
	< 5	0
	≥ 5	1
Poly-pharmacy (No. of Medication)		
	< 5	0
	≥ 5	1
Total		6

ADL: activities of daily living; GDS: geriatric depression scale; MNA-SF: The shortened MNA form; MMSE: mini-mental state examination.

between CGA, including CGA score and its components, and risk of fall were compared with Spearman rank correlation analysis. The binary logistic regression analysis was used for further analysis about the association between fall risks and CGA components, adjusting age, BMI, benzodiazepine use, cardiovascular disease, cerebrovascular disease, chronic obstructive pulmonary disease (COPD) and osteoarthritis. Odds ratios (ORs) are reported for significant associations.

Analyses were conducted with SPSS software Version 18.0 at the two-tailed significance level of 0.05.

3 Results

Of the 342 participants previously diagnosed with hypertension included in the analysis, 132 were in the lower tertile of CGA score, and 145 were in the middle tertile, 65 were in the higher one (Table 2). Participants with higher CGA score were likely to be older, had a lower BMI, and a higher prevalence of cardiovascular diseases, COPD, cerebrovascular diseases and osteoarthritis. Participants with higher CGA score were also more likely to take benzodiazepine medications. There were no differences in sex, smoking status, duration and grade of hypertension, anti-hypertensive medication application, or diabetes.

Table 2. Baseline characteristics of patients according to tertiles (T) of the CGA Score.

	CGA-T1, <i>n</i> = 132	CGA-T2, <i>n</i> = 145	CGA-T3, <i>n</i> = 65	<i>P</i> Value
Age, yrs	76.9 ± 6.4	80.3 ± 6.4	83.2 ± 5.6	< 0.001
65–74	37.1%	18.6%	6.2%	
75–84	54.5%	54.5%	53.8%	
≥ 85	8.3%	26.9%	40.0%	
Gender (men)	64.4%	62.8%	64.6%	0.948
Current smoker	12.1%	6.9%	7.7%	0.291
BMI	24.7 ± 3.1	23.8 ± 3.4	22.8 ± 3.9	0.002
Duration of hypertension, yrs				0.366
0–5	20.4%	12.1%	13.3%	
6–10	36.3%	33.1%	30.0%	
11–20	29.2%	31.5%	33.3%	
> 20	14.2%	23.4%	23.3%	
Grade of Hypertension				0.287
Grade 1	12.1%	7.6%	7.7%	
Grade 2	29.5%	30.3%	26.2%	
Grade 3	33.3%	41.4%	50.8%	
Unknown	25.0%	20.7%	15.4%	
Antihypertensive medication				
Diuretic	22%	26.2%	29.2%	0.504
CCB	51.5%	60.7%	58.5%	0.291
β-blocker	14.4%	22.1%	20.0%	0.251
ACEI or ARB	61.4%	55.9%	61.5%	0.586
Co-morbidity				
Diabetes	19.7%	26.2%	32.3%	0.138
Cardiovascular disease	18.2%	41.4%	33.8%	< 0.001
Cerebrovascular disease	14.4%	35.2%	44.6%	< 0.001
COPD	5.3%	17.9%	21.5%	< 0.001
Osteoarthritis	14.4%	30.3%	30.8%	0.003
Benzodiazepine use	3.8%	13.1%	24.6%	< 0.001
History of fall in the recent year	21.2%	33.1% ^a	55.4% ^{c,d}	< 0.001
Morse fall scale > 45	20.5%	35.9% ^b	67.7% ^{c,d}	< 0.001
POMA ≤ 24	29.5%	51.7% ^b	87.7% ^{c,d}	< 0.001

Data are presented as mean ± SD or %. ^a*P* < 0.05 T2 vs. T1; ^b*P* < 0.01 T2 vs. T1; ^c*P* < 0.01 T3 vs. T1; ^d*P* < 0.01 T3 vs. T2. ACEI: angiotensin-converting enzyme inhibitors; ARB: angiotensin receptor blocker; BMI: body mass index; CCB: calcium channel blockers; CGA: comprehensive geriatric assessment; COPD: chronic obstructive pulmonary disease; POMA: performance oriented mobility assessment.

Prevalence of fall risks measured according to the history of fall in the recent year, Morse fall scale and POMA were substantially different between the tertiles of CGA score. Of

the 145 participants in the middle tertile (T2), all of the three measurements for fall risks were higher compared with the lower tertile (T1), while fall risks in the top tertile (T3) were significantly higher than the middle one (Table 2).

Of the six components of CGA score, participants with impaired ADL, MNA-SF and MMSE showed a substantial increase of fall risks in all the three measurements. Participants with GDS impairment were more likely to have a history of fall in the recent year. Participants taking five or more prescription medications, considered to be poly-pharmacy, were likely to have a poorer performance in POMA test (Table 3).

Whether fall risk was associated with higher CGA score and its components (ADL, MNA-SF, GDS, MMSE, poly-pharmacy and co-morbidity) was investigated. In analysis, treating CGA score and other assessment results as continuous variables, it was observed that CGA score was positively associated with Morse fall scale (Table 4, $P < 0.001$), and negatively associated with POMA score ($P <$

0.001). Meanwhile, there was a correlation between Morse fall scale and ADL, MNA-SF, GDS, MMSE, number of prescription medications, as well as number of diagnosis. There was also a correlation between POMA and ADL, MNA-SF, GDS, MMSE, and number of medication. No significant differences observed in number of clinical diagnosis among individuals with different POMA score (Table 4). Then the relationships of fall risks and each of the CGA components were subsequently assessed using binary logistic regression analysis (Table 5). After adjusting age, BMI, benzodiazepine use, cardiovascular disease, cerebrovascular disease, COPD and osteoarthritis, history of fall in the recent year was only significantly associated with ADL impairment (Table 5, OR = 2.748, 95%CI = 1.598–4.725). Rising Morse fall scale was also associated with ADL impairment (OR = 3.310, 95%CI = 1.893–5.788). Decreased Tinetti POMA score, which representing gait and balance impairment, was associated with MMSE (OR = 4.035,

Table 3. Fall risk assessment of patients according to CGA components.

	One year fall history		Morse fall scale		POMA	
	< 1, $n = 230$	≥ 1, $n = 112$	≤ 45, $n = 219$	> 45, $n = 123$	> 24, $n = 171$	≤ 24, $n = 171$
ADL ≤ 95	88 (38.3%)	79 (70.5%) ^b	75 (34.2%)	92 (74.8%) ^b	52 (30.4%)	115 (67.3%) ^b
MNA-SF ≤ 11	44 (19.1%)	34 (30.4%) ^a	40 (18.3%)	38 (30.9%) ^b	25 (14.6%)	53 (31.0%) ^b
GDS ≥ 6	22 (9.6%)	19 (17.0%) ^a	23 (10.5%)	18 (14.6%)	18 (10.5%)	23 (13.5%)
MMSE ≤ 24	63 (27.4%)	45 (40.2%) ^a	53 (24.2%)	55 (44.7%) ^b	25 (14.6%)	83 (48.5%) ^b
No. of medication ≥ 5	98 (42.6%)	51 (45.5%)	88 (40.2%)	61 (49.6%)	59 (34.5%)	90 (52.6%) ^b
No. of diagnosis ≥ 5	115 (50.0%)	63 (56.3%)	107 (48.9%)	71 (57.7%)	84 (49.1%)	94 (55.0%)

The normal range of Morse fall scale is ≤ 45, POMA is > 24, ADL is > 95, MNA-SF is > 11, GDS is < 6, MMSE is > 24. Taking five or more medications is considered to be poly-pharmacy. Having five or more clinical diagnosis is defined as co-morbidity. ^a $P < 0.05$, ^b $P < 0.01$ compared with the normal range group. ADL: activities of daily living; CGA: comprehensive geriatric assessment; GDS: geriatric depression scale; MMSE: mini-mental state examination; MNA-SF: the shortened mini nutritional assessment form; POMA: performance oriented mobility assessment.

Table 4. Association between CGA and fall risks in older patients with hypertension.

	CGA score	ADL	MNA-SF	GDS	MMSE	No. of medication	No. of clinical diagnosis
Morse fall scale, r	0.418 ^b	−0.502 ^b	−0.270 ^b	0.152 ^b	−0.261 ^b	0.250 ^a	0.121 ^a
POMA, r	−0.456 ^b	0.539 ^b	0.292 ^b	−0.164 ^b	0.425 ^b	−0.238 ^b	−0.062

ADL: activities of daily living; CGA: comprehensive geriatric assessment; GDS: geriatric depression scale; MMSE: mini-mental state examination; MNA-SF: the shortened mini nutritional assessment form; POMA: performance oriented mobility assessment. Spearman rank correlation analysis indicates statistically significant difference, ^a $P < 0.05$, ^b $P < 0.01$.

Table 5. Association between CGA components and fall risks in older patients with hypertension.

	History of fall in the recent year		Morse fall scale		Tinetti POMA	
	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P
ADL	2.748 (1.598–4.725)	0.000	3.310 (1.893–5.788)	0.000	2.380 (1.357–4.175)	0.004
MMSE	–	–	1.670 (0.921–3.027)	0.091	4.035 (2.100–7.751)	0.000
MNA-SF	–	–	–	–	2.692 (1.147–6.319)	0.023

Age, BMI, benzodiazepine use, cardiovascular disease, cerebrovascular disease, COPD and osteoarthritis were adjusted. ADL: activities of daily living; CGA: comprehensive geriatric assessment; COPD: chronic obstructive pulmonary disease; MNA-SF: the shortened mini nutritional assessment form; MMSE: mini-mental state examination; OR: odds ratio; POMA: performance oriented mobility assessment.

95%CI = 2.100–7.751), ADL (OR = 2.380, 95%CI = 1.357 – 4.175) and MNA-SF impairment (OR = 2.692, 95%CI = 1.147 – 6.319).

4 Discussion

In this study, we have demonstrated that in older patients with hypertension, a worse score of 6-item CGA is associated with increased fall risks. Moreover, independence of daily activity, malnutrition, cognitive impairment, polypharmacy and co-morbidity, which were components of the CGA were also associated with risk of falling.

Participants in this study were in-patients. Most of them had duration of hypertension over five years and treated with one or more antihypertensive medications. Although older adults with hypertension may suffer from antihypertensive medication application related fall risks,^[7,22] it is still not agreed any category of antihypertensive medication related with fall.^[23] Among the tertiles of CGA score, there was no significant difference on length of hypertension duration, grade of hypertension, as well as antihypertensive medication choice. However, a prospective study over 12 months quantified antihypertensive dose by estimating daily defined dose showed higher dose of antihypertensive medication is independently associated with falls in older people.^[24] Thorough correlation between dose of antihypertensive medication, pulse pressure, blood pressure control, the occurrence of orthostatic hypotension and fall risk particularly in CGA declined elders still needs further study.

Previous studies have shown a correlation between functional independence and increased risk of falling.^[12] Here we designed a CGA score comprised by six variables reflecting status of global physical and mental function. Our results suggest that in older patients with hypertension, worse performance in comprehensive geriatric assessment is associated with higher fall risk. Specifically, a low ADL score, reveals a limitation in a person's overall ability to cope with daily life can be regarded as a risk factor, as can a MMSE score of ≤ 24 , presenting a cognitive impairment. Malnutrition as defined by a low MNA-SF score also constitutes a risk for fall in geriatric patients with hypertension. In addition, more prescription medication application and co-morbidity is attributed with a high risk of falling. The results are consisted with those obtained in previous studies. Padubidri, *et al.*^[25] reported in Mexican Americans over 75 years old, having two or more falls was independently related with sudden decline in cognition over 6 years. Another study in Taiwan community-dwelling older adults suggested nutritional status is an independent predictor of falls.^[13] Moreover, Sibley, *et al.*^[11] reported that both the

number and pattern of chronic conditions were associated with falls. Besides, there were higher fall risks for participants in our study with worse score in GDS, which indicate depression. Regression analysis showed nonetheless no significant differences. The possible reason may be a limited morbidity in GDS impairment. Finally, it is expected that worse CGA result and either of its components is associated with increased fall risk.

There are a few limitations of the present study. First is that the social association as an aspect of CGA, could account for fall risks and fall related serious injuries, however, we lack the information to explore the role of this potential mechanism. Second, though conducting CGA for hospitalized older adults can be a prediction as risk of in-hospital death and adverse outcomes, as well as an effective approach to increase the likelihood of being alive for elders admitted as an emergency,^[26,27] CGA score at admission is partially different from that home-dwelling status due to the influence of acute disease. As a result, patients with recently acute cardiocerebrovascular events and uncontrolled malignant tumor were excluded in this study. Third, this study was based on cross-sectional data, which may be limited by bias from interindividual variability or cohort effects. Prospective studies will be required to determine whether individuals who got a higher CGA score would be in an increased incidence of falling and if an effective intervention of functional decline according to comprehensive geriatric assessment can be dedicated to avoidance of falling.

Despite these limitations, this study had several strengths. The population included Chinese in-patient adults aged 65 years or older with hypertension, which is one of the most popular chronic diseases in Chinese elders. This study is among the first to investigate fall risk impact factors through a comprehensive geriatric assessment score in elderly hypertension patients. The result indicated those with a CGA score more than 3 points conferring higher fall risk.

In summary, this study suggests that for older hypertensives, impaired physical and mental function is associated with increased fall risk. Daily living ability impairment, cognitive decline, malnutrition, co-morbidity and polypharmacy contribute to additional risk of falling. Continued research is warranted to investigate the mechanistic basis of the observed associations and whether interventions for functional decline could help decrease fall risks in older adults is critically important.

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