CLINICS

CLINICAL SCIENCE

Accuracy of the Timed Up and Go test for predicting sarcopenia in elderly hospitalized patients

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OBJECTIVES: The ability of the Timed Up and Go test to predict sarcopenia has not been evaluated previously. The objective of this study was to evaluate the accuracy of the Timed Up and Go test for predicting sarcopenia in elderly hospitalized patients.

METHODS: This cross-sectional study analyzed 68 elderly patients (⩾60 years of age) in a private hospital in the city of Salvador-BA, Brazil, between the 1st and 5th day of hospitalization. The predictive variable was the Timed Up and Go test score, and the outcome of interest was the presence of sarcopenia (reduced muscle mass associated with a reduction in handgrip strength and/or weak physical performance in a 6-m gait-speed test). After the descriptive data analyses, the sensitivity, specificity and accuracy of a test using the predictive variable to predict the presence of sarcopenia were calculated.

RESULTS: In total, 68 elderly individuals, with a mean age 70.4 ± 7.7 years, were evaluated. The subjects had a Charlson Comorbidity Index score of 5.35 ± 1.97. Most (64.7%) of the subjects had a clinical admission profile; the main reasons for hospitalization were cardiovascular disorders (22.1%), pneumonia (19.1%) and abdominal disorders (10.2%). The frequency of sarcopenia in the sample was 22.1%, and the mean length of time spent performing the Timed Up and Go test was 10.02 ± 5.38 s. A time longer than or equal to a cutoff of 10.85 s on the Timed Up and Go test predicted sarcopenia with a sensitivity of 67% and a specificity of 88.7%. The accuracy of this cutoff for the Timed Up and Go test was good (0.80; IC=0.66-0.94; p=0.002).

CONCLUSION: The Timed Up and Go test was shown to be a predictor of sarcopenia in elderly hospitalized patients.

KEYWORDS: Limitation of mobility; sarcopenia; elderly; hospital.

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INTRODUCTION

The performance of daily living activities, as evaluated with specific physical tests, is associated with clinically relevant outcomes, such as mortality and quality of life (1). It might be important for elderly hospitalized patients to undergo physical tests to evaluate skeletal muscle function, which could be severely compromised by aging and comorbidities (1).

Aging is responsible for changes in peripheral muscle mass and strength, particularly after 50 years of age, when muscle mass declines by 1 to 2% per year, and muscle strength declines by 1.5 to 5% per year (2). Longitudinal studies have demonstrated that reductions in muscle strength predict mortality over a period of years to a greater extent than do changes in skeletal muscle mass (3,4). Additionally, studies have noted that physical tests might be useful for evaluating reductions in mobility in elderly individuals; these reductions might be related to decreased muscle mass and strength, which is known as sarcopenia (5). In addition to muscle-mass and muscle-strength parameters, gait speed has been evaluated to assess physical performance; in particular, the Timed Up and Go (TUG) is a simple

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test that could be used even in a limited-resource environment to assess physical performance (5). Additionally, elderly patients readily perform the TUG test, and TUG-test scores are well correlated with the risk of falling in this patient group (6,7). In a recent study that evaluated elderly patients in a primary care setting, the cutoff TUG-test score for predicting falls was a value greater than 12.47 s (8). To our knowledge, the ability of the TUG test to predict sarcopenia has not been evaluated.

The goal of this study was to evaluate the accuracy of the TUG test in predicting sarcopenia in a sample of elderly inpatients.

METHODS

This work was a cross-sectional study conducted from August 2013 to January 2014 in a hospital that assists patients from public and private healthcare systems in Brazil. The inclusion criteria for this study were age $\geqslant$60 years, body mass index (BMI) $<$30 kg/m^2, enrollment between the 1st and 5th day of hospitalization, self-report of walking independently and without external help prior to hospitalization, a physician's permission to walk without assistance after hospitalization, and no use of vasoactive and/or inotropic drugs. The exclusion criteria were peripheral oxygen saturation (SpO_2) lower than 90% during an evaluation, an increase in heart rate (HR) of more than 30% of the baseline value (before the test began) and dyspnea or discomfort during the performance of the tests. This project was approved by the ethics committee of the Bahia School of Medicine and Public Health (protocol number 336.469), and all of the study participants signed informed consent forms and were provided information regarding participation in the study.

Measurements

First, anthropometric measurements were taken, and handgrip strength and physical performance were measured using the gait-speed and TUG tests. Additionally, we assessed self-reports of falls during the previous year and of cognitive function. The data were obtained from the patient records including the diagnoses at medical admission, the admission profile (surgical or clinical), the Charlson Comorbidity Index score and the length of stay at the time of the data collection.

The diagnostic criteria for sarcopenia were a reduction in skeletal muscle mass (SMM), with reduced handgrip strength and/or poor physical performance in a 6-m gait-speed test. The SMM was obtained using the Lee anthropometric equation, which yields results that are highly correlated with the SMM calculated with magnetic resonance data (9) and dual-energy X-ray absorptiometry (DXA, previously DEXA) data (10,11). SMM was calculated as a function of weight and height as follows: (height [m] $\times$ 0.244 $\times$ body mass) + (7.8 $\times$ height) + (6.6 $\times$ sex) – (0.098 $\times$ age) + (ethnicity – 3.3). The SMM index was then calculated by dividing an individual's SMM (kg) by his or her height squared (m^2). The criteria used to identify a reduction in SMM were values $\leqslant$6.37 kg/m^2 for women and $\leqslant$8.90 kg/m^2 for men, which are equivalent to 20% of lowest percentile distribution reported by Alexandre et al. (12).

To evaluate handgrip strength, each subject was seated in a chair, with the elbows at 90°, and was asked to exert maximum force on a Saehan dynamometer (SAEHAN CORPORATION, Yangdeok-Dong, Masan, South Korea) (13). This measurement was performed three times with a rest interval of one minute between measurements; the greatest measurement was reported. The criteria for muscle weakness indicative of sarcopenia were values lower than 20 kg in women and lower than 30 kg in men (14).

The 6-m walking test was conducted to assess an individual's physical performance. To perform this test, each subject was asked to walk 10 m on a flat, straight course at the fastest possible speed, and the time required to walk the central 6 m was measured. The highest speed among three measurements was used in the analyses, with values lower than or equal to 0.8 m/s being considered weak physical performance indicative of sarcopenia (15). To measure physical performance using the TUG test, each individual was asked to stand up from a seated position, walk 3 m and then return to a seated position on the same chair, while a previously trained physical therapist measured the time (s) required to perform this task (16).

The body mass index (BMI) of each subject was obtained by dividing his or her body weight (kg) by his or her squared height (m^2). The World Health Organization criteria were used to classify the subjects as low-weight (BMI$<$18.5), eutrophic (18.5$<$BMI$\leqslant$24.99), overweight (25$\leqslant$BMI$\leqslant$29.99) or obese (BMI$\geqslant$30.00) (17). Cognitive function was evaluated using the mini-mental state examination (MMSE) (18), which quantifies various cognitive abilities, such as orientation, attention, calculation, visuo-constructive ability, language and evocation, with a score that ranges from 0 to 30 points. The Charlson Comorbidity Index was used to evaluate the presence of comorbidities, and the data were collected within the first 24 hours (19).

Statistical analysis

The numerical data were described by the means and standard deviations, and the categorical data were described by the proportions and confidence intervals. The accuracy was evaluated using receiver operating characteristic (ROC) curves obtained from the sensitivity and specificity analyses; the TUG test measured the physical performance as the predictive variable and the presence of sarcopenia as the outcome variable. Student's *t*-test was used for the inter-group comparisons of the numerical variables (the age, muscle mass index, mental function, length of hospital stay at the time of the data collection, Charlson Comorbidity Index score and physical performance) using a cut-off of $\geqslant$10.85 s on the TUG test for the prediction of sarcopenia. These analyses were performed using the SPSS statistical software, version 14.0.

RESULTS

In total, 68 elderly hospitalized individuals (58.8% males) were evaluated, and 22.1% of these patients had sarcopenia. The mean age of the study subjects was 70.4 ± 7.7 years, and the mean BMI was 25.7 ± 3.3 kg/m^2. Most (64.7%) of the study subjects had a clinical admission profile. The major reasons for hospitalization were cardiovascular disorders (22.1%), pneumonia (19.1%), abdominal surgery (19.1%) and abdominal disorders (10.2%). The mean duration of hospitalization at the time of the data collection was 2.76 ± 1.71 days, and the subjects' mean Charlson Comorbidity Index score was 5.35 ± 1.97. Regarding the self-reports of falls in the previous year, 30.9% of the subjects reported having had at least one fall in the previous year (Table 1). The accuracy

Table 1 - Baseline characteristics of the sample of 68 elderly hospitalized patients.

Variable	Value
Age (years)	70.4 ± 7.7
BMI	25.7 ± 3.3
Gender (male)	40 (58.8)
Length of hospitalization (days)	2.76 ± 1.71
Admission profile	
Clinical	44 (64.7)
Surgical	24 (35.3)
Comorbidity Index score	5.35 ± 1.97
Mini-mental state examination score	23.7 ± 5.0
Skeletal muscle mass (kg)	22.9 ± 6.1
Muscle mass index (kg/m^2)	8.65 ± 1.92
Handgrip strength (kgf)	27.7 ± 9.0
Timed Up and Go test time (s)	10.02 ± 5.38
Falls in previous 12 months (yes)	21 (30.9)

Table 2 - Diagnostic performance of the Timed Up and Go test for predicting sarcopenia in the sample of 68 elderly hospitalized patients.

	%	95% CI	*p*-value
Sensitivity	66.7	0.38–0.85	
Specificity	88.7	0.77–0.96	
Accuracy	0.80	0.66–0.94	0.001

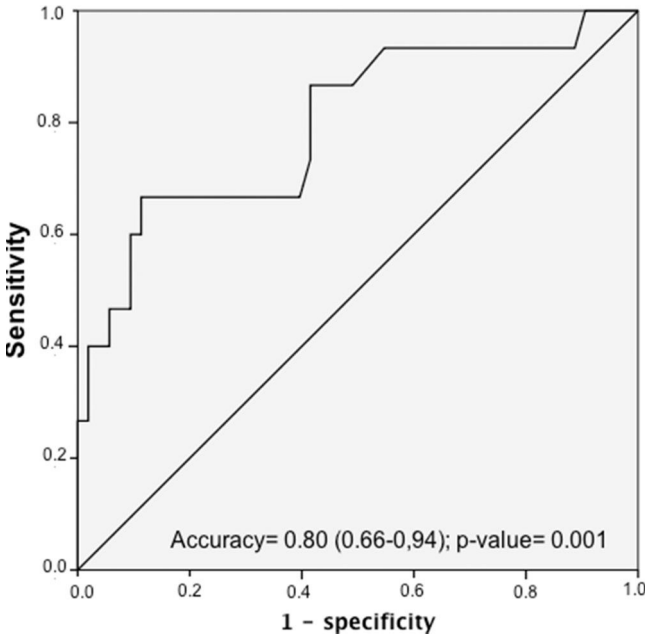

Figure 1 - Accuracy of the test Time Up and Go to predict sarcopenia in the sample of 68 elderly hospitalized patients.

of TUG was considered moderate (0.80; IC = 0.66–0.94; *p*-value = 0.001) for predicting sarcopenia in the sample studied. After the analysis of the ROC curve, we observed that TUG presented a sensitivity of 66.7% and specificity of 88.7% for the prediction of sarcopenia (Table 2). The sarcopenia predictor cut-off point was a TUG $\geqslant$ 10.85 seconds, found in the point of greatest accuracy in the ROC curve (Figure 1). In the intergroup comparison, the elderly with a physical performance predictive of sarcopenia (TUG $\geqslant$ 10.85 seconds) had worse cognitive function, were older and presented higher scores of the Charlson comorbidity index and a lower quantity of skeletal muscle mass. There were no significant differences in the comparison between the mean duration of hospitalization (Table 3).

DISCUSSION

This study found that the TUG test predicted sarcopenia in elderly hospitalized patients with good accuracy. This finding suggests that this test might be a useful in the evaluation of at risk-patients with similar profiles in the hospital environment. This study evaluated, for the first time, the ability of the TUG test of physical performance to predict the presence of sarcopenia.

The cut-off point that predicted sarcopenia in this study was a time longer than or equal to 10.85 s in the performance of the TUG test. This time was lower than the time that is predictive of falls in elderly Brazilians ($\geqslant$12.47 s) (8). No reference values for the TUG test exist for the prediction of sarcopenia, according to the definitions of the consensus of The European Working Group on Sarcopenia in Older People (5), which limits comparisons with reference values. One of the reasons that the TUG test predicts sarcopenia with good accuracy might be the significant muscular participation that is required for transferring rapidly from a sitting position to a standing position, which is one of the test activities.

Falsarella et al. (20) evaluated the influence of muscle and bone mass on the functionality of 99 elderly women and observed that reduced muscle mass was associated with poor physical performance in the gait-speed and TUG tests. In this study, reduced muscle mass ($p < 0.01$) was observed in elderly patients with a poor physical performance (time $\geqslant$10.85 s on the TUG test) in an intergroup comparison; this finding suggests that the skeletal muscle mass variable might be associated with performance on the TUG test. One reason for this association might be the changes in muscle composition during aging; these alterations might occur in parallel with reduction in muscle strength and thereby affect physical performance in this population.

The individuals with the worst physical performance exhibited worse cognitive function. This finding suggests that a relationship might exist between these variables. This study had a cross-sectional design, and whether a causal relationship exists between these variables could not be determined; however, a recent study did not find an association between sarcopenia and cognitive dysfunction after adjusting for the confounding variables (21). Additionally, high Charlson Comorbidity Index scores in elderly subjects with poor physical performance suggest that a greater presence of comorbidities might be associated with changes in performance; changes in performance might result from sarcopenia secondary to one or more comorbidities, in addition to primary sarcopenia, which occurs with aging (5).

Using sensitive tests to identify risk factors for patients is crucial because such tests facilitate the identification of patients who would benefit from physical therapy and specific clinical interventions. This study demonstrated that the TUG test might be capable of identifying patients with and without sarcopenia because it had a sensitivity of 67%

Table 3 - Intergroup comparisons of the Timed Up and Go test results at the point of greatest accuracy in the sample of 68 elderly hospitalized patients.

	TUG time <10.85 s	TUG time $\geqslant 10.85$ s	*p*-value
Age (years)	68.4 ± 6.3	76.9 ± 8.6	0.001
Charlson Comorbidity Index score	5.0 ± 1.8	6.7 ± 2.1	0.003
SMI (kg/m^2)	9.1 ± 1.7	7.3 ± 2.0	0.001
MMSE score	24.8 ± 3.9	20.3 ± 6.6	0.002
TUG test time (s)	7.9 ± 1.6	16.8 ± 7.5	0.001
Duration of hospitalization (days)	2.7 ± 1.7	2.9 ± 1.8	0.77

MMSE: mini-mental state examination; TUG: Timed Up and Go; SMI: skeletal muscle mass index.

and a specificity of 88.7%. The diagnosis of sarcopenia was based in part on the estimated skeletal muscle mass, which was computed using an anthropometric equation that exhibited high sensitivity and specificity with the gold-standard measurement techniques used in previous studies, including a recent study in a Brazilian population (9,10).

In spite of this high correlation, anthropometry is considered to result in measurements that are less accurate than those obtained using gold-standard measurement methods (magnetic resonance imaging, computed tomography and dual energy X-ray absorptiometry) (22). The feasibility of using these more accurate instruments is restricted by operational and financial aspects of daily clinical practice. Another consideration is that the use of the SMM obtained with the anthropometric equation, as with the use of the BMI, is limited in that it does not distinguish among the different components of body mass, such as muscle, bone and fat. This limitation suggests that this instrument should not be used to measure the responses to interventions over time. Although the physical tests did not exhibit the level of accuracy of the gold-standard methods, using these tests is more feasible in daily practice, and their use might facilitate identification of patients with sarcopenia among elderly hospitalized patients. This factor is of extreme importance because the elderly population is more vulnerable to complications (23,24), particularly in the musculoskeletal system, and the consequences, including falls or death, might be severe.

Another limitation is that the studied population included only elderly patients who were able to walk without any assistance; this limitation prevents use of the TUG test to predict sarcopenia in elderly individuals who need assistive devices.

The Timed Up and Go test was shown to be a good predictor of sarcopenia in elderly hospitalized patients. Evaluating physical performance with this test might provide another method for identifying elderly patients with sarcopenia in cases in which a patient's TUG test time is over 10.85 s. In this study, the patients with the worst physical performance were older and had worse cognitive function and less SMM.

AUTHOR CONTRIBUTIONS

Martinez BP, Camelier FW and Camelier AA participated in the conception, design and performance of the study. Gomes IB, Oliveira CS and Ramos IR participated in the performance of the study. Martinez BP drafted the first version of the manuscript. Martinez BP, Forgiarini Jr LA, Camelier FW and Camelier AA were responsible for critical revision and final approval of the manuscript.

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