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ORIGINAL RESEARCH

Bed bridge test predicts return to occupational activities six months after hospital discharge: a longitudinal study

O Teste da Ponte no Leito prediz retorno às atividades ocupacionais após seis meses da desospitalização: estudo longitudinal

El Bed Bridge Test predice la reincorporación a las actividades ocupacionales después de seis meses del alta hospitalaria: estudio longitudinal

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ABSTRACT | Introduction: The bed bridge test (BBT) assesses the functional capacity of hospitalized patients. Objective: to evaluate the efficiency of BBT in predicting clinical and functional outcomes six months after hospital discharge. Method: this observational longitudinal study was conducted in two phases. Phase 1: BBT in five and 10 repetitions (BBT5R and BBT10R) or for 30 and 60 seconds (BBT30s and BBT60s) during hospitalization. Phase 2: six months after discharge, participants were phoned and information on occupational return, readmission, falls, walking, and death were obtained. Results: of the 92 evaluated participants, 57 remained in this study after six months. Of these, 28% returned to work, 26% were readmitted, 7% reported falls, 5% were unable to walk, and 3% had died. BBT30s and BBT60s were related to the return to occupational activities (r=0.28; r=0.37, respectively). In addition to performing BBT60s, factors such as the female sex and lower incidence of comorbidities explained 40% of the returns to occupational activities. Conclusion: we concluded that BBT60s can predict the return to occupational activities after hospital discharge in the medium term, possibly configuring an indicator to guide hospital rehabilitation and facilitate the return to occupational activities.

Descriptors | Disability Evaluation; Hospitalization; Exercise Test.

RESUMO | O Teste da Ponte no Leito (TPL) avalia a capacidade funcional de pacientes hospitalizados. Objetivamos avaliar a capacidade do TPL em prever desfechos clínico-funcionais seis meses após a alta hospitalar. Utilizamos como método o estudo observacional, longitudinal, realizado em duas fases. Fase 1: realização dos TPL em 5 e 10 repetições (TPL5R e TPL10R), 30 e 60 segundos (TPL30s e TPL60s) durante hospitalização. Fase 2: após seis meses da alta, foi realizado contato telefônico e obtido informações sobre o retorno ocupacional, reinternação, quedas, deambulação e óbito. Obtivemos como resultados o seguinte: dos 92 participantes avaliados, 57 permaneceram no estudo após 6 meses. Destes, 28% retornaram ao trabalho, 26% foram reinternados, 7% relataram quedas, 5% não deambulavam e a porcentagem de óbito foi de 3%. Os TPL30s e TPL60s se relacionaram com o retorno às atividades ocupacionais (r=0,28; r=0,37, respectivamente). Além do desempenho no TPL60s, fatores como sexo feminino e menor presença

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de comorbidades explicaram 40% dos retornos às atividades ocupacionais. Concluímos que o TPL60s pode predizer o retorno às atividades ocupacionais após alta hospitalar a médio prazo, sendo um possível indicador para orientar a reabilitação hospitalar e facilitar o retorno às atividades ocupacionais.
Descritores | Avaliação da Deficiência; Hospitalização, Teste de Esforço.

RESUMEN | El Bed Bridge Test (BPD) evalúa la capacidad funcional de los pacientes hospitalizados. El objetivo fue evaluar la capacidad del BPD para predecir los resultados clínico-funcionales seis meses después del alta hospitalaria. Se utilizó como método el estudio observacional, longitudinal, realizado en dos fases. Fase 1: realización de BPD en 5 y 10 repeticiones (BPD5R y BPD10R), 30 y 60 segundos (BPD30s y BPD60s) durante la hospitalización. Fase 2: Seis meses después del alta, se realizó contacto telefónico y se obtuvo información sobre la reincorporación ocupacional, readmisión, caídas, deambulación y muerte. Los siguientes resultados fueron: de los 92 participantes evaluados, 57 permanecieron en el estudio después de 6 meses. De estos, el 28% se reincorporó al trabajo, el 26% fue readmitido, el 7% reportó caídas, el 5% no deambuló y el porcentaje de muerte fue del 3%. Los BPD30s y BPD60s se relacionaron con la reincorporación a las actividades ocupacionales (r=0,28; r=0,37, respectivamente). Además del rendimiento en los BPD60s, factores como el género femenino y la menor presencia de comorbilidades explicaron el 40% de las reincorporaciones a las actividades ocupacionales. Se concluyó que los BPD60s pueden predecir la reincorporación a las actividades ocupacionales tras el alta hospitalaria a medio plazo, además de ser un posible indicador para orientar la rehabilitación hospitalaria y facilitar la reincorporación a las actividades ocupacionales.
Palabras clave | Evaluación de la Discapacidad; Hospitalización, Prueba de Esfuerzo.

INTRODUCTION

Functionality is a fundamental physical domain for maintaining independence and quality of life[1]. Functional loss resulting from hospitalization predicts higher risk of falls, delayed return to occupational activities, readmissions, and death[2-6]. Thus, measuring functionality during hospitalization can provide important information for early preventive or rehabilitative therapeutic measures to make patients return to their functional activities[7].

Several clinical tests can assess the functional status of individuals in hospitals, such as walk-based tests[8], the sit and stand test[9], the timed up and go test[10], and the short physical performance battery (SPPB)[11], which can predict outcomes. It has been shown that worse timed up and go test performances in patients with chronic obstructive pulmonary disease may be associated with a higher risk of sarcopenia[12]. Worse performance in short physical performance battery predicts fall risk[13] and mortality[14]. However, it is often impossible to perform these tests in bedridden patients, reducing their spectrum of applicability[15]. Questionnaires and mobility scales have been commonly used in bedridden patients[16]. However, these instruments are generally limited to assessing mobility categorically, neither quantifying performance nor obtaining enough information to predict outcomes[17].

To overcome these limitations, our group adapted a well-known bridge exercise for an evaluative performance test called bed bridge test (BBT), which is based on a hip lifting movement in bed[18] that involves activating the flexor and extensor trunk muscles and the pelvic and lower limb muscles[19], which play an essential role on the functional stability of the trunk and the lumbopelvic region, which is crucial for a wide variety of daily activities[20].

Participants randomly performed four versions of the BBT: the five- (BBT5R) and 10-repetition BBT (BBT10R) and the 30- (BBT30S) and 60-second BBT (BBT60S). For the BBT5R and BBT10R, participants were to perform from five to 10 repetitions as quickly as possible, and the time taken to complete the movements was recorded. For the BBT30S and BBT60S, participants were to perform as many repetitions as possible in 30 and 60 seconds, respectively, and the number of repetitions was recorded[18].

BBT has been shown to be a feasible, safe, reliable, and valid test to evaluate a wide variety of hospitalized patients, from those restricted to the bed to those who can walk by themselves[18]. Nevertheless, the ability of BBT to predict clinical and functional outcomes after hospital discharge is yet to be shown.

This study aimed to examine whether performing the BBT during hospitalization could predict the return to occupational activities, incidence of falls,

readmission, walking capacity, and death six months after hospitalization. It hypothesized that patients who performed better in the BBT during hospitalization would have better outcomes after six months of follow-up.

METHODOLOGY

Study design

This observational and longitudinal study was held from March 2022 to February 2023.

Sample calculation

The sample size was theoretically estimated on GPower 3.0. Assuming a bivariate correlation of 0.40 between the outcomes and the BBT test, a statistical power of 90%, and an alpha error of 5%, the sample size totaled 82 participants. Considering possible losses, 10 to 15% were added as compensation, resulting in a sample size of 92 participants.

Population

Subjects who were hospitalized in a public university general hospital (the Universidade Federal de Juiz de Fora University Hospital), aged from 18 to 80 years and needed no bed restraint were included. Patients who showed hemodynamic instability and adverse clinical conditions, such as febrile state or severe pain, were excluded. Patients with orthopedic and/or neurological restrictions that made it impossible test performance and those with cognitive impairment as per a score ≤4 in the Six Item Screener[21] were also excluded.

Selection criteria

Half of the eligible patients that were screened daily were randomly selected by electronic generation to avoid selection bias.

Data collection

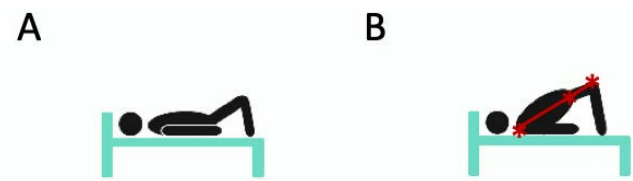
Sociodemographic information, clinical data (reason for hospitalization), the Charlson comorbidity index, and length of hospitalization were recorded.

The four versions of BBT, limited by their number of repetitions or length, were performed during participants' hospitalization[18].

The test was performed with patients positioned in supine position in a bed the headboard of which stood at zero degrees, with their upper limbs extended and parallel to their trunk, their hands pronated, knees and hips flexed at 60 and 45 degrees, respectively, bare feet, and knees apart and aligned with the shoulders (Figure 1)[18]. A 1-cm thick, 40-cm long, and 35-cm wide wooden board was placed under patients' feet to improve their grip, working as a non-slip surface. Patients had to perform the hip lift and return to the initial position, and only the complete movements in which hips and shoulders were aligned were counted. Patients only received simple verbal commands: "you can start" and "you can rest." The examiner counted only complete movements, when knees, hips, and shoulders were aligned. Patients could interrupt the test due to fatigue or intolerable dyspnea. Moreover, following the safety criteria, the examiner stopped the test in case of a maximum HR above 85% predicted for age, bradycardia (<50bpm), blood pressure >180/70 mmHg, or oxygen saturation <88%. Time count was never interrupted, only ending when participants completed the number of repetitions (in the five and 10-repetition versions) or at the end of the prescribed duration (in the 30- and 60-second versions)[18].

The BBT was performed randomly in its four versions: five- (BBT5R) and 10-repetition BBT (BBT10R) and 30- (BBT30S) and 60-second BBT (BBT60S). An arbitrary five-minute interval was taken between each test or until the variables of heart rate and symptoms returned to baseline values. In the BBT5R and BBT10R versions (limited by repetitions), participants were asked to perform five or 10 repetitions as quickly as possible, and the time taken to complete the repetitions was recorded. In the BBT30S and BBT60S versions (limited by time) participants were asked to perform as many repetitions as they could in 30 and 60 seconds, respectively.

Figure 1. A) Initial and final position of the test; B) Execution of the bridge movement



Then, six months after hospital discharge, evaluators tried to phone participants up to three times. A structured interview script was followed during such calls. Initially, the examiner identified himself, described the objectives of the call, and forwarded the informed consent form. The following outcomes were recorded: return to occupational activities, occurrence of falls, readmissions, walking capacity, and death. If participants or family members failed to answer the calls, they would be classified as "non-responders." The interview script can be seen in Chart 1.

Chart 1. Telephone interview script

TELEPHONE INTERVIEW SCRIPT – Phase 2

Good morning/afternoon!
Here is the researcher (identification of the researcher), is this XXXX? (confirmation of the identification of the possible participant) _____
I am calling to invite you to participate in a brief study by telephone about your current health and occupational status. Do you allow me to continue the call at this time? ( ) Yes ( ) No.
Or can we reschedule?
I would like to inform a day and time ( ) Yes, which one? _____ ( ) No.
If we can talk now, we will record this call, do you authorize it? ( ) Yes ( ) No.
If yes, the call will be recorded and I will further explain the study. If you cannot speak now, can we schedule another day and time for you?
If so, we will continue.
This survey will be very brief, involving only three questions. If you do not understand or want me to repeat them, just ask me to repeat them.
After your discharge from the hospital six months ago, have you been readmitted?
( ) Yes ( ) No
After your discharge from the hospital six months ago, did you return to work or the activities you did as before?
( ) Yes ( ) No
After your discharge from the hospital six months ago, are you carrying out your day-to-day activities independently or do you need help?
( ) Independently
( ) Need help in some activities
( ) Need help in most activities

Call attempt 1	Call attempt 2	Call attempt 3
Date and time:	Date and time:	Date and time:

Was contact possible?
( ) Yes ( ) No
Did they accept consent by phone?
( ) Yes ( ) No
Did they agree to record their consent?
( ) Yes ( ) No
Did they understand the research?
( ) Yes ( ) No
Did they agree to participate in the survey?
( ) Yes ( ) No
If yes, they want to receive the ICF by:
( ) Email ( ) Mail correspondence

Data analysis

Parametric continuous variables are shown as mean and standard deviation, whereas nonparametric variables, as medians and interquartile ranges. Categorical variables are shown as absolute and relative frequencies. To evaluate the relationship between the performance in the BBT versions and the outcomes of interest, the Pearson's or Spearman's coefficients of correlation were used as appropriate. The magnitude of the correlation was interpreted according to Cohen: values from 0.10 to 0.29 were considered low; from 0.30 to 0.49, medium; and from 0.50 to 1, high[22].

To compare patients with positive and negative outcomes, the Student's *t*- or the Mann-Whitney U tests were used, depending on the nature of the data.

The results of the univariate analysis determined the variables that were included in the stepwise multiple linear regression analysis on the relative importance of the variables in predicting post-hospital outcomes. Predictive variables that reached $p<0.1$ in the univariate analysis were included in the model. The results are shown as the total percentage of variance explained by the regression model (R^2) and beta with 95% confidence intervals. A p-value <0.05 was considered statistically significant. Statistical analysis was performed on SPSS (v21.0, Chicago, Illinois).

RESULTS

In total, 92 patients carried out the BBT in the hospital. However, this study excluded 35 individuals due to lack of contact six months after hospital discharge, resulting in 57 responding participants. Table 1 shows the sample characteristics and performance of the BBT5R, BBT10R, BBT30S, and BBT60S.

Considering the six months after hospitalization found that 28% of the participants who responded to follow-up returned to their occupational activities and that 26% were readmitted. Moreover, this research observed a reduced incidence of falls and deaths and that only one participant remained restricted to bed in their home (Table 1).

Table 1. Sample characteristics

Characteristic	Hospitalized participants (n=92)	Responding participants after six months (n=57)
Age (years)	50.5±16.1	50.9±16.2
Female, n (%)	56 (61)	37 (65)
Comorbidities (Charlson Index)	2 (0–10)	2 (0–10)
Reasons for hospitalization		
Clinical, n (%)	61 (66)	34 (60)
Surgical, n (%)	31 (34)	23 (40)
Diagnosis on admission		
Gastrointestinal	19 (20.6)	
Respiratory	15 (16.3)	
Non-respiratory infection	8 (8.6)	
Hematologic	4 (4.3)	
Cardiovascular	4 (4.3)	
Renal	4 (4.3)	
Neoplasia	3 (3.2)	-
Lupus	3 (3.2)	
Neurological	1 (1.0)	
Gastrointestinal surgery	17 (18.4)	
Urological surgery	11 (11.9)	
Thoracic surgery	3 (3.2)	
Hospital variables		
Use of supplemental oxygen	23 (25)	-
Length of hospitalization (days)	16.9±13.1 (2–84)	-
Age groups		
Up to 60 years, n (%)	63 (68)	41 (72)
>60 years, n (%)	29 (32)	16 (28)
BBT5R, seconds	9.1±3.5 (4–20)	-
BBT10R, seconds	19.8±6.9 (7–42)	-
BBT30S, no. repetitions	15.49±4.83 (5–30)	-
BBT60S, no. repetitions	28.9±8.8 (13–60)	-
Outcomes six months after hospital discharge		
Death, n (%)	-	3 (3)
Bedridden, n (%)	-	1 (5)
Return to occupational activities, n (%)	-	16 (28)
Readmission, n (%)	-	15 (26)
Fall	-	4 (7)

Data shown in absolute (relative) values; mean ± standard deviation; and minimum – maximum values. * p<0.05.

Return to occupational activities was moderately correlated with BBT60S and weakly correlated with BBT30S. The outcomes of fall, readmission, death, and bedridden state showed no correlation with BBT (Table 2).

Table 2. Association between BBT versions and functional and hospital outcomes (n=57)

Parameter	BBT5R	BBT10R	BBT30S	BBT60S
Age	0.43*	0.42*	−0.50*	−0.37*
Comorbidities	0.35*	0.28*	−0.34*	−0.20*
Length of hospitalization	0.07	0.06	−0.33	−0.12
Return to occupational activities	−0.14	−0.10	0.28*	0.37*
Readmission	0.09	0.06	−0.15	−0.17
Bedridden state	0.13	0.17	−0.22	−0.19
Fall	0.06	0.17	−0.09	−0.47
Death	0.07	0.10	−0.08	−0.04

Abbreviations: BBT5R: 5-repetition bed bridge test; BBT10R: ten-repetition bed bridge test; BBT30S: 30-second bed bridge test; BBT60s: 60-second bed bridge test. * p < 0.05.

Individuals who returned to their occupational activities within six months after hospitalization had performed better in the BBT30S and BBT60S than those who were unable to return (Table 3).

Table 3. Comparison of performance in BBT between participants who returned or not to occupational activities

	Return to occupational activities		
	Yes	No	P
BBT30S	19 ± 6	15 ± 3.5	0.007
BBT60S	35 ± 11	30 ± 5.4	0.015

BBT30S: 30-second bed bridge test; BBT60S: 60-second bed bridge test.

The return to occupational activities six months after hospital discharge was associated with better performance in BBT60S, the female sex, and low comorbidity index, explaining 40% of the variation in return to activities [F (3.46)=10.411]; p <0.001; R^2=0.40 (Table 4).

Table 4. Factors influencing the return to occupational activities of patients six months after hospital discharge

	non-standardized coefficient (B)	95%CI	P-value	standardized coefficient (B)
Constant	0.789	−0.25–1.8	0.135	-
Comorbidities	0.174	0.08–0.26	0.000	0.492
BBT60S	0.028	0.05–0.006	0.013	0.300
Sex	0.480	0.08–0.87	0.019	0.288

BBT60S: 60-second bed bridge test.

DISCUSSION

This study evaluated the performance of the bed bridge test (BBT) during hospitalization to predict important

outcomes, such as return to occupational activities, incidence of falls, readmissions, mobility, and mortality six months after hospital discharge. We found that performance in BBT, particularly in its 30- and 60-second versions, is related to return to occupational activities. Patients who performed better on these tests during their hospitalization were more likely to return to work after discharge. Furthermore, we found that the variables female sex and fewer comorbidities are associated with returning to occupational activity.

In a previous study from us, BBT versions showed indicators of good reliability (ICC 0.87 – 0.92) and strong validity with the short physical functional battery (-0.58; -0.63 < r > 0.47; 0.53)[18], which makes it available for use in further studies with this test. Functionality is a crucial aspect for people's quality of life and independence, especially during and after a hospital stay. This study aimed to evaluate the ability of BBT performance during hospitalization to predict relevant outcomes, such as return to occupational activities, incidence of falls, readmissions, mobility, and mortality, six months after hospital discharge. Of the four BBT versions, only BBT30S and BBT60S were associated with the return to occupational activities. Return to occupational activities occurred in 26% of followed-up participants. This low prevalence of return to work also occurred in another longitudinal study with the Brazilian population, which showed a return to work rate of 34% after one year of hospitalization[23].

As expected, patients who returned to occupational activities had better functional capacity than those who were unable to return, as evinced by a better performance in the BBT30S and BBT60S tests. This finding is in line with Motizuki et al.[23], which showed that functional limitations increased the risk of non-return to work by 2.5 times after one year of hospitalization.

The observed relationship between return to occupational activities and physical performance in the longer versions of the BBT (BBT30S and BBT60S) — when compared to the shorter versions (BBT5R and BBT10R) — can be explained by the superior discriminative capacity of the longer duration tests. These findings agree with a study comparing the sit-stand test with varying durations in patients with chronic obstructive pulmonary disease, which observed correlations between the longer versions of the test and functional capacity and physical activity in daily life[24].

This study also shows that a good performance in BBT, belonging to the female sex, and fewer comorbidities explain 40% of the return to occupational activities six months after hospital discharge. Based on these findings, we suggest optimizing rehabilitative interventions to help patients with low functional performance, including those of the male sex and with more comorbidities, to increase the impact on the return to occupational activities after discharge. However, it is important to recognize that other factors may be involved, such as motivation, social support, needs for occupational adaptations, among others.

These results indicate that functional capacity is fundamental for returning to work after hospitalization. We suggest improving rehabilitation for patients with low functional performance, including those of the male sex and with more comorbidities. However, other factors such as motivation, social support, and adaptations in the work environment also play an important role in returning to work[25,26]. Occupational reintegration after hospitalization is crucial for physical and mental recovery, as well as for quality of life. Nevertheless, the transition back to work is often challenging and requires attention since the period of hospitalization[27,28].

Moreover, this study found no associations between performance on BBT and bed restriction, readmissions, falls, and deaths. This may be due to its short follow-up period of six months and the difficulty maintaining contact with participants after discharge from the hospital. Follow-up showed sample loss but the characteristics of the remaining sample resembled initial ones. It is important to note that longitudinal studies often face sample loss, ranging from 15 to 41%, depending on various factors such as the nature of the study, the number of visits, and the length of follow-up[29]. This sample loss may occur due to a variety of reasons, including participant abandonment, address changes, or difficulty locating respondents[29].

A strong point of this study refers to it showing that a simple, low-cost, and easily executable functional test in the hospital environment can serve as an indicator of the return to occupational activities by finding patients who need rehabilitation optimization to facilitate occupational return after hospital discharge.

This study has some limitations, such as being carried out in a single hospital center, with a sample composed of patients from a general public hospital. Therefore, its results prohibit generalization to other clinical and social contexts. Moreover, as is common in longitudinal studies, this research lost participants over time due to the difficulty of maintaining contact with

them after their hospital discharge. Another limitation refers to the absence of an evaluation of participants' psychosocial and environmental factors since they play an important role in occupational reintegration after hospitalization, which, in turn, may limit the comprehensive understanding of the determinants of occupational return.

In conclusion, patients' performance in BBT30S and BBT60S is associated with the return to occupational activities six months after their hospital discharge. These results highlight the importance of considering the functionality of patients during hospitalization as a possible indicator to guide rehabilitation and facilitate the return to occupational activities.

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