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Assessment of potential risk factors for falls in osteoporotic elderly versus individual mobility considerations

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Abstract
Background. Incidental falls are anxiously perceived by an increasing number of elderly persons as a clear symptom of ageing, potentially leading to permanent care-dependency.
Methods. The study population comprised 72 patients recruited from respective university clinic geriatric wards (aged 81- 95). A Timed UP & GO test (TUG) was applied (in line with Tinetti POMA protocol), to assess an individual risk of fall. Group I comprised the patients (48 women; $\bar{x}$=84 years) who scored 14 seconds or more; Group II - the patients who scored 13.5 seconds or less (24 women; $\bar{x}$=82 years).
Results. When completing Tinetti (POMA) test, Group I women (TUG test scores of 14 seconds and more) ultimately scored below 19 points, i.e. their risk of fall was assessed as 5-fold greater than in their Group II peers (TUG test scores of 13.5 seconds and less).
Consequently, statistical significance of the correlation coefficients between the TUG and Tinetti (POMA) test scores was established as $p < 0.05$. In Group I (TUG > 14 s) this correlation coefficient was negative and equaled $r = -0.74$, whereas in Group II (TUG < 13.5 s) it was ($r = -0.62$).
Conclusions. The TUG test makes up an effective diagnostic instrument for assessing a potential risk of fall (i.e. identify potential fallers) and may therefore be applied as an effective screening test for this group of patients. Community dwellers of higher functional capabilities, despite the risks related to osteoporosis, are far less likely to sustain an accidental fall.

Key words:
geriatrics, falls, osteoporosis, functional capabilities, Timed UP & GO test

Introduction

Accidental falls and mobility problems among the elderly are clearly the two most serious problems presently facing geriatric care-providers and clinicians alike [1]. Very frequently accidental falls sustained by the elderly persons result in their premature admission into the nursing facilities, which then permanently changes their social status from fairly self-reliant community dwellers into the care-dependent nursing home residents [2]. Impaired gait and balance may be regarded as both the leading underlying causes of accidental falls, as well as their most common consequences [3]. Either of them requires extensive remedial action which then results in serious financial consequences with regard to the much overstrained public health care resources [4].

On the one hand, the diagnostic approach should best always be a multi-factorial one and take into consideration all the factors contributing to the identification of the true nature of the problem [5]. It seems quite reasonable, though, to concentrate initially on the simple screening procedure that makes use of the Timed UP & GO (TUG) and Tinetti (POMA) tests, as this actually allows to identify the subjects most at risk, and consequently select them as standing the best chance of responding favorably to the proposed intervention [6]. Such an approach combines two major advantages: simplicity of application and inherent cost-effectiveness.

The aim of the present study consisted therefore in gaining a detailed insight into the actual circumstances of such adverse events, so that all key risk factors could be identified. Considering, however, that both those elderly persons whose functional capabilities were demonstrably reduced (e.g. wobbly walking, difficulties in executing postural shifts effectively) and their relatively fit (i.e. demonstrably more self-reliant) peers seemed equally exposed to a potential risk of accidental falls, the most essential objective was therefore to assess as closely as possible the potential risk factors in relation to such individual functional characteristics, as described at baseline.

This was attempted through addressing the following two main research issues:

Does a TUG test make an effective risk assessment instrument in the elderly osteoporotic patients that might possibly replace the Tinetti POMA procedure and make a relatively uncomplicated screening test for potential fallers?
Could it be established beyond any reasonable doubt that osteoporotic community dwellers of relatively unimpaired mobility are exposed to a lesser risk of sustaining an accidental fall?

Methods

Out of the 107 community dwellers (i.e. former patients of the respective geriatric wards) diagnosed with osteoporosis who had sustained accidental falls within the last three months immediately preceding the study, originally considered as potential participants (i.e. long-term inner city residents), 72 were eventually enrolled as fully compliant with the admission criteria.
The following inclusion criteria were applied:
1. age ranging 80-95 years,
2. living in the community (i.e. not in the residential nursing facilities),
3. osteoporosis diagnosed by densitometric method (DXA), bone mineral density (BMD) T-score less than 2.5 SD,
4. at least one accidental fall sustained within the 3 months immediately preceding the study protocol,
5. overall fitness facilitating effective execution of the study protocol,
6. mental condition facilitating written consent to the participation in the study protocol.

The study population comprised 72 community dwellers (aged 81-95) recruited from former patients of the respective university clinic geriatric wards, subsequently becoming the free-living study subjects (i.e. community dwellers). Each one of them was reported to have sustained at least one fall prior to the commencement of the study protocol.
The largest part of the study population (88% in Group I and 63% in Group II) was made up of patients whose principal ailments were anchored in circulatory disorders. Impaired pulmonary function prevailed in 63% (Group I) and 38% (Group II), whereas various disorders of the nervous system accounted for 37% and 25% of the patients.
The 72 patients were randomly split up into two groups: Group I comprised the patients (48 women; $\bar{x}$=84 years) who scored in the TUG test 14 seconds or more, whereas Group II (24 women; $\bar{x}$=82 years) consisted of those who scored 13.5 seconds or less.
Baseline characteristics of the study subjects are provided in Table 1. A TUG test was applied (accuracy of the measurement was up to 0.5 sec), in compliance with the Tinetti's Performance Oriented Mobility Assessment (POMA) protocol constraints (as subsequently modified) to assess an individual risk of fall [7, 8, 9, 10]. The key objective was to assess the risk of accidental falls, as well as individual functional capabilities.
The present study protocol was approved by an Independent Ethics Review Committee (District Chamber of Physicians, Ref. No 141/KBL/OIL/2011), as well as a written informed consent was received from each study participant.

Statistical methods

The statistical analysis made use of the following trait characteristics: arithmetic mean (AM), standard deviation (SD), minimum value (Min), maximum value (Max).
The results of statistical significance were provided either by the Student tests whenever the data complied with the attendant criteria, or the Wilcoxon tests, whenever the data proved non-compliant. Statistical significance was established as $p < 0.05$. Since individual balance and gait scores were assessed with the aid of the 0-2 scale (as per the modified Tinetti POMA test), a non-parametric Wilcoxon test was used for comparing the paired variables.
The correlation analysis was carried out with the aim of determining the relation between the TUG test scores and the risk of fall, as assessed by the Tinetti POMA test. The Spearman correlation coefficient Rs was computed for the respective groups. In order to determine the strongest correlation only the values r >= 0.6 were taken under consideration.

Table 1. Baseline characteristics of the study population

Characteristics	Group I (n=48) (TUG > 14 s)	Gropu II (n=24) (TUG < 13.5 s)
Age, years	84.9 (5.4)	82.3 (6.1)
Height, cm	155 (4.2)	159 (4.2)
Weight , kg	59.1 (11.4)	57.2 (9.4)
Systolic blood pressure , mmHg	142 (8.1)	136 (17.2)
Diastolic blood pressure , mmHg	86 (8.4)	82 (8.4)
Heart rate	78 (6.2)	74 (6.5)
Diagnoses and medications		
Cardiovascular diseases, %	88	63
Pulmonary disorders , %	63	38
Neurological disorders, %	37	25
Urinary system diseases, %	25	13
Visual deficits, %	50	37
Regular medications	9.4 (5.7)	7.2 (4.2)
Functional capability and mental ability		
ADL	5.1 (0.9)	5.6 (0.2)
IADL	20.9 (6.4)	22.1 (6.1)
6MW test, m	361 (119)	502 (107)
Use walking aids, %	63	38
MMSE	24.8 (6.7)	25.5 (8.2)

Data are presented as mean (standard deviation) unless otherwise stated.
TUG – The Timed Up and Go test, ADL – Activities of Daily Living (0-6), IADL – Instrumental Activities of Daily Living (0-27), 6MW – Six-Minute Walk test, MMSE – Mini-Mental State Examination (0-30).

All data were subsequently processed by STATGRAPHICS Plus v. 5.0. for Windows® software package.

Results

The analysis of the results yielded by the tests (Tables 2 and 3) showed there was a clear-cut correlation between the time required to complete the TUG test and the increased risk of fall in the individuals under study.

Table 2 comprises the mean scores of the final scores yielded by the Tinetti (POMA) test and the assessment of both balance and gait scores in the respective groups. When completing the Tinetti (POMA) test, the Group I women (whose respective TUG test scores reached 14 seconds and more) ultimately scored below 19 points, i.e. their risk of fall was assessed as 5-fold greater than in their Group II peers (whose respective TUG test scores reached 13.5 seconds and less). Statistical significance was set at $p < 0.01$.

It seemed only prudent therefore to verify to what extent the TUG test scores might actually impact the correlation between those scores and the risk of fall assessment.

Consequently, it was established that statistical significance of the correlation coefficients between the TUG and Tinetti (POMA) test scores was $p < 0.05$. In Group I (TUG > 14 s) this correlation coefficient was negative and equaled $r = -0.74$, whereas in Group II (TUG < 13.5 s) it was ($r = -0.62$).

In Group I the coefficient between the TUG test and Tinetti (POMA) balance scores was negative ($r = -0.76$); between the TUG test and Tinetti (POMA) gait scores was ($r = -0.72$), whereas in Group II it was also negative, i.e. for balance ($r = -0.64$) and gait ($r = -0.60$) scores, respectively.

Discussion

Enhancement of everyday practices in the provision of geriatric care in a high-risk population may result in significant improvements in patient outcomes. In order to make possible effective and valid comparisons between diverse national systems of geriatric care management, however, one should concentrate most of all on comparing those constituent elements that are functionally identical and

Table 2. Scores of the Tinetti (POMA) test in the respective groups (p-value at the 0.01 level).

	Group I (n=48) (TUG > 14 s)	Gropu II (n=24) (TUG < 13.5 s)
POMA – T	17.1 (4.1)	22.4 (4.9)
POMA – B	10.6 (2.5)	12.8 (2.9)
POMA – G	6.5 (2.1)	9.6 (2.4)

Data are presented as mean score (standard deviation).
TUG – The Timed Up and Go test, POMA-T – Performance Oriented Mobility Assessment – Total score (0-28), POMA-B – Performance Oriented Mobility Assessment – Balance score (0-16), POMA-G – Performance Oriented Mobility Assessment – Gait score (0-12)

Table 3. Spearman correlation between the TUG test scores and the risk of fall assessment by the Tinetti (POMA) test.

	Group I (n=48) (TUG > 14 s)			Gropu II (n=24) (TUG < 13.5 s)		
	POMA – T	POMA – B	POMA – G	POMA – T	POMA – B	POMA – G
TUG	-0.74*	-0.76*	-0.72*	-0.62*	-0.64*	-0.60*

*Correlation is significant at the 0.05 level.
TUG- The Timed Up and Go test, POMA-T – Performance Oriented Mobility Assessment – Total score, POMA-B – Performance Oriented Mobility Assessment – Balance score, POMA-G – Performance Oriented Mobility Assessment – Gait score

therefore certain to provide unbiased data, irrespective of a specific clinical setting. One of them is the TUG test which in practical terms may well serve as a benchmark in assessing overall quality of mobility disorder management for the osteoporotic elderly.

Numerous reports on the subject, as well as pertinent research observations, provide sufficient grounds to believe that by far the highest risk of sustaining an accidental fall is run by the community dwellers living on their own. It should also be noted at this point that ca. 40% of the frail elderly eventually end up as permanent nursing home residents due to having earlier become the victims of such adverse events, frequently leaving them permanently incapacitated or even seriously disabled [1]. As may be concluded from numerous reports, the highest risk of fall is usually associated with carrying out ostensibly simple tasks of daily living, e.g. postural shift from a sitting-down to a fully upright position, initiation of a walk [11].

Gillespie et al. (2) and Lord et al. [11], who studied a similarly sized population, strongly believe that the factors most likely to contribute to such adverse events are associated with the age-related degenerative changes in individual functional capabilities, impaired eyesight and dependence upon specific pharmacotherapy. The same also seems to be true for the relatively fit and self-reliant elderly who, despite being well capable of carrying out their routine daily tasks unassisted, are by no means any less likely to become the victims of accidental falls. It is generally estimated that ca. 80% of the elderly experience the need for urination during the night, which in turn makes it far more likely for them to sustain an accidental fall on the way to the toilet [12].

Other reports by Cameron et al. [13] revealed that almost 50% of the falls tended to occur during the activities requiring only a slight postural shift, e.g. change from a sitting position to a fully upright position. This also proved irrespective of whether it actually was the frail and incapacitated elderly, or their relatively fit and self-reliant peers. This is very much in line with the findings of Menz et al. [14] who allocated to a high-risk group all subjects with geriatric gait and/or the ones experiencing difficulties with the about-turns. Their findings were further corroborated by the results yielded by the present study.

Apart from the quantified results, the present study also yielded an interesting observation regarding the subjects allocated to Group II (i.e. scores in the TUG test of 13.5 seconds or less). Namely none of them reported a single accidental fall during their stay in the respective geriatric wards. This only further encouraged the present Authors in the belief that their findings might potentially have a much wider impact on the actual design of any prospective therapeutic interventions. Those subjects who had worse scores in the TUG test in fact proved significantly more likely to sustain accidental falls than their slightly more able-bodied peers. Hence the application of the TUG test was deemed of particular benefit here.

It follows that worse scores in the TUG test are clearly predictive of worse long-term outcomes and therefore due allowances should be made in designing individual therapeutic regimens. In practical terms, this would simply mean that whenever a specific regimen is being designed, it should first and foremost be closely tailored to addressing individual functional deficits in the first place, before moving on to concentrate on teaching the seniors the actual falls prevention techniques. Only then could we ensure that such techniques would really be used to maximum effect and provide a stable platform for an effective therapeutic intervention, whatever its specific design [15].

That said, any such programme should also most definitely comprise certain suitably modified modules to allow for the therapeutic requirements of the elderly patients with osteoporosis/osteopenia. As those patients also happen to be at high risk of cardiovascular events, it is essential that effective monitoring and elimination of the recognised risk factors, whenever practicable, should seriously be considered in designing any such falls prevention programmes [16].

Epidemiological studies reveal that by far the largest proportion of fall-related fractures is encountered in the 8 - 15 and in the over 60 age ranges, although their consequences are disparate enough to effectively render themselves incomparable [15]. Fractures sustained by children and youths usually do not result in any serious complications, whereas in the case of the elderly they frequently lead to permanent incapacitation, as well as account for ca. 20% of mortality in the over 75s. [17].

Cummings and Melton reported that in 1990 there were 1 600 000 femoral neck fractures [18]. It is estimated that by the year 2050 this number may rise to a staggering 6 260 000 cases. Accidental falls are reported to account for ca. 25% of fractures regarding the spine, 90% – femoral neck, 100% – forearm, i.e. effectively account for 90% of non-spinal fractures and the vast majority of them is directly related to osteoporosis [18].

Femoral neck fractures, being the most frequent ones, usually require long-term hospitalizations, and in ca. 25% of the hospitalized patients a 24h nursing care is required for at least one year after the incident [19, 20]. This consequently translates into appreciable increase in the costs of medical care. For example in 1991-92 in the US alone the costs of medical care extended to the victims of femoral neck fractures were around the US $ 2.9 billion mark [21]. It is estimated that an average cost of hospitalization of a single victim of a femoral neck fracture is ca. US $ 44 000 [22]. Most recent estimates project the direct costs of medical care extended to the patients who fell victims of osteoporosis-related fractures at ca. US $ 12-18 billion [23].

Considering that official US demographic prognosis puts the population of over 65s in the year 2040 at ca. 77 million (i.e. an over 100% rise on the current 34 million), whereas in the over 85s this rise is going to be even more dramatic, it is quite easy to predict that the attendant rise in the costs of direct medical care extended to the victims of fall-related fractures is going to be really substantial [15, 17, 18].

Studies comprehensively addressing the issue of accidental falls in the elderly and the attendant medical care costs sustained by the public health system are still rather scarce. The problem itself, however, definitely merits further in-depth investigations, especially in consideration of the now well recognized potential for making substantial economies in the medical service sector through streamlining the available resources, all with the aim of ensuring more effective care management [24, 25, 26].

Conclusions

The TUG test makes up an effective diagnostic instrument for assessing a potential risk of fall (i.e. identify potential fallers) and may therefore be applied as a screening test for this group of patients.

Community dwellers of higher functional capabilities, despite the risks specifically related to osteoporosis, are far less likely to sustain an accidental fall.

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