

Many participants in inpatient rehabilitation can quantify their exercise dosage accurately: an observational study

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Question: Are inpatients undergoing rehabilitation who appear able to count exercises able to quantify accurately the amount of exercise they undertake? **Design:** Observational study. **Participants:** Inpatients in an aged care rehabilitation unit and a neurological rehabilitation unit, who appeared able to count their exercises during a 1–2 min observation by their treating physiotherapist. **Measurements:** Participants were observed for 30 min by an external observer while they exercised in the physiotherapy gymnasium. Both the participants and the observer counted exercise repetitions with a hand-held tally counter and the two tallies were compared. **Results:** Of the 60 people admitted for aged care rehabilitation during the study period, 49 (82%) were judged by their treating therapist to be able to count their own exercise repetitions accurately. Of the 30 people admitted for neurological rehabilitation during the study period, 20 (67%) were judged by their treating therapist to be able to count their repetitions accurately. Of the 69 people judged to be accurate, 40 underwent observation while exercising. There was excellent agreement between these participants' counts of their exercise repetitions and the observers' counts, ICC (3,1) of 0.99 (95% CI 0.98 to 0.99). Eleven participants (28%) were in complete agreement with the observer. A further 19 participants (48%) varied from the observer by less than 10%. **Conclusion:** Therapists were able to identify a group of rehabilitation participants who were accurate in counting their exercise repetitions. Counting of exercise repetitions by therapist-selected patients is a valid means of quantifying exercise dosage during inpatient rehabilitation. [Scrivener K, Sherrington C, Schurr K, Treacy D (2011) Many participants in inpatient rehabilitation can quantify their exercise dosage accurately: an observational study. *Journal of Physiotherapy* 57: 117–122]

Key words: Rehabilitation, Physiotherapy, Dosage, Exercise

Introduction

Accurate quantification of the nature and dose of the interventions provided in rehabilitation settings is an important challenge for both clinicians and researchers. For rehabilitation participants to reacquire skilled motor performance, a significant amount of repetitive task practice is required (Butefisch et al 1995, Classen et al 1998). Studies of neural plasticity have shown that repetitive task training can change cortical organisation (Plautz et al 2003) however, the dose of repetitive task practice often available in therapy sessions is unlikely to be sufficient to induce cortical changes (Lang et al 2009). Some rehabilitation units seek to maximise the dose of repetitive task practice by the prescription of task-related exercises to be undertaken daily during the inpatient stay in the rehabilitation gymnasium (Olivetti et al 2007, Sherrington et al 2003). Unfortunately, therapists' estimates of the amount of exercise that occurs in rehabilitation have been shown to be poor (Bagley et al 2009, Collier and Bernhardt 2008, Lang et al 2007). More accurate knowledge of exercise dosage may assist in intervention prescription and assessment of goal achievement. Thus a method for objectively recording the amount of exercise that participants complete is required.

Establishing the effectiveness of different components of rehabilitation or 'unpacking the black box' has been identified as a key research area (Langhorne and Duncan

2001) and establishing the impact of a higher dose versus lower doses of rehabilitation intervention is an important aspect of this investigation (Kwakkel et al 2004). Guidelines for complex interventions suggest that a clear description of the intervention needs to be provided to enable others to replicate the intervention clinically, replicate the study, and combine evidence (Craig et al 2008). To date, the standard method used to quantify exercise dosage is the time rehabilitation participants spend in therapy (Cooke et al 2010, French et al 2008, Galvin et al 2008, Kwakkel et al 2004). However, time spent in therapy is unlikely to be an accurate measure of the actual exercise dose for individual rehabilitation participants. The dose and intensity of exercise each participant completes in a set time can vary significantly. In addition, measurement of total time spent in therapy may not take into account rests and other interruptions to therapy sessions. In fact, an observational study of activity levels in rehabilitation found that rehabilitation participants complete relevant activities only 45% of the time they are in a therapy area (Mackey et al 1996). This suggests that studies using time as a measure of exercise dosage may be overestimating actual exercise substantially.

A count of each repetition of exercise the participant completes may be a more accurate measure of exercise dosage. This would capture the work the participant completes and not any accessory activities nor resting

time. Several published studies have used repetitions to measure dosage (Lang et al 2009, Lang et al 2007, Nugent et al 1994). These studies have used either a therapist or an external observer to record repetitions of exercise. External observation is a labour-intensive process that would be impractical for studies with large cohorts or for daily clinical practice. An alternative strategy is for rehabilitation participants to count their own exercise repetitions while completing their prescribed exercise. This method has been implemented in several rehabilitation units including Bankstown-Lidcombe Hospital in Sydney, Australia. It is usual clinical practice at Bankstown-Lidcombe Hospital for rehabilitation patients to count their own exercise repetitions with a hand-held tally counter if they are able to do this. These exercise totals are recorded and used for clinical decision-making and documentation.

The aim of this study was to determine if rehabilitation participants assessed by their therapist as being able to count their repetitions of exercise accurately (based on a short period of observation) are able to count exercise repetitions accurately when observed more closely over a longer period of time. The validity of exercise dose quantification by therapist-selected rehabilitation participants was determined by comparing the number of exercise repetitions counted by participants to the number counted by an external observer. Therefore, the research question for this study was:

Can therapist-identified rehabilitation participants accurately quantify their exercise dosage during inpatient rehabilitation?

Method

Design

An observational study was conducted involving people admitted to inpatient rehabilitation at Bankstown-Lidcombe Hospital, Sydney during the six-week study period beginning in November 2009. Participants were included from two rehabilitation units: aged care rehabilitation and stroke/neurological rehabilitation. We sought to observe 20 participants from each unit who were deemed likely to be able to count exercise repetitions accurately while they exercised.

Participants

Patients were included in the observational phase of the study if they were a current rehabilitation inpatient and their treating physiotherapist judged that they were not obviously inaccurate in counting their exercise repetitions. The therapists' decision regarding ability to count was used clinically to determine which patient's results were trusted and therefore documented. Therapists observed the patients counting their exercise repetitions during semi-supervised or group sessions for a short period, normally 1–2 minutes. This was to determine if there was any obvious inaccuracy in the patient's counting ability. Common inaccuracies are counting multiple times for each exercise, or inconsistent counting of each repetition of exercise, meaning that patients miss repetitions.

This study aimed to reflect clinical practice. Therefore those patients who were obviously inaccurate in counting were excluded from the study. Clinically, these individuals are not asked to count their exercise independently. Instead therapists, therapy assistants, or family members tally

exercise dosage. So, the focus of the study was whether those patients who seem able to count accurately and were left to count exercises independently for extended periods, were truly accurate when observed closely.

The participants who were observed were chosen randomly from all patients admitted to the two rehabilitation units during the study period and who were judged by therapists to be able to count accurately (based on a short period of observation). Random selection was achieved using a random number generator on a computer. A research assistant who did not work clinically on the rehabilitation units completed this process. This research assistant scheduled the observation sessions based on observer and participant availability. When scheduling the sessions she ensured that the observer was not the participant's treating therapist.

Participants were unaware of their inclusion in the study and did not know they were being observed. The treating therapists did not know the timing of observations and were also unaware which aged care rehabilitation patients had been selected for the study. This was to ensure that increased therapist time was not devoted to the participant during the observation period.

Measurement

Prior to inclusion into the study, the treating physiotherapist collected eligible participants' demographic data. The Mini-Mental State Examination was completed as part of usual practice on admission to each rehabilitation unit but two participants were unable to complete this test due to limited English language skills. The treating therapist also rated the participants' level of disability with the Modified Rankin Scale.

An observer, who was a physiotherapist but not the participant's treating therapist, covertly counted each participant's exercise repetitions via direct observation in the rehabilitation gymnasium. Direct observation was chosen as it is considered the gold standard means of observing behaviour over time (Ryan et al 1995). The covert observation of the participant's exercise was for a period of 30 minutes. The observer and the participant each counted the exercise repetitions using a hand-held tally counter. Participants were instructed to count all repetitions of their exercise accurately. At the end of the 30-minute observation session, the observer recorded the two tallies: the observer's tally and the participant's tally.

Participants were observed in the rehabilitation gymnasium, located adjacent to the two rehabilitation wards. Most participants attended the gym twice daily and participated in a variety of exercise groups, eg, the Upper Limb Group or Standing Balance Group. Observations occurred at different times of day and in a variety of therapy contexts including the exercise groups. Different exercises were observed in the study including task-related upper limb practice (eg, reaching and manipulation) or lower limb practice (eg, sit-to-stand and walking), balance training, and strength exercises. The number of exercises completed by participants varied depending on the participants' physical abilities and the exercise type. Some participants were observed in an exercise circuit where they changed exercises every six minutes, and others carried out the same exercise for the 30-minute period.

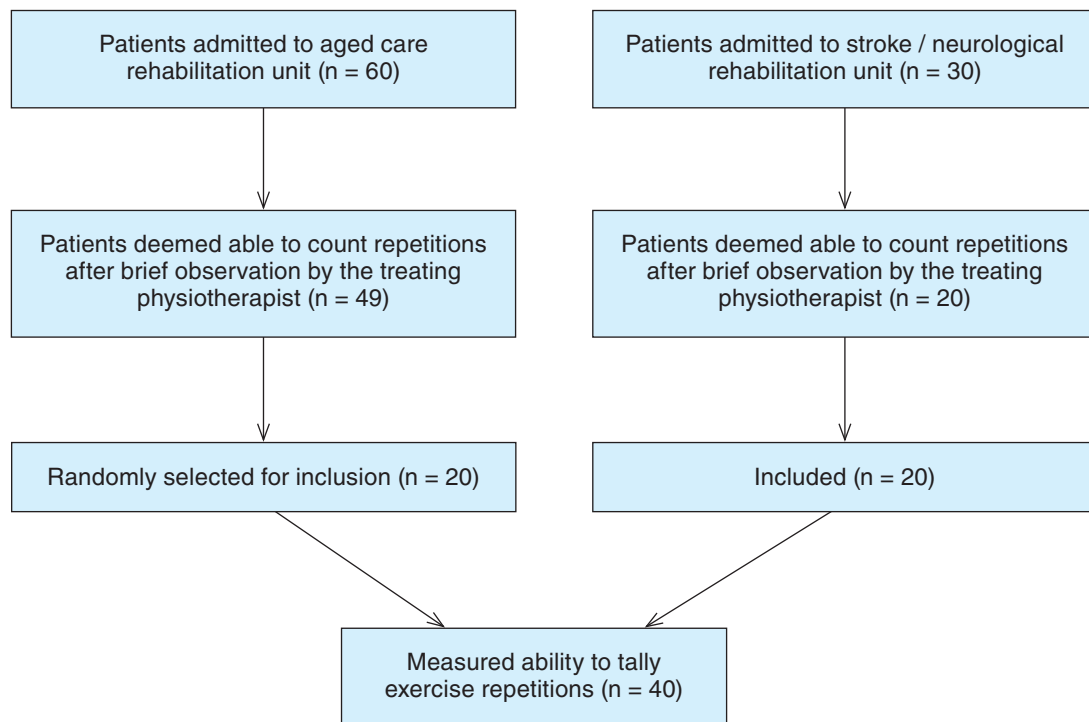


Figure 1. Flow of participants through the study.

Data analysis

Criterion-related validity was assessed by investigating the level of agreement of the participant-and observer-counted exercises using the intraclass correlation coefficient (ICC). The 3,1 form was used as we considered it to be the most appropriate form for this research question. An ICC of greater than 0.75 is generally considered to represent excellent agreement (Fleiss 1986). The level of agreement of participants with the observer was also calculated by tallying the proportion of participants in complete agreement with the observer. The proportion of participants in close agreement with the observer (ie, absolute percentage error up to 5%, 10%, 20%, and 30%) was also calculated. In addition, Pearson’s r was used to assess the degree of correlation between each participant’s counting ability (calculated by the percentage agreement for their count compared to the observer) and their cognition (assessed by the Mini-Mental State Examination), their age, and their disability level (as assessed by the Modified Rankin Scale).

Results

Flow of participants and therapists through the study

Ninety people were admitted to the rehabilitation units during the study period: 60 to the aged care rehabilitation unit and 30 to neurological rehabilitation unit. Of the 60 patients admitted for aged care rehabilitation, 49 (82%) were judged by their treating therapist to be able to count their own exercise accurately. Twenty of these patients were randomly selected for inclusion in the 30-minute observation component of the study. Of the 30 patients admitted for neurological rehabilitation, 20 (67%) were judged by their treating therapist to be able to accurately

Table 1. Characteristics of the study participants.

Characteristic	n = 40
Age (years), mean (SD)	73 (12)
Gender n female (%)	17 (43)
Diagnosis	
Stroke, n (%)	17 (43)
Other neurological, n (%)	5 (12)
Orthopedic, n (%)	9 (23)
Frailty, n (%)	6 (15)
Amputee, n (%)	3 (8)
Cognition (MMSE), mean, (SD)	26 (5)
Disability (mRS), mean (SD)	3.2 (0.8)
Able to sit independently, n (%)	39 (98)
Able to sit-to-stand independently, n (%)	23 (58)

MMSE = Mini-Mental State Examination, mRS = Modified Rankin Scale

count exercise repetitions. All 20 were included in the 30-minute observation component of the study (see Figure 1). Although there was no random selection of the neurological rehabilitation participants, blinding of therapists was maintained as the research assistant was the only person aware of the number of included participants. All participants were observed within five days of inclusion.

As shown in Table 1, the participants had a range of diagnoses, with stroke (43%) being the most common diagnosis. Participants had reasonable cognition as measured by the Mini Mental State Examination, with an average score of 26 out of a possible 30 points, although

Table 2. Number of participants in complete agreement with the observer, and the number and cumulative total of participants in agreement with the observer to within the specified range of percentage error.

Error of participants compared to observer	Aged care participants	Neurological participants	All participants	
	n (%)	n (%)	n (%)	Cumulative percentage
0%	6 (30)	5 (25)	11 (27.5)	27.5
1–5%	6 (30)	6 (30)	12 (30)	57.5
6–10%	3 (15)	4 (20)	7 (17.5)	75
11–20%	3 (15)	0 (0)	3 (7.5)	82.5
21–30%	1 (5)	3 (15)	4 (10)	92.5
>30%	1 (5)	2 (10)	3 (7.5)	100

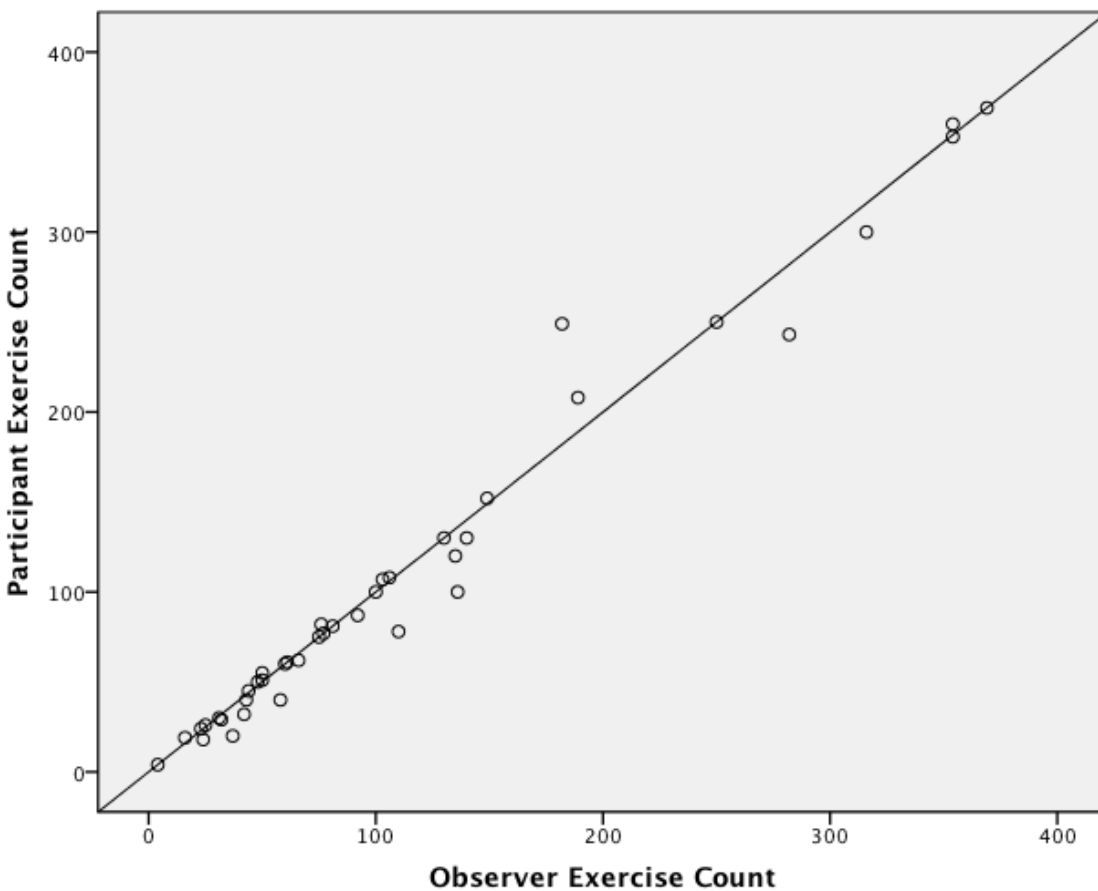


Figure 2. The relationship between participant and observer exercise count values (n = 40).

scores ranged from 13 to 30. The average Modified Rankin Scale score was 3.2 out of 6 points, indicating that typically the participants were limited by their disability but did not need assistance to walk. Participants were observed at different time points in their rehabilitation, with time from admission to inclusion in the study varying from 2 to 46 days.

The therapists determining the accuracy of participant counting varied in clinical experience from 0.5 years to greater than 20 years of experience. The number of exercise repetitions, which were counted in the 30-minute

observation periods, ranged from a minimum of 4 to a maximum of 369 repetitions. The average number of repetitions observed was 113 (SD 100).

Validity of participant counting

The intraclass correlation coefficient (ICC) (3,1) between participant and observer exercise counts was 0.99 (95% CI 0.98 to 0.99). This suggests that there is excellent agreement between the two counts of exercise repetitions.

The level of agreement for neurological rehabilitation participants was ICC (3,1) 0.99 (95% CI 0.98 to 1.00). The

agreement for aged care rehabilitation participants was ICC (3,1) 0.98 (95% CI 0.95 to 0.99).

The accuracy in counting varied between the participants, as shown in Table 2, with 11 participants (28%) being in complete agreement with the observer. Moreover a further 19 participants (48%) were within 10% of the observer's total. There were 3 participants (8%) with more than a 30% differential. The most inaccurate participant underestimated the exercise tally by 47% (17 repetitions). Again there was minimal difference in error rates between neurological and aged care participants. The relationship between the observer and participant counts can be seen more clearly in Figure 2.

The participants' ability to count exercise repetitions did not correlate with their cognition ($r = 0.16$, $p = 0.35$), age ($r = 0.12$, $p = 0.46$), or level of disability ($r = 0.16$, $p = 0.34$).

Discussion

This study provides evidence that therapist-selected rehabilitation patients are able to count their repetitions of exercise accurately. The high level of agreement (ICC = 0.99, 95% CI 0.98 to 0.99) between therapist-selected participant count data and the data from an external observer, and the low percentage errors suggest that therapist-selected patient count data may be used in place of observer data in future research.

The 30-minute observation component of this study included only those participants deemed by their treating therapist likely to be accurate in counting exercise repetitions. The high level of agreement found by this study suggests that therapists demonstrate good judgement regarding the ability of rehabilitation patients to count exercise repetitions accurately. The observation of a patient counting for a small period (1–2 minutes) to look for obvious errors in counting can be used by therapists to determine if the patient is able to count accurately.

It is often perceived by clinicians that rehabilitation patients with neurological diagnoses have less ability to concentrate and multi-task. The results of this study indicate that patients with neurological diagnoses can be accurate in counting their exercises repetitions. However, a lower percentage of participants with neurological diagnoses met this study's inclusion criteria (67% for people admitted to the neurological rehabilitation unit vs 82% of people admitted to the aged care rehabilitation unit were included). Therefore there were more rehabilitation patients with neurological diagnoses excluded from the study because they were obviously unable to count their exercise repetitions accurately.

This appears to be the first observational study to analyse the accuracy of quantification of exercise dosage by patients undertaking rehabilitation. Previous methods of analysing exercise dosage include the use of time in therapy and behaviour mapping (Kwakkel et al 2004, Mackey et al 1996). Both methods were based on time rather than dosage of exercise. In this study the number of exercise repetitions observed in the 30-minute sessions varied greatly, with a range of 4 to 369 repetitions. Those studies that only consider time will not take into account the rate and therefore the intensity of exercise.

A strength of this study is the blinding of both participant and therapist to when the covert observation was occurring. In addition, a variety of therapy contexts were observed, meaning that the results are representative of daily therapy practice. The participants were also observed at various time points in their rehabilitation. Another strength is that the method used to identify patients who are able to count is simple and efficient so it can be replicated clinically.

A limitation of this study could be the 30-minute observation period. This represents a small proportion of time the participant would be in therapy each day at Bankstown-Lidcombe Hospital. However, for pragmatic reasons a substantial yet not exhaustive time period was chosen. It is reasonable to believe that if a participant is able to count in this period, that skill would be transferable to other times. It is also important to consider that other studies investigating activity levels in rehabilitation have found that on average participants spend 39 minutes each day in physiotherapy and occupational therapy combined (Kwakkel et al 2004), which would indicate that the 30-minute timeframe is typical of usual clinical practice at many sites.

All observations were completed in the rehabilitation gymnasium with therapy staff present. The exercise observed was semi-supervised meaning therapists may sometimes provide feedback and check on progress including current participant exercise tally. No independent exercise, eg, exercise that occurred outside the therapy setting, was observed. However, due to the nature of the gymnasium environment and the fact that participants were exercising alone but in the presence of others, it is possible that the results may be extrapolated to home/room based programs.

Another limitation of the study is the low power to detect factors that influence the accuracy of exercise repetition counting. We did not find strong correlations between accuracy of exercise repetition counting and cognition, age, or disability level. Future research with a larger sample could further investigate predictors of accurate exercise repetition counting.

In conclusion, this study indicates that therapist-identified rehabilitation participants are able to count their repetitions of exercise accurately. This method can be used clinically or in future research. ■

Ethics: The Human Research Ethics Committee (Western Zone) of the Sydney South West Area Health Service approved this study on the 13th August 2008. Project number QA2008/049. All patients consent to the counting and documenting of exercise repetitions as part of their usual care on the rehabilitation units.

Competing interests: Nil.

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