PAPER

"Stops walking when talking" as a predictor of falls in people with stroke living in the community

D Hyndman, A Ashburn

See Editorial Commentary, p 949

J Neurol Neurosurg Psychiatry 2004;**75**:994–997. doi: 10.1136/jnnp.2003.016014

See end of article for authors' affiliations

Correspondence to: Dr D Hyndman, Mail point 886, Level E Centre Block, Southampton General Hospital, Tremona Road, Southampton SO16 6YD, UK; dh197@soton.ac.uk

Received 2 April 2003
In revised form 31 October 2003
Accepted 23 February 2004

Objective: To test "Stops walking when talking" (SWWT) as a predictor of falls among people with stroke living in the community.
Methods: People with stroke were identified through hospital records. Mobility, ADL (activites of daily living) ability, mental state, mood, and SWWT were assessed in a single session. Participants were followed prospectively for six months, using falls diaries and regular telephone calls.
Results: Sixty three participants (36 men, 27 women; mean (SD) age 68.4 (10.6)) were recruited. Four subjects had a brainstem lesion, 30 had right hemisphere, and 29 left hemisphere infarctions. Mean time since onset of stroke was 20 months (range 2–72). Twenty six subjects stopped walking when a conversation was started and 16 of them fell during the six month follow up period (11 experienced repeated falls). For all fallers ($\geqslant$1) the positive predictive value of SWWT was 62% (16/26), the negative predictive value 62% (23/37), specificity 70% (23/33) and sensitivity 53% (16/30). For repeat fallers ($\geqslant$2) the positive predictive value of SWWT was 42% (11/26), the negative predictive value 89% (33/37), specificity 69% (33/48) and sensitivity 73% (11/15). Those who stopped walking were significantly more disabled ($p<0.001$)—that is, they were more dependent in activities of daily living, had worse gross function as well as worse upper and lower limb function, and had depression ($p=0.012$).
Conclusions: The specificity of the SWWT test was lower but sensitivity was higher than previously reported. Although the SWWT test was easy to use, its clinical usefulness as a *single* indicator of fall risk in identifying those community dwelling people with stroke *most* at risk of falls and in need of therapeutic intervention is questionable.

It is known that people with stroke are at higher risk of falling than the general population,[1 2] yet risk factors such as previous falls and multiple medications have been reported to be less important in predicting falls than factors such as the inability to walk, visuospatial deficits, and apraxia.[3] In addition, factors such as impulsivity,[4] slowed response times[5] as well as selective and divided attention deficits have been linked to balance impairments and increased fall risk among people with stroke.[6–8] Findings from previous studies exploring the influence of cognitive tasks on physical performance highlighted that dual task performance produced significant impairments in gait and cognitive performance and it has been suggested that this interference could be due to an increased use of central resources rather than overall reduction in a patient's processing capacity.[9 10]

To date, few tests have been designed to address the multifactorial nature of postural stability and falls.[11 12] A relatively simple test that simultaneously challenged a motor and cognitive component "Stops walking when talking" (SWWT) has been found to be a good predictor of falls among frail institutionalised elderly patients.[12] Lundin-Olsson and colleagues[12 13] reported that this test demonstrated good specificity (95%) as well as acceptable positive predictive values (PPV, 83%) and negative predictive values (NPV, 76%) with moderate sensitivity (48%) in predicting falls. Among people with Parkinson's disease (PD)[14] SWWT did not predict falls. Only four people with PD stopped walking when talking, the test had poor sensitivity (14%) but good specificity (96%).[14] Although the researchers used similar designs, variation in the prevalence of the target disorder (SWWT), differences in sample sizes, and outcomes measured (all falls *v* repeated falls) hinders comparison between studies. More specifically, whilst Lundin-Olsson *et al*[12] included a high number of frail elderly subjects with dementia and depression, Bloem *et al*[14] excluded PD patients with cognitive impairment. Both reports failed to describe whether the researchers stopped walking with the patient and the "stop time" chosen as an indicator of a positive test differed between studies (any stop[12] *v* three second stop[14]). Bloem *et al*[14] standardised the walk as well as the conversation, but Lundin-Olsson *et al*[12] failed to describe what the conversation consisted of and it remained unclear whether the length of the walkway differed between subjects. People with PD rarely stopped walking when talking possibly because participants were "instructed" to walk along the 150 m walkway—that is, they were aware that their walking performance was being tested. In summary, although the SWWT test has shown promising results in predicting falls among frail elderly subjects, these findings could not be repeated among people with PD. This raises the question as to whether the SWWT test can predict falls among people with stroke living in the community. The present study set out to explore the usefulness of the SWWT test as a predictor of falls in people with stroke and to describe the characteristics of those who stop walking when talking.

METHODS

Patients

Ethical approval for this prospective predictive investigation was obtained from the Isle of Wight Health Authority Local Research Ethics Committee. People with stroke, who had been admitted to St Mary's Hospital on the Isle of Wight, UK,

Abbreviations: ADL, activites of daily living; HAD, Hospital Anxiety and Depression scale; NPV, negative predictive value; PD, Parkinson's disease; PPV, positive predictive value; RMA, Rivermead Motor Assessment; SWWT, stops walking when talking within the preceding 12 months were identified from hospital records (through a computerised search of admission and discharge records as well as a handsearch of medical and therapy records). Subjects were eligible for participation if they had a diagnosis of stroke, were independently mobile (with or without a walking aid), oriented to place and time[15] and able to complete by interview administered questionnaires. Subjects were excluded if they were bed or chairbound or required assistance from another person to mobilise, had other neurological conditions (such as PD, Ménière's disease, peripheral neuropathy, or unstable epilepsy), and acute medical or musculoskeletal conditions impeding mobility or balance (that is, lower limb amputations or recent joint replacement surgery). The working definition of a fall for this study was ''an event that results in a person coming to rest unintentionally on the ground or other lower level, not as a result of a major intrinsic event or overwhelming hazard''.[16] A near-fall was defined as ''an occasion on which an individual felt that they were about to fall but did not actually fall''.[17] Fallers were classified according to information from the falls diaries as repeat fallers ($\geqslant$2 falls), one time fallers, non-fallers with near-falls, and non-fallers with no near-falls.[17]

Procedure

A standardised single assessment session took place in a treatment room at a day hospital. With patient consent, general information was collected (including questions about medical conditions, medication and adaptive devices). This was followed by measures of cognition,[15] mobility,[18] ADL (activites of daily living) ability,[19] mood,[20] and the SWWT test.[12] Prospective fall information was collected using falls diaries and two weekly follow up phone calls. The present study set out to address some of the issues that have limited comparison and repeatability of the SWWT test in previous studies. The walk as well as the timing and content of the conversation of the SWWT test were standardised. The conversation was cognitively challenging using open questions and patients were not ''instructed'' to walk along the walkway. The following procedure was followed: patients were informed that the paper and pencil assessments had been completed and that they could return to the lounge area for a cup of tea or to await transport home. The researcher accompanied patients on this walk (to arrange transport or to make a cup of tea when they got there). Ten seconds (timed using a wristwatch with a second hand) into the walk from the assessment room to the lounge area (30 m), the researcher initiated a conversation (patients were asked a question about their medication). A positive test result was noted if a person stopped walking for at least one second. When a patient stopped walking, the researcher initially continued walking, by taking at least one more step, this was done to ensure that any ''stop'' was not initiated or encouraged by the researcher. After taking one or two steps the researcher stopped with the patient as it was deemed unethical to just continue walking. Patients were then followed prospectively over a period of six months using standardised forms to document falls (falls diary based on a falls interview schedule[17]) and, to assure higher accuracy, participants were also contacted by telephone every two weeks to remind them to update their falls diary.

Statistical analysis

Data were analysed using SPSS for Windows. Descriptive statistics were used to describe the sample and the frequency of falls. The analysis for the SWWT test as a predictor for falls was completed first for all fallers and then for repeat fallers in order to allow comparison with previous research. As the data were not normally distributed, non-parametric statistics (Mann–Whitney *U*-test) were used. Analysis also tested the sensitivity, specificity as well as PPV and NPV of the SWWT test. The test outcome was rated as positive when a participant stopped walking when talking and negative when a participant continued walking when talking and the ''disease outcome'' was positive if those who stopped walking experienced falls and confirmed the positive test outcome. The significance level for statistical analysis was set at $p<0.05$.

RESULTS

Patients

One hundred and seventy five subjects were identified and considered for inclusion in this study. General practitioners (GPs) gave their consent to contact 115 of these patients. Reasons for GPs not to give consent included death, bereavement, dysphasia, inability to walk, not registered with the practice anymore, patient had moved, presented with other acute medical diseases, and unsure of diagnosis. Of the 115 patients invited to participate in the study, 32 did not respond to the invitation letter, 12 did not want to take part in the study and three patients had died. Sixty eight (59%) patients agreed to take part in the study, of which three had to be excluded (one developed acute medical problems and was admitted to hospital, two were bed or chairbound). Sixty five subjects were recruited and interviewed, but two subjects were lost to follow up (one died, one developed acute medical problems).

Therefore, data for 63 patients (36 men, 27 women; mean age 68 years, range 42–84) were included in the analysis. The majority of patients (59, 94%) had a first incident stroke but four patients (6%) had suffered a previous stroke and mean time since onset of stroke was 20 months (range 2–72). Twenty nine had a left hemisphere infarction, 30 a right hemisphere infarction, and four had a brainstem stroke. Overall the sample presented with mild to moderate levels of disability and was not cognitively impaired. Assessment scores of participants are shown in table 1.

Stops walking when talking as a predictor of falls

Thirty subjects (48%) fell during the subsequent six months. Of those 15 (24%) reported two or more falls and 15 (24%) reported one fall. Eleven (18%) reported near-falls and 22 (35%) did not report any falls or near-falls during the six month prospective follow up period. The SWWT test was positive in 26 (41%) out of the 63 participants—that is, 26 subjects stopped walking when talking.

All fallers

Sixteen of the 26 subjects who stopped walking when talking and 14 people who did not stop walking when talking experienced one or more falls during the six month follow up period (table 2). The proportions that were correctly predicted based on the SWWT test were $16/30 = 0.53$ and $23/33 = 0.70$, respectively. Therefore, the SWWT test sensitivity was 53% and specificity was 70%. Clinically, it is of interest to know what proportion of people who stopped walking when talking would fall—that is, what is the probability that the SWWT test can distinguish fallers from the non-fallers? The proportion of correct diagnoses was $16/26 = 0.62$. Among the 37 subjects who did not stop walking when talking, the proportion of those who did not fall was $23/37 = 0.62$. Hence, the PPV of the SWWT test for all falls was 62% (16/26) and the NPV was 62% (23/37).

Repeat fallers

Eleven of the 26 subjects in whom the SWWT test was positive and four people in whom the SWWT test was negative experienced repeated falls during the six month

Table 1 Descriptive data and assessment scores of total sample (N = 63)

Variable	Median (range)
Age (years)	71 (42–84)
Time since onset of stroke (months)	12 (2–72)
Middlesex Elderly Assessment of Mental State (score)	12 (8–12)
Nottingham Extended ADL scale (score)	41 (5–61)
RMA upper limb (score)	10 (1–15)
RMA leg and trunk (score)	9 (2–10)
RMA gross function (score)	10 (6–15)
HAD anxiety (score)	5 (0–17)
HAD depression (score)	4 (1–17)

ADL, activites of daily living; HAD, Hospital Anxiety and Depression scale; RMA, Rivermead Motor Assessment

Table 2 Stops walking when talking as a predictor of falls

Group	Stopped (%)	Didn't stop (%)
Fallers	16 (62)	14 (38)
Non-fallers	10 (38)	23 (62)
Repeat fallers	11 (42)	4 (11)
Non-repeat fallers	15 (58)	33 (89)
Total	26 (100)	37 (100)

follow up period (table 2). The proportions that were correctly predicted based on the SWWT test were 11/15 = 0.73 and 33/48 = 0.69, respectively. Therefore the SWWT test sensitivity was 73% and specificity was 69%. The proportion of correct diagnoses was 11/26 = 0.42. Among the 33 subjects who did not stop walking when talking, the proportion of those who did not fall was 33/37 = 0.89. Hence, the PPV of the SWWT test for repeated falls was 42% (11/26) and the NPV was 89% (33/37).

Characteristics of those who stopped walking when talking

Those patients who stopped walking when talking were significantly more disabled ($p<0.001$)—that is, less mobile, more dependent in ADL, and depressed ($p = 0.012$) than those who continued walking when talking (table 3). Those who stopped walking when talking but did not experience falls during the follow up period had significantly greater functional impairments. Repeat fallers who continued walking when talking were less disabled and experienced falls under different circumstances, often during more demanding activities such as ''climbing a ladder'' or ''playing ball on the beach''.

DISCUSSION

The SWWT test was easily applied within a clinical environment and required no equipment other than a wristwatch with a second hand. Difficulties arose when comparing PPV and NPV across studies as the prevalence of stopping when talking in this study was not the same as in previous studies. In comparison to previous studies among the general population[12 13] and people with PD,[14] a greater percentage of people with stroke in the present study stopped walking when talking.

Specificity was poorer but sensitivity was better in comparison to previous work,[12 13] however, the promising results from the original study[12] could not be reproduced. The SWWT test had an acceptable NPV for repeat fallers. However, based on the moderate PPV reported in the present study, the clinical usefulness of the SWWT test as a single indicator of fall risk is questionable. The SWWT test could not reliably predict which people with stroke were at greatest risk of falling, thus supporting recent evidence that a single test may not be sufficiently accurate in predicting falls in stroke patients.[13 21] Further work should explore whether the SWWT test could prove useful in predicting falls as part of a more comprehensive fall risk assessment among people with stroke. However, results from the present study support the notion that competition for attentional resources occurs among people with stroke when a motor and a cognitive task are performed simultaneously[9 10 22] but the findings also raise a number of issues that could potentially influence the outcome of the SWWT test. First, those who stopped walking when talking were generally more disabled and depressed, which may indicate greater cognitive motor interference due to reduced automaticity of movements.[9 10] Secondly, in subjective reports to the researcher some participants explained that they stopped walking when talking because they had recognised that they required greater attentional resources for walking and that switching concentration away from the walking task could have destabilising effects, which raises the question as to whether stopped walking when talking could be a coping strategy. Thirdly, a number of repeat fallers who continued walking when talking had significantly better functional abilities and experienced falls during more complex circumstances, suggesting that the test was not sensitive enough to pick up those fallers who were able to perform the two tasks simultaneously. This might also indicate that some participants were more willing to take more risks and therefore experienced falls during more demanding activities.

Recruitment through hospital and therapy records might not reflect a true community population, as it is possible that some patients were excluded who had not been admitted to hospital, when they had their stroke. People with stroke in this study varied in age, stroke severity, and amount and stage of recovery, and therefore fall groups were not homogeneous in contrast with the original study.[12] While this might explain why the SWWT test was not a good predictor for falls among this sample it is argued that this variability reflects the nature of a sample of people with stroke living in the community. To improve prospective fall reports participants were given instructions on how to use the falls diary (based on the interview schedule used at the initial interview[17]), were contacted by telephone every two weeks and were given a contact number to ring if they experienced difficulties completing the diary. All participants had passed a cognitive screening test and were encouraged to have another person assist them in the recording of fall events in the diary.

Although the sample size was comparable to the original study,[12] it is acknowledged that larger samples might produce different results, as this would allow for more detailed subgroup analysis. Future studies should allow for longer follow up periods and classify stroke patients according to site and size of lesion, as it is hypothesised that certain types of lesion might lead to certain types of fall that could be predicted using the SWWT test.

In summary, the SWWT test was easy to use within a clinical environment but the clinical usefulness of this test as a single predictor for falls among people with stroke is questionable since it could not reliably predict fallers. The outcome of the SWWT test was found to be related to level of disability, as well as to ''risk reducing'' and ''risk taking'' behaviours. Those who stopped walking when talking were significantly more disabled, dependent in activities of daily living, and depressed, whilst repeat fallers who continued

Table 3 Comparison of characteristics of those who stopped and those who didn't stop walking when talking

Variable	Stopped median (range)	Didn't stop median (range)	p value
Age (years)	73 (49–83)	67 (42–84)	p>0.05
Time since onset (months)	14 (2–72)	11 (2–72)	p>0.05
Side of lesion (left/right/brainstem)	15/11/0	14/19/4	p>0.05
Nottingham Extended ADL scale (score)	23 (5–52)	49 (9–61)	p<0.001
RMA upper limb (score)	9 (1–14)	14 (1–15)	p<0.001
RMA leg and trunk (score)	6 (2–10)	10 (2–10)	p<0.001
RMA Gross function (score)	9 (6–11)	10 (6–15)	p<0.001
HAD anxiety (score)	5 (0–17)	5 (1–13)	p>0.05
HAD depression (score)	6 (1–17)	3 (1–9)	p = 0.012

See table 1 for abbreviations.

walking when talking were more functionally able and fell under more complex circumstances. Research exploring the SWWT test in larger samples or as part of a fall risk assessment is required.

Authors' affiliations

D Hyndman, A Ashburn, School of Health Professions and Rehabilitation Sciences, University of Southampton, Southampton, UK

Competing interests: none declared

REFERENCES

1 **Forster A**, Young J. Incidence and consequences of falls due to stroke: a systematic inquiry. *BMJ* 1995;**311**:83–6.
2 **Nyberg L**, Gustafson Y. Patient falls in stroke rehabilitation. A challenge to rehabilitation strategies. *Stroke* 1995;**26**:838–42.
3 **Nyberg L**, Gustafson Y. Using the Downton Index to predict those prone to falls in stroke rehabilitation. *Stroke* 1996;**27**:1821–8.
4 **Rapport LJ**, Webster JS, Flemming KL, *et al.* Predictors of falls among right-hemisphere stroke patients in the rehabilitation setting. *Arch Phys Med Rehabil* 1993;**74**:621–6.
5 **Mayo NE**, Korner-Bitensky N, Kaizer F. Relationship between response time and falls among stroke patients undergoing physical rehabilitation. *Int J Rehabil Res* 1990;**13**:47–55.
6 **Robertson IH**, Ridgeway V, Greenfield E, *et al.* Motor recovery after stroke depends on intact sustained attention: A 2-year follow-up study. *Neuropsychology* 1997;**11**:290–5.
7 **Hyndman D**, Ashburn A. People with stroke living in the community: an investigation into the relationship between attention, balance and falls. *Clin Rehabil* 2002;**16**:228.
8 **Stapleton T**, Ashburn A, Stack E. A pilot study of attention deficits, balance control and falls in the subacute stage following stroke. *Clin Rehabil* 2001;**15**:437–44.
9 **Haggard P**, Cockburn J, Cock J, *et al.* Interference between gait and cognitive tasks in a rehabilitating population. *J Neurol Neurosurg Psychol* 2000;**69**:479–86.
10 **Bowen A**, Wenman R, Mickelborough J, *et al.* Dual-task effects of talking while walking on velocity and balance following a stroke. *Age Ageing* 2001;**30**:319–23.
11 **Tinetti ME**, Franklin WT, Mayewski R. Fall risk index for elderly patients based on number of chronic disabilities. *Am J Med* 1986;**80**:429–34.
12 **Lundin-Olsson L**, Nyberg L, Gustafson Y. ''Stops walking when talking'' as a predictor of falls in elderly people. *Lancet* 1997;**349**:617.
13 **Lundin OL**, Nyberg L, Gustafson Y. The Mobility Interaction Fall chart. *Physiother Res Int* 2000;**5**:190–201.
14 **Bloem BR**, Grimbergen YAM, Cramer M, *et al.* ''Stops walking when talking'' does not predict falls in Parkinson's disease. *Ann Neurol* 2000;**48**:268.
15 **Sheil A**, Wilson BA. Performance of stroke patients on the Middlesex Elderly Assessment of Mental State. *Clin Rehabil* 1992;**6**:283–9.
16 **Clark R**, Lord S, Webster I. Clinical parameters associated with falls in an elderly population. *Gerontology* 1993;**39**:117–23.
17 **Stack E**, Ashburn A. Fall events described by people with Parkinson's disease: implications for clinical interviewing and the research agenda. *Physiother Res Int* 1999;**4**:190–200.
18 **Lincoln N**, Leadbitter D. Assessment of motor function in stroke patients. *Physiotherapy* 1979;**65**:48–51.
19 **Nouri FM**, Lincoln NB. An extended activities of daily living scale for stroke patients. *Clin Rehabil* 1987;**1**:301–5.
20 **Zigmond AS**, Snaith RP. The Hospital Anxiety and Depression scale. *Acta Psychiatr Scand* 1983;**67**:361–70.
21 **Lamb SE**, Ferruci L, Volapto S, *et al.* Risk factors for falling in home-dwelling older women with stroke: the Women's Health and Aging Study. *Stroke* 2003;**34**:494–501.
22 **Fordham C**, Cock J, Cockburn J, *et al.* Reciprocal interference between gait and cognition during recovery from acquired brain injury. *Clin Rehabil* 2000;**14**:223–4.