Accelerometric-based Features as Surrogate of Tinetti test

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INTRODUCTION

Risk of falling is estimated by visual inspection of patient's movements using clinical scales, *e.g.*, Tinetti test, Berg Balance Scale, Timed Up & Go *etc*. However, a continuous evaluation of such risk requires both subject hospitalization and expert clinical personnel. We believe that continuous automatic monitoring of the fall risk would provide rapid intervention as well as a reduction of the health care system costs. The main goal of this study is then to determine whether features extracted from low cost accelerometric signals can predict the physician assessments during a Tinetti test.

METHODS

Thirty-seven subjects were enrolled at the rehabilitation and medical research center INRCA (Istituto Nazionale Riposo e Cura Anziani), Casatenovo, Italy. Subjects using breathing supports, walkers and crutches were excluded from the study. All participants signed the informed consent. The median population age at time of the test was 75 (IQR = 81 - 70) years.
3D-axis accelerometric signals were collected using a wearable device (±8g, 12 bits, sampling rate 50 Hz, Geneactiv, Activinsights Limited, UK) positioned at the chest using an elastic band.
Each subject underwent a Tinetti test divided in 8 motor tasks [2]. The Tinetti score was assigned by an expert physician and used as gold standard. For the present study only 4 items of the full test were considered (two for balance and two for gait): 1) Rise from the chair (score 0=unable, 1=able with arms, 2=able); 2) Immediate standing balance (score 0=unsteady, 1=steady with supports, 2=steady); 3) Step symmetry (score 0=asymmetric, 1=symmetric); and 4) Step continuity (score 0=discontinuous, 1=continuous).
Features were extracted from the accelerometric signals. Sit to Stand Time and Balance after Standing (standard deviation of the vector magnitude within 5s after standing) were computed for the balance part. Step Symmetry and Step Regularity were determined on the vertical axis during walking phase as in [1].
ROC analysis was used to test features' power in classifying the score assigned to each item by the physician. The area under the ROC curve (AUC) was computed for each combination of scores.

RESULTS

Proportion and age of people with high risk of falling (Tinetti score ≤ 18) were not statistically different to those with low risk (0.46 vs 0.54; median age 76 vs 74; $p > 0.05$). Male proportion was higher than that of female (0.78 vs 0.22; $p < 0.05$).
Step Regularity proved moderately predictive of the clinician's scores (AUC > 0.79) while Sit to Stand Time, Balance after Standing and Step Symmetry were sufficiently predictive (AUC > 0.60).

Table 1. Area under the ROC curve for each feature. AUC was computed only when the number of subjects for each score was at least 5 (NS=number of subjects < 5).

Test Item	Feature	Score 0 vs 1	0 vs 2	1 vs 2
1) Rise from the chair	Sit to Stand Time	NS	NS	0.68
2) Immediate standing balance	Balance after Standing	NS	0.64	NS
3) Step symmetry	Step Symmetry	0.60	-	-
4) Step continuity	Step Regularity	0.79	-	-

DISCUSSION

Accelerometric-based features can provide useful information on the body movements as well as correctly classify the physician's item assessments.

REFERENCES

[1] Moe-Nilssen R, Helbostad JL. *J Biomech* 2004; 37:121–126
[2] Rivolta MW, et al*. EMBC* 2015; 6935-6938.