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Using the Timed Up and Go Test to stratify elderly inpatients at risk of falls

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Objective: To determine whether the Timed Up and Go Test is useful at stratifying acutely unwell elderly inpatients according to their risk for subsequent falls.
Design: Prospective cohort study.
Setting: Multidisciplinary acute care unit for the elderly at Liverpool Hospital, in Sydney, Australia.
Participants: A total of 2388 consecutive admissions to the unit of mean age 82 years.
Intervention: The Timed Up and Go, administered on admission to the unit, and two modifications (an ordinal scale and a dichotomous scale, both incorporating patients unable to complete the Timed Up and Go) were evaluated.
Main outcome measures: Number of falls, and reasons for the inability to complete the Timed Up and Go.
Results: During a median length of stay of nine days, 180 patients had at least one fall. The Timed Up and Go was unable to identify those patients who subsequently fell ($P = 0.78$). When the Timed Up and Go was modified to include the majority of patients unable to complete the test, both the ordinal (range of values 1–8, odds ratio (OR) 1.12, 95% confidence interval (95% CI) 1.03–1.21, $P = 0.01$) and dichotomous (OR 1.59, 95% CI 1.09–2.32, $P = 0.02$) modifications significantly predicted falls in multivariate analyses. Patients unable to do the Timed Up and Go due to non-physical disability had the highest fall rate (11%), followed by those with physical disability (9%), while those able to do the Timed Up and Go had the lowest fall rate (6%) ($P < 0.001$). Acutely unwell, immobile patients with dementia and delirium were not at excessive risk of falls.
Conclusion: In the acute care setting, the value of the Timed Up and Go lies in the inability to complete the test, and the reasons for this inability, rather than the time recorded.

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Introduction

While many of the predictors of falls in the hospital are well known, few publications address assessment tools that may help to stratify elderly patients in acute care settings according to their risk for further falls.[1] Impaired mobility, lower-extremity muscle weakness and impaired balance are established risk factors for falls,[2,3] hence assessment tools that include these domains may also predict falls. The Timed Up and Go Test,[4] a widely used and simple measure of basic mobility that compares well with other measures of balance and function,[4] may be useful in this regard. It involves a person standing from a 46-cm-high chair, walking 3 m, turning, walking back to the chair and sitting down. While the Timed Up and Go has been shown to predict falls in elderly community-dwelling persons,[5] its effectiveness in acute inpatient settings is largely unknown, despite its extensive use. In a retrospective audit of 160 medical records of patients admitted to an acute medical ward, Lindsay *et al.*[6] reported that the Timed Up and Go did not identify those patients who fell. However, only 17 experienced a fall, and those unable to do the Timed Up and Go were excluded, as were patients with an altered mental state. To the best of our knowledge, the Timed Up and Go has not been evaluated in other acute inpatient populations. Furthermore, many patients are unable to do the test, due to physical disability and other reasons (such as delirium or dementia), and excluding their data may be wasteful and misleading, both in the research setting and in daily clinical practice.

The purpose of this study was to determine whether the Timed Up and Go was useful at stratifying patients admitted to an acute care unit for the elderly according to their risk for falls. Specific aims were to incorporate data from those able and unable to complete the Timed Up and Go in an overall measure, and to test the hypotheses that those unable to do the Timed Up and Go were the most likely to fall.

Methods

Subjects

The participants were consecutive elderly patients admitted to the Aged Care Unit under the care of any of four geriatricians between November 2000 and December 2004. The Aged Care Unit is a multidisciplinary acute care unit at Liverpool Hospital, a busy tertiary referral hospital in south-western Sydney, NSW. The institutional review committee of the South Western Sydney Area Health Service approved the study protocol.

Measurements

A multidisciplinary team, comprising allied health, nursing and medical staff, comprehensively assessed all patients. The Timed Up and Go was administered by a physiotherapist to all patients able to mobilize independently or with standby supervision, within 24 h of admission to the Aged Care Unit, or on the next working day after a weekend. Those with cognitive impairment were included if they were able to follow simple verbal commands, and interpreters were used for patients unable to speak English. Based on a clinical designation, patients unable to do the Timed Up and Go belonged to one of two groups; those unable to sit, stand or walk independently, or with standby assistance (designated 'physical disability'); and those who refused, or were unable to follow instructions or attempt the Timed Up and Go for medical reasons (designated 'non-physical disability'). The need for a mobility aid and the assistance needed to walk (standby, or with assistance of one, two, or more than two persons) were documented for all patients.

A geriatrician evaluated each patient for active medical diagnoses (those causing physical, social or psychological dysfunction, or needing further investigations or changes to medications) and atypical presentation (non-specific presentation of disease common in the elderly). Diagnoses identified in previous publications as being related to falls were selected for further analysis. Other variables collected on admission were current domicile, whether known to a community-based aged care team, serum albumin, presence and grade of any pressure area, and demographic information. Details of falls during the Aged Care Unit stay were documented from mandatory incident reports.

Statistical analyses

A logarithmic transformation was applied to the Timed Up and Go times (designated 'log-Timed

Up and Go time') to change the heavily right-skewed distribution into a near normal distribution. As only 908 of 2196 (41%) patients with available data were able to do the Timed Up and Go, we created an ordinal scale based on the mean and standard deviations of the transformed Timed Up and Go time (designated 'ordinal-Timed Up and Go', range 1–7), and allocated a score of 8 to those unable to do the Timed Up and Go due to physical disability, ensuring more complete use (and less wastage) of the Timed Up and Go data. Patients who refused to attempt the Timed Up and Go, or were unable to attempt it for medical reasons, or were unable to follow instructions (non-physical disability) were excluded from analyses (unless otherwise stated). This exclusion helped reduce measurement bias, as we had no way of knowing which patients in this group could do the Timed Up and Go and what times they would record. The effect of coding the Timed Up and Go as a dichotomous variable (able or unable to do the Timed Up and Go, designated 'dichotomous-Timed Up and Go') was also explored. Hence, we evaluated the effect of the Timed Up and Go in three formats, the log-Timed Up and Go time in those able to do the test, the ordinal-Timed Up and Go score (incorporating those unable to do the Timed Up and Go due to physical disability), and the dichotomous-Timed Up and Go score (also incorporating those unable to do the Timed Up and Go).

Linear associations between variables were measured using the Spearman rank-order correlation coefficient. Between-groups comparisons were tested using Wilcoxon rank-sum tests for ordinal variables and Fisher's exact tests for dichotomous variables. One-way between-groups ANOVA was used to compare the means of continuous variables (e.g. Timed Up and Go times and levels of mobility aid), and Mantel–Haenszel trend analysis to evaluate trends between the three Timed Up and Go groups (those able to do the Timed Up and Go, those unable due to physical disability, and those unable due to non-physical disability) and variables such as whether the patient fell. When a significant difference was found in the ANOVA, a Tukey post-hoc analysis was applied to determine where the significance occurred. Multiple logistic regression was used to model the probability of at least one fall in the Aged Care Unit. Risk factors for falls in the literature (age, sex, comorbid disease)[1,7,8] were included in the final logistic regression model, together with the study variable (Timed Up and Go) and significant predictors from our dataset ($P < 0.05$).

Assuming 10% of patients would fall,[6] a minimum of 750 patients were required for multiple logistic regression to ensure sufficient power (90%) to detect an odds ratio of 1.5 (i.e. a Timed Up and Go score at which patients are 1.5 times as likely to fall than those with a lower score). A one-tailed test with a significance level of 5% was used, assuming a correlation coefficient of 0.4 between the Timed Up and Go and the highest correlated independent variable.[9] SAS software (version 8.02, SAS Institute, Inc., Cary, NC, USA) was used for all analyses.

Results

Characteristics of patients

Table 1 shows the characteristics of the 2388 study patients. Although 1319 (55%) were born in one of nine English-speaking background countries, the study population was multicultural, with 728 (30%) born in one of 31 European non-English-speaking background countries, 208 (9%) in one of 16 Asian countries, and the remaining 116 (5%) in one of 19 South American, African or Middle Eastern countries. The country of birth was unknown for 17 patients (1%).

Falls in Aged Care Unit

One hundred and eighty of 2361 (8%) patients with available fall data had at least one fall during their stay in the Aged Care Unit. Of these, 142 had one fall only, 29 had two falls, eight had three falls, and one had five falls.

Of 336 patients unable to do the Timed Up and Go due to non-physical disability, 146 (43%) refused, 134 (40%) were unable to attempt it for medical reasons, and 56 (17%) were unable to follow instructions. Table 2 shows the number of falls according to the ability or inability to complete the Timed Up and Go test. Patients unable to do the Time Up and Go due to non-physical disability had the highest fall rate (11%, 38 falls), followed by those with physical disability (9%, 83 falls), while those able to do the Timed Up

Table 1 Characteristics of patients

Characteristic	Number with data	Value
Age in years (mean ± SD)	2388	82.1 ± 7.7
Male, no. (%)	2388	912 (38)
English-speaking, no. (%)	2176	1721 (79)
Known to community aged care team, no. (%)	2345	1284 (55)
Living in nursing home, no. (%)	2205	216 (10)
Referral source to Aged Care Unit	2388	
Via emergency department, no. (%)		1442 (60)
Consultation-transfer care, no. (%)		544 (23)
Direct from community, no. (%)		244 (10)
Other, no. (%)		158 (7)
TUG	2196	
TUG score (median, Q1-Q3)		28, 19–41
TUG completed, no. (%)		908 (41)
TUG not done for physical reason, no. (%)		952 (43)
TUG not done for non-physical reason, no. (%)		336 (15)
Walking aid needed, no. (%)	2040	1497 (73)
Walking assistance needed, no. (%)	2049	951 (46)
Active diagnoses (median, Q1–Q3)	2388	8, 5–10
Selected diagnoses	2388	
Dementia present, no.(%)		893 (37)
Delirium present, no. (%)		905 (38)
Postural hypotension present, no. (%)		191 (8)
Pressure area present, no. (%)	1726	314 (18)
Albumin (mean ± SD)	2265	35 ± 6
Length of stay in Aged Care Unit (median, Q1-Q3)	2388	9, 5–15

Number with data, number of patients with complete data for characteristic (maximum 2388); Q1–Q3, interquartile range; TUG, Timed Up and Go.

and Go had the lowest fall rate (6%, 54 falls) ($P < 0.001$, Mantel–Haenszel trend test). Patients with higher fall rates were more likely to be living in a nursing home (17% of those with the highest fall rate, 13% of those with the intermediate rate, and 3% of those with the lowest rate, $P < 0.001$), less likely to speak English (69% versus 78% versus 86%, $P < 0.001$), and more likely to have additional active medical diagnoses ($P < 0.001$). Among patients with non-physical disability, the fall rate was 21% (12 falls) in those unable to follow the Timed Up and Go instructions (with an interpreter as needed), compared with 12% (18 falls) in those who refused ($P = 0.12$). Patients unable to attempt the Timed Up and Go for medical reasons (8 falls) had the same fall rate as those able to do the Timed Up and Go (54 falls) (both 6%).

The univariate predictors of falls in the Aged Care Unit were number of active medical diagnoses, delirium, referral from the emergency department (all $P < 0.001$), male sex ($P = 0.001$), atypical presentation ($P = 0.006$), ordinal-Timed Up and Go score ($P = 0.02$), and dichotomous-Timed Up and Go ($P = 0.02$). Tables 3–5 show the multiple logistic regression models for falls in the Aged Care Unit using the log-Timed Up and Go time, the ordinal-Timed Up and Go score and the dichotomous-Timed Up and Go formats, respectively. Log-Timed Up and Go time did not predict falls ($P = 0.78$). Both the ordinal-Timed Up and Go score ($P = 0.01$) and the dichotomous-Timed Up and Go ($P = 0.02$) significantly predicted the occurrence of at least one fall during the Aged Care Unit stay. The adjusted odds of falling was 59% higher in those unable to do the Timed Up and Go (due to physical disability), compared to those able to do the Timed Up and Go (Table 5).

Table 2 Falls in the Aged Care Unit according to ability or inability to complete the TUG

Fall	Able to complete TUG	Unable to complete TUG (physical reasons)	Unable to complete TUG (non-physical reasons)
Yes	54	83	38
No	854	869	298

$N = 2196$; TUG, Timed Up and Go.

Referrals from the emergency department were significantly older (83 years versus 81 years, $P < 0.001$), more likely to reside in a nursing home (12% versus 7%, $P < 0.001$), and less likely to speak English (77% versus 82%, $P = 0.01$), factors that may predispose to falls. However, their length of stay in the Aged Care Unit was considerably shorter (medians of 8 days versus 11 days, $P < 0.001$). Emergency referrals and referrals from all other sources were equally likely to die (both 7%) or be newly discharged to a nursing home (10% versus 11%).

Log-Timed Up and Go time, age and mobility aid

There was a weak but significant relationship between log-Timed Up and Go time and age ($r = 0.17$, $P < 0.001$, $n = 918$). One-way ANOVA showed a strongly significant effect for level of mobility aid (no aid $n = 346$, one stick $n = 216$, rollator frame $n = 286$, pick-up frame $n = 46$) on the log-Timed Up and Go time, with more dependent patients having higher log-Timed Up and Go times ($F = 227.4$, df = [3,890], overall $P < 0.001$, $P < 0.05$ for all comparisons).

Discussion

The log-Timed Up and Go time, completed on admission to an acute care unit for the elderly, was not able to identify those patients who subsequently fell. However, only 41% of the patients were able to complete the Timed Up and Go, due to physical disability (inability to sit, stand or walk independently, or with standby assistance), or non-physical disability, including refusal, inability to follow instructions (e.g. dementia or delirium) and inability to attempt the Timed Up and Go for medial reasons (e.g. untreated severe cardiac failure). When the Timed Up and Go score was modified to include the majority of patients unable to complete the test, both the ordinal-Timed Up and Go and the dichotomous-Timed Up and Go significantly predicted falls in multivariate analyses.

The ability or inability to complete the Timed Up and Go stratified patients according to their risk of falls, with those unable to do the Timed Up and Go for non-physical reasons having the highest fall rate of 11%. Those unable to do the Timed Up and Go for physical reasons had a lower fall rate of 9%, while those able to complete the Timed Up and Go had the lowest fall rate (6%). Patients unable to follow instructions had a fall rate of 21% (though the small number of falls in this group makes the estimate somewhat unreliable). Excluding patients unable to complete the Timed Up and Go fails to detect those with the highest fall rates. This may help to explain the negative result of the only other study to evaluate the Timed Up and Go in the acute hospital setting.[7] In a retrospective

Table 3 Logistic regression model for falls in the Aged Care Unit: log-TUG time format

Variable	Parameter estimate	Standard error	*P*- value	OR (95% CI)
Log-TUG time	0.077	0.28	0.78	1.08 (0.63–1.85)
Age	−0.011	0.02	0.58	0.99 (0.95–1.03)
Sex (male)	0.35	0.29	0.22	1.42 (0.81–2.51)
Walking aid needed	0.072	0.36	0.84	1.08 (0.54–2.16)
Delirium	1.00	0.29	< 0.001	2.73 (1.54–4.85)
Postural hypotension	1.01	0.37	0.006	2.74 (1.33–5.65)
Via emergency department	−0.62	0.29	0.03	0.54 (0.30–0.96)

$N = 912$; 54 patients with at least one fall in the Aged Care Unit; −2 log (likelihood) 385.
Log-TUG time, logarithmic transformation of Timed Up and Go time; via emergency department, referral to the Aged Care Unit from the emergency department; OR, odds ratio; 95% CI, 95% confidence interval.

Table 4 Logistic regression model for falls in the Aged Care Unit: Ordinal-TUG score format

Variable	Parameter estimate	Standard error	*P*-value	OR (95% CI)
Ordinal-TUG	0.11	0.043	0.01	1.12 (1.03–1.21)
Age	−0.0087	0.012	0.47	0.99 (0.97–1.02)
Sex (male)	0.53	0.18	0.003	1.70 (1.20–2.43)
Walking aid needed	−0.37	0.21	0.09	0.69 (0.46–1.05)
Via emergency department	−0.57	0.18	0.002	0.57 (0.40–0.81)
Active diagnoses	0.13	0.043	0.003	1.14 (1.05–1.24)

$N = 1833$; 137 patients with at least one fall in the Aged Care Unit; −2 log (likelihood) 935.
Ordinal-TUG, logarithmic transformation of the Timed Up and Go score, with the ordinal scale based on the mean and standard deviations, with those unable to do the Timed Up and Go due to physical reasons given the highest value of 8 (range of values 1–8); via emergency department, referral to the Aged Care Unit from the emergency department; active diagnoses, number of active medical diagnoses (maximum of 10); OR, odds ratio; 95% CI, 95% confidence interval.

audit of 160 medical records, Lindsay *et al.* excluded patients unable to complete the test, and found that the Timed Up and Go time was unable to identify patients who fell during their admission to an acute medical ward. While we agree that the Timed Up and Go time alone (in the minority able to complete the test) does not identify those who subsequently fall, we suggest that the value of the Timed Up and Go lies in the inability to complete the test, rather than the time recorded.

Patients with higher fall rates in the Aged Care Unit had more active medical diagnoses, were more likely to reside in nursing homes and less likely to speak English. More than 50% of nursing home residents fall during any 12 months,[10,11] and when admitted to the hospital, the effects of acute illness, poor communication and multiple medications predispose them to further falls.[12] Dehydration, impaired baroreceptor reflexes and many medications cause postural hypotension, a risk factor both in the literature[13] and among our patients who were mobile (able to complete the Timed Up and Go) (Table 3).

Despite evidence of harm, and little if any benefit, physical restraints continue to be used in nursing homes (where the majority of residents are demented) and hospitals to prevent falls.[14–16] While many studies have evaluated restraint minimization in nursing homes, few have addressed this issue in acute care settings.[16] In our study, dementia was not a risk factor for falls in any of the groups, and delirium was a risk factor only in patients able to complete the Timed Up and Go (adjusted OR 2.73, 95% CI 1.54–4.85). The prevalence of dementia was similar among patients able to complete the Timed Up and Go, and those with physical and non-physical disability (35%, 40% and 39%, respectively, $P = 0.07$). While the prevalence of delirium was significantly different at 30%, 44% and 41%, respectively ($P < 0.001$), patients with the highest fall rate (non-physical disability group) did not have the highest prevalence of delirium. Our data suggest that acutely

Table 5 Logistic regression model for falls in the Aged Care Unit: dichotomous-TUG score format

Variable	Parameter estimate	Standard error	*P*-value	OR (95% CI)
Dichotomous-TUG	0.46	0.19	0.02	1.59 (1.09–2.32)
Age	−0.008	0.012	0.51	0.99 (0.97–1.02)
Sex (male)	0.53	0.18	0.004	1.69 (1.19–2.41)
Walking aid needed	−0.30	0.21	0.15	0.74 (0.50–1.12)
Via emergency department	−0.57	0.18	0.002	0.57 (0.40–0.81)
Active diagnoses	0.13	0.043	0.002	1.14 (1.05–1.24)

$N = 1833$; 137 patients with at least one fall in the Aged Care Unit; −2 log (likelihood) 936.
Dichotomous-TUG, inability (due to physical disability) to complete Timed Up and Go; via emergency department, referral to the Aged Care Unit from the emergency department; active diagnoses, number of active medical diagnoses (maximum of 10); OR, odds ratio; 95% CI, 95% confidence interval.

Clinical messages

- On admission to an acute care unit for the elderly, the inability to complete the Timed Up and Go, and the reasons for this, stratified patients according to their risk of subsequent falls.
- Patients unable to complete the Timed Up and Go for non-physical reasons had the highest fall rate.
- Acutely unwell, immobile patients with dementia and delirium were not at excessive risk of falls.

unwell, immobile patients with dementia and delirium are not at excessive risk of falls, supporting recommendations on restraint minimization.[16,17]

The common sources of referral to the Aged Care Unit were the emergency department, other services at Liverpool Hospital following geriatric consultation, and directly from the local community. Compared with all other sources of referral, patients referred from the emergency department were significantly less likely to fall. Although older, more likely to reside in a nursing home, and less likely to speak English (factors that may predispose to falls), patients referred from the emergency department had a reduced tendency to fall. Their lengths of stay in the Aged Care Unit were considerably shorter, most likely due to less severe illness, faster recovery and better overall function (and hence a reduced tendency to fall).

While men were more likely to fall in analyses of the ordinal-Timed Up and Go (Table 4) and dichotomous-Timed Up and Go (Table 5) formats, this was not so with the log-Timed Up and Go time format (Table 3). Women fall more often than men in most, though not all studies.[18] Selection bias in those accepted to the Aged Care Unit remains a possibility, though the inconsistency in our results casts doubt on male sex as a risk factor for falls.

Our prospective cohort study of 2388 patients has a number of strengths. First, the study was sufficiently powered to detect even small differences in fall rates defined by the Timed Up and Go time or its modifications. Second, all patients admitted to the Aged Care Unit over four years were enrolled, minimizing selection bias. Finally, we analysed data from patients unable to complete the Timed Up and Go, and showed that the reasons for this inability had an important impact on subsequent falls.

A limitation of this study is that the data were collected in only one acute care unit, limiting the ability to generalize the results to other acute care settings. A further limitation is that the ordinal-Time Up and Go scale is somewhat subjective. The aim was to incorporate data from those able and unable to complete the Timed Up and Go in an overall measure, based on the near-normal distribution of the log-Timed Up and Go times. Patients unable to complete the Timed Up and Go were given the highest value of 8, equivalent to four standard deviations from the mean log-Timed Up and Go time. Though an extreme value and open to debate, we believed that it more fairly reflected the differences between those able and unable to complete the Timed Up and Go than values based on other methods (such as percentiles derived from the heavily right-skewed raw Timed Up and Go times). Quantitative interpretations should be avoided, but the overall qualitative conclusions appear valid. In any case, the importance of the Timed Up and Go in this population appears to rest primarily on the inability to complete the test, and the reason for this, rather than on the ordinal-Timed Up and Go score (or the log-Timed Up and Go time).

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Author contributions, competing interests and funding source

Julienne Large conceived the study. All authors contributed to protocol development, data collection and quality control. David Basic managed the data and undertook all analyses. All authors drafted the manuscript and contributed to its revision.

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