

Barriers to outcome measure administration and completion at discharge from inpatient rehabilitation of people with amputation

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Abstract—We performed a retrospective chart review of consecutive patients discharged from an inpatient amputee rehabilitation program over a 2 yr period (January 2010–December 2011). Our objective was to determine barriers to the completion of a standardized maximum walk test (MWT) at discharge. Over the study period, there were 190 discharges. The sample had a mean age of 63.5 yr (standard deviation [SD] \pm 14.2 yr), was 71.6% male, and had a majority of transtibial amputation (67%). The average length of inpatient stay was 28.1 d (SD \pm 13.2 d). MWT including distance and time was completed in 149 (78%) of the discharges; the main factors limiting patient performance on this measure were cardiorespiratory fatigue (53%), lower-limb pain (24%), back pain (12%), and skin problems (6%). Among those patients who completed the MWT, in 31% no limiting factor was identified. Forty-one discharge MWTs were not completed as a result of nonambulatory status (34%), acute illness (17%), limb pain (7%), skin problems (12%), or other reasons. Knowing these limitations may direct care from a clinical standpoint and provides valuable data for research planning to further examine outcome measures in this population.

Key words: amputees, diabetes, gait, locomotion, lower-limb amputation, outcome measures, peripheral vascular disease, rehabilitation, rehabilitation center, walk test.

INTRODUCTION

Outcome measures provide an objective capacity for the assessment of each patient that may further direct treatment, assist in goal setting, or help to refine prognosis. Furthermore, they can be used to identify patients who are performing significantly better or worse than expected based on the normal range. In patient care, Feinstein et al. reported that outcome measurements are needed to determine compensation, predict prognosis, plan placement, estimate care requirements, choose types of specific care, and indicate status changes [1]. From a program standpoint, outcome measures derived from large samples of a population can provide an indication of program efficacy. Subsequently, comparisons can be

Abbreviations: 2MWT = 2-min walk test, 6MWT = 6-min walk test, AKA = above-knee amputation, BKA = below-knee amputation, FIM = Functional Independence Measure, LOS = length of stay, MWT = maximum walk test, SD = standard deviation, TUG = Timed Up and Go.

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made between programs and the effect of quality improvement interventions can be studied.

When compared with generic measures, instruments designed for particular patient populations are better able to identify specific patient concerns and measure the small yet clinically important changes seen with treatment [2]. Unfortunately, few inpatient outcome measures have been specially designed for and tested on people with lower-limb amputation. Historically these patients have been assessed using measures originally designed for general or neurologically based rehabilitation populations, such as the Functional Independence Measure (FIM) [3–5]. However, Leung et al. demonstrated that the admission FIM, admission motor FIM subscore, and the change in FIM score did not differentiate between successful and unsuccessful prosthetic users in an inpatient amputee rehabilitation unit [6]. Furthermore, Deathe et al. concluded that the FIM, when used as a measure of activities of daily living performance, has both content and ceiling problems in the amputee population [7]. As a result of these psychometric limitations, measures of walking performance are increasingly being used, including the L test of functional mobility, Timed Up and Go (TUG), 2-min walk test (2MWT), and 6-min walk test (6MWT), by inpatient amputee rehabilitation programs, even though no consensus exists on which tools are most appropriate in patients with amputation [3,7–8].

Before using activity-based outcomes, administration feasibility must be considered and quantified; certain barriers may prevent the successful administration of walk tests at the time of discharge from amputee rehabilitation, including medical, prosthetic, practical, and social factors [9]. In order for walk tests to be successfully completed, the patient must be medically stable with a functioning prosthesis and a tolerant limb. Furthermore, the discharge date must be known far enough in advance such that the patient is able to attend a prearranged testing session within a short window of time prior to leaving the program. Even when an outcome measure is administered, knowing the specific limitation to higher-level performance on that test is valuable feedback for the program, thereby also improving the quality of care delivered.

The 6MWT is one measure that is increasingly being used in inpatient amputee rehabilitation programs and has established psychometric properties in a sample of people with transtibial amputation. The maximum walk test (MWT) is a novel measure that has been adapted from the 6MWT. Similar to other activity-based outcome measures, little literature exists on the appropriateness

and feasibility of administering this tool to inpatients with amputation. This study's objective was to identify barriers to the administration of the MWT at discharge from an inpatient amputee rehabilitation program. Secondly, we aimed to identify patient factors to be targeted clinically to improve both activity-based outcome measure administration rates as well as patient performance.

METHODS

Design and Participants

Our regional inpatient rehabilitation program is located within a tertiary-care, publicly funded health center in Southwestern Ontario, Canada. All adult patients with major upper- and lower-limb amputations are referred to the program and assessed for appropriateness of inpatient rehabilitation. Patients are deemed appropriate if they are medically stable and have clearly defined rehabilitation goals; goal topics may include but are not limited to prosthetic fitting, activity of daily living performance, mobility training, wound care, and/or pain management. Patients with cognitive impairment likely to limit their ability to learn and retain information between therapy sessions are not admitted to the program. Following surgery, the majority of patients are discharged to the community for a period of time to allow for wound healing prior to readmittance for inpatient rehabilitation focused on prosthetic fitting and gait training.

One senior researcher retrospectively reviewed the records of all consecutive patients discharged from the amputee rehabilitation program over a 2 yr period (January 2010–December 2011). All patients attending the amputee rehabilitation program over this period were included except for patients with upper-limb amputations. We collected and input into an Excel database demographic data including age, sex, rehabilitation length of stay (LOS), amputation level, type of gait aid used, and amputation etiology. We also extracted results from activity-based outcome measures from patient charts reflecting performance on the TUG, L test of functional mobility, 2MWT, and MWT.

As the primary outcome measure collected in this amputee rehabilitation program, the MWT was the focus of this study. We first determined whether the MWT was administered. If it was administered, we extracted the following information from the patient chart, when available: (1) performance on the MWT (“maxed” or “limited”),

(2) the distance walked and corresponding time required to do so, (3) the type of gait aid used during testing, and (4) limitations affecting MWT administration and performance.

Measurement

The main outcome measure collected in this amputee rehabilitation program was the MWT. The MWT is derived from the 6MWT with minor alterations for practical purposes related to available space and time for testing, as described subsequently. Though the MWT has not been independently validated, because of the close similarities between the 6MWT and the MWT, we feel that the properties of the 6MWT can be extended to the MWT. The 6MWT has been shown to have excellent psychometric properties based on a sample of patients with transtibial amputation [8].

The amputee rehabilitation program standardized administration of the MWT. Components of this included the following: (1) the MWT was administered by the treating physiotherapist within 48 h of anticipated discharge from the program; (2) the MWT was done by walking in loops of approximately 7 m by 3 m around the therapy gym; (3) distances were tracked and recorded with a wheeled measuring device; (4) patients were instructed to walk at a comfortable walking speed; (5) the gait aid expected to be used most commonly upon discharge was used during testing; (6) immediately following testing the patient was asked to identify factors that may have effected or impaired his or her performance, and these were documented in the chart; and (7) the physiotherapist documented any factors he or she thought had limited the patient's performance.

An outcome of "not administered" was used if the MWT was not initiated or not properly completed for any reason. If available, we extracted this reason for data analysis. For the purposes of this study, the MWT was considered completed and valid only if both time and distance were recorded in the chart.

During administration, the MWT was stopped for any of three reasons: (1) if the patient walked for a total time of 6 min, (2) if the patient walked a total distance of more than 200 m, or (3) if the patient or therapist decided to stop the test for any reason. If scenario (1) or (2) was reached, the outcome was recorded as "maxed." If the MWT was performed but stopped early, as in scenario (3), the outcome was recorded as "limited." For this study, we extracted from the patient charts the type of

gait aid used, distance and time walked, and the presence of limiting factors. We calculated gait speed as an average speed from the time and distance data collected.

The TUG begins with the patient sitting on a standard armchair. On the word "go," the patient stands, walks to a line on the floor 3 m away, turns, walks back to the chair, and returns to a sitting position. This test has been found to be a reliable measure in patients with lower-limb amputation [10].

The L test of functional mobility is a modified version of the TUG that involves walking a total of 20 m with two transfers and four turns. The psychometric properties of this tool have been found to be excellent when measured in patients with lower-limb amputation [11].

The 2MWT measures the distance that an individual is able to walk at his or her "usual" pace. The patient starts from a standing position and walks around pylons for 2 min. This measure has been found to correlate with measures of physical functioning and is responsive to change in rehabilitation patients with lower-limb amputation [12].

Statistical Analysis

We completed frequency calculations to determine the percentage of patients who were administered the TUG, L test of functional mobility, 2MWT, and MWT. We calculated the frequency of "maxed" and "limited" results for those who had the MWT administered as well as frequencies to consider the most prevalent reasons why the MWT was not administered.

To consider differences between patients that did and did not have the MWT administered, age and LOS were compared through independent *t*-tests. Similarly, to determine differences among the subgroup of patients who had the MWT administered, we compared those who scored "limited" versus "maxed" through independent *t*-tests to look for variability in age, LOS, and gait speed. To adjust for multiple comparisons, a Bonferroni correction was used for *t*-tests; an alpha value of <0.01 was required for significance.

In addition, chi-square tests of independence were conducted to determine categorical factors that may have been associated with patients who did versus did not have the MWT administered and to identify variables associated with patients who received a "maxed" versus "limited" score. Amputation etiology, level of amputation, and type of gait aid were tested as the independent variables.

Prior to analyzing the data, we collapsed and categorized patient etiology and level of amputation variables to

eliminate small cell numbers that might arise. Specifically, we divided etiology of amputation according to whether it was disease or event related. Therefore, those who had their limb removed for reasons related to congenital malformation, cancer, or trauma were considered distinct from those who had an amputation related to peripheral vascular disease or diabetes. The decision to define amputation cause this way was based on clinical experience and the understanding that, though some crossover may exist, typically those patients with an event-related amputation tend to be younger and have fewer chronic comorbidities. Level of amputation was categorized as (1) below-knee amputation (BKA), which also included Symes level amputation; (2) above-knee amputation (AKA), which also included knee disarticulations; (3) bilateral BKA; and (4) complex cases that included people with hemipelvectomy-level amputation and multiple levels where at least one involved an AKA. Gait aid use was broken into the following categories: (1) no gait aid, (2) unilateral gait aid including single cane or crutch, (3) bilateral gait aid including two canes or crutches, (3) rollator walker, (4) standard walker, and (4) nonambulatory.

All analyses were conducted using SPSS software (version 21.0, IBM; Armonk, New York), and all statistical tests were two sided with a $p < 0.05$ significance level unless otherwise specified.

RESULTS

In total, 190 patient discharges occurred during the study review period; there were 172 primary rehabilitation admissions and 18 repeat admissions. Patients were predominantly male (71.6%), had a mean age of 63.5 yr (standard deviation [SD] ± 14.2), and a mean LOS of 28.1 d (SD ± 13.2). MWT administration by etiology and level of amputation is shown in **Table 1**. Two patients with Symes level amputations were included in the BKA group, while the AKA group included two patients with knee disarticulations. The complex group included four patients with AKA/BKA combination, two patients with a hemipelvectomy, and one person with concurrent bilateral AKA.

Of the total sample, the TUG and L test of functional mobility were successfully administered to 65 percent of patients, while the 2MWT was successfully administered to 71 percent of patients. The MWT was administered most often with successful administration of the measure in 149 patients (78%), of which 103 reported a performance-

limiting factor. Reasons for failing to administer the MWT for the remaining 41 cases are shown in **Figure 1**. Among patients who did have the MWT administered, gait speed ranged from 0.02 to 1.07 m/s. Independent t -tests revealed significant differences in LOS ($t(187) = -2.73$, $p = 0.007$), with those patients having the MWT administered demonstrating a greater mean LOS (mean = 29.6 d, SD = 11.8) than those who did not have the test administered (mean = 23.2 d, SD = 16.7). No significant difference for age was found between groups [$t(188) = 1.80$, $p > 0.05$] (see **Table 1**).

Independent t -tests revealed significant differences between those patients with limitations on the MWT compared with those who had a result of “maxed” for LOS ($t(147) = 2.54$, $p = 0.01$) and gait speed ($t(148) = -6.92$, $p < 0.001$). Patients whose MWT was “limited” had a greater LOS (mean = 31.0 d, SD = 12.5) and a slower calculated gait speed (mean = 0.37 m/s, SD = 0.2) than patients who “maxed” their MWT (mean LOS = 25.7 d, SD = 9.9; mean gait speed = 0.59 m/s, SD = 0.2). No significant difference for age was found between groups ($t(188) = 1.80$, $p > 0.01$).

The limitations identified for the 103 patients who reported a performance-limiting factor and completed the MWT without a “maxed” result are shown in **Figure 2**. When the MWT was formally administered, the category of cardiorespiratory fatigue (including shortness of

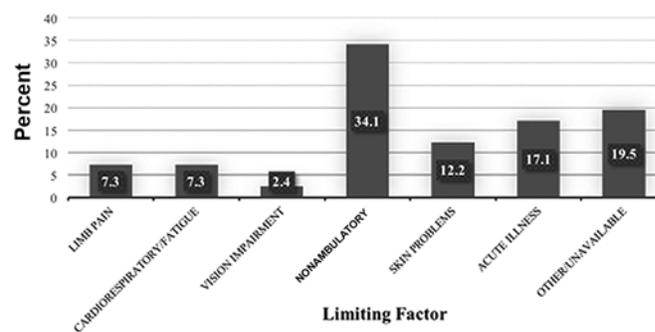


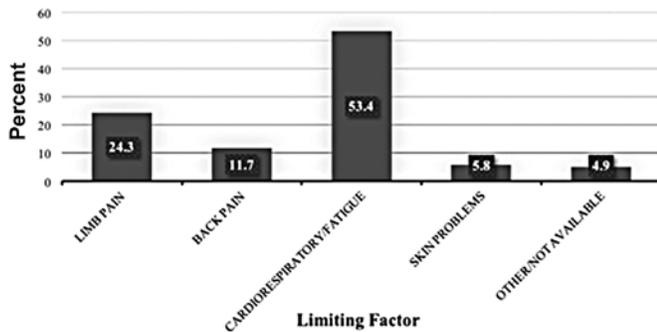
Figure 1. Reasons why maximum walk test (MWT) was not administered ($n = 41$). Note: Percentages are per total number of reported limitations for patients who did not have the MWT administered. “Other” includes sudden, unpredicted discharges (typically back to home hospital when a bed became available), refusal to participate, and social reasons.

Table 1.Patient demographics when maximum walk test (MWT) was formally administered and not administered ($N = 190$).

Characteristic	Subject Data	MWT Administered ($n = 149$)	MWT Not Administered ($n = 41$)
Age, yr (mean \pm SD)	63.5 \pm 14.2	62.6 \pm 14.2	67.1 \pm 13.7
Length of Stay, yr (mean \pm SD) *	28.1 \pm 13.2	29.6 \pm 11.8	23.2 \pm 16.7
Sex, n (%)			
Male	136 (71.6)	108 (72.5)	28 (68.3)
Female	54 (28.4)	41 (27.5)	13 (31.7)
Level of Amputation, n (%)			
BKA	130 (68.4)	103 (69.1)	27 (65.9)
Bilateral BKA	20 (10.5)	18 (12.1)	2 (4.9)
AKA	40 (21.1)	28 (18.8)	12 (29.3)
Etiological Group, n (%)			
Disease	165 (86.8)	132 (88.6)	33 (80.5)
Event	25 (13.2)	17 (11.4)	8 (19.5)

* $p < 0.05$ between Administered and Not Administered groups.

AKA = above-knee amputation, BKA = below-knee amputation, SD = standard deviation.

**Figure 2.**Limitations when maximum walk test was administered and not "maxed" ($n = 103$).

breath, generalized sense of weakness, and nonspecific tiredness) accounted for 53 percent of the test limitations.

Chi-square test of independence results found that type of gait aid ($\chi^2(5, N = 169) = 24.72, p < 0.001$) and level of amputation ($\chi^2(3, N = 190) = 15.54, p = 0.001$) were significantly related to the administration of the MWT. Specifically, all patients were administered the MWT if they did not have a gait aid. In contrast, very few patients with a standard walker or rollator were administered the test. Furthermore, the majority of patients with BKA, AKA, or bilateral BKA had the test administered, but patients with more complex levels of amputation did not. Gait aid type ($\chi^2(4, N = 149) = 20.36, p < 0.001$) was

also significantly associated with whether the test was "maxed" or "limited." No significant differences were found for amputation etiology for either the test being administered or level of amputation for either outcome ($p > 0.05$). **Tables 2 and 3** demonstrate the significant chi-square results.

DISCUSSION

This study examined the MWT, an unconventional outcome measure, in a population of people with lower-limb amputation admitted for inpatient rehabilitation to a single center in Southwestern Ontario. In 22 percent of discharges, the MWT could not be formally administered. However, of all the activity-based outcome measures used in this rehabilitation program, the MWT was the measure that was most often successfully administered before patient discharge. In some cases, the barrier preventing MWT administration could have been predicted in advance, for example, in those admitted with no goals for prosthetic ambulation, whereas in other cases the barrier was unpredictable, such as when an acute illness interfered with testing.

The medical frailty of people with amputation is illustrated by a retrospective cohort study by Meikle et al., which reported that, in a population of 254 people with amputation admitted for inpatient rehabilitation, patients had a mean of 2.8 comorbid medical conditions,

Table 2.

Significant chi-square results for maximum walk test administered versus not administered by level of amputation and gait aid category.

Category	Administered	Not Administered	Total
Level of Amputation*			
BKA/Symes	103	28	131
AKA/Knee Disarticulation	27	5	32
2× BKA	17	2	19
Complex	2	6	8
Total	149	41	190
Gait Aid Category†			
None	2	0	2
Unilateral	14	2	16
Bilateral	49	3	52
Standard Walker	13	6	19
Roller or Wheelchair	71	7	78
Nonambulatory Parallel	0	2	2
Total	149	20	169

* $p = 0.001$; Pearson chi-square = 15.54.

† $p < 0.001$; Pearson chi-square = 24.72.

AKA = above-knee amputation, BKA = below-knee amputation.

Table 3.

Maximum walk test “maxed” versus “limited” (when administered) by gait aid category.

Gait Aid	Maxed	Limited	Total
None	2	0	2
Unilateral	7	7	14
Bilateral	22	27	49
Standard Walker	0	13	13
Roller or Wheelchair	15	56	71
Total	46	103	149

Note: $p < 0.001$; Pearson chi-square = 20.36.

most commonly peripheral vascular disease (78%), diabetes (64%), and coronary artery disease (42%) [9]. Though the type and number of comorbidities for each patient was not documented in the current study, amputations were most commonly disease related. Though the presence of multiple medical comorbidities was contributory, a heterogeneous group of factors including limb pain, cardiorespiratory fatigue, vision impairment, and skin problems also acted as barriers to outcome measure administration in this population.

Patients who did not have the MWT administered had an LOS that was on average 6 d shorter than those patients who did have the test administered. During a shorter admission, time constraints may limit the ability to schedule a testing session for completion of activity-based outcome measures. LOS may be shortened if there are fewer mobility goals, such as for those who are

nonambulatory. Acute medical illness that requires discharge, as well as sudden discharges for social reasons, will also shorten LOS and prevent collection of functional discharge testing, as was the case in up to 37 percent of our sample (20 other/unexplained and 17 acute illness). Additionally, patients with more complex amputation levels as well as those requiring more supportive gait aids were less likely to have the test administered. These variables may reflect a group of patients who are less mobile overall. Furthermore, this may reflect a systemic bias within the inpatient amputee program against testing in this patient subset because, intuitively, they are expected not to perform as well on measures of activity. Ensuring that clinicians attempt to administer activity-based outcome measures to all intended patients, regardless of their use of gait aids, may be necessary to increase the adherence to outcome measure administration.

In 54 percent of discharges in our study, the MWT was administered but stopped early (“limited”). The main performance-limiting factors generally fell into the categories of cardiorespiratory fitness, limb pain, back pain, and skin problems, all components that should be considered when setting goals for prosthetic rehabilitation. Compared with those who achieved a “maxed” outcome on their MWT, patients who had the MWT administered but were “limited” tended to have a slower mean gait speed and longer rehabilitation LOS. These variables may indicate increased medical frailty.

Amputee rehabilitation proceeds in a progressive pattern as the user becomes more comfortable with prosthetic ambulation and as the supports needed for walking are advanced [13]. Improvements in gait speed have been seen 6 mo after discharge from an amputee rehabilitation program, and the likelihood of falling continues to diminish even years later [14–15]; this suggests that the ambulatory limitations present at discharge are not fixed and are likely to improve even after the patient transitions into the community. Early identification of performance-limiting factors can be used to direct rehabilitation efforts across the continuum for both inpatient and outpatient programs. In addition, educating patients on how to manage and overcome the factors limiting their ambulation can further facilitate the expected course of improvement following discharge.

CONCLUSIONS

This study has identified the frequency with which patient, system, social, and prosthetic factors act as barriers to the completion of the MWT, an activity-based outcome measure, upon termination of a formal inpatient amputee rehabilitation program. Specific factors, including patients' LOS, type of gait aid used, and level of amputation, were found to influence not only patient performance during testing but also whether the MWT outcome measure was administered prior to discharge. Factors that limited patients' performance on the MWT included cardiorespiratory fatigue, skin problems, limb pain, back pain, and acute illness. This information emphasizes the importance of a holistic approach to patient care during inpatient rehabilitation for people with major lower-limb amputations. Knowledge of these factors can be used to determine the most appropriate environmental context and patient population for the use of activity-based outcome measures and is significant in the planning of research studies utilizing activity-based outcome measures at discharge from inpatient amputee rehabilitation.

This study provides preliminary evidence to suggest that the MWT is a feasible tool to administer for the majority of patients in an inpatient amputee rehabilitation program. Furthermore, it can aid in the identification of performance-limiting factors prior to discharge, thus allowing for patient education and the individualization of outpatient programming to facilitate ongoing improvement in prosthetic ambulation.

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