REVIEW ARTICLE

Using the six minute walk test to evaluate walking capacity in patients with stroke

Uso do teste de caminhada de seis minutos para avaliar a capacidade de deambulação em pacientes com acidente vascular cerebral

Christiane Riedi Daniel[1], Linamara Rizzo Battistella[2]

ABSTRACT

The 6-minute walk test (6MWT) measures the maximum distance that a person can walk in 6 minutes. The test is gaining popularity because it assesses the functional capacity of different patients and is considered a simple, safe, valid, inexpensive, and noninvasive cardiopulmonary test. **Objective:** The aim of this review was to investigate the applicability of the six-minute walk test in stroke survivors. **Method:** A literature search of MedLine (PubMed) databases dating from January 1, 2000 to April 16, 2013 was performed. The search terms used were stroke (or cerebrovascular accident or hemiplegia) and walking (mobility limitation). Author number one reviewed the titles and/or abstracts of displayed articles and determined their relevance to this review. Full text copies of relevant articles were obtained. Reference lists were screened for identification of other relevant articles. Only articles written in English were included in this review. **Results:** The 31 included studies were divided into 9 randomized controlled trials, 2 case-control studies, 5 prospective studies, and 15 cross-sectional studies and involved 1,824 surviving stroke patients, 146 healthy controls, and 38 Multiple Sclerosis patients. **Conclusion:** The 6MWT is useful in evaluating de functional capacity of patients with stroke, however, it should be used along with other assessment tools to determine the general profile of these patients. More studies are necessary to verify the factors that influence the test results and as a way to supplement them.

Keywords: Stroke, Hemiplegia, Mobility Limitation, Walking

RESUMO

O teste de caminhada de 6 minutos (TC6) mede a distância máxima que uma pessoa pode caminhar em 6 minutos. O teste está ganhando popularidade porque avalia a capacidade do estado funcional dos pacientes com diferentes patologias e é considerando simples, seguro, válido, barato e não invasivo. **Objetivo:** O objetivo desta revisão foi investigar a aplicabilidade do teste de caminhada de seis minutos em sobreviventes de AVC. **Método:** A pesquisa bibliográfica foi realizada na base de dados MedLine (PubMed) de 1 de Janeiro de 2000 a Abril, 16 2013 Os termos de pesquisa utilizados foram AVC (acidente vascular cerebral e/ou hemiplegia) e caminhada (limitação da mobilidade). O primeiro autor revisou os títulos e/ou resumos de artigos encontrados e determinou relevância para a revisão. Cópias de texto completo de artigos relevantes foram obtidas. Após a leitura foram selecionados os artigos mais relevantes. Apenas artigos escritos em Inglês foram incluídos nesta revisão. **Resultados:** Os 31 estudos incluídos foram divididos em 9 estudos de ensaio clinico randomizado, 2 estudos caso-controle, 5 estudos prospectivos e 15 estudos transversais e envolveu 1.824 pacientes sobreviventes de AVC, 146 controles saudáveis e 38 pacientes com Esclerose Múltipla. **Conclusão:** O TC6 é útil para avaliar a capacidade de funcional em pacientes com acidente vascular cerebral, no entanto deve ser usado em conjunto outras ferramentas de avaliação para determinar o perfil geral desses pacientes. Mais estudos são necessários para verificar os fatores que influenciam o resultado do teste e a forma de complementá-lo.

Palavras-chave: Acidente Vascular Cerebral, Hemiplegia, Limitação da Mobilidade, Caminhada

[1] Physiotherapist, Assistant Professor at the Universidade Estadual do Centro-Oeste - UNICENTRO.
[2] Physiatrics Doctor, Full Professor at the University of São Paulo Medical School.

Mailing address:
Christiane Riedi Daniel
Rua Jandiatuba, 580
São Paulo - SP
CEP 05716-150
E-mail: christiane_riedi@usp.br

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BACKGROUND

Originally developed to assess cardiorespiratory and cardiovascular endurance, the 6-minute walk test (6MWT) measures the maximum distance that a person can walk in 6 minutes.[1] Primarily, it was developed as a tool for assessing functional capacity in patients with cardiovascular and pulmonary diseases.[2] The test is gaining popularity because assesses the patients' functional capacity and is considered a simple, safe, valid, inexpensive, and noninvasive cardiopulmonary test.[1]

The 6MWT has been used to investigate endurance and correlates well with measurements of impairment in daily life activities because it is a general indicator of overall physical performance, morbidity, and mortality. Performance of the 6MWT has been shown useful in investigating older adults,[3] patients with pulmonary hypertension,[4] patients with severe chronic obstructive disease,[5] advanced heart failure[6] and neurological disorders such as stroke,[7] Parkinson's,[8] and Multiple Sclerosis.[7]

In patients with neurological disorders it is common to observe some deterioration in their mobility that results in lingering physical impairments, a sedentary lifestyle, a decline in cardio-respiratory fitness; these have been related to a higher risk of a new stroke and stroke mortality.[9] Another problem is the fatigue after stroke that presents high incidence and that appears to be related to depression, chronic pain, sleep disturbances, immobility, and lack of exercise. Survivors of stroke may experience increased energy expenditure during gait due to the inability to activate normal motor patterns, which clarifies the use of the walking test to investigate the stroke performance during gait.[10]

So, the aim of this review was to investigate the applicability of the six-minute walk test in stroke survivors.

METHOD

Search strategy

A literature search was performed in the MedLine (PubMed) databases ranging from January 1, 2000 to April 16, 2013. The search terms used were stroke (or cerebrovascular accident or hemiplegia) and walking (mobility limitation). Author number one reviewed the titles and/or abstracts of displayed articles and determined their relevance to this review. Full text copies of relevant articles were obtained. Reference lists were screened for identification of other relevant articles. Only articles written in English were included in this review.

Inclusion Criteria

Studies were included in the review if they: included participants with a diagnosis of stroke and the results of the 6MWT to determine functional capacity. Exclusion criteria for this review was the 6MWT not being the focus of the study, but with pharmacological interventions as the study focus.

Data extraction

Information about the study design, setting, participants, and results were extracted by the first author and checked by the second author.

RESULTS

The electronic search identified 393 articles. After screening all the titles and abstracts, 38 articles were identified, but after reviewing the full text, 31 articles were included.

Characteristics of included studies

The 31 included studies were divided into 9 randomized controlled trials, 2 case-control studies, 5 prospective studies, and 15 cross-sectional studies and involved 1,824 surviving stroke patients, 146 healthy controls, and 38 Multiple Sclerosis patients. The results are presented separately in Table 1.

The randomized controlled trials are presented in Table 2.

The characteristics of the prospective studies are shown in Table 3.

The cross-sectional studies are presented in Table 4.

Functional capacity tests

As for functional testing, it is possible to verify that the 6MWT was used in conjunction with the 10MWT in 20.7% of the studies, followed by the TUGT, the step test, and exercise tolerance test 10.3%. It was also used in a study with the shuttle walk and short walk tests (3.4%).

Functional scales

The studies that made use of the 6MWT also used different scales and assessment tools. The Berg Balance Scale was among the most commonly used scales, verified as the most frequently used with 31% of the studies, followed by 20.6% that used the Barthel index and Functional Independence Rankin Score to measure, and 10.3% with the Functional Ambulation Category 6.8%.

Variables

The variable most often used was the distance in 6MWT, but this was associated with peak VO_2 in 17.24% of the studies, with gait speed in 6.8%, 3.4% with stride length, heart rate with 6.8%, Borg scale in 3.4%, and lower limb strength in 10.3% of the studies analyzed.

Walking distance

Comparing the distance traveled between studies in randomized clinical trials, the study by Brock et al.[16] found the lowest values for both the treated group and the control group with 102.6 ± 64 and 78.5 ± 61.3 meters, respectively, whereas Mayo et al.[13] found the greatest distances with 321.1 for group experiences, and 321.6 meters for the group treated with exercise. The largest gains in the distance before and after the interventions were found in the study by Blennerhassett & Dite[19] showing an increase of 223 meters for the mobility group and of 132 meters for the upper limb group. In prospective studies the lowest entered values in patients with stroke were from the study by Iosa et al.[24] with a distance of 94.1 meters and the highest values were found by Rose et al.[20] whose post-stroke individuals traveled a distance of 318.8 meters.

In cross-sectional studies, the smallest footage was found in the study by Ng and Hui-Chan[29] with a distance of 183 meters and the largest found by Blennerhassett et al.[27] with 463 meters.

Table 1. Number of subjects involved in this review

Type of study	Patients	Control	Other patients
Experimental			
Randomized controlled trial	381	0	
Observational			
Case control study	34	10	
Prospective study	640	90	
Cross-sectional study	667	46	38
Total	1,722	146	38

Table 2. Studies of randomized controlled trial characteristics

Study	Sample size	Age	Intervention	Studied Variables	6MWD (m)	6MWD difference (m)
Kang et al.[11]	30 post-stroke 10 per group (intervention, conventional and control)	56.1 ± 7.3	Treadmill training with OFG on balance and gait compared with TG and CG	6MWT, 10MWT, TUGT	OFG: 240, TG: 237, CG: 239	OFG: 24.5 TG: 4.6 CG: 1.8
Lam et al.[12]	52 post-stroke 20 USA 32 Germany	66.8 ± 1.1	Prediction of response to T-EX3 and T-EX6	6MWT, 10MWT, peak VO_2	T-EX3: 210.6 T-EX6: 279.9	T-EX3: 42.35 T-EX6: 48.75
Mayo et al.[13]	87 post-stroke 43 cycle group 44 exercise group	67.7 ± 13.3	Two home-based exercise (cycle group x exercise group) programs to improve functional walking	6MWT, physical function, role participation, quality of life exercise adherence, and adverse events	Cycle group: 321.1 Exercise group: 321.6	Cycle group: 18 Exercise group: 1
Monticone et al.[14]	60 sub-acute stroke 30 regent suit group (RSG) 30 control group (CG)	61.1 ± 7.9	Compare the regent suit training to improve recovery of motor and daily living activities with the same exercise without the regent suit	6MWT, BBS, FIM, BI	Used only the gait velocity	
Globas et al.[15]	38 residual hemiparetic gait 20 TAEX group 18 control group	68.7 ± 6.4	Compare TAEX or conventional care physiotherapy with 3 month of rehabilitation to improve sustained walking capacity and cardiovascular fitness out to a 1-year follow-up.	6MWT, BBS, RMI, Quality of life and peak VO_2	TAEX group 332.18 ± 136 Control group 265.9 ± 189	TAEX group 57.7 Control group 4.7
Brock et al.[16]	26 patients 20 weeks post-stroke	59.9 ± 14	Physiotherapy based on the Bobath concept in conjunction with a task practice *versus* structured task practice alone in improvement in walking ability	6MWT, gait velocity, BBS	Bobath group: 102.6 ± 64m5 Control Group: 78.5 ± 61.3	Bobath group: 89.8 Control Group: 41
Kuys et al.[17]	24 people with first stroke. 12 higher-intensity treadmill walking, 12 conventional physiotherapy	67.5 ± 15.5	Investigate whether HITW during rehabilitation is feasible, detrimental, or beneficial	6MWT, BI	HITW: 177 ± 130 Control Group 219 ± 180	HITW: 177 ± 130 Control Group 219 ± 180
Langhammer & Stanghelle[18]	34 post-stroke 18 Treadmill training 16 walking outdoors.	74.5 ± 11.7	Comparing effectiveness of exercise on a treadmill with walking outdoors	6MWT, 10MWT, pulse rates at rest and in activity.	Treadmill training: 277 ± 139 Walking outdoors 299.4 ± 159.3	Treadmill training: 31.1 Walking outdoors 24.1
Blennerhassett & Dite[19]	30 stroke subjects 15 Upper Limb 15 Mobility Group.	55.1 ± 15.1	Verify whether task-related practice improved mobility and upper limb function	6MWT, TUGT, ST, JTHFT, MAS	Mobility Group 183 ± 84 Upper Limb 181 ± 85	Mobility Group 233 Upper Limb 132

6MWD: six minute walk distance; 6MWT: six minute walk test, 10MWT: 10 meters walk test; TUGT: time up and go test; peak VO_2: peak oxygen consumption; BBS: Berg Balance Scale; FIM: functional impairment measures; BI: Barthel Index; RMI: Rivermead Mobility Index, SP: step test; JTHFT: Jebsen Taylor Hand Function Test; MAS: Motor Assessment Scale; OFG: Treadmill training with optic flow; TG: treadmill group; CG: control group; T-EX3: treadmill exercises comparing 3; T-EX6: 6 months of the treadmill exercise therapy; TAEX: high-intensity aerobic treadmill exercise; HITW: Investigate if higher-intensity treadmill walking

Table 3. Studies of prospective and case control characteristics

Study	Type of study	Sample size	Age	Studied Variables	6MWD (m)
Rose et al.[20]	Prospective cohort study	469 post-stroke Community-dwelling individuals	62.9 ± 12.7	ETT, 10MWT, LEFM-M, 6MWT	318.8 ± 78.6
Carroll et al.[21]	Prospective cohort study	50 Independently mobile stroke patients	72.4 ± 12.3	BI, RS, 6MWT; short walk.	158.6 ± 129.2
Mehrholz et al.[22]	Prospective cohort study	55 non-ambulatory patients after stroke	62.8 ± 10.2	FAC, RMI, walking velocity, step length, 6MWT	112.3 ± 143.9
Simpson et al.[23]	Case-control study	80 people with stroke 90 controls	Stroke: 67.6 ± 9.9 Control: 68.4 ± 10	CCSE; BBS, TUGT, 6MWT	Stroke: 275.9 ± 141.8 Control: 527.08 ± 85.9
Iosa et al.[24]	Case-control study	20 post-stroke patients 10 controls	Stroke: 64.4 ± 9.7 Control: 62.8 ± 9.7	BI, FAC, 6MWT	Stroke: 94.1 ± 73 Control: 226 ± 111

ETT: exercise tolerance test; LEFM-M: Lower Extremity Fugl-Meyer - Motor Assessment; 6MWT: six minute walk test, 10MWT: 10 meters walk test; BI: Barthel Index; RS: Rankin Score; FAC: Functional Ambulation Category; RMI: Rivermead Mobility Index; CCSE: Cognitive Capacity Screening Examination; BBS: Berg Balance Scale; TUGT: Timed Up and Go Test

DISCUSSION

This literature review found that the 6MWT is effective in evaluating functional capacity. Normally the 6MWT was used together with the 10MWT; this is important because while the 6MWT was used to investigate the walking endurance, the 10 MWT was used for testing walking speed. Both are necessary to evaluate one's walking capacity.[7] In their study, Dalgas et al.[7] found that the walking speeds of a short walking test and a long walking test are very closely correlated in patients with stroke, whereas correlations in healthy subjects were weaker. The timed up e/and go test is considering a basic functional mobility test that has shown good construct validity and reliability in assessing the basic functional mobility of stroke survivors.

Exercise tolerance needs to be associated with the 6MWT because, the Pang et al.[34] study found a low correlation between the 6MWT and VO_2 peak (r = 0.402). This suggests that the 6MWT distance alone should not be used to indicate cardiorespiratory fitness in individuals with chronic stroke.

Because of their being responsive, the functional scales should be used to supplement

Table 4. Summary of Cross-sectional studies characteristics

Study	Sample size	Age	Studied Variables	6MWD (m)
Van Bloemendaal et al.[25]	75 patients after stroke	58.8 ± 9.8	SWT, 6MWT	472.5 ± 156.1
Rand et al.[26]	40 people with stroke	66.5 ± 9.6	Chedoke Assessment; BI; FMA, EE, 6MWT	318.8 ± 78.6
Blennerhassett et al.[27]	30 Community-dwelling stroke survivors	66 (49.3-72.0)	6MWT, FSST, ST, EAMQ, FES-I, self-reported falls	463 (266-508)
Schmid et al.[28]	77 People with stroke	64 ± 8.78	Modified Rankin Scale, 10MWT, 6MWT, BBS, FAB, ABC, MFES	885 ± 430
Ng e Hui-Chan[29]	62 Subjects with spastic hemiplegia	57.4 ± 7.8	6MWT, Ankle dorsiflexor and plantarflexor strength, CSS	183.7 ± 84.3
Liu et al.[30]	91 People living in the community with a residual walking deficit within the first year of a first or recurrent stroke	72 ± 10	BBS, 6MWT	196 ± 119 197 ± 126
Dalgas et al.[7]	38 Patients with Multiple sclerosis (MS), 48 patients with stroke, and 46 healthy subjects	MS: 48.7 ± 8.8 Stroke 67.7 ± 8.5 Heallty: 46.9 ± 12.2	EDSS, FMA, 6MWT, 10MWT	MS: 436 ± 144 Stroke 292 ± 117 Heallty: 711 ± 71
Sibley et al.[31]	24 community dwelling, independently ambulating individuals more than 3 months after stroke	63 ± 13	6MWT; BBS, NIH, CMSA, ETT	283.3 ± 136.8
Kosak &Smith[32]	18 inpatient stroke rehabilitation program	77 ± 11	FIM, 2, 6, 12 MWT	unidentified
Severinsen et al.[33]	48 post-stroke patients	68 ± 9	VO_2 peak and isometric knee extensor muscle strength at the paretic knee, 6MWT, 10MWT	291 ± 171
Pang et al.[34]	63 post-stroke patients	65.3 ± 8.7	ETT and a 6MW, VO_2 peak, modified Ashworth scale, BBS, isometric knee extension strength	370.2 ± 159.2
Tseng & Kluding[10]	9 people post-stroke	56.8 ± 9	FI; 6MWT, Fugl-Meyer, VO_2 peak	295.5 ± 171.4
Muren et al.[35]	30 subjects with stroke	59 ± 9	HRQoL, 6MWT	353 ± 137
Kluding & Gajewski[36]	26 people with chronic stroke	55.6 ± 11	6MWT, BBS	202.4 ± 134.3
Ng et al.[37]	26 people with chronic stroke	58.5 ± 6.1	6MWT with different walkway lengths (10-, 20-, and 30-m walkway distances) turning directions (turning to affected side and unaffected side); BS, and HR	10 metes: 227.3 ± 79.07 20 meters: 252.2 ± 5.3 30 meters: 265.47 ± 9.4

SWT: Shuttle walk test; 6MWT: Six-minute walk test; Chedoke Assessment: Chedoke McMaster Stroke Assessment; FMA: Fulg-Meyer Assessment; EE: energy expenditure; FSST: Four Square Step Test; ST: step test; EAMQ: Environmental Analysis of Mobility Questionnaire; FES-I: Falls Efficacy Scale-International; BBS: Berg Balance Scale, FAB: Fullerton Advanced Balance Scale; ABC: Activities-specific Balance Confidence; MFES: Modified Falls Efficacy Scale; NIH: National Institutes of Health Stroke Scale CSS: composite spasticity scale; CMSA: sensorimotor recovery; FIM: functional, impairment measure scores, VO_2 peak: Peak oxygen consumption; FI: fatigue index, HRQoL: health-related quality of life, HR: heart rate; ETT: exercise tolerance test; BS: Borg Scale

the evaluation of patients with stroke because they have good responsiveness. In a systematic review, Scrivener et al.[38] studied the responsiveness of lower limb physical performance measurements in inpatient care after stroke and found a large responsiveness them very sensitive, being able to detect changes in these patients.

In our study, the scale most used was the BBS that has been determined to be valid and reliable. The BBS is a physical performance measure that includes 14 items designed to assess both static and dynamic balance. Bland et al.[39] found that a Berg Balance Scale score of 20 and an FIM walk item score of 1 or 2 at admission of rehabilitation indicates that a person with stroke is highly likely to achieve only household ambulation speeds at discharge from an inpatient rehabilitation facility.

The BI is a commonly used measurement of daily life activities (DLA) for patients with stroke that is related to ambulation capacity, as described by Saker et al.[40] The FIM is considered valid and one of the most widely used functional measurement tools. Measures in rehabilitation facilities use the Functional Independence Measure (FIM), which measures degree of disability. Performance is measured in the five domains of the FIM (Self-care, Sphincter control, Transfers, Locomotion, and Cognition).[41]

In the study by Fulk et al.[42] the 6MWT was strongly to moderately correlated with gait speed (r = 0.89), locomotion (walk) FIM (r = 0.69), and motor FIM (r = 0.52). The 6MWT is a clinically useful measure of post-stroke walking ability. It is reliable and is related to other measures of walking ability and function that are commonly used during rehabilitation after stroke.

Independent gait is considered a primary goal in stroke rehabilitation. What constitutes independent gait is often based on the Functional Ambulation Categories (FAC) classification. The FAC instrument is designed to provide information on the level of physical support needed by subjects in order to ambulate safely. This instrument has been found to be reliable and valid in classifying hemiplegic gait. 4-6 Walking speed has been established.[43]

Despite this use, the 6MWT had different results in your distance traveled. This could be related with time post stroke or the age with difference about 22 year between the studies. But it is possible to detect that the distance traveled changes with the rehabilitation, as seen in the randomized clinical trials. It is important to note that the 6MWT shows the functional capacity of ambulation because when comparing post stroke volunteers with healthy people were is possible detected that post stroke walk less.

However, Duncan et al.[44] pointed out that one of the problems with current stroke outcome measurement tools is that these tools were not always developed specifically for stroke. For example, there are a number of stroke-specific impairments that could potentially alter the outcome of the functional walk tests. Individuals with stroke may be limited by cardiovascular performance; however, factors such as muscle weakness (of peripheral and central origin), balance impairment, and spasticity could potentially influence the distance walked.

CONCLUSION

The 6MWT is useful in evaluating the functional capacity in patients with stroke, however, it should be used along with other

assessment tools to reveal the general profile of these patients. More studies are necessary to verify and support the factors that influence the test results.

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