Timed "Up & Go" Test as a Predictor of Falls Within 6 Months After Hip Fracture Surgery

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Background and Purpose

Previous studies of Timed "Up & Go" Test (TUG) scores as a predictor of falls were based primarily on retrospective data, and no prospective studies of the TUG for predicting falls in people with hip fracture are available. The purpose of this study was to determine whether TUG scores obtained upon discharge from an acute orthopedic hip fracture unit can predict falls in people with hip fracture during a 6-month follow-up period.

Subjects

The subjects included in this study were 79 consecutive elderly people who had hip fractures and were able to perform the TUG when discharged directly to their own homes or to assisted living facilities from a specialized acute orthopedic hip fracture unit, with 59 (75%) being able to participate in the follow-up interview.

Methods

In this prospective study, all subjects were contacted for a 6-month follow-up interview about falls since discharge from the hospital. The score on the TUG performed at discharge (median of 10 days after surgery) was compared with the New Mobility Score, which describes functional level before the fracture and mental status on admission, sex, type of fracture, residence, and walking aids before and after the fracture. All subjects followed a well-defined care plan with multimodal fast-track rehabilitation including an intensive physical therapy program comprising 2 daily sessions; discharge was in accordance with standardized criteria. Analyses and correlations of all variables were examined for prediction of falls, and sensitivity, specificity, predictive values, and likelihood ratios were calculated. Falls were classified as "none" or as "1 or more."

Results

Among the 59 subjects in the follow-up group, 19 subjects (32%) experienced 1 or more falls in the period since discharge; 4 of these falls resulted in new hip fractures. The TUG performed at discharge with a cutoff point of 24 seconds was the only parameter that significantly predicted falls during the 6-month follow-up period, with a negative likelihood ratio of 0.1 to be a faller as a nonfaller.

Discussion and Conclusion

The results suggest that the TUG is a sensitive measure for identifying people with hip fracture at risk for new falls, and it should be part of future outcome measures to decide for whom preventive measures against falls should be instituted.

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Hip fracture after falls in elderly people represents an increasing challenge for the health care system worldwide. Approximately 30% of community-residing people aged 65 years or older fall each year, with higher numbers in institutions.[1] Hip fracture after falls has been related to preexisting mobility, balance, osteoporosis, and visual or other health problems.[2] Furthermore, Pearse et al[3] showed that 12% of patients with a hip fracture had a second hip fracture with a "significant further impact on patients' mobility and social independence." A prospective study by Stewart et al[4] involving a post–hip fracture follow-up at 52 weeks (25–80 weeks) for 394 patients who were more than 50 years of age revealed that a poor mobility score was a significant risk factor of a new fall. Prevention of falls, therefore, should be of the highest priority for all people with hip fracture during the stay at the orthopedic ward or rehabilitation unit and after discharge. In this context, methods for characterizing people at risk for falling are needed.

Scores on the Timed "Up & Go" Test (TUG), which measures functional mobility (in seconds), have been found in frail, community-dwelling older people to correlate well with scores on the Barthel Index of activities of daily living, on the Berg Balance Scale, and on gait speed testing[5]; "the patients who took 30 seconds or more to complete the test, on the other hand, tended to need the assistance of others for many mobility tasks."[5] Very high intrarater and interrater reliability[5,6] and test-retest reliability[7] have been found for the TUG. Lusardi et al[8] found that age and the use of an assistive device were associated with significantly slower TUG scores (7.9–17.7 seconds) in community-dwelling people who were 66 to 101 years of age. Two studies of community-dwelling elderly people[9,10] revealed that a TUG score of more than 13 or 14 seconds was able to discriminate people who fell from people who did not fall in the preceding 6 months. Okumiya et al[11] found that a TUG score of more than 16 seconds predicted falls during a 5-year follow-up period. In contrast, Boulgarides et al[12] found that 5 balance tests, including the TUG, did not predict falls during a 12-month follow-up period for a group of 99 community-dwelling, older, active and independent adults who were 65 to 90 years of age.

The TUG has been used in several studies of people with hip fracture. Crotty et al[13] used the TUG as an outcome measure 12 months after home-based therapy for people with hip fracture and reported significant improvements in TUG scores. Similar results were reported by Mendelsohn et al[14] for people who had hip fracture and who were admitted to a specialized musculoskeletal inpatient rehabilitation program, by Kristensen et al[15] for a 6-month post–hip fracture follow-up period, and by Reardon et al[16] at 5 months after total hip arthroplasty. Hall et al[17] used the TUG to compare a group of community-dwelling subjects at 6 to 12 months after hip fracture with a matched community-dwelling group without fracture and found that the group with fracture was significantly slower (19 versus 10.5 seconds). In Denmark, the TUG with a cutoff point of 30 seconds was recommended as an indicator of the quality of treatment for people with hip fracture during their hospital stay. However, no prospective studies of the use of the TUG for predicting falls in people with hip fracture are available.

The aim of this prospective study, therefore, was to examine the use of the TUG performed at discharge with people with hip fracture who were discharged directly to their own residences or assisted-living facilities from an acute orthopedic hip fracture unit and with a cutoff point of 30 seconds as a potential predictor of falls during the 6-month postsurgery follow-up period. The risk of falls also was compared with age, prefracture residence, walking aids, type of fracture, mental status on admission, and the New Mobility Score (NMS),[18] which describes prefracture functional level.

Method

Subjects

Patients at the special orthopedic hip fracture unit at Hvidovre University Hospital between September 2002 and March 2003 were included prospectively as subjects in this study. The inclusion criterion was the ability of patients to perform the TUG at discharge directly to their own residences or to assisted-living facilities in the community. Patients primarily underwent rehabilitation directly in the orthopedic ward and were discharged when they were safely able to perform what Isaacs[19] has called the "basic mobility skills" of getting in and out of a bed and a chair, getting on and off of a toilet, and walking a few feet.

Patients who, after 2 to 3 weeks of initial rehabilitation at the orthopedic ward, still required inpatient rehabilitation were transferred to a secondary rehabilitation unit. During their hospital stay, all patients followed a well-defined care plan with multimodal fast-track rehabilitation[20,21]; this plan included early surgery within 24 hours of admission, epidural anesthesia and epidural analgesia initiated immediately after admittance and continued for 96 hours after surgery, a standardized transfusion protocol if the hemoglobin level was less than 6.0 mmol/L, supplemental oxygen when the patient was positioned supine in the perisurgical period, prophylactic

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intraoperative antibiotics, perisurgical low-molecular-weight heparin, and enforced perisurgical oral nutrition and hydration, including energy and protein supplementation. The patients were mobilized on the day of surgery, and an intensive physical therapy program comprising 2 daily 30-minute sessions was initiated on the first day after surgery. After discharge, most patients continued physical therapy training twice weekly at hospital outpatient facilities until the final level of training was reached. All patients were contacted 6 months after surgery for a follow-up interview. All participants gave written informed consent.

A total of 79 subjects with hip fracture were included in this study. The median age of the subjects was 80 years; 15 subjects (19%) were younger than 65 years of age.

Measurements

Data were gathered prospectively, and a database was instituted for all patients admitted to the unit. This database comprised information on age; sex; body mass index; cerebrovascular, cardiovascular, and pulmonary diseases; diabetes; number of medications; type of fracture; and prefracture residential status, walking aids, and functional level evaluated with the NMS.[18] A validated 9-point Danish version of an abbreviated mental test was taken at admission.[22] The TUG was performed at discharge of patients from the unit to the community. Six months after the hip fracture surgery, all patients were contacted for a follow-up interview about falls since discharge from the hospital; all interviews were performed by one physical therapist with no knowledge of baseline data at the time of the interview.

The TUG measures the time (in seconds) that it takes an individual to rise from an armchair (chair seat height=45 cm), walk 3 m to a line drawn on the floor, and return to the chair. The time was measured from a seated position (back against the backrest) with a stopwatch started on the command "ready—go" and stopped when the seat position was reached again. The participant was given a practice trial followed by 1 timed trial performed on the day before discharge. All tests were conducted by 1 of 3 physical therapists after participation in a training session in accordance with national guidelines previously developed and examined for reliability in the study unit, with intratester and intertester reliability (Spearman correlation coefficient) of .91.

The NMS is a composite score of an individual's ability to perform indoor walking, outdoor walking, and shopping before the hip fracture and provides a score of between 0 and 3 for each function; the total score can range from 0 to 9, with 9 indicating a high prefracture functional level. The score was previously described as a predictor of long-term mortality[18] and rehabilitation,[15,18] with a cutoff point of 5. The mental score has a cutoff value of 5 or less for cognitive impairment, which has been described as an independent predictor of long-term mortality.[18]

The use of walking aids, which correlates with slower performance on the TUG,[10,23] also was assessed, with reports of the walking aid used during the TUG. We included patients who were younger than 65 years of age as subjects in this study because they comprise 12.5% of patients with hip fractures admitted to our unit and, as their fractures were due to a fall, they have the potential to fall again after discharge. All subjects were asked about the number of any unexpected falls from a standing position to the ground or floor since discharge.

Data Analysis

All data from subjects who were able to participate in the 6-month follow-up interview were compared with those from nonparticipants, and the potential for selected variables to predict falls at 6 months after the fracture was tested. The cutoff points for the individual variables were as follows:

- age—<80 or ≥80 years
- prefracture residence—own homes or assisted living facilities
- walking aids—none, cane, 1- or 2-elbow crutches, or walker on wheels
- NMS score—0 to 5 (low) or 6 to 9 (high)
- dementia on admission—0 to 5 (dementia) or 6 to 9 (no dementia)
- type of fracture—cervical, trochanteric, or subtrochanteric
- TUG score—<30 or ≥30 seconds
- walking aids at discharge—1- or 2-elbow crutches, walker, or walker on wheels

Falls were classified as none or as 1 or more. Statistical analysis was conducted with SPSS for Windows version 10.1.* The level of significance was set at $P<.05$. Significant differences between groups were investigated with the chi-square test for categorical data and with the Fisher exact test for continuous numerical data.

Results

The TUG was performed at a median of 10 days (range=3–40) after surgery. At 6 months, 59 of the 79 subjects (75%; 8 of whom were younger than 65 years of age) were able to participate in the follow-up interview. The prefracture characteristics and postsurgery data for the subjects are shown in Table 1, and the exclusion criteria for the 20 subjects who were not able to participate in the 6-month follow-up interview are shown in Figure 1. Among the 59

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Table 1.
Baseline Characteristics and Results for 79 Subjects Included in a 6-Month Follow-up Study of the Use of the Timed "Up & Go" Test for Predicting Falls After Hip Fracture[a]

Characteristic	Subjects With Follow-up Data (n=59)	Subjects Without Follow-up Data (n=20)
Age (y)	81 (42–97)	75 (47–89)
Women	45 (76)	14 (70)
Body mass index	23.8 (21.1–26.0)	21.5 (21.0–26.0)
Living in own residence	54 (92)	18 (90)
Prefracture walking aids	24 (41)	7 (35)
Low prefracture functional level (New Mobility Score of <6)	13 (22)	5 (25)
Cerebrovascular disease	8 (14)	2 (10)
Cardiovascular disease	35 (59)	12 (60)
Pulmonary disease	11 (19)	4 (20)
Diabetes	2 (3)	1 (5)
No. of medications	2 (1–4)	2 (0–5)
Dementia on admission	3 (5)	2 (10)
Fracture type		
Cervical	30 (51)	14 (70)
Trochanteric	26 (44)	4 (20)
Subtrochanteric	3 (3)	2 (10)
Walking aids at discharge	59 (100)	18 (90)
Low functional mobility at discharge (Timed "Up & Go" Test score of ≥30 s)	36 (61)	12 (60)
Postsurgical day of Timed "Up & Go" Test	10 (3–40)	11 (3–35)

[a] Data are presented as number (percentage) for categorical data and as median (interval) for numerical data. There were no significant differences between groups.

subjects in the follow-up group, 19 subjects (32%) experienced from 1 to 4 falls (median=2) in the period since discharge; 4 of these falls resulted in new hip fractures, and 18 of the subjects who fell scored more than 24 seconds on the TUG. Eighty-five percent of the subjects in the follow-up group received a plan for additional physical therapy after discharge.

The analyses of all predictors were examined, and the categorical outcome of 1 or more falls versus no falls showed that only the TUG performed at discharge with a cutoff point of 30 seconds was significantly (P=.02) associated with falls (Tab. 2). All subjects used walking aids when performing the TUG, and a progressive tendency toward falls was seen with the use of more assistive aids, because 15 (79%) of the subjects who fell used a walker or a walker on wheels rather than crutches. The TUG scores are shown in Figure 2; the median TUG scores were 42 seconds for subjects who fell and 29.5 seconds for subjects who did not fall. Only 3 subjects who fell had TUG scores of less than 30 seconds. In accordance with the directions given by Riddle and Stratford,[24] the sensitivity, specificity, predictive values, and likelihood ratios of the TUG are shown in Table 3; the TUG had very high sensitivity and negative predictive values for several cutoff points. A cutoff point of 24 seconds rather than 30 seconds strengthened the data (P=.01), resulting in a sensitivity of 95%, a negative predictive value of 93%, and a negative likelihood ratio of 0.1.

Discussion and Conclusion

The present study showed that the TUG performed at discharge with people with hip fracture who were discharged directly to their own homes or to assisted living facilities from an acute orthopedic hip fracture unit and with a cutoff point of 24 seconds was a valid predictor of falls in people with hip fracture within the first 6 months after dis-

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charge. Thus, 95% of subjects who fell had TUG scores of ≥24 seconds; TUG scores of <24 seconds resulted in the prediction of 93% of subjects who did not fall, and these subjects were only 0.1 times as likely to fall as were other subjects.

Several studies previously assessed predictors of falls in elderly people, but most studies were conducted among community dwellers. Tinetti et al[25] studied 1,103 older people (≥72 years of age) living in the community for a median follow-up of 31 months and found that cognitive impairment, the presence of at least 2 chronic conditions, balance and gait impairments, and a low body mass index were independently associated with an individual experiencing a serious injury during a fall. Tinetti et al[26] also found that the risk of falling increased linearly with the number of risk factors, from 8% with none to 78% with 4 or more; these results suggested that measurements of balance and gait impairments should be combined with other risk factors, such as sedative use, cognitive impairment, disability of the lower extremities, palmomental reflexes, and foot problems. Similar results were found in a 12-month follow-up study[27] for 1,517 elderly subjects who were ambulatory; in that study, lower-limb muscle power and balance and gait functions were stronger predictors of falls and recurrent falls than other clinical predictors. Similarly, functional mobility evaluated with the TUG discriminated between subjects who fell and subjects who did not fall.[28]

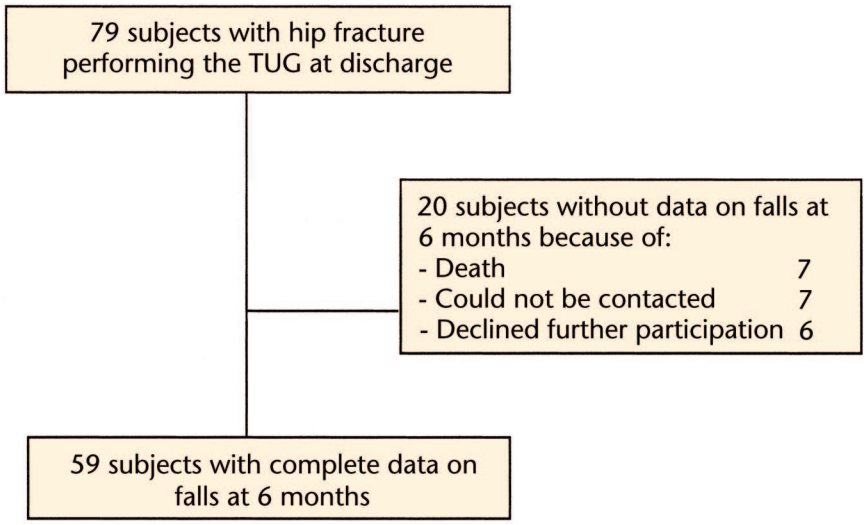

Figure 1.
Use of the Timed "Up & Go" Test (TUG) for predicting falls after hip fracture in a 6-month follow-up study of 79 subjects discharged directly to their own homes or assisted living facilities from an acute orthopedic hip fracture unit.

Table 2.
Associations Between All Predictors and the Categorical Outcome of Falls Versus No Falls and Significance of Associations for 59 Subjects Discharged Directly to Their Own Homes or Assisted Living Facilities From an Acute Orthopedic Hip Fracture Unit[a]

Parameter	Subjects With Falls (n=19)	Subjects Without Falls (n=40)	*P*
Age (<80 y/≥80 y)	8 (42)/11	20 (50)/20	.38[b]
Living in own residences/assisted living facilities	16 (84)/3	38 (95)/2	.32[c]
Prefracture walking aids: none/cane/1- or 2-elbow crutches/walker on wheels	7/4/1/0/7	28/4/1/1/6	.13[b]
Prefracture functional level (New Mobility Score of 0–5/6–9)	6 (32)/13	7 (18)/33	.22[b]
Dementia on admission (yes/no)	1 (5)/18	2 (5)/38	1.00[c]
Fracture type: cervical/trochanteric/subtrochanteric	10 (53)/8/1	20 (50)/18/2	.98[b]
Walking aids at discharge: 1- or 2-elbow crutches/ walker/walker on wheels	0/4/6/9	4/15/11/10	.17[b]
Functional mobility at discharge (Timed "Up & Go" Test score of <30 s/≥30 s)	3 (16)/16	18 (45)/22	.02[c]

[a] Data are presented as number (percentage).
[b] The chi-square test was used as the statistical test for significance.
[c] The Fisher exact test was used as the statistical test for significance.

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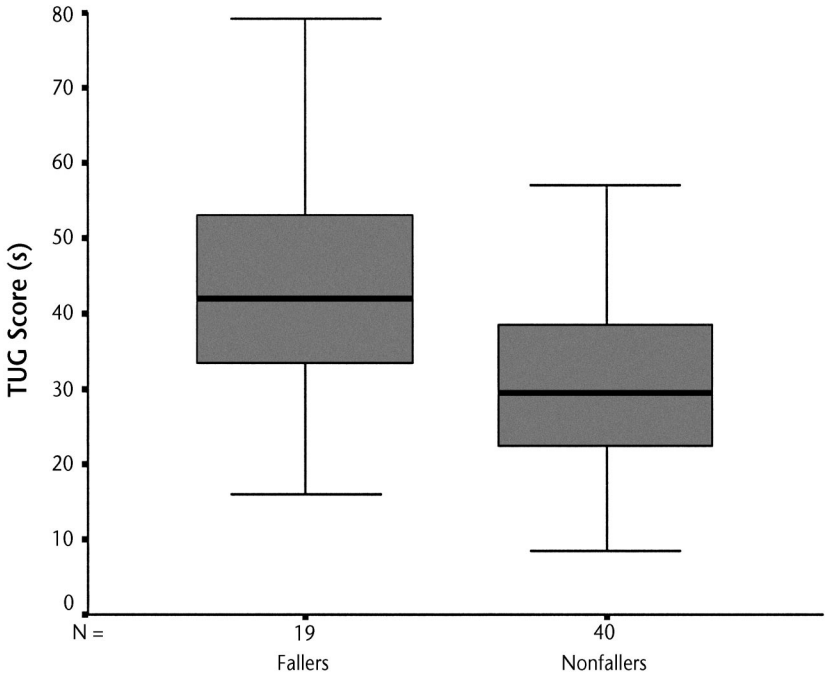

Figure 2.
Distribution of Timed "Up & Go" Test (TUG) scores for 19 subjects with falls and 40 subjects without falls in a 6-month period after hip fracture. Gray boxes represent 25th through 75th quartiles, horizontal black bars in gray boxes represent medians, and error bars represent 95% confidence intervals.

Other studies[9,10] established cutoff points for the TUG of 13 and 14 seconds for discriminating retrospectively between subjects who fell and subjects who did not fall. The only previous study in which the TUG was found to predict falls was a Japanese study[11] with 278 older people (>75 years of age) who had not fallen before and who were followed over a 5-year period; in that study, a TUG score of >16 seconds was established as an independent predictor of falls, with a sensitivity of 54%, a specificity of 74%, and a positive predictive value of 44%. Our cutoff point of 24 seconds for predicting falls is higher than that in this last study. Our assessment was performed at a median of 10 days after surgery; in another study,[17] TUG scores after hip fracture were obtained at later times (6–12 months). Thus, different cutoff points for different patient populations at different times during rehabilitation may be necessary. Therefore, this prospective study using the TUG in the early period of rehabilitation and establishing cutoff points for people with hip fracture and at risk of new falls demonstrates that the TUG may be a valuable tool in future fall prevention efforts following hip fracture.

We are aware that our study design, which was reliant on the ability to recall falls during a 6-month period after hip fracture, could have led to some falls not being recalled, as indicated by Cummings et al.[29] A log system might have provided a more accurate registration of falls, but other studies[9,28] have used the same design as that used for our follow-up group.

One study[10] separating people with falls from people without falls included only older adults with 2 or more falls. Another study showed that "nonfallers were significantly faster than both one-time fallers and frequent fallers ($P<.01$) during the Get Up and Go."[28(p M674)] In our opinion, because a single fall may be fatal in this frail group, the cutoff in the present study was set at people with-

Table 3.
Predictive Values and 95% Confidence Intervals (CI) for Several Different Cutoff Points of the Timed "Up & Go" Test (TUG) for Predicting Falls Within 6 Months After Discharge for 59 Subjects Discharged Directly to Their Own Homes or Assisted Living Facilities From an Acute Orthopedic Hip Fracture Unit[a]

TUG Score, in Seconds (No. of Subjects)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood, Ratio (95% CI)
≥20 (54)	33 (21–46)	80 (45–100)	95 (75–99)	10 (4–23)	1.1 (0.9–1.2)	0.5 (0.1–4.4)
≥24 (44)	41 (26–55)	93 (81–100)	95 (75–99)	35 (22–51)	1.5 (1.1–1.8)	0.1 (0.0–1.1)
≥30 (34)	47 (30–64)	88 (75–100)	84 (62–94)	55 (40–69)	1.9 (1.3–2.8)	0.3 (0.1–0.8)
≥34 (28)	50 (31–69)	84 (71–97)	74 (51–88)	65 (50–77)	2.1 (1.3–3.4)	0.4 (0.2–0.9)

[a] Data are reported as percentages unless otherwise indicated.

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out falls versus those with 1 or more falls.

However, our study also has some limitations in that only subjects who could perform the TUG at discharge were assessed; therefore, the subjects who were assessed were not those with the lowest functional ability. This limitation is inherent in the TUG, in that the ability to perform the test requires a moderate functional capacity. In addition, the number of subjects in our study was relatively small. Further studies with larger groups of subjects and measurements of functional mobility that can be used during their hospital stay and at discharge for all patients, regardless of functional level, are needed. A measure that evaluates daily walking ability for all patients during their hospital stay, such as the Cumulated Ambulation Score,[30] may be useful. In conclusion, our study showed that a TUG score of more than 24 seconds at discharge was a significant predictor for falls within 6 months after hip fracture.

Mr Kristensen provided writing. Dr Foss provided data analysis. Dr Kehlet provided consultation (including review of manuscript before submission).

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