

HOW TO IDENTIFY POTENTIAL FALLERS IN A STROKE UNIT: VALIDITY INDEXES OF FOUR TEST METHODS

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Objective: The aim of this study was to describe general characteristics of patients with stroke who have a tendency to fall and to determine whether certain test instruments can identify fallers.

Methods: Patients treated in a stroke unit during a 12-month period were included. At inclusion assessments were made with Berg Balance Scale, Stops Walking When Talking, Timed Up & Go (TUG) and diffTUG. At follow-up 6 or 12 months later, patients who had fallen were identified.

Results: During the time from discharge to follow-up on 159 patients, 68 patients fell and 91 did not. Fallers fell more often during their initial hospital stay, used sedatives more often and were more visually impaired, compared with non-fallers. The Berg Balance Scale, Stops Walking When Talking and TUG results differed between fallers and non-fallers. The combined results of Berg Balance Scale and Stops Walking When Talking increased the possibility of identifying fallers.

Conclusion: Berg Balance Scale, Stops Walking When Talking and TUG can be used to evaluate which patients have a tendency to fall in order to carry out preventive measures. Berg Balance Scale can be used in all patients. Stops Walking When Talking can give additional information if the patient is able to walk. TUG is a possible choice, but fewer patients can perform it.

Key words: stroke, fall risk prevention.

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INTRODUCTION

Falls in older people are sometimes referred to as one of the “geriatric giants”. They are a major public health concern in terms of morbidity, mortality and healthcare costs. Although falls may not result in fractures or other injuries, the fear of a new fall may restrict activities of daily living and even precipitate new falls (1). There is now evidence that multifactorial assessments and intervention programmes are effective in reducing the risk of falling (2, 3).

Falls result from multifactorial deficits. Risk factors include features such as age, previous falls, impaired vision, problems

with motor control, impaired gait, poor balance, cognitive impairment and use of certain medications (4).

Patients with stroke have a high risk of falling. Studies have shown between 14% and 39% falling incidences during hospital stays (5–8). People with stroke continue to be at high risk of falling after hospital discharge. Falls are more frequent among non-institutionalized long-term stroke survivors than among community control subjects (9). The number of hospital falls among patients with stroke predicts falls after hospital discharge (10). Therefore, it is important to identify which patients have a risk of falling and therefore would benefit from fall prevention measures. To accomplish this, valid and reliable clinical scales that are easy to administer are needed. Assessment scales that predict falls have been tested in different populations. While most studies have evaluated one assessment scale, the present prospective study evaluates a selection of scales in the same population.

The aim of this study was to describe general characteristics of fallers and non-fallers and to determine whether Berg Balance Scale (BBS) (11), Stops Walking When Talking (SWWT) (12), Timed Up & Go (TUG) (13) and diffTUG (14) can identify which patients with stroke are prone to fall.

METHODS

Subjects

A community-based stroke-incidence study was carried out in Örebro during a 12-month period (15). A total of 377 first-ever cases of stroke were registered from February 1, 1999, through January 31, 2000. Of these, 219 were treated in the stroke unit at Örebro University hospital where this study took place. One of the 219 patients denied consent and 22 patients died within the first 28 days after stroke onset. Therefore 196 patients (103 men and 93 women) were included in this study. Fig. 1 illustrates the study design and drop-outs.

Patients who were considered to be able to gain most from stroke unit care were admitted in the first place. When comparing the patients admitted to the stroke unit with patients treated elsewhere there were some differences. The patients admitted to the stroke unit were younger, a larger proportion of them were men and the 28-day fatality rate was lower. A majority of patients with stroke of mild to moderate severity were admitted to the stroke unit and patients with pre-stroke dementia were admitted less frequently (16).

The physician responsible for the stroke-incidence study (PA) reported when patients who met the standard World Health Organization (WHO) diagnostic criteria for stroke (17) were admitted to the stroke unit. Only first-ever strokes were included. Subarachnoidal haemorrhage was excluded from the present study. The assessments started at a median of 8 days (interquartile range 5–11) after the stroke event. Sixty-two patients were examined before the seventh day because they were discharged from the hospital before that day.

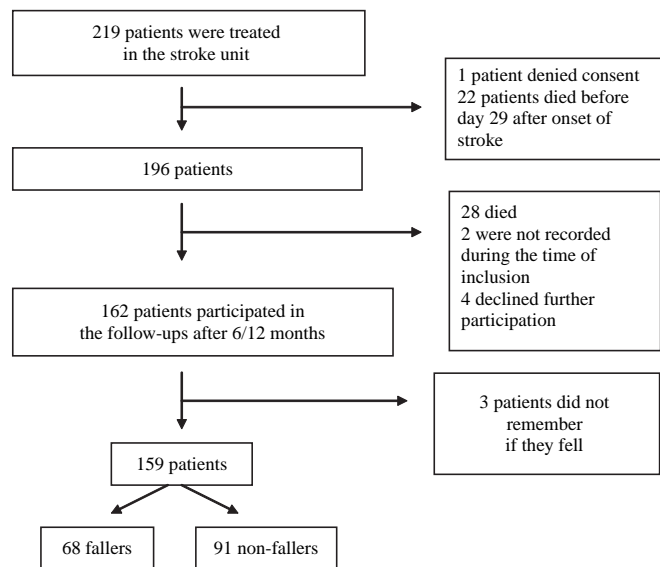


Fig. 1. Study design and drop-outs.

A fall was defined as an event in which the patient unintentionally came to rest on the ground or floor, regardless of whether or not an injury was sustained. In the interview conducted at the stroke unit, patients were asked about falls during the preceding year (18). During the stay at the stroke unit the staff registered when they found a patient on the floor, if they observed a fall, or when the patients reported falls. At the follow-up at 6 or 12 months after the stroke onset the patients were asked whether they had fallen during the time since discharge from the stroke unit.

Interview and measurements at inclusion

A structured interview was conducted by the first author in order to gather general information about each patient and the risk factors known to be associated with falls. Data were collected from the patients themselves and from their medical records. The patients self-rated their vision as normal or impaired. Medication data were obtained from medical records.

To assess cognitive function the Mini-Mental State Examination (MMSE) was used (19). This instrument includes 6 sections: orientation, registration, attention and calculation, recall, language, and copying. The score ranges from 0–30, and 23 points or less has often been used as cut-off for cognitive impairment. This cut-off was adopted for the present study. The physician evaluated the stroke severity using the National Institutes of Health Stroke Scale (NIHSS). The scale consists of 11 items representing consciousness, vision, language, sensory and motor function (20). The score ranges from 0–38. An occupational therapist performed neglect assessments. A three-item version of the Behavioural Inattention Test (21) and the Baking Tray Task (22) were used. Neglect was diagnosed if the patient reached cut-off in at least one of the tests.

The first author and 4 other physiotherapists assessed the patients as follows: Birgitta Lindmark motor assessment scale (BL) was used for assessment of motor capacity. BL was developed for evaluation of motor performance in patients with acute stroke, but can also be used in later stages (23, 24). The instrument consists of 7 parts. In this study we used the part that evaluates ability to perform active selective movements with both the paretic and the non-paretic side. Each item is assessed on a 4-point scale, where 0 = inability to perform the movement and 3 = normal function. The total score for each side ranges from 0–57 for the upper extremity, and 56 points or less was considered as motor impairment. For the lower extremity the total score for each side ranges from 0–36, and 35 points or less was considered as motor impairment.

The modified Ashworth scale (MAS) was used for assessing muscle tone (25). The scale grades the resistance of a relaxed limb to passive stretches in 6 scale stages, where 0 = no increase in muscle tone and 5 =

an affected part is rigid in flexion or extension. Muscle groups tested in this study were plantar flexors, knee flexors and extensors, palmar flexors, elbow flexors and extensors. If a patient scored more than 0 for any of the muscle groups he or she was rated as spastic.

BBS consists of 14 items representing functional movements common in everyday life (11). Some items require that the patient maintains positions of increasing difficulty, from sitting to standing on one leg. Other items evaluate the ability to perform specific tasks, such as reaching forward, turning around and picking up an object from the floor. Scoring is based on the ability to meet certain time or distance requirements and to perform the items independently. Each task is scored on a 5-point scale from 0 to 4 giving a maximum score of 56, which indicates balance ability within the normal range. In one study the developers showed that a patient with a BBS score less than 45 is prone to fall (26). This cut-off was adopted for the present study.

SWWT was designed to examine whether or not a patient stops walking when the examiner starts an occasional conversation. Lundin-Olsson et al. (12) have previously shown that stopping when talking is associated with a risk of falling. In the present study, patients were considered as test positive if they stopped walking when they talked.

TUG is a test of basic functional mobility. The time is taken when the patients rise from an armchair, walk 3 m as fast as possible, cross a line on the floor, turn, walk back and sit down again (13). Shumway-Cook et al. (27) concluded that subjects who take longer than 14 seconds to complete the TUG have a higher risk for falls. In the present study we adopted the same cut-off score. TUG was performed twice. The second time the patient carried a glass of water. The difference between the 2 performances is called diffTUG. Persons with a diffTUG \geq 4.5 seconds are considered to be distracted by a second task (14) and the same cut-off was used in the present study. Lundin-Olsson et al. (14) found that the test appeared to be a useful tool to identify older persons prone to falling.

Follow-up

Each patient was offered a free follow-up examination. Patients with an odd inclusion-number were followed up 6 months after the stroke onset, and patients with an even inclusion-number were followed up after 12 months. The follow-up was performed during the time interval plus/minus 2 weeks in relation to the target date. Optional to the patient the physiotherapist either examined the patient at the department of physiotherapy at the hospital, or visited the patient in his or her home. At the follow-up the patients were asked if they had fallen during the time since discharge from the stroke unit. The patient who had experienced at least one fall during the time between admission and follow-up was defined as a faller.

Ethics

Before entering the study, the patients were informed that participation was voluntary and that they could choose not to participate at any time without justification. They also received an information letter. If a patient's ability to communicate was restricted, consent by next-of-kin was obtained. The Human Ethics Committee of the Örebro County Council and the local Data Inspection Board approved the study.

Statistical analysis

Age was analysed by using independent sample *t*-test. The Mann-Whitney test was used to compare length of stay and the scores of the NIHSS between fallers and non-fallers. The difference of proportions between fallers and non-fallers for the dichotomized variables were calculated with the method described by Newcombe & Altman (28). The accuracy of the fall prediction was calculated for the different tests and for the combination of BBS+SWWT (29, 30).

RESULTS

A total of 196 patients were included. The characteristics of the study population are given in Table I. Baseline examinations were not performed in 24 patients: 4 due to low level of consciousness, 8 due to aphasia, 4 due to language problems and 8 due to lack of time because they were admitted to and discharged from the department during a weekend. These patients participated, however, in the follow-up examinations. When analysing baseline characteristics and the prevalence of fallers, no differences were found between the 24 patients who could not participate in the baseline examinations compared with the patients who could participate. For 121 patients (76%) the follow-up examinations were carried out in hospital and 38 patients (24%) were examined in their homes. The mean age was higher for the 37 drop-outs than for the patients who participated in the follow-up, 80 years and 73 years, respectively, and the median stay in hospital was longer, median 21 days compared with 14 days.

Sixty-eight (43%) of the 159 patients fell at least once during the time from discharge from the stroke unit to the follow-up and 91 (57%) patients did not fall. At the follow-up at 6 months 23 of 66 patients (35%) had fallen, and 45 of 93 patients (48%) had fallen at 12 months. Forty-one (60%) of the fallers were repeat fallers. The prevalence of fallers did not differ between the patients followed-up at 6 and 12 months, respectively, and no differences were found between the groups concerning baseline and functional characteristics. As shown in Table I, fallers stayed longer at the stroke unit, fell more often already during their initial hospital stay, used sedatives more often and were more visually impaired, compared with non-fallers.

When comparing the results of the functional measurements presented in Tables I and II, there were significant differences between fallers and non-fallers in all, except for NIHSS, MAS and diffTUG. All patients however, were not able to participate in all functional tests at inclusion. The reasons for drop-out were not cognitive impairment or neglect, but for most of them an inability to walk. One hundred and forty-one (89%) of the patients participated in the BBS, 115 (72%) performed the SWWT-test, 105 (66%) performed the TUG and 88 (55%)

were able to make the diffTUG-test. Eighty-five patients (53%) were able to participate in all of the tests.

The accuracy of the fall risk prediction differed for the different tests as shown in Table III. For the patients who could perform the BBS only, the sensitivity of the test was 100%. The likelihood ratio for a positive test indicates by how much the test result will raise or lower the post-test probability, that is the probability for the patient being a faller after the test results are obtained. The post-test probability was higher than pre-test probability for all the tests. The prevalence of fallers was highest in patients who were able to perform BBS and in patients who were able to perform SWWT. Therefore calculations of the accuracy of the fall risk prediction was made for the combinations of the tests, that is patients obtaining positive or negative test results in both of them. The post-test probability for the combination BBS+SWWT was 0.86.

DISCUSSION

The present study was conducted to describe general characteristics of fallers and non-fallers and to determine whether BBS, SWWT, TUG and diffTUG could identify which patients with stroke are prone to fall. Factors such as stroke severity, cognitive impairment and neglect seemed to be less important. On the other hand, visual impairment and use of sedatives were significant predictors of falls. Such risk factors are potentially modifiable.

We found that the BBS, SWWT and TUG results differed between fallers and non-fallers but not the results of the diffTUG. If patients were able to perform both BBS and SWWT, the combined results increase the possibility of identifying fallers.

Based on clinical experience, the developers of BBS stated that scores below 45 indicate an increased risk for falls (31). When this cut-off point was used, the specificity was lower than reported by Thorbahn & Newton (32) who used the same cut-off. When comparing the results of the studies one has to keep in mind that only a few patients in the other study suffered from neurological impairment.

Regarding SWWT, 41% of the patients were positive in the study made by Hyndman & Ashburn (27) compared with 21% in the study by Lundin et al. (12) and only 8% in the present study. The difference between the original study and ours might be due to the fact that a greater proportion of the participants suffered from cognitive impairment in the study conducted by Lundin-Olsson and co-workers (12).

Both sensitivity and specificity for TUG were 87% in a study made by Shumway-Cook and colleagues (26) compared with our results of 50% and 78%, respectively. They included community-dwelling individuals. Half of the participants had no history of falls, and the other half had a history of 2 or more falls. The different definition of a faller, their exclusion of individuals with known neurological diagnosis as well as a smaller study population may explain the differences between the 2 studies.

Table I. Characteristics of fallers (F) (n=68) and non-fallers (NF) (n=91)

| Characteristics | Fallers | | Non-fallers | n tested | |
|---|------------|--------|-------------|----------|----|
| | | | | F | NF |
| Age, mean (range) (years) | 74 (33–94) | NS | 73 (35–94) | 68 | 91 |
| Sex, men (%) | 56 | NS | 54 | 68 | 91 |
| Length of stay, Md (IQR) | 20 (9–38) | <0.001 | 8 (5–22) | 68 | 91 |
| Hemisphere damage, n (%) | | | | 68 | 91 |
| Right | 33 (49) | NS | 37 (41) | | |
| Left | 35 (51) | NS | 50 (55) | | |
| Unknown or bilateral | 0 (0) | | 4 (4) | | |
| NIHSS, Md (IQR) | 5 (3–9) | NS | 4 (2–8) | 68 | 91 |
| BL – motor impairment upper ex, n (%) | 46 (74) | * | 46 (58) | 62 | 81 |
| BL – motor impairment lower ex, n (%) | 46 (74) | * | 42 (52) | 62 | 81 |
| Spastic (MAS), n (%) | 18 (30) | NS | 13 (17) | 60 | 78 |
| Cognitively impaired, MMSE ≤ 23, n (%) | 25 (43) | NS | 28 (35) | 58 | 81 |
| Neglect, n (%) | 17 (25) | NS | 15 (16) | 68 | 91 |
| Patients who fell at the stroke unit, n (%) | 13 (19) | * | 1 (1) | 68 | 91 |
| Visual impairment, n (%) | 26 (44) | * | 21 (26) | 59 | 81 |
| Drugs, n (%) | | | | 68 | 91 |
| Sedatives | 15 (22) | * | 7 (8) | | |
| Antidepressants | 7 (10) | NS | 5 (5) | | |
| Diuretics | 16 (24) | NS | 21 (23) | | |
| Recurrent stroke | 3 (4) | NS | 3 (3) | 68 | 91 |

Md = median; IQR = interquartile range; NIHSS = National Institutes of Health Stroke Scale; BL = Birgitta Lindmark motor assessment scale; MAS = modified Ashworth scale; MMSE = Mini-Mental State Examination.

*The 95% confidence interval did not include zero.

Our study failed to show that diffTUG is a useful tool for prediction of falls in stroke patients. We support the conclusion made by Shumway-Cook and colleagues: “the ability to predict falls is not enhanced by adding a secondary task when performing the TUG” (27). The prevalence of fallers in the study by Lundin et al. (14) compared with our study was almost the same, but the patient characteristics may differ in other ways between the 2 studies. The elderly frail persons included in the study made by Lundin-Olsson and colleagues seemed to be more distracted by performing a concurrent manual task than the stroke patients in the present study, since diffTUG was positive for 24% in the original study, compared with 9% in our study.

The results from the assessments of BBS, SWWT and TUG differed significantly between fallers and non-fallers, but the accuracy of the fall risk prediction differed between the tests. The specificity for all of them was higher than the sensitivity, and except for the SWWT and the combined results of BBS and

SWWT, negative predictive value was higher than positive predictive value. That indicates that the tests are better at identifying patients who are non-fallers than patients who are fallers.

If a patient is able to perform SWWT, the results from BBS and SWWT should be combined. If the patient obtains positive test results in both of them the level of certainty of fall risk prediction is substantially increased. When combining the results of BBS and SWWT the probability that the patient is a faller increases from the prevalence of 0.35, that is the pre-test probability, to the post-test probability of 0.86, indicating a great shift in accuracy of fall prediction. Based on the varying accuracy of fall risk prediction, a single test to identify fallers and non-fallers cannot be used. The precision of the test may be lost when dichotomizing the results, and use of other cut-offs may give different results.

The strength of the BBS is that all patients can be examined regardless of stroke severity. This means that it is possible to identify patients who are prone to fall, even if a patient is not able to walk independently at the test occasion. Since the BBS is easy to administer and requires no special equipment it is easily included as a part of the routine examination. The other tests could also be used if a patient is able to walk independently. Since falling is a complex and multifaceted event, information about the patients’ mobility and capacity to walk and talk simultaneously contribute to make the fall risk analysis more complete.

One of the limitations of this study is that only stroke unit patients were included. Due to a shortage of stroke unit beds in the University Hospital Örebro, patients who are considered to gain most from stroke unit care are admitted in the first place.

Table II. Results in number (%) of functional measurements for fallers (F) (n=68) and non-fallers (NF) (n=91)

| | Fallers | | Non-fallers | n tested | |
|----------------------|---------|----|-------------|----------|----|
| | | | | F | NF |
| BBS <45 | 39 (63) | * | 28 (35) | 62 | 79 |
| SWWT | 7 (15) | * | 2 (3) | 48 | 67 |
| TUG >14 seconds | 20 (50) | * | 14 (22) | 40 | 65 |
| diffTUG ≥4,5 seconds | 5 (17) | NS | 3 (5) | 29 | 59 |

BBS = Berg Balance Scale; SWWT = Stops Walking When Talking; TUG = Timed Up & Go.

*The 95% confidence interval did not include zero.

Table III. Accuracy of the fall risk prediction

| | Prevalence of fallers | | Sensitivity | Specificity | Positive predictive value | | Negative predictive value | | LR + | LR - | Post-test probability |
|----------------------|-----------------------|------------|-------------|-------------|---------------------------|-------|---------------------------|-------|------|------|-----------------------|
| | % (n) | % (n) | | | % (n) | % (n) | % (n) | % (n) | | | |
| BBS <45 p | 44 (62/141) | 63 (39/62) | 65 (51/79) | 58 (39/67) | 69 (51/74) | 1.8 | 0.57 | 0.58 | | | |
| SWWT | 42 (48/115) | 15 (7/48) | 97 (65/67) | 78 (7/9) | 61 (65/106) | 5 | 0.88 | 0.78 | | | |
| Timed Up & Go ≥ 14 s | 38 (40/105) | 50 (20/40) | 78 (51/65) | 59 (20/34) | 72 (51/71) | 2.3 | 0.64 | 0.58 | | | |
| diFTTUG | 33 (29/88) | 17 (5/29) | 95 (56/59) | 63 (5/8) | 70 (56/80) | 3.4 | 0.87 | 0.63 | | | |
| BBS + SWWT | 35 (28/79) | 21 (6/28) | 98 (50/51) | 86 (6/7) | 69 (50/72) | 10.7 | 0.81 | 0.86 | | | |

LR + and LR - = Likelihood Ratio for a positive and negative test, respectively; Post-test probability = the patient's chance of being a faller after the results of the test are obtained; BBS = Berg Balance Scale; SWWT = Stops Walking When Talking.

Therefore, the results of this study may be less valid for patients with severe strokes or with pre-stroke dementia. Another limitation is that we relied on self-rating of vision and self-reporting when documenting falls. The correct reporting of falls is fundamental to the validity. To ask about falls that have occurred since some memorable event is one way to improve the accuracy of the recall of falls for specific periods of time (18). We considered discharge from the hospital to be a memorable event and therefore the patients were asked whether they have fallen during the time since discharge from the stroke unit to the follow-up.

The follow-up at 2 different points of time and to present the results in combination may be another limitation of this study. However, when analysing baseline characteristics and functional characteristics, no differences were found between the 2 groups. The only differences found were between the patients who had experienced a fall during the time between admission and follow-up and the ones who had not.

There is now good evidence that multifactorial assessments and intervention programmes are effective in reducing the risk of falling (2, 3). The management of patients at risk of falling requires a tailored approach. Oliver and co-workers suggest that, for in-patients, it may be better to look for common reversible fall risk factors in all patients (33). Impairments of balance and gait have been shown to be strongly associated with falls and they are potentially reversible. Based on the results of the present study we conclude that BBS, TUG and SWWT could add useful information to a multidisciplinary fall risk analysis when used in stroke patients.

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