Patients receiving inpatient rehabilitation for lower limb orthopaedic conditions do much less physical activity than recommended in guidelines for healthy older adults: an observational study

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Question: Are ambulant patients who are admitted for inpatient rehabilitation for a lower limb orthopaedic condition active enough to meet current physical activity guidelines? Design: Prospective observational study. Participants: Adults admitted for inpatient rehabilitation for a lower limb orthopaedic condition who were cognitively alert and able to walk independently or with assistance. Outcome measures: Participants wore an activity monitor for three full days. Participants spent a median of 398 (IQR 140 to 993) steps per day and spent a median of 8 (IQR 3 to 16) minutes walking per day. Results: Fifty-four participants with a mean age of 74 years (SD 11) took a median of 398 (IQR 140 to 993) steps per day and spent a median of 8 (IQR 3 to 16) minutes walking per day. There was no participant who completed a 10-minute bout of moderate intensity physical activity during the monitoring period. One participant accumulated 30 minutes of moderate intensity physical activity and nine participants accumulated 15 minutes of moderate intensity physical activity in a day. Physical activity was associated with shorter length of stay (r = –0.43) and higher functional status on discharge (r = 0.39). Conclusions: Adults with lower limb orthopaedic conditions in inpatient rehabilitation are relatively inactive and do not meet current physical activity guidelines for older adults. Results of this study indicate that strategies to increase physical activity are required. [Peiris CL, Taylor NF, Shields N (2013) Patients receiving inpatient rehabilitation for lower limb orthopaedic conditions do much less physical activity than recommended in guidelines for healthy older adults: an observational study. Journal of Physiotherapy 59: 39–44]

Key words: Motor activity, Orthopaedics, Rehabilitation, Physical therapy modalities, Exercise therapy

Introduction

Regular physical activity is directly related to positive health outcomes (Schnohr et al 2003, Wen et al 2011). To achieve positive health outcomes, guidelines recommend that adults should accumulate 30 minutes of moderate intensity aerobic activity on most days of the week (Pate et al 1995). Updated versions of these guidelines, which also consider older adults (≥ 65 years) and people with chronic health conditions, state that the activity must be completed in bouts of 10 minutes or more, on at least 5 days of the week (Haskell et al 2007, Nelson et al 2007, WHO 2011). There is emerging evidence to suggest that as little as 15 minutes of moderate intensity physical activity may be beneficial to health for community-dwelling adults and older adults (Wen et al 2011). Furthermore, it is recommended that older adults who are limited by health conditions be ‘as physically active as their abilities and conditions allow’ (WHO 2011).

Orthopaedic rehabilitation aims to promote independence and improve function to prepare patients to return to living independently in the community. Therefore, it could be expected that patients are trained while in rehabilitation to have levels of physical activity that are recommended for maintenance of health, in preparation for living independently in the community. However, adults with lower limb orthopaedic conditions in inpatient rehabilitation may find it difficult to be sufficiently active to meet physical activity guidelines because of the difficulty in restoring mobility after injury and/or surgery (Beringer et al 2006, Groen et al 2012, Koval and Zuckerman 1994, Resnick et al 2011, Schmalzried et al 1998, Silva et al 2005). Following hip fracture, inpatients who were more active during therapy sessions had better functional outcomes than those who were less active (Talkowski et al 2009), suggesting a positive relationship between physical activity and functional outcome. However, we were unable to locate any research that quantifies the physical activity levels of adults with lower limb orthopaedic conditions during inpatient rehabilitation in relation to physical activity guidelines. Therefore, the research questions for this study were:

1. Are ambulant patients who are admitted for inpatient rehabilitation for a lower limb orthopaedic condition active enough to meet current physical activity guidelines?
2. Is there a relationship between physical activity and functional outcome in this population?

What is already known on this topic: Various guidelines recommend the amount, intensity, duration and frequency of physical activity that adults should undertake to maintain health. Orthopaedic rehabilitation aims to restore sufficient function to allow independent living in the community, which ideally would include restoration of the recommended physical activity levels.

What this study adds: Inpatients receiving rehabilitation for lower limb orthopaedic conditions are relatively inactive and do not meet current physical activity guidelines. Changes are required to reverse this sedentary behaviour during rehabilitation.
Method
Design
This prospective observational study was conducted on a subgroup of participants during the baseline phase (ie, prior to the randomised intervention) of a randomised controlled trial evaluating the effects of additional weekend allied health services (Peiris et al 2012a). Participants underwent objective physical activity monitoring for three days and their activity levels were assessed against recommended levels of activity in several guidelines about physical activity for maintenance of health. This study took place on one ward at an inpatient rehabilitation facility with 30 rehabilitation beds servicing a metropolitan area over a 4-month period (1 March 2011 to 30 June 2011).

Participants
Patients were included if they were aged 18 years or older, were admitted for rehabilitation in the orthopaedic ward, had a lower limb orthopaedic condition (eg, hip or knee replacement, hip fracture), were able to walk (independently or with assistance), and were cognitively alert. To estimate the physical activity pattern of an adult reliably, at least three days of monitoring is recommended (Trost et al 2005) so patients were only eligible if they had three consecutive days of weekday monitoring before the randomised intervention of the larger study began. All patients received usual medical, nursing and allied health care.

Outcome measures
Primary outcome: To determine whether physical activity guidelines were being met, activity monitor data were used to compare the level of physical activity to three physical activity guidelines:

1. 30 minutes accumulated moderate intensity physical activity per day (Pate et al 1995);
2. 30 minutes of moderate intensity physical activity per day accumulated in bouts of at least 10 minutes (Haskell et al 2007, Nelson et al 2007, WHO 2011); and
3. 15 minutes accumulated moderate intensity physical activity per day (Wen et al 2011).

Measures of moderate intensity were obtained from the activity monitors through secondary analysis via a custom-made software program using threshold values:

1. Walking cadence > 60 steps/minute. Greater than 100 steps/minute is accepted as moderate intensity (Rowe et al 2011) but at least 60 steps/minute may be beneficial to health (Tudor-Locke et al 2011) and was therefore used as a threshold for moderate intensity in this population where mobility is limited.
2. Metabolic equivalents (METs) > 3.0. The activity monitor assigns a MET value to each activity it records according to the Compendium of Physical Activities (Ainsworth et al 1993). It assigns fixed values to sitting, lying, and standing while the value for stepping increases with increased cadence. It is estimated that individuals expend 3 to 6 times their basal METs when completing moderate intensity activity (Haskell et al 2007).
3. Activity counts > 1075 counts. Activity counts are based on an algorithm that averages bodily accelerations (recorded every tenth of a second) into activity counts per 15 seconds. Greater than 1075 activity counts per 15 seconds is considered moderate intensity in young adult females in free-living situations (Harrington 2010). We were unable to locate threshold values for older adults.

Because normal walking is not always continuous and may include short breaks in motion (eg, when stopping to talk to someone in the corridor) these were accounted for when assessing activity bouts. A modified 10-minute activity bout definition, which takes into account interruptions of up to 2 minutes, was applied and has been used previously (Harrington 2010, Troiano et al 2008).

Secondary outcomes: Outcomes used to describe physical activity levels included steps per day, time spent in upright activities per day (minutes), time spent walking per day (minutes), and time spent inactive per day (hours). The Functional Independence Measure (FIM) was used to assess the amount of assistance required to complete activities of daily living at baseline and on discharge (Hamilton and Granger 1994). The FIM consists of 18 items in two domains: motor (13 items) and cognitive (5 items). Each item is rated on a 7-point scale, where 1 reflects complete dependence and 7 reflects complete independence. Scores range from 18 (lowest function) to 126 (highest function). The FIM mobility score refers to items 9 through 13 which relate to transfers, walking, and stairs. Co-morbidities were recorded using the Charlson Co-morbidities Index (Charlson et al 1994), the 10-metre walk test (Hollman et al 2008) was used to calculate cadence at baseline (steps per minute), and length of stay in inpatient rehabilitation (days) was recorded.

A uniaxial accelerometer-based activity monitor was used to provide an objective measure of physical activity. Activity monitors were attached to the participant's non-affected lower limb on the mid-anterior thigh at the earliest convenient time after admission and remained in place for five days (the middle three days of recording were used to ensure that three complete days were drawn on for analyses). To allow for continuous monitoring (including showering) the monitor was taped inside a zip-lock bag and affixed to the skin with a water-proof medical dressing.

The activity monitor used is a valid and reliable measure of walking in healthy adults (Ryan et al 2006) and community dwelling older adults (Grant et al 2008), and is a valid measure of activity or inactivity for the long-term monitoring of older adults with impaired function (Taraldsen et al 2011) and of steps taken at slower walking speeds (Kanoun 2009).

Data analysis
The number of participants meeting activity guidelines was described. For normally distributed data the mean and standard deviation (SD) were reported. For skewed data the median and inter-quartile range (IQR) were reported. Bivariate correlations examined the relationships between steps taken per day, length of stay and FIM.

Results
Flow of participants through the study
One hundred and nine orthopaedic patients were admitted to the ward during the study period. Only patients who were available to have the activity monitors applied early in the week (Monday or Tuesday) were screened for eligibility to...
participate because three uninterrupted days of monitoring were needed before the weekend. Therefore 51 patients were not eligible because they were admitted later in the week. A further 4 patients were excluded due to cognitive impairment. During the study period 54 patients (median 9 days after surgery, fracture, or acute event, IQR 7 to 14) met all inclusion criteria and provided informed consent to participate in the study (Figure 1). The characteristics of the participants are presented in Table 1. All participants were able to walk, with 10 (19%) classified as independently mobile and the remainder requiring supervision or assistance to walk. One participant noted redness and minor itching around the dressing that secured the monitor but did not withdraw due to the minor nature of this irritation. There were no other adverse events and three full days of data were available for analysis for all participants.

Achievement of physical activity guidelines

No participant completed a 10-minute bout of moderate intensity physical activity. No participant accumulated a total of 30 minutes of moderate intensity physical activity on any day according to criteria of cadence > 60 or energy expenditure > 3 METs. When using the threshold value of > 1075 activity counts per 15 seconds, one participant accumulated 30 minutes of moderate intensity physical activity on one day. Nine participants accumulated a total of 15 minutes of moderate intensity physical activity in a day according to the activity counts threshold. Some participants met guidelines on more than one day monitored, therefore the number of days on which the guidelines were met are also presented in Table 2.

Participants took a median of 398 (IQR 140 to 993) steps per day. The most active participant took 2628 steps on one day. Participants spent a median of 8 (IQR 3 to 16) minutes walking per day and a mean of 58 (SD 37) minutes upright and 23.0 (SD 0.7) hours sitting or lying down per day.

Patients did not meet physical activity guidelines regardless of other clinical factors. Days post acute event, diagnosis, and co-morbidities did not impact significantly on physical activity levels. Patients who were classified as independently mobile (n = 10) had higher admission FIM scores (mean difference 14, 95% CI 4 to 24) and took significantly more steps per day (mean difference 496, 95% CI 116 to 876) compared to those who required supervision or assistance to ambulate (n = 44), but they still did not meet physical activity guidelines.

Relationship between physical activity and functional outcomes

There was a moderate, negative correlation between steps taken per day and length of stay ($r = -0.43, p < 0.01$) (Figure 2) and a moderate, positive correlation between steps taken per day and discharge FIM mobility score ($r = 0.39, p < 0.01$). When participants took less than or equal to the median number of steps per day (398 steps per day), their mean length of stay was 24 (SD 17) days. Participants who took more than the median steps per day had a mean length of stay of 14 (SD 4) days.

Overall, steps per day was not significantly correlated with the change in FIM mobility score per day ($r = 0.17, p = 0.21$). Considering participants who took less than or equal to the median number of steps per day there was no correlation with FIM mobility change per day ($r = 0.23, p = 0.24$). For participants who took more than the median number of steps per day, there was a moderate, positive correlation between steps taken per day and FIM mobility change per day ($r = 0.42, p = 0.03$) (Figure 3).

Table 1. Characteristics of the participants.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participants (n = 54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>74 (11)</td>
</tr>
<tr>
<td>Gender, n female (%)</td>
<td>40 (74)</td>
</tr>
<tr>
<td>Independent walking status on admission, n (%)</td>
<td>10 (19)</td>
</tr>
<tr>
<td>FIM total score (18 to 126), mean (SD)</td>
<td>83 (15)</td>
</tr>
<tr>
<td>admission</td>
<td>14 (6)</td>
</tr>
<tr>
<td>discharge</td>
<td>27 (4)</td>
</tr>
<tr>
<td>FIM mobility score (5 to 35), mean (SD)</td>
<td>109 (10)</td>
</tr>
<tr>
<td>admission</td>
<td>17 (31)</td>
</tr>
<tr>
<td>discharge</td>
<td>9 (17)</td>
</tr>
<tr>
<td>other lower limb fracture</td>
<td>6 (11)</td>
</tr>
<tr>
<td>ankle fracture</td>
<td>5 (9)</td>
</tr>
<tr>
<td>amputation</td>
<td>4 (7)</td>
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<tr>
<td>other</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Length of stay (days), mean (SD)</td>
<td>19 (13)</td>
</tr>
</tbody>
</table>

FIM = Functional Independence Measure, 10MWT = 10-metre walk test
## Discussion

No participant consistently achieved the minimum level of health-enhancing physical activity recommended in current guidelines. Overall, participants were relatively inactive taking a median of 398 (IQR 140 to 993) steps per day and spending 8 (IQR 3 to 16) minutes walking per day. In comparison to activity guidelines for healthy older adults (Nelson et al 2007, WHO 2011) or to activity levels of older adults living in the community (Grant et al 2010, Smith et al 2008) or even to physical activity levels of adults living in the community (Tudor-Locke et al 2008) or even to physical activity levels of adults in the community (Smith et al 2009) the levels of physical activity completed in inpatient orthopaedic rehabilitation were low.

Despite the very low levels of activity observed in our study, it is possible that current physical activity guidelines for older adults may not be appropriate for inpatients receiving rehabilitation. It should be considered whether it is unreasonable to expect inpatients in rehabilitation to be physically active at a moderate intensity for 30 minutes each day. Currently there are no recommendations on the amount of physical activity inpatients in rehabilitation should complete to improve function and prepare for discharge, although it is recommended that they should be as physically active ‘as their abilities and conditions allow’ (WHO 2011). This makes it difficult to determine whether the activity level in the current study is considered to be adequate. Physical activity guidelines for people in rehabilitation, who are recovering from a lower limb orthopaedic condition, would need to consider factors such as pain, fatigue, fear of falling, and feeling unwell (Capdevila et al 2006), all of which may make it more difficult to be physically active. However,
in other rehabilitation populations, for example patients recovering from a cardiac event. 30 minutes of moderate intensity physical activity daily can be applied safely during inpatient rehabilitation (Hirschhorn et al 2008).

Physical activity has a direct dose-response relationship with health outcomes (Schoenhofer et al 2003, Wen et al 2011). Following hip fracture, higher activity levels during therapy correlated with better functional outcomes (Talkowski et al 2009). Similarly, following knee arthroplasty, greater completion of independent home exercises correlated with better functional outcomes (Franklin et al 2006). In our study, physical activity during inpatient rehabilitation was significantly correlated with a reduced length of stay and higher functional levels at discharge. At very low levels of physical activity (less than 398 steps per day) length of stay was higher and there was no correlation between physical activity and functional gains per day. When participants were more active than this they had shorter length of stay and there were significant correlations with functional gains per day. If physical activity guidelines for people in inpatient rehabilitation are to be developed they would need to consider a minimum threshold of physical activity required to lead to significant functional gains. Data from the current study suggesting an association between functional gains and physical activity for participants taking more than 398 steps per day could contribute to development of such guidelines.

No matter whether current physical activity guidelines for older adults are appropriate for orthopaedic rehabilitation inpatients, the results of the current study suggest that these patients could benefit from being more active. A change to the rehabilitation ward environment has been shown to reduce the amount of time patients spent at their bedside but did not increase physical activity levels (Newall et al 1997) highlighting the need for supervision, encouragement, and a change in attitude of hospital staff who are risk-averse and prefer patients not to mobilise independently. Inpatients in rehabilitation do more physical activity when therapy is being provided (Bear-Lehman et al 2001, Smith et al 2008) and spend little time in self-directed physical activity (Newall et al 1997, Patterson et al 2005, Tinson 1989). This suggests that one potential way of increasing physical activity levels would be to provide additional allied health therapy. In a recent randomised controlled trial, participants who received physiotherapy and occupational therapy interventions six days per week had significantly higher physical activity levels than those who received the intervention on five days (Peiris et al 2012a). Results from a qualitative study of patients in the same setting indicate that patients are agreeable to the additional therapy (Peiris et al 2012b) and the resulting higher levels of physical activity. Other options include group therapy and utilisation of allied health assistants to increase physical activity levels. However, as resources can be limited, efforts need to be made by physiotherapists to implement strategies to empower ward staff, patients, and their carers to increase physical activity levels outside of therapy.

One limitation of our study is that the activity monitor used did not record activity in lying or sitting. However, it has been advocated that doing non-stopping activity such as bed exercises should not be considered mobilisation or a substitute for upright physical activity (Bernhardt et al 2006) and that, in this population, walking is the most important activity to measure (Tudor-Locke et al 2011).

In conclusion, patients with lower limb orthopaedic conditions in inpatient rehabilitation are relatively inactive and do not meet current physical activity guidelines. Given the importance of physical activity for general health and functional improvements following hospitalisation it is important to develop methods to decrease sedentary behaviour and increase physical activity levels in rehabilitation. ■

Footnotes: 1ActivPAL, PAL Technologies, Glasgow.

Ethics approval: Eastern Health and La Trobe University Ethics Committees approved this study. All participants gave written informed consent before data collection began.

Competing interests: The authors declare no conflict of interest related to this work.

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References


people are not active enough to maintain their health and fitness: an observational study. *Journal of Physiotherapy* 58: 113–116.


Peiris CL, Taylor NF, Shields N (2012a) Additional Saturday allied health services increase habitual physical activity among patients receiving inpatient rehabilitation for lower limb orthopedic conditions: a randomized controlled trial. *Archives of Physical Medicine & Rehabilitation* 93: 1365–1370.


