First Results of Evaluation of a Falls Clinic

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SUMMARY

Background: A falls clinic was established at the Waldkrankenhaus St. Marien, Erlangen, Germany. Risk factors for falls in community dwelling elderly adults were assessed and targeted interventions were recommended.
Methods: The assessment consisted of patient history, physical examination, evaluation of medication intake, clinical gait assessment, and static posturography and electronic gait analysis. The results of the first 61 assessments are reported in this study.
Results: Forty-two participants reported at least one fall in the last 6 months, with half reporting multiple falls. Gait impairments were discovered in 32 participants. Eight participants were diagnosed to suffer from a fall disease (recurring falls during the past 12 months), while nine participants were diagnosed with a fall syndrome (recurring falls during the past 12 months leading to severe injuries). A significant difference between fallers and nonfallers ($p < 0.05$) was discovered during the patient history and balance assessment using static posturography ($p < 0.05$). The participants received medical advice, recommendations for individually targeted interventions, and suggestions to see other specialists. Compared to an age-matched local population, our sample showed a higher prevalence of falls.
Conclusion: The results showed that a high-risk population attended our falls clinic. We presume that the falls clinic will have a beneficial effect in reducing the prevalence of falls in a high-risk population. Further studies are necessary to test this hypothesis. [International Journal of Gerontology 2010; 4(3): 130–136]

Key Words: accidental falls, aged, gait, postural balance, prevention

Introduction

Research indicates that multifactor assessment and targeted interventions can reduce the number of falls in elderly adults[1–3]. High-risk patients can be identified in specialized falls clinics and consequently adequate interventions can be introduced[4].

It is crucial to identify the following risk factors: poor subjective health status[5], reduced muscular strength[6], reduced peripheral sensation[6], and the number of falls in the past 12 months[5]. Targeted interventions include exercises to improve strength, coordination and balance[7–10]; adaptation of the home environment; adjustment of visual aids[11]; or modification of medication intake[8].

The effectiveness of the interventions seems to depend on whether they are transmitted to the correct population[1–3]. Some recent studies showed an improvement in certain risk factors or a reduction in the number of falls[7,12–14]. However, five randomized controlled trials showed inconsistent results when assessing the effect of targeted interventions on the number of falls[7,8,14–16].

In the Federal Republic of Germany, the analysis of fall risk occurs only in the context of inpatient stays in geriatric hospitals. Only patients who have already experienced a fall or a fall-related injury receive the necessary diagnosis. Therefore, any therapeutic interventions only have a secondary preventive effect.

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Ambulatory clinics for outpatients seeking medical advice on frequent falling or balance disorders have not yet been established. Based on this background, an outpatient falls clinic was founded in our hospital in 2008. It invites elderly persons to have an assessment of their individual fall risk, especially persons who suffer from a combination of risk factors or those who have already experienced one or several falls. In this paper the results of the first 61 assessments are presented.

Methods

Participants

Sixty-one community-dwelling older adults (41 women, 20 men) from the Erlangen-Nürnberg area participated in this study. Their mean age was 75.6 (±8.3) years (fallers 75.95 years, nonfallers 75.35 years). Participants were considered community-dwelling if they lived independently in their own homes. They were recruited through a newspaper advertisement. Criteria for inclusion in this study were age 60 years and over, gait or balance impairments, dizziness, or a history of falls. Additional criteria were being able to walk 10 meters with or without a walking aid, being able to stand independently for 90 seconds, and being able to understand and follow verbal instructions. Exclusion criteria were acute or subacute diseases or acute injuries. The study was approved by the Ethics Committee of the Friedrich-Alexander-University, Erlangen-Nürnberg. All participants signed informed consent prior to the investigation.

Assessment

Assessments consisted of patient history, physical examination, clinical balance and gait assessment, force plate measurements, and electronic gait analysis. The test conditions (light, room temperature and noise) were standardized before the tests, and all trials were conducted by the same two experienced researchers. A fall was defined according to the Prevention of Falls Network Europe group[17] as, "an unexpected event in which a participant comes to rest on the floor, ground or a lower level".

A participant's number of falls in the past 12 months, health status, balance and walking ability, and use of walking aids were determined using a standardized questionnaire. The present and past level of physical activity of 50 participants was assessed using a second standardized questionnaire. Relevant illnesses, as well as any medication taken daily, were recorded with a standardized questionnaire and through a patient history. Using another standardized questionnaire, we evaluated which kind of dizziness the affected patients suffered.

The clinical assessment consisted of: the Timed Up-and-Go Test[18], the Tinetti-Balance Scale[19], the 5-chair Sit-to-stand Test[20], a test for orthostatic blood pressure changes[21], assessment of visual acuity[22], and a screening test for peripheral diabetic neuropathy[23].

The electronic gait analysis was performed using the GAITRite system (CIR Systems Inc., Havertown, PA, USA). This assessment consisted of a series of four tests: (1) participants walked at their normal speed; (2) participants walked while counting backwards from 50 to 1; (3) participants walked while naming different animals (semantic memory); (4) participants walked while counting backwards from 100 in steps of 3. Tests (3) and (4) were included after the falls clinic was opened, therefore, *n* is smaller for these tests. Participants were asked to walk at their self-selected "normal" speed. The coefficients of variation for step time and cycle time were calculated for the left and right foot respectively. The reliability and validity of the GAITRite system has been published by several researchers[24,25]. The assessment was carried out according to the international standard published by the European GAITRite Network Group[26].

The force plate measurements were done on a SATEL force plate. Participants stood quietly on the force plate and maintained each test position for 30 seconds. Data were recorded during the last 25.6 seconds. All tests were done with shoes removed. Participants were told to look straight ahead with their heads erect and their arms resting at their sides, with instructions to maintain balance. In the first test, participants remained in a specified stance (heel distance, 2 cm; angle between feet, 30°) and looked straight ahead to a point 90 cm in front of them (eyes open). For the second test, participants closed their eyes and remained in the same position (eyes closed). The third test was performed in the narrow stance (ankles and toes touching) with eyes open. The last test was conducted in a narrow stance with eyes closed. This position was determined by a vertical red line in the middle of the force plate. The following nine parameters were calculated: the mean speed of the center of pressure (CoP) in mm/s; the amplitude of the CoP movement in mediolateral (ML) and anterior-posterior (AP) direction, and the quotient

of both directions (Amp_{ML}/Amp_{AP}); the area of sway (mm^2); the length of sway (mm); and the frequency of the signal by means of fast fourier transformations (Cooley-Tokey algorithm) for the ML and AP signals. The frequency content was divided into three categories (0–0.5 Hz; 0.5–2 Hz; > 2 Hz). The relation of the length of sway to the area of sway (LA) was calculated. LA_{max} and LA_{min} represent the upper and lower values of this parameter relative to time. The reliability of this protocol has been assessed, and its validity is subject to an ongoing study[27,28].

Classification

The participants were classified as follows: fall syndrome if two or more falls occurred in the previous 12 months resulting in at least one serious injury, fall disease if two or more falls occurred in the previous 12 months, and gait-disorder if there was no more than 1 fall in the past 12 months and an abnormal gait pattern, or no apparent problem. The participants fall risk was classified into "not increased," "increased," or "strongly increased." The participants' risk factors, the conducted interventions, as well as the recommended therapies or recommended referrals to specialists were documented and sent to the participants' general physician.

Statistical analysis

All calculations were performed using SPSS (SPSS Inc., Chicago, IL, USA). Differences between fallers and non fallers were calculated using the χ^2 test and Mann-Whitney *U* test.

Results

The overwhelming majority (90.9%) of the participants lived in their own home, with only 9.1% living in facilities for senior residents. Twenty-three participants (48%) were exercising on a regular basis; 16 (34%) had taken regular exercise throughout their working life. Twenty-seven participants stated that their job consisted predominantly of office work without physical activity (57.6%) (6 answers missing).

History of falling

Seventeen participants (28.8%, 2 missing answers) had not experienced a fall in the past 12 months. Twenty-one (35.6%) experienced one fall, and 21 participants suffered from multiple falls (35.6%). Fall-related injuries, unconsciousness and abnormal sensations prior to a fall are shown in Table 1.

Mobility

Results from the mobility questionnaire are presented in Table 2. Mean self-rated walking ability was 3.72 (1 = very good, 6 = poor) and self-rated walking security was 3.82 (same scale).

Diseases

Of the 61 participants, two rated their subjective state of health as "very good" (3.5%), 31 as "good" (57.9%), 22 (38.6%) as "less good", and 2 (3.5%) as "poor" (4 answers missing). On average, 5.57 (± 2.3) relevant diseases and an intake of 5.4 (± 3.4) medications were reported.

Dizziness

Participants most frequently described their dizziness as a walking disorder. The detailed evaluation of the dizziness questionnaire is presented in Table 3.

Clinical assessment

Results of the clinical assessment are presented in Table 4[23]. Orthostatic blood pressure dysregulation was diagnosed in six participants (9.8%).

Table 1. *Fall-related injuries and unconsciousness*

	n (%)
Fallers	42 (100%)
No injury	11 (26.2%)
Wounds or sutures	31 (73.4%)
Fractures	3 (7.1%)
Unconscious prior to fall	1 (1.6%)
Unusual sensation prior to fall	7 (17.5%)

Table 2. *Results from the Mobility Questionnaire*

	n (%)
Participants	61 (100%)
Deterioration of gait during the past 12 months	43 (70.4%)
More insecure while walking compared to 12 months ago	51 (83.6%)
Fear of falling	41 (67.2%)
Withdrawal from social activities due to fear of falling	21 (34.4%)
Pain affecting gait or balance	24 (39.3%)
Use of regular walking aid	17 (27.8%)
Missing answers	4 (6.5%)

Table 3. *Dizziness evaluation*

	n (%)
Participants	29 (100%)
Dizziness prior to fall	7 (21.14%)
Description	
Walking disorder	14 (48.28%)
Rotary dizziness	7 (21.14%)
Fainting	1 (3.44%)
Other	4 (13.79%)
No answer	3 (10.33%)
Duration	
Seconds	17 (58.62%)
Minutes	5 (17.23%)
1–2 hr	2 (6.89%)
>2 hr	2 (6.89%)
Permanently	2 (6.89%)
No answer	1 (3.44%)
Onset	
<2 mo	2 (6.89%)
>2 mo	4 (13.79%)
>4 mo	4 (13.79%)
>12 mo	12 (41.37%)
No answer	7 (21.14%)

Force plate measurements

The length and area of sway, as well as the mean speed of sway, increased during the eyes closed tests compared to the eyes open tests. The force plate measurements are presented in Table 5.

Gait analysis

Results of the electronic gait analysis are presented in Table 6. This analysis was supplemented by a clinical

Table 4. *Clinical assessment*[23]

Test	*n*	Mean	SD
Timed Up-and-Go Test	61	13.08	5.01
Tinetti Balance Scale	61	21.64	2.92
Tinetti Balance Score	61	12.08	2.01
Tinetti Gait Score	61	9.34	1.80
5-chair Sit-to-stand Test	58	14.86	5.88
Vision left	60	0.43	0.23
Vision right	60	0.39	0.24
Proprioception left*	59	0.53	0.25
Proprioception right*	59	0.50	0.25

**Part of the Michigan Neuropathy Screening Instrument (MNSI)[23]. SD = standard deviation.*

Table 5. *Force plate variables**

Variables	EO	EC	NEO	NEC
Area of sway (mm^2)	306.49 (244.57)	598.48 (554.34)	495.47 (352.78)	1122.12 (995.1)
Length of sway (mm)	398.31 (233.59)	612.73 (384.18)	569.61 (282.74)	936.54 (607.52)
Length of sway in ML direction (mm)	211.35 (108.29)	299.04 (173.68)	382.84 (206.15)	628.11 (445.67)
Length of sway in AP direction (mm)	291.38 (193.93)	470.57 (322.58)	339.71 (166.58)	559.46 (365.91)
LF_{max}	0.82 (0.29)	0.94 (0.34)	0.97 (0.33)	0.96 (0.39)
LF_{min}	0.42 (0.16)	0.51 (0.18)	0.51 (0.19)	0.55 (0.21)
Mean speed (mm/s)	13.32 (7.76)	21.11 (14.55)	19.04 (9.33)	31.56 (1.92)
Mean amplitude ML	21.13 (8.88)	28.01 (14.99)	32.11 (11.67)	45.71 (2.2)
Mean amplitude AP	24.75 (9.93)	34.72 (16.46)	26.75 (10.26)	41.76 (2.52)
Amp_{ML}/Amp_{AP}	1.31 (0.62)	1.42 (0.86)	0.88 (0.34)	1.09 (0.61)
FFT ML	158.22 (121.62)	296.91 (353.29)	353.26 (285.04)	733.58 (603.34)
FFT AP	238.46 (192.47)	480.58 (548.25)	339.71 (166.58)	612. 51 (683.1)
FFT ML 0–0.5 Hz	131.75 (83.14)	227.75 (264.03)	271.24 (205.32)	485.21 (388.65)
FFT ML 0.5–2 Hz	25.83 (27.64)	66.69 (137.28)	78.41 (109.85)	238.29 (329.45)
FFT ML > 2 Hz	1.25 (1.35)	2.77 (5.41)	4.09 (6.21)	11.01 (23.37)
FFT AP 0–0.5 Hz	202.84 (171.61)	334.71 (334.56)	200.25 (193.29)	445.24 (579.39)
FFT AP 0.5–2 Hz	33.58 (44.74)	133.91 (268.67)	49.88 (44.25)	155.01 (171.91)
FFT AP > 2 Hz	2.78 (4.44)	12.44 (37.58)	4.41 (4.69)	12.99 (24.93)

**Data presented as mean (standard deviation). EO = eyes open; EC = eyes closed; NEO = narrow stand eyes open; NEC = narrow stand eyes closed; ML = mediolateral; AP = anterior-posterior; LF_{max} = maximal value of length of sway/sway area; LF_{min} = minimal value of length of sway/ sway area; Amp_{ML}/Amp_{AP} = quotient of mediolateral and anterior-posterior amplitudes; FFT ML = frequency content of ML sway; FFT = AP frequency content of AP sway.*

Table 6. *Electronic gait analysis*

Test	*n*	Step Time Left CV (SD)	Step Time Right CV (SD)	Cycle Time Left CV (SD)	Cycle Time Right CV (SD)
Normal walking	58	5.07 (3.11)	5.12 (2.66)	4.01 (2.43)	4.01 (2.43)
50–1	58	6.84 (8.66)	6.66 (5.83)	5.66 (5.54)	5.67 (5.85)
Semantic	21	7.14 (4.22)	11.33 (14.36)	7.87 (7.71)	7.81 (7.81)
100–3	16	8.88 (11.17)	6.56 (4.41)	6.69 (6.12)	6.63 (6.04)

CV = coefficient of variation.

Table 7. *Evaluation*

	n (%)
No. of participants	61 (100%)
Classification	
Gait disorder	22 (36.1%)
Fall disease	16 (26.2%)
Fall syndrome	4 (6.7%)
Healthy	17 (27.9%)
No. of risk factors identified	
Mean (SD)	1.78 (1.2)
Interventions in falls clinic	
General information on gait disorders and falls	34 (55.7%)
Information on selected interventions	19 (31.1%)
Fall diary	16 (26.6%)
Recommendation	
Walking aids	7 (11.2%)
Home environment adaptation	40 (65.6%)
Falls prevention program	51 (80.3%)
Referrals to specialists	24 (39.3%)
Hip protectors	6 (9.8%)
Subsequent visit to falls clinic	28 (45.9%)
No. of recommendations	
Mean (SD)	2.1 (1.1)

SD = standard deviation.

gait analysis. Forty-three participants (70.5%) showed deviations from the norm in the clinical gait analysis.

Evaluation

The classification of the participants and the recommended interventions are presented in Table 7.

Differences between fallers and nonfallers

Significantly more fallers answered "yes" on the item, "Did your walking ability decrease in the past 12 months?" ($p < 0.05$). The subgroup of patients suffering from dizziness consisted of significantly more fallers than nonfallers ($p < 0.001$). Furthermore, certain parameters measured on the force plate, such as LA_{min} and LA_{max}, showed significant differences between fallers and nonfallers. These results are presented in Table 8.

Table 8. *Significant differences between fallers and nonfallers measured on the force plate*

Variables	Test	*p*
LF_{max}	EC	0.028
LF_{min}	EC	0.018
FFT AP > 2Hz	EC	0.048
Amp_{ML}/Amp_{AP}	EC	0.047
FFT ML 0–0.5 Hz	NEC	0.037

LF_{max} = maximal value of length of sway/sway area; EC = normal standing with eyes closed; LF_{min} = minimal value of length of sway/sway area; FFT = AP frequency content of AP sway; Amp_{ML}/Amp_{AP} = quotient of medio-lateral and anterior-posterior amplitudes; FFT ML = frequency content of ML sway; NEC = narrow standing with eyes closed.

Discussion

Gait disorders and a history of falls are important predictors of future falls[5]. Our results confirmed the supposed high prevalence of gait disorders (36.1%), fall diseases (26.2%), and fall syndromes (6.6%) in our sample. In our study, 71.2% of the participants reported at least one fall in the previous 12 months; 35.6% reported multiple falls. The measured fall rates were far above those measured in a representative comparative sample from the same local area[5]. However, other studies on fall risk patients showed a higher number of previous falls[4,13].

An important aim of our falls clinic is the recommendation of targeted interventions or referrals to specialists. Most often physical exercise was recommended (80.3%), which is in accordance with other corresponding studies[12]. A mean of 2.1 interventions was recommended and was less than that of other studies[4]. Because too many interventions might negatively

affect the compliance and adherence of the patients[29], we developed a training program which encouraged the patients to continue their exercises at home[30]. It included balance, coordination, strength and endurance exercises, combined with lessons on the use of walking aides and home environment adaptations. Previous research has shown good adherence to this program[30] so that we expect a similar effect in the participants examined in this study.

A comparison between fallers and non-fallers in this study showed significant differences between these groups. Some variables of the force plate measurements showed significant differences between fallers and non-fallers, especially while standing with eyes closed, when dividing the length of sway by the sway area. Furthermore, fallers exhibited a different sway frequency during narrow standing with eyes closed, in the mediolateral direction. However, the predictive value of force plate variables is currently controversial and subject to ongoing research[31]. Fallers reported a higher incidence of dizzy spells than non-fallers. This indicates the importance of assessing dizziness in high risk populations. In persons with advanced age, dizziness often seems to be an expression of gait disorders[32].

The small number of significant differences is perhaps caused by the chosen assessment tools, and may relate to a ceiling effect. Whether these screening instruments are suited in this form for patients with a high fall risk is not proven[31,33]. During the last few years there has been growing criticism of some screening and assessment tools[33,34]. In a subsequent study we will measure the number of falls prospectively. Following this, the presented assessment and screening instruments will be reassessed for their predictive value.

According to the Australian model[4], an interlinking of falls clinics in Germany is recommended. A minimal consensus on data evaluation should be agreed between the different clinics. This would allow us to start multicenter studies with higher case numbers and better comparability of the data. This could contribute to the long-term improvement of the care of fall-prone older people in Germany. Regrettably, the high temporal and personnel expenses were not refunded by legal health insurances. Hence, it is not possible to examine its effects in a prospective setting.

In conclusion, our results indicate that people with a high risk of future falls and a poor subjective health status predominantly attend our falls clinic. The measured fall rates lie far above those measured in a representative age-matched sample from the same local area[5].

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