Validity and Responsiveness to Change of the 30-Second Chair-Stand Test in Older Adults Admitted to an Emergency Department

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ABSTRACT

Background and Purpose: Few physical performance measurement tools are validated for acutely admitted older adults, and for this reason we aimed to examine the validity and responsiveness to change of the 30-second Chair-Stand Test (30s-CST) used to assess physical performance in older adults admitted to a short-stay unit in an emergency department.

Methods: Construct validity of the 30s-CST, using 8 as a cut-off point for dependency in activities of daily living, was examined using 207 patients. Self-reported information on everyday activities was obtained by asking patients about need for help in bathing, dressing, cooking, cleaning and shopping. Concurrent validity of the 30s-CST compared to the de Morton Mobility Index (DEMMI) on physical performance of acutely admitted older adults was examined with 156 patients. The analysis of concurrent validity included the entire DEMMI and 2 subsets of DEMMI: 'DEMMI walking' and 'DEMMI dynamic balance'. The responsiveness to change in the 30s-CST compared to DEMMI was examined with 117 patients. All patients were classified as having either low physical performance (30s-CST $\leq$ 8) or high physical performance (30s-CST > 8); these groups were used in the analysis of validity and responsiveness to change.

Results and Discussion: Regarding construct validity using 8 as a cut-off point, the study showed a significant difference between patients with low physical performance compared to patients with high physical performance. Moreover, a decrease in the 30s-CST was followed by an increase in the need for help with everyday activities. There was a significant association between the 30s-CST and DEMMI (r = 0.72); for every extra repetition in the 30s-CST, the DEMMI score increased by 4.9. There was significant association between the 30s-CST and the 2 subsets 'DEMMI walking' and 'DEMMI dynamic balance', yet a pronounced floor effect was found in the subsets. The analysis demonstrated a very wide prediction interval, indicating that DEMMI has a better responsiveness to change than the 30s-CST, especially in older adults with low physical performance. However, the 30s-CST is easier and faster to use than DEMMI.

Conclusion: This study found a significant difference in the patients' need for help with everyday activities when comparing low and high physical performance groups. The concurrent validity of the 30s-CST was acceptable in assessing physical performance in older adults at the time of admission; the 30s-CST is thus a tool that is easy to use in older adults with acute disease. In contrast, based on very wide prediction intervals, DEMMI demonstrated better responsiveness to change than the 30s-CST, especially in older adults with low physical performance.

Keywords: 30 second Chair-Stand test, acutely admitted older adults, physical performance, validity, responsiveness to change

INTRODUCTION

Older adults constitute a large proportion of the patients in the emergency department's (ED) short-stay unit.[1] A short-stay unit provides targeted care for 48–72 hours—a critical period for non-disease-specific assessment of physical performance.[2] Despite the importance of physical performance assessment in predicting limitations in mobility, length of stay and discharge destination,[3-5] only a few physical performance measures for acutely admitted older adults are validated. In addition, the validated performance measures are time-consuming due to their many items.[6,7]

The 30-second Chair-Stand Test (30s-CST) is a single-item physical performance tool for the assessment of lower body strength. It is performed by counting the number of stands completed in 30 seconds with hands crossed against the chest.[8] The simplicity of the test makes it easy to use, requiring less than 5 minutes.

The loss of muscle mass and reduced functional reserve capacity entailed by the aging process usually leads to reduced physical performance and functional decline.[9] In active community-dwelling older adults, a cut-off point (30s-CST $\leq$ 8) has demonstrated its ability to identify community-dwelling older adults at risk of functional decline in their later years.[10] Acutely admitted older adults with low physical performance can improve during hospitalization, but their physical performance nevertheless remains low at discharge.[11] In addition, low physical performance, as indicated by the inability to perform more than 5 chair stands, relates to risk of sarcopenia.[12]

Lower body strength and balance are keys to good mobility; the ability to rise from a chair with hands crossed against the chest at time of admission is a good indicator of mobility limitations in older adults 30 days after hospital discharge.[3,13] The 30s-CST demonstrates a floor effect at the time of admission for acutely admitted older adults, indicating a poor responsiveness to change.[14] The cut-off point for floor and ceiling effects was defined, as > 15% of patients achieving the lowest or highest possible score.[15]

The De Morton Mobility Index (DEMMI), a frequently used multi-item instrument for measuring mobility and balance across the spectrum from bed-bound to independent mobility,[16] is a valid and reliable instrument, not only for acutely admitted older adults, but also for subacute hospitalized older adults and community-dwelling older adults. No floor or ceiling effects are demonstrated.[6,17-19] A DEMMI assessment takes 10–15 minutes.[20]

We believe that the ease of use of the 30s-CST, as a single-item instrument, will stimulate the use of physical performance assessments of patients admitted to a short-stay unit in an ED. However, the 30s-CST has never been validated for this population. For this reason, this study aimed to examine the validity and responsiveness to change of the 30s-CST used to assess physical performance in older adults acutely admitted to a short-stay unit in the ED.

The objectives were to examine the instrument with regard to its:

1) construct validity when using 8 as a cut-off point for dependency in activities of daily living,

2) concurrent validity when compared to DEMMI, and

3) its responsiveness to change when compared to DEMMI.

METHODS

Design and Setting

We conducted a prospective cohort study in a short-stay unit at a Danish hospital from December 2014 to May 2015. The reporting of the study complies with the STROBE guidelines (Strengthening the Reporting of Observational Studies in Epidemiology).[21]

Study Participants

All patients were admitted to the short-stay unit on a weekday and screened for eligibility within the first 48 hours. The inclusion criteria were: 65 years of age or older; admitted for "medical" reasons (as distinct from surgical or psychiatric reasons); oriented to time and place; able to sit on a chair independently; and able to speak and understand Danish. Patients who were unable to walk were excluded. All participants gave written consent to participate in the study.

Outcome Measures

Outcome measures were collected as physical performance measures and self-reported information on everyday activities.

Physical performance measures

The 30s-CST with a cut-off point of 8 or less is validated in community-dwelling older adults and compared to self-reported information on the basic activities of daily living (BADL), such as bathing and dressing; and instrumental activities of daily living (IADL), such as shopping and cleaning.[22] A clinimetric evaluation of the 30s-CST shows moderate concurrent validity when compared to leg-press performance and good inter-rater reliability in acutely admitted patients.[8,14] Moreover, the 30s-CST is easy to complete in an busy short-stay unit, as only an ordinary chair is required.[8] A minimal detectable change (MDC) of 2 has been determined for the 30s-CST.[23] Patients were classified as having either low physical performance (30s-CST ≤ 8) or high physical performance (30s-CST > 8).

DEMMI is a valid and reliable physical performance measurement tool; we therefore consider it an appropriate reference standard.[6,17-19,24] The DEMMI assessment takes more than twice as long as the 30s-CST and requires more equipment and floor space as it also tests for the abilities to get out of bed, to go from sitting to standing position, and to walk a distance of 50 metres.[16] DEMMI is hierarchically structured, beginning with the easiest activity (sitting unsupported) and ending with the hardest (tandem standing with eyes closed). The maximum DEMMI score is 100; with reference to the hierarchical structure no score higher than 53 points can be achieved without the ability to perform item 6: 'sit to stand no arms'. An MDC of 9 has been determined for DEMMI.[6] The focus of this study is older adults with functional decline or at

risk of functional decline, and thus only patients in the group with low physical performance (30s-CST ≤ 8) performed the DEMMI test.

We expected an association between a low 30s-CST score and need for gait aids. We tested this relationship for 2 DEMMI subsets: ‘walking’ (Items 11 and 12) and ‘dynamic balance’ (Items 13, 14, and 15). The walking score includes independent walking with or without a gait aid. The ‘dynamic balance’ tasks must be carried out without gait aids.[16]

Self-reported information on activity: Information on everyday activities, including bathing, dressing, cooking, cleaning, and shopping, was obtained by asking: “Can you bathe [dress, etc.] without help, with help, or not at all?” with the following response options: “Without help”, “With help”, or “Cannot at all”. The BADL were chosen as the focus of these questions as dressing and so on are basic activities, while IADL involve more demanding everyday tasks such as cleaning. With both instruments, the need for help in completing an activity was defined as dependency on assistance from another person. If help was needed, the response would be: “Need for help”. If patients were unable to answer the response field was left blank.

Data collection

At admission: Eligible patients were first subjected to the 30s-CST, after which self-reported information on mobility and everyday activities was obtained. Inability to rise with hands crossed against the chest in the 30s-CST resulted in a score of 0; patients who completed the practice trial but were unable to rise with hands crossed over the chest in the test proper scored 1. The DEMMI protocol was followed, except for the ‘sit to stand no arms’ (Item 6), as this was covered by the 30s-CST.

Follow-up: A follow-up visit was carried out at the patients’ homes no earlier than 14 days after the time of admission. Data were collected independently by 2 physiotherapists, first at admission and then at the follow-up. Inter-rater reliability was tested in a pilot study of 21 randomly selected patients admitted to the short-stay unit, showing acceptable reliability with an intra-class correlation ($ICC_{2.1}$) in the 30s-CST of 0.98 (95% CI: 0.96; 0.99) and in DEMMI of 0.87 (95% CI: 0.69; 0.95).[25]

Data analysis

Construct validity was tested using the following a priori hypotheses[26]

1. Comparing patients with low physical performance (defined as 30s-CST ≤ 8) with patients with high physical performance (defined as 30s-CST > 8), we expect a significant difference in need of help with everyday activities as measured by self-reported information.
2. With decreasing 30s-CST score, the relative number of patients in need of help with BADL will increase.

When analyzing construct validity, patients with high physical performance were not expected to need help with everyday activities; conversely, patients with low physical performance were expected to need help. In the analysis, the 2 response options “With help” or “Cannot at all” were collapsed, since both answers reflect the need for help. Fisher’s exact test was used for testing the hypothesis. Need for help with everyday activities was tested using 3 parameters: BADL, IADL, and help with at least 1 activity in BADL or IADL.

Concurrent validity was tested using the following a priori hypotheses[26]

1. Test results from the 30s-CST and DEMMI will show significant correlation.
2. The 30s-CST and the 2 DEMMI subsets ‘walking’ and ‘dynamic balance’ will be significantly correlated.

When analyzing concurrent validity, the correlation coefficient and a scatter plot with the fitted values were prepared; only significant correlations are presented here ($p < 0.05$). Correlations above 0.70 were found acceptable.[25] The fitted value represents the beta coefficient calculated by linear regression analysis. Prediction intervals (PI) were calculated for DEMMI and for each 30s-CST score: A 95% PI is the interval in which observations are predicted to fall with a probability of 95%. If the variance in scores is high, the clinical value is low.[27]

Responsiveness to change was tested using the following a priori hypotheses:[26]

1. In more than 75% of the patients, changes in DEMMI scores between the time of admission and follow-up will be greater than the MDC.
2. In less than 50% of the patients, changes in 30s-CST scores between the time of admission and follow-up will be greater than the MDC.
3. In less than 50% of the patients with 30s-CST scores > 5 at admission, the changes in the 30s-CST score between time of admission and follow-up will be greater than the MDC.

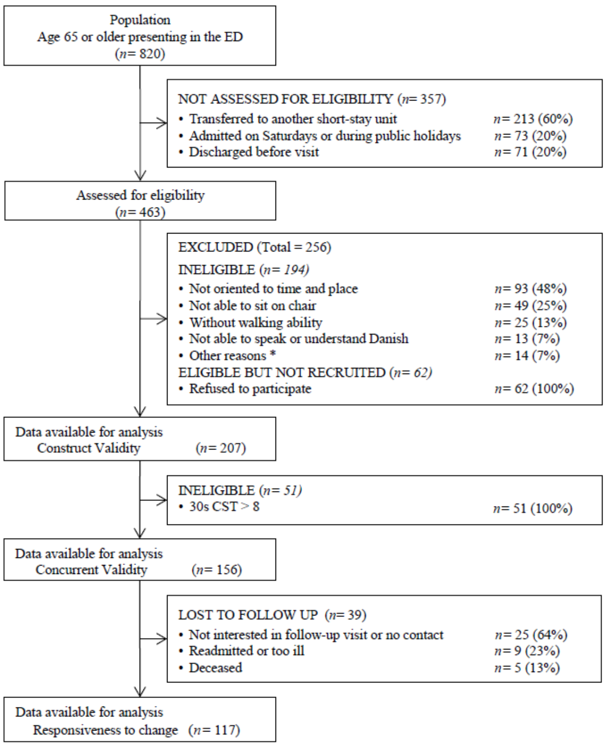
Hypothesis testing and a criterion approach[15] was chosen due to the known floor effect in the 30s-CST using DEMMI as a criterion standard. Re hypothesis 1: We expected good responsiveness in DEMMI, meaning that the majority of older adults will experience a change greater than the MDC of 9.[6] Re hypothesis 2: We expected a floor effect in 30s-CST at time of admission,[14] reflecting a reduced physical reserve capacity. Even though patients with poor physical function are known to improve the most, [28] we expected less than half of the patients to experience a change greater than the MDC of 2.[23] Re hypothesis 3: A 30s-CST of 5 repetitions or less is an indicator of sarcopenia.[12] Conversely, patients performing more than 5 repetitions are less physically sensitive to the cause of hospitalization. Therefore, we expected less than half of the patients performing more than 5 repetitions to experience a change greater than MDC between time of admission and follow-up. When analyzing responsiveness to change, percentages were calculated in accordance with the hypothesis. In the criterion approach[15] we used the correlation between changes in 30s-CST and DEMMI from the time of admission to follow-up. A scatter plot was prepared to illustrate changes in 30s-CST and the DEMMI.

The sample size calculation was based on our prospective study, which was designed with a view to a multivariate analysis. The sample size was $n = 50 + 8x$, where x is the number of independent variables. In the prospective cohort study, 10 independent variables and a 20% dropout was expected; 156 patients were therefore included.[29] We assumed that 40% of the recruited patients would have 30s-CST > 8; a sample size of 260 was thus scheduled for the study. Analysis was performed using STATA 14 (Stata Statistical Software, 2015, College Station, TX).

The Regional Scientific Ethical Committees of Southern Denmark approved this study with a waiver (20 August, 2014). Written informed consent was obtained from all participants for collection of information from the medical records, which is required according to Danish legislation. The project was registered with the Danish Data Protection Agency (2008-58-0035) and on ClinicalTrials.gov with the identifier: NCT02474277 (12 October, 2014).

RESULTS

Overall, 820 patients were admitted to the short-stay unit during the recruitment period. Construct validity was assessed using data from the 207 included patients; concurrent validity was assessed using data from the 156 patients with low physical performance (30s-CST $\leq$ 8), this group performed DEMMI. At the follow-up visit, 39 patients (25%) had dropped out, leaving data on 117 patients for the responsiveness-to-change analysis. The follow-up visit was carried out a median of 34 days (IQR 27–40) after the day of admission. A flow chart of inclusions, reasons for exclusion and loss to follow-up are given in Figure 1.



* Other reasons mainly refer to patients who were isolated during hospitalization.

Figure 1. Flow chart for the inclusion process

No significant differences were found between the patients lost to follow-up and the completers, except for independent walking ability, where 25 of the 39 (64%) dropouts had no independent walking ability compared to 50 of the 117 (43%) completers (p = 0.02). Characteristics of the 207 included patients are provided in Table 1, as are their characteristics at the time of admission in accordance with outcome status at follow-up.

Table 1. Sample characteristics for all patients at time of admission

Characteristic		All participants (n=207)		Admission characteristics in accordance with outcome status at follow-up			
				30s-CST[1] ≤ 8 (n=156)		30s-CST > 8 (n=51)	
Age median (IQR[2])		76 (71–84)		78 (71–85)		73 (70-78)	
		n	%	n	%	n	%
Gender	female	119	57	88	56	31	61
Living arrangement	alone	112	54	89	57	23	45
	cohabiting	92	44	64	41	28	56
	nursing home	3	1	3	2		
Education	no education	76	37	63	40	13	25
	vocational or short-term training	93	45	69	44	24	47
	medium/long/other education	38	18	24	15	14	27
Self-reported information on activity							
Self-rated health (n=206)	excellent/very good/good	147	71	102	66	45	88
	less good/poorly	59	29	53	34	6	12
Using walking device indoors	all the time	35	17	34	22	1	2
	sometimes	32	15	31	20	1	2
	not at all	140	68	91	58	49	96
Using walking device outdoors	all the time	62	30	58	37	4	8
	sometimes	18	9	18	12		
	not at all	119	57	72	46	47	92
	not going out	8	4	8	5		
Climbing a flight of stairs	without difficulty	110	53	68	44	42	82
	with some difficulty	27	13	21	13	6	12
	with much difficulty	15	7	15	10		
	cannot	55	27	52	33	3	6
Walking 400 meter	without difficulty	112	54	71	46	41	80
	with some difficulty	25	12	18	12	7	14
	with much difficulty	13	6	12	8	1	2
	cannot	57	28	55	35	2	1

[1] 30-second Chair-Stand Test [2] Interquartile range

Information on physical performance at baseline is provided in supplemental files (Supplemental Table 1).

Construct validity

As hypothesized, a significant difference was detected for everyday activities when patients with low physical performance (30s-CST≤ 8) were compared with patients with high physical performance (30s-CST > 8) ($p < 0.01$) (see Table 2). Moreover, Figure 2 shows that the proportion of patients in need of help with BADL and IADL decreased with increasing physical performance, as measured by the 30s-CST.

Table 2. Construct validity on the 30s-CST≤8 and risk of loss of functional mobility

Everyday activities	30s-CST [1]≤8 (n= 156)		30s-CST>8 (n= 51)		
	n	%	n	%	*p*-value
Need help with dressing	17	11	0	0	.01
Need help with bathing	31	20	0	0	<.001
Need help with cooking	47	30	1	2	<.001
Need help with cleaning	98	63	5	10	<.001
Need help with shopping	76	49	4	8	<.001
Need help with at least one BADL[2]	34	16	0	100	<.001
Need help with at least one IADL[3]	110	71	7	14	<.001
Need help with at least one activity	112	72	7	14	<.001

[1]30-second Chair-Stand Test [2]Basic activities of Daily Living [3]Instrumental activities of Daily Living

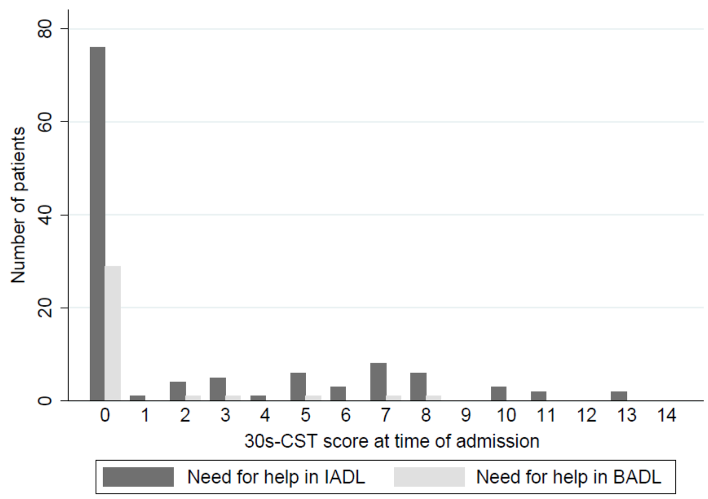


Figure 2. Proportion of patients needing help with BADL or IADL in accordance with the 30s-CST score

Concurrent validity

The results demonstrated a significant acceptable correlation (*r* = 0.72) ($p < 0.001$) between DEMMI and the 30s-CST. The regression analysis showed an increase in the DEMMI score of 4.9 for each additional repetition in the 30s-CST (Beta coefficient: 4.9 95% CI: 4.1; 5.7). Figure 3 and Table 3 illustrate a wide DEMMI PI, indicating several different DEMMI scores for each 30s-CST score, which points to the inappropriateness of attempting to predict patients' DEMMI scores on the basis of 30s-CST scores. The scope and quantity of circles in Figure 3 illustrate a clear floor effect in the 30s-CST, with 94 (60%) patients having a 30s-CST score of 0 and a DEMMI score between 0 and 62.

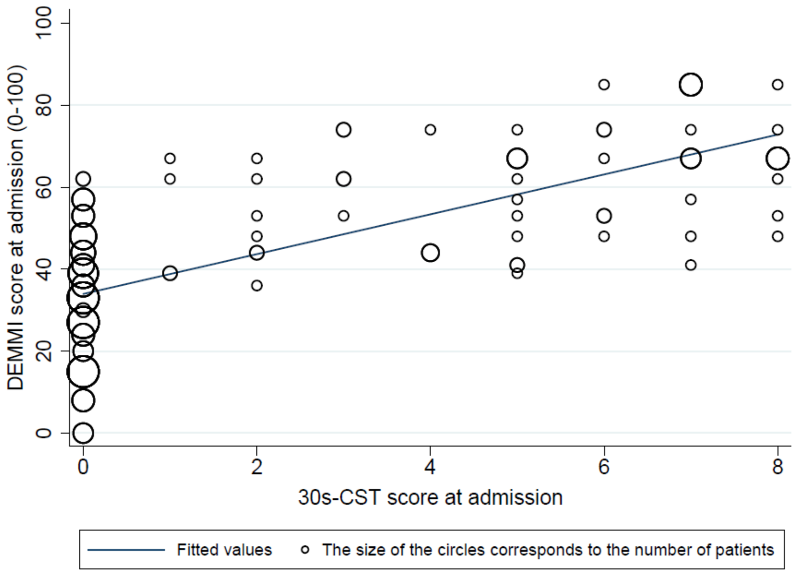


Figure 3. DEMMI and 30s-CST scatter plot

Table 3. DEMMI score and prediction interval for each of the 30s-CSTs at admission

DEMMI[2]	30s-CST[1] = 1	30s-CST = 2	30s-CST = 3	30s-CST = 4	30s-CST = 5	30s-CST = 6	30s-CST = 7	30s-CST = 8
Mean (95 % PI[3])	52 (PI: 23;81)	51 (PI: 29;72)	65 (PI: 47;83)	52 (PI: 22;81)	57 (PI: 33;81)	65 (PI: 38;92)	70 (PI: 41;99)	66 (PI: 46;86)

[1] 30 second Chair - Stand Test [2] De Morton Mobility Index (0-100) [3] PI = Prediction Interval

With regard to the DEMMI subsets 'walking' and 'dynamic balance', the correlation to the 30s-CST was $r = 0.55$ ($p < 0.001$) and $r = 0.69$ ($p < 0.001$), respectively. Although significant, this result was lower than the acceptable level of 0.70, and thus not acceptable. The very large circle formed by the scatter plots shown in Figures 4a and 4b demonstrates a clear floor effect in the 2 DEMMI subsets and the 30s-CST ; 33% of patients had a 0 score for both the 30s-CST and DEMMI 'walking'; the proportion was 46% for DEMMI 'dynamic balance'.

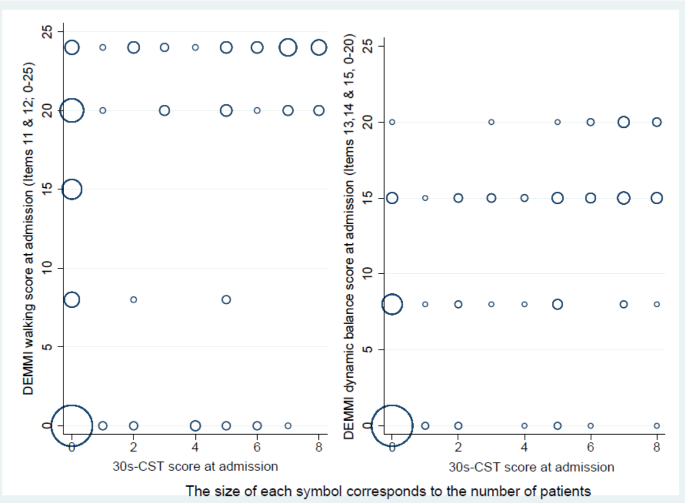


Figure 4. Scatter plots of (a; left) DEMMI ‘walking’ and 30s-CST, and of (b; right) ‘DEMMI dynamic balance’ and 30s-CST

Responsiveness to change

Responsiveness was tested by 3 hypotheses: 1) changes in DEMMI scores were higher than the MDC in more than 75% of the patients; 2) changes in the 30s-CST were higher than MDC in less than 50% of the patients; 3) changes in 30s-CST from admission to follow-up will be greater than the MDC in less than 50% of the patients with 30s-CST > 5 at admission. As Table 4 shows, neither of the first 2 hypotheses were corroborated by the results, whereas the results confirmed the third hypothesis.

Table 4. Responsiveness to change

Hypotheses	At admission mean (SD[4])	At follow-up mean (SD)	n	%
1. Changes in DEMMI[1] scores between time of admission and follow-up were higher than MDC[2] in more than 75% of the patients.	45.6 (18)	61.2 (16)	72	62
2. Changes in 30s-CST[3] scores between time of admission and follow-up were higher than MDC[2] <50% of the patients.	2.2 (3)	5.9 (5)	71	61
3. In <50% of the patients with a 30s-CST>5 at admission, the changes in 30s-CST scores between time of admission and follow-up were higher than MDC[2].	7 (1)	10 (3)	19	16

[1] De Morton Mobility Index (0-100) [2]MDC for DEMMI: 9. MDC for 30s-CST: 2 [3]30-second Chair-Stand Test
[4] Standard Deviation

The results for changes in the 30s-CST and DEMMI between admission and follow-up are presented in Figure 5. The plot demonstrates a wide range of changes in DEMMI for each 30s-CST score, especially in patients who were unable to rise with hands crossed against the chest (30s-CST = 0). The result is in accordance with the low correlation (r =0.43) ($p < 0.001$) between the changes in DEMMI and the 30s-CST.

Overall, 78 (67%) of the patients improved their 30s-CST scores during the median 34 days from time of admission until follow-up; 35 (30%) had unchanged scores, while 4 (3%) scored lower. In DEMMI, 88 (75%) showed improvement, 13 (11%) saw no change, and 16 (14%) had lower scores. 69 of the 117 (59%) patients were unable to perform a 30s-CST at admission; at follow-up, 34 of 117 (32%) patients were unable to rise. Moreover, 19% saw a mean improvement of 11 in their 30s-CST. These results indicate better responsiveness to changes in DEMMI compared to the 30s-CST.

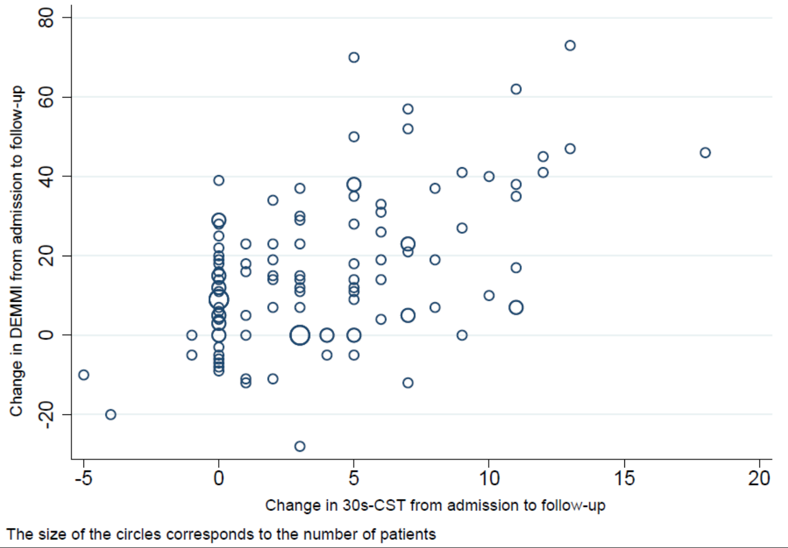


Figure 5. Changes between admission and follow-up in 30s-CST and DEMMI

DISCUSSION

Among patients admitted to a short-stay unit in an ED, this study showed a significant difference between patients with high and low physical performance, as measured by the 30s-CST, and their need for help with everyday activities at the time of admission. A significant association (r = 0.72) between the DEMMI and 30s-CST scores indicates the suitability of the 30s-CST for the assessment of physical performance in older adults at time of admission. Although the wide PI precludes a reliable prediction of the DEMMI score based on the 30s-CST score, it indicates a better responsiveness to change in DEMMI than in the 30s-CST.

Construct validity

Our study showed a significant difference in help needed with everyday activities between patients with low physical performance and those with high physical performance. It is reasonable to assume that a patient's physical performance reflects their poor condition at admission, at which time about half of the

patients were unable to perform the 30s-CST; by the follow-up, this proportion had dropped to a third. This demonstrates the need for further assessment of patients with a 30s-CST ≤ 8 in order to determine whether they are currently in need of help with everyday activities or whether their low physical performance is due to the cause of hospitalization. Data on received physical therapy during and after the hospitalization would have improved the possibilities for assessing whether the improvements were related to improved physical performance or whether their improvements were related to recovering from the illness causing the hospitalization. Future research can advantageously examine reasons for improvement.

The aging process entails a loss of muscle mass and decreasing functional reserve capacity, usually followed by reduced physical performance and functional decline. Moreover, the patient's deterioration is typically reflected by a loss of ability to perform the instrumental activities of daily living, followed by a deterioration in the ability to perform the basic activities of daily living.[9,30] The results of this study confirm this general progression and thus the appropriateness of using the value of 8 as a cut-off point for hospitalized older adults. Across all levels of physical performance, as measured by the 30s-CST, more patients needed help with IADL than with BADL (Figure 2). At the time of admission, only 14% of the patients with high physical performance reported a need for help with IADL, while none reported a need for help with BADL. The corresponding figures for patients with low physical performance were 71% and 16%. These differences were supported by the self-reported information. At baseline, the majority of high performers were able to climb a flight of stairs and walk 400 metres without difficulty; conversely, only half of the patients with low physical performance had the same ability.

We found that 31% of those patients who were unable to perform the 30s-CST reported a need for help with BADL, demonstrating a link between being unable to rise and needing help with BADL. Gill et al[31] tested whether community-dwelling older adults' physical performance at a one-year follow-up could identify individuals at increased risk of functional dependence. The participants were independent in BADL at the baseline, and the study demonstrated that older adults who were unable to rise with hands crossed against the chest were at increased risk of a decline in BADL. Such inability can identify some patients in need of help with BADL; however, further research is needed as the inability to rise with hands crossed against the chest only identified 31% of those currently in need of help with BADL.

Concurrent validity

Our study demonstrated a significant association between performance in the 30s-CST and in DEMMI at time of admission, indicating that the 30s-CST is an appropriate tool for assessing physical performance in older adults admitted to a short-stay unit. For all 30s-CST scores, we demonstrated a wide PI in DEMMI; since this nearly covers the entire range of DEMMI, the use of the 30s-CST to predict DEMMI scores is of little clinical relevance.

In relation to the DEMMI hierarchy, a patient who is unable to perform the 'sit to stand no arms' item (Item 6) cannot be given a score above 53 points, indicating limited mobility. In our study, approximately

15% of the patients were unable to perform the 30s-CST, yet were able to walk without aids; their performance thus did not adhere to the expected hierarchy, which was established to provide goals for therapeutic interventions by identifying items that patients, against expectations, are unable to perform.[20] In accordance with the presumed influence of the cause of hospitalization on physical performance, a follow-up assessment or additional information is needed in order to provide reliable goals for an intervention. The original DEMMI study included only acutely admitted older adults with an expected stay of at least 48 hours.[20] The present study included patients discharged within the first 48 hours—a difference which may imply greater variation in physical performance and affect the hierarchy.

The floor effect in the DEMMI ‘walking’ and ‘dynamic balance’ items demonstrates that a large proportion of patients were unable to perform the 30s-CST and had difficulties with ‘walking’ or ‘dynamic balance’; this information is concealed by the total DEMMI score. This situation should be remedied, as such information is crucial for avoiding falls during hospitalization.[32]

When space and time are limited, the ease of use and speed of the 30s-CST makes it ideal for clinical settings. The implementation of the 30s-CST in the short-stay unit would offer important knowledge of physical performance at an early stage of hospitalization, information that would be highly useful in identifying vulnerable patients as well as allowing for continuous measurement during and after hospitalization.

Responsiveness to change

Our expectation that more than 75% of the patients would improve their DEMMI scores above the MDC was not fulfilled, as only 62% did so. In the 30s-CST, we had expected fewer than 50% to experience above-MDC changes; however, the results showed 61% to have achieved this level of change. A study of geriatric inpatients (> 65 years) has demonstrated that whereas initial high-performers’ changes are reflected by test scores in the 30s-CST, changes in initially poorly performing patients are best reflected in the DEMMI scores.[33] We believe that the difference between the expected and obtained proportion of DEMMI changes may be explained by its higher sensibility to low-scale performances below the MDC threshold. In the 30s-CST, habitual physical performance was high in 19% of patients, as they improved markedly; moreover, another 30% of patients improved sufficiently to gain the ability to rise with hands crossed against the chest. Of our original 3 hypotheses, only 1 was confirmed; however, the scatter plot of changes from admission to follow-up demonstrates a rather wide PI for each 30s-CST score, which indicates a better responsiveness in DEMMI than in the 30s-CST. The data also show a wide range of DEMMI scores related to the large number of patients with a 30s-CST score = 0, likewise proving DEMMI’s superior responsiveness, in particular for poorly performing patients. This result is very much in line with the aforementioned study.[33]

Strengths and limitations

The strengths of this study are its sample size and the use of physical performance measurement upon admission to the short-stay unit and at follow-up some weeks after hospitalization. A further strength lies in

entertaining a priori hypotheses, since this prevents the formulation of hypotheses based on the results. The use of self-reported information is weakened by the use of individual questions rather than a validated questionnaire. However, uses of individual questions correspond to usual practice.

We selected the 30s-CST despite its known floor effect for acutely admitted older adults.[14] The well-known 'sit-to-stand five times' test[7] could be an alternative, but this would entail an even larger floor effect, as 73% were unable to complete that test, compared to 60% in the case of the 30s-CST (Supplemental Table 1). Further research is needed to address the floor effect in the 30s-CST at time of admission. This may involve a combination of physical performance measures and self-reported information on the older adults' physical performance in daily life.

Our restricted focus – the assessment of concurrent validity included only older adults with low physical performance at the time of admission – can be seen as a limitation. This in spite of the fact, that the majority of older adults with high physical performance (30s-CT > 8) manage everyday activities independently.

In the present study, the ICC in DEMMI was 0.87 (95% CI: 0.69; 0.95), a figure lower than that found in a study of geriatric inpatients (0.91; 95% CI 0.811–0.957).[33] The differences in these results may have been caused by the necessity of testing reliability on patients with no changes, which only leaves a few hours for retesting our population of acute patients, introducing a risk of recall of their previous result and thereby prompting a desire to improve their performance.

In terms of external validation, a selection bias may be present, as 55% of the older adults were not assessed for eligibility; however, this was entirely due to organizational conditions, such as transferrals. A total of 20% of the older adults refused to participate, either because they felt the project was irrelevant to them, or because they could not contemplate more visits than were already entailed by their need for home help. The results of this study should be generalized only to older "medical" patients, as distinct from patients admitted for surgical or psychiatric reasons. A further condition is that they must be oriented to time and place, and with low physical performance at admission.

CONCLUSION

This study demonstrates significant variation in the need for help with everyday activities in acutely admitted older adults. To operationalize the decision process, we recommend using a cut-off point of 8 in the 30s-CST to distinguish between patients with low physical performance and those with high physical performance. The study also found a significant association between the scores of the 30s-CST and DEMMI at time of admission. Each extra repetition in the 30s-CST was followed by an increase in the DEMMI score, thus making the 30s-CST well suited for assessment of physical performance at the time of admission. The acceptable validity implies a good possibility of implementing the 30s-CST in acute settings with limited time and space for testing, such as examination rooms and short-stay units.

However, the wide PI found here prevents us from predicting a patient's DEMMI score on the basis of the 30s-CST score. With regard to responsiveness to change, the wide PI demonstrated a better responsiveness in

DEMMI than in the 30s-CST, which leads us to recommend DEMMI over the 30s-CST in evaluation studies, especially of older adults with low physical performance.

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REFERENCES

1. Carter-Storch R, Frydkjær-Olsen U, Backer-Mogensen C. Admissions to emergency department might be classified into specific complaint categories. *Dan Med J.* 2014;61(3):A4802.

2. Moseley MG, Hawley MP, Caterino JM. Emergency department observation units and the older patient. *Clin Geriatr Med.* 2013;29(1):71-89.

3. Bodilsen AC, Klausen HH, Petersen J, et al. Prediction of mobility limitations after hospitalization in older medical patients by simple measures of physical performance obtained at admission to the emergency department. *PLoS One.* 2016;11(5):e0154350.

4. Ostir GV, Berges I, Kuo YF, Goodwin JS, Ottenbacher KJ, Guralnik JM. Assessing gait speed in acutely ill older patients admitted to an acute care for elders hospital unit. *Arch Intern Med.* 2012;172(4):353-358.

5. Volpato S, Cavalieri M, Guerra G, et al. Performance-based functional assessment in older hospitalized patients: Feasibility and clinical correlates. *J Gerontol A Biol Sci Med Sci.* 2008;63(12):1393-1398.

6. de Morton NA, Davidson M, Keating JL. Validity, responsiveness and the minimal clinically important difference for the de morton mobility index (demmi) in an older acute medical population. *BMC Geriatr.* 2010;10:72.

7. Fisher S, Ottenbacher KJ, Goodwin JS, Graham JE, Ostir GV. Short physical performance battery in hospitalized older adults. *Aging Clin Exp Res.* 2009;21(6):445-452.

8. Jones CJ, Rikli RE, Beam WC. A 30-s chair-stand test as a measure of lower body ssrength in community-residing older adults. *Res Q Exerc Sport.* 1999;70(2):113-119.

9. Goldspink DF. Ageing and activity: Their effects on the functional reserve capacities of the heart and vascular smooth and skeletal muscles. *Ergonomics.* 2005;48(11-14):1334-1351.

10. Rikli RE, Jones CJ. *Senior fitness test manual.* 1st ed.Fullerton, CA: California State University; 2001.

11. De Buyser SL, Petrovic M, Taes YE, Vetrano DL, Onder G. A multicomponent approach to identify predictors of hospital outcomes in older in-patients: A multicentre, observational study. *PLoS One.* 2014;9(12):e115413.

12. Cruz-Jentoft AJ, Landi F, Topinkova E, Michel JP. Understanding sarcopenia as a geriatric syndrome. *Curr Opin Clin Nutr Metab Care.* 2010;13(1):1-7.

13. Brown CJ, Flood KL. Mobility limitation in the older patient: A clinical review. *JAMA.* 2013;310(11):1168-1177.

14. Bodilsen AC, Juul-Larsen HG, Petersen J, Beyer N, Andersen O, Bandholm T. Feasibility and inter-rater reliability of physical performance measures in acutely admitted older medical patients. *PLoS One.* 2015;10(2):e0118248.

15. de Vet HCW, Terwee CB, Mokkink LB, Knol DL. *Measurement in medicine.* 1st ed.New York: Cambridge University Press; 2011.

16. de Morton NA. De morton mobility index [Internet]. http://www.demmi.org.au/demmi/web/downloads/demmi.pdf. Updated April 18 2017. Accessed November 22, 2011.

17. de Morton NA, Davidson M, Keating JL. Reliability of the de morton mobility index (demmi) in an older acute medical population. *Physiother Res Int.* 2011;16(3):159-169.

18. de Morton NA, Lane K. Validity and reliability of the de morton mobility index in the subacute hospital setting in a geriatric evaluation and management population. *J Rehabil Med.* 2010;42(10):956-961.

19. Davenport SJ, de Morton NA. Clinimetric properties of the de morton mobility index in healthy, community-dwelling older adults. *Arch Phys Med Rehabil.* 2011;92(1):51-58.

20. de Morton NA, Davidson M, Keating JL. The de morton mobility index (demmi): An essential health index for an ageing world. *Health Qual Life Outcomes.* 2008;6:63.

21. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the reporting of observational studies in epidemiology (strobe): Explanation and elaboration. *Ann Intern Med.* 2007;147(8):W163-194.

22. Rikli RE, Jones CJ. Development and validation of criterion-referenced clinically relevant fitness standards for maintaining physical independence in later years. *Gerontologist.* 2013;53(2):255-267.

23. Dobson F, Hinman RS, Hall M, Terwee CB, Roos EM, Bennell KL. Measurement properties of performance-based measures to assess physical function in hip and knee osteoarthritis: A systematic review. *Osteoarthritis Cartilage.* 2012;20(12):1548-1562.

24. de Morton NA, Brusco NK, Wood L, Lawler K, Taylor NF. The de morton mobility index (demmi) provides a valid method for measuring and monitoring the mobility of patients making the transition from hospital to the community: An observational study. *J Physiother.* 2011;57(2):109-116.

25. Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol.* 2007;60(1):34-42.

26. Carter RE, Lubinsky J. *Rehabilitation research: Principles and applications.* 5th ed.St. Louis, Missouri: Elsevier 2016.

27. Altman DG. *Practical statistics for medical research.* 1st ed.London: Chapman & Hall; 1991.

28. De Buyser SL, Petrovic M, Taes YE, et al. Functional changes during hospital stay in older patients admitted to an acute care ward: A multicenter observational study. *PLoS One.* 2014;9(5):e96398.

29. Green SB. How many subjects does it take to do a regression analysis. *Multivariate Behav Res.* 1991;26(3):11.

30. Fried LP, Guralnik JM. Disability in older adults: Evidence regarding significance, etiology, and risk. *J Am Geriatr Soc.* 1997;45(1):92-100.

31. Gill TM, Williams CS, Tinetti ME. Assessing risk for the onset of functional dependence among older adults: The role of physical performance. *J Am Geriatr Soc.* 1995;43(6):603-609.

32. Aranda-Gallardo M, Morales-Asencio JM, Canca-Sanchez JC, Toribio-Montero JC. Circumstances and causes of falls by patients at a spanish acute care hospital. *J Eval Clin Pract.* 2014;20(5):631-637.

33. Karlsen A, Loeb MR, Andersen KB, et al. Improved functional performance in geriatric patients during hospital stay. *Am J Phys Med Rehabil.* 2017;96(5):e78-e84.