Circuit Class Therapy and 7-Day-Week Therapy Increase Physiotherapy Time, But Not Patient Activity
Early Results From the CIRCIT Trial

Coralie English, PhD; Julie Bernhardt, PhD; Susan Hillier, PhD

Background and Purpose—The optimum model of physiotherapy service delivery for maximizing active task practice during rehabilitation after stroke is unknown. The purpose of the study was to examine the relative effectiveness of 2 alternative models of physiotherapy service delivery against a usual care control with regard to increasing patient activity.

Methods—Substudy within a large 3-arm randomized controlled trial, which compared 3 different models of physiotherapy service delivery, was provided for 4 weeks during subacute, inpatient rehabilitation (n=283). The duration of all physiotherapy sessions was recorded. In addition, 32 participants were observed at 10-minute intervals for 1 weekday and 1 weekend day between 8:00 AM and 4:30 PM. At each observation, we recorded physical activity, location, and people present.

Results—Participants receiving 7-day-week and circuit class therapy received an additional 3 hours and 22 hours of physiotherapy time, respectively, when compared with usual care. Participants were standing or walking for a median of 8.2% of observations. On weekdays, circuit class therapy participants spent more time in therapy-related activity (10.2% of observations) when compared with usual care participants (6.1% of observations). On weekends, 7-day therapy participants spent more time in therapy-related activity (4.2% of observations) when compared with both usual care and circuit class therapy participants (0% of observations for both groups). Activity levels outside of therapy sessions did not differ between groups.

Conclusions—A greater dosage of physiotherapy time did not translate into meaningful increases in physical activity across the day.

Clinical Trial Registration—URL: http://www.anzctr.org.au/. Unique identifier: ACTRN12610000096055.

Key Words: physiotherapy (techniques) ■ rehabilitation

Active task practice drives recovery of motor function after stroke.1 Lasting neuroplastic changes occur in the cortex with repetitive practice of active, meaningful movements.1,2 Opportunities to engage in active task practice in rehabilitation hospitals after stroke may be limited. Australia’s National Stroke Foundation Clinical Guidelines recommend that people with stroke engage in ≥1 hour/d of active task practice while in rehabilitation hospitals.3 However, estimates of the amount of physiotherapy time routinely provided to people after stroke are well below this, at 30 to 40 minutes/d.4,5 For the past 15 years research has consistently shown that during rehabilitation people with stroke spend as little as 113 minutes a day walking, standing or in activities likely to produce benefit,5–7 and that the majority of physical activity occurs in the presence of a therapist and in therapy areas.6–8 It is therefore important to investigate alternative models of rehabilitation care with a view to increasing the amount of time people with stroke spend in active task practice each day.

Several meta-analyses have demonstrated the superiority of circuit class therapy to usual care physiotherapy in improving walking ability for people after stroke.9–11 The purpose of the 3-arm Circuit class therapy and 7-day-week therapy for Increasing Rehabilitation Intensity of Therapy after stroke trial (CIRCIT) was to examine the relative effectiveness and cost-effectiveness of 2 alternative models of physiotherapy service delivery against a usual care control. In this substudy, we hypothesized that compared with usual care physiotherapy, providing physiotherapy services in group circuit classes or for 7 days/wk would result in

1. more time spent in physiotherapy sessions,
2. more time spent active in physiotherapy sessions,
3. the same amount of time spent active outside of therapy sessions,
4. more time in the therapy areas, and
5. less time alone.

A

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Methods

Study Population and Settings

The CIRCIT trial was registered with the Australian and New Zealand Trial Registry (ACTRN12610000096055) and the full methods are published.13 Briefly, all people admitted for rehabilitation to 1 of 5 participating rehabilitation centers in Australia were screened for eligibility and recruited as soon as possible after stroke and usually within the first week. Participants were recruited if they had a moderate degree of disability, defined as a Functional Independence Measure score between 40 and 80. All sites were tertiary rehabilitation settings, taking referrals from acute hospitals.

Study Design

This was an observational study in which measures of therapy time and observational behavioral mapping were used to meet substudy aims. This study of 32 participants was nested within the larger randomized controlled trial (n=283). In the main randomized controlled trial, participants were randomized to 1 of 3 arms of the trial. Usual care therapy was provided 5 days a week, predominately in individual therapy sessions (1 therapist/1 participant ratio). Participants in the 7-day-week arm of the trial received additional usual care physiotherapy (one-to-one) on Saturdays and Sundays. Participants in the circuit class therapy arm of the trial did not receive any one-to-one therapy after randomization, but instead received ≤2 90-minute sessions of physiotherapy per day, in groups with ≤3 participants per therapist. Ethical approval for the study was obtained from the University of South Australia Human Ethics Committee and the ethics committees of all participating sites.

Therapy Data

Data on therapy session duration, reasons for shortened or nonattended therapy sessions were recorded at the end of each session by the treating therapist. These data from the full sample of CIRCIT participants were used to determine whether more time was spent in therapy under intervention conditions when compared with usual care conditions (hypothesis 1). Therapy data were collected for each participant for the duration of their hospital stay or ≤4 weeks. Total therapy time was defined as the number of minutes of therapy provided up until the point of discharge or until 4 weeks post randomization, whichever was the sooner.

Observational Technique and Duration

We used behavioral mapping,14 to examine time spent active across the day and time spent alone (hypotheses 2–5). Participants were observed every 10 minutes (excluding 4 randomly selected 10-minute breaks throughout the day) between the hours of 8:00 AM and 4:30 PM. On six separate occasions between December 2010 and May 2013, behavioral mapping was conducted at 2 of the largest participating sites (Hampstead Rehabilitation Center and Repatriation General Hospital). On each occasion, all CIRCIT trial participants who were still receiving inpatient care were observed. Each participant was observed on 1 weekday (Thursday) and 1 weekend day (Sunday). At every observation, participants were observed for 1 minute and their activity, location, and details of people present were recorded. Interobserver agreement was evaluated by 2 observers who simultaneously and independently observed 12 participants on 3 separate occasions for between 60 and 80 minutes each time. On the basis of the high agreement (see Results section of this article) between these 2 observers, we felt confident to use 4 trained observers to collect the mapping data.

Participant Demographics and Other Prespecified Data

Stroke was defined using the Oxfordshire Stroke Classification.15 Time since stroke and time since admission to rehabilitation were collected from the medical records. Degree of functional disability was measured using the Functional Independence Measure as recorded by the treating team within 72 hours of admission to rehabilitation. We also recorded whether English was a first language, previous level of mobility, and previous living arrangements.

Data Processing and Analysis

The sample size for the observational substudy was set at 32 people (≥10% of the randomized controlled trial sample), which would provide 1632 observations.

Activity categories have been described previously14 and are summarized in Table 1. There were 11 categories of people present, including medical, nursing and therapy staff, family and ancillary staff (porters/volunteers). The location categories were bedroom, hall, therapy area, and off ward. Behavioral mapping data were processed by a custom-built Microsoft Access database14 and exported to an Excel spreadsheet. Data from each individual participant were reviewed. For our results to be representative of a full day in rehabilitation, if an individual was observed for ≤4 hours on a given day (eg, because of weekend leave), this day was removed from further analyses. Formulas were created in Excel to calculate the highest level of activity (activity categories 0–4) for each 10-minute interval and were then pooled over recruitment sites and observation periods. Activity during physiotherapy sessions was defined as activity that occurred either in the therapy area or in the presence of a physiotherapist. Summary data were exported to Statistical Software Package for Social Sciences (SPSS; version 21, IBM) for analyses. Data were pooled across weekdays and weekend days initially, and then examined separately. As observation data were not normally distributed, summary statistics are presented as medians (interquartile range). We examined group differences in activity, location, and people present using Kruskall–Wallis tests. Agreement between the observers was examined using weighted κ statistics.

Therapy data (for all CIRCIT trial participants; n=283) were entered into an Excel spreadsheet and exported to SPSS 21 (IBM) for analyses. Between-group differences in therapy time and proportions of therapy sessions missed were analyzed using 1-way ANOVA with Tukey post hoc tests.

Results

Participant Characteristics

Participant characteristics are presented in Table 2. The 32 participants who were observed using behavioral mapping represented 11.3% of the total CIRCIT participant sample and were evenly distributed across arms of the trial (usual care, n=10; 7-day-week therapy, n=11; and circuit class therapy, n=11). The whole sample and the mapping subgroup were similar.

Table 1. Description of AC

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC0</td>
<td>No activity</td>
</tr>
<tr>
<td>AC1</td>
<td>Nontherapeutic activity</td>
</tr>
<tr>
<td>AC2</td>
<td>Minimal therapeutic activity</td>
</tr>
<tr>
<td>AC3</td>
<td>Moderate therapeutic activity</td>
</tr>
<tr>
<td>AC4</td>
<td>High therapeutic activity</td>
</tr>
<tr>
<td>AC5</td>
<td>Unobserved</td>
</tr>
</tbody>
</table>

AC indicates activity category.
in age, stroke type, side of lesion, and admission Functional Independence Measure scores.

Inter-Rater Reliability
Based on 195 pairs of observations from 2 observers, weighted $k$ scores (95% confidence intervals [CIs]) for agreement on activity, location, and people present were $0.907 (0.842–0.971)$, $0.92 (0.976–1.00)$, and $0.893 (0.802–0.985)$ respectively.

Therapy Data
Complete therapy data for 277 (98%) participants (total of 7040 therapy sessions) were available. On a daily basis, participants in the circuit class therapy arm of the trial received 2.5 times the amount of physiotherapy time (130.2±32.8 minutes) than participants in the usual care arm (52.4±20.4; mean difference, 77.8 minutes; 95% CI, 69.7–86.0). Participants in the 7-day-week therapy arm of the trial received less therapy time per day (47.0±13.0 minutes) when compared with usual care participants (mean difference, −5.4 minutes; 95% CI, −13.4 to 2.6; Table 3). In terms of total therapy time provided in the 4-week period, circuit class therapy participants received 22.2 hours (95% CI, 19.1–25.3) of additional therapy time when compared with usual care participants and 19.1 hours (95% CI, 16.0–22.2) of additional therapy when compared with 7-day-week participants.

Compliance with physiotherapy sessions was high (Table 3) although significantly more circuit class therapy sessions were missed (median, 10.0% [interquartile range, 11.5]) than either 7-day-week therapy sessions (6.0% [13.0]; $P<0.001$) or usual care therapy sessions (4.0% [9.3]; $P<0.001$).

Activity Across the Day
Combining weekday and weekend observations for all participants (Figure [A]), participants were engaged in high therapeutic activity (standing and walking) in 8.2% (10.5) of all observations or 42 minutes/d.

Activity During Physiotherapy Sessions
On weekdays, participants in the circuit class arm of the trial were observed to be active in physiotherapy sessions (10.2% [12.5] of observations; 52 minutes/d) significantly more often than usual care participants (6.1% [3.1] of observations; 31 minutes/d; $P=0.02$), but not 7-day therapy participants (9.5% [8.1] of observations; 48 minutes/d; Table 4). On weekends, participants in the 7-day arm of the trial were observed to be active in physiotherapy sessions in 4.2% (6.9) of observations (21 minutes/d), which was significantly more often ($P=0.001$)

<table>
<thead>
<tr>
<th>Table 2. Participant Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristics</strong></td>
</tr>
<tr>
<td>Age, y</td>
</tr>
<tr>
<td>Men</td>
</tr>
<tr>
<td>Women</td>
</tr>
<tr>
<td>Side of stroke lesion</td>
</tr>
<tr>
<td>Left</td>
</tr>
<tr>
<td>Right</td>
</tr>
<tr>
<td>Brain stem</td>
</tr>
<tr>
<td>Combination</td>
</tr>
<tr>
<td>No lesion on imaging</td>
</tr>
<tr>
<td>Unknown</td>
</tr>
<tr>
<td>Stroke type</td>
</tr>
<tr>
<td>Infarct</td>
</tr>
<tr>
<td>Hemorrhage</td>
</tr>
<tr>
<td>Unknown</td>
</tr>
<tr>
<td>Time between stroke and admission to rehab, d</td>
</tr>
<tr>
<td>Time between admission to rehab and mapping day, d</td>
</tr>
<tr>
<td>FIM total</td>
</tr>
<tr>
<td>FIM motor</td>
</tr>
<tr>
<td>Values represent n (%) or mean (SD). FIM indicates Functional Independence Measure; and N/A, not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3. Therapy Duration and Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Therapy time, min/d</strong></td>
</tr>
<tr>
<td>Therapy time, min/d</td>
</tr>
<tr>
<td>Total therapy time, h</td>
</tr>
<tr>
<td>Proportion (%) sessions missed</td>
</tr>
<tr>
<td>Proportion (%) sessions missed because of fatigue</td>
</tr>
<tr>
<td>Proportion (%) sessions refused</td>
</tr>
</tbody>
</table>

Mean and SD for therapy time, median and interquartile range for missing, fatigue, and refused. 7-d indicates 7-day-week therapy; CCT, circuit class therapy; CI, confidence interval; and UC, usual care.
than participants in the usual care and circuit class therapy arms of the trial, who did not receive weekend physiotherapy services and therefore were never observed to be engaged in therapy-related activity on those days.

**Activity Outside of Physiotherapy Sessions**

There were no between-group differences in activity levels outside of physiotherapy sessions on either weekdays or weekends (Table 4).

**Location**

Participants spent most of the day in their bedrooms (55.10% [32.8] of observations; 4.7 hours/d) and were observed to be in the therapy area for 14.6% (15.5) of observations (1.2 hours/d; Figure [B] and [C]). On weekdays, participants in the circuit class therapy arm of the trial were more often observed to be in the therapy area (39.6% [15.8] of observations or 3.4 hours/d) when compared with participants in either the 7-day-week therapy arm (24.5% [8.1] of observations or 2.1 hours/d) or the usual care arm of the trial (19.6% [20.1] of observations or 1.7 hours/d; \( P = 0.004 \)). On weekends, participants in the 7-day-week arm of the trial were observed to be in the therapy area for 6.2% (10.0) of observations (32 minutes/d), which was significantly more often than circuit class therapy and usual care participants who were never observed to be in the therapy area (\( P = 0.005 \)) on those days.

**Table 4. Observation Data; Between-Group Differences in Activity, Location, and People Present**

<table>
<thead>
<tr>
<th>Activity Category</th>
<th>Whole Sample (n=32)</th>
<th>Usual Care (n=10)</th>
<th>7-D Week Therapy (n=11)</th>
<th>Circuit Class Therapy (n=11)</th>
<th>P Value (Kruskal–Wallis Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC0–2</td>
<td>97.5 (20.1)</td>
<td>77.1 (21.0)</td>
<td>75.0 (20.0)</td>
<td>75.0 (22.2)</td>
<td>0.955</td>
</tr>
<tr>
<td>AC4</td>
<td>8.2 (10.4)</td>
<td>6.2 (7.1)</td>
<td>10.4 (6.5)</td>
<td>6.3 (16.7)</td>
<td>0.025</td>
</tr>
<tr>
<td>Activity in physiotherapy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.020</td>
</tr>
<tr>
<td>Weekdays</td>
<td>6.1 (8.4)</td>
<td>6.1 (3.1)</td>
<td>9.5 (8.0)</td>
<td>10.2 (12.5)</td>
<td>0.001</td>
</tr>
<tr>
<td>Weekends</td>
<td>0.0 (3.1)</td>
<td>0.0 (0.0)</td>
<td>4.2 (6.9)</td>
<td>0.0 (0.0)</td>
<td>0.001</td>
</tr>
<tr>
<td>Activity outside physiotherapy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.442</td>
</tr>
<tr>
<td>Weekdays</td>
<td>2.0 (4.3)</td>
<td>1.0 (2.6)</td>
<td>4.1 (6.3)</td>
<td>0.0 (2.1)</td>
<td>0.119</td>
</tr>
<tr>
<td>Weekends</td>
<td>2.1 (6.3)</td>
<td>2.1 (5.3)</td>
<td>4.2 (8.3)</td>
<td>0.0 (4.1)</td>
<td>0.119</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.129</td>
</tr>
<tr>
<td>Bedroom</td>
<td>55.1 (32.8)</td>
<td>58.3 (29.6)</td>
<td>55.1 (34.0)</td>
<td>45.8 (32.6)</td>
<td>0.004</td>
</tr>
<tr>
<td>Therapy area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>Weekdays</td>
<td>25.0 (15.9)</td>
<td>19.6 (20.1)</td>
<td>24.5 (8.1)</td>
<td>39.6 (15.8)</td>
<td>0.827</td>
</tr>
<tr>
<td>Weekdays</td>
<td>0.0 (6.3)</td>
<td>0.0 (0.0)</td>
<td>6.2 (10.0)</td>
<td>0.0 (0.0)</td>
<td>0.533</td>
</tr>
<tr>
<td>People</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.942</td>
</tr>
<tr>
<td>Alone</td>
<td>46.9 (28.2)</td>
<td>47.9 (24.2)</td>
<td>41.7 (39.0)</td>
<td>46.9 (25.7)</td>
<td>0.013</td>
</tr>
<tr>
<td>Weekdays</td>
<td>43.5 (27.0)</td>
<td>47.8 (23.6)</td>
<td>41.7 (33.6)</td>
<td>40.5 (21.9)</td>
<td>0.749</td>
</tr>
<tr>
<td>Weekends</td>
<td>52.1 (37.5)</td>
<td>56.3 (43.2)</td>
<td>46.3 (61.5)</td>
<td>54.1 (30.0)</td>
<td>0.004</td>
</tr>
<tr>
<td>Therapist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>Weekdays</td>
<td>30.6 (14.7)</td>
<td>19.6 (20.1)</td>
<td>24.5 (8.1)</td>
<td>39.6 (15.8)</td>
<td>0.004</td>
</tr>
<tr>
<td>Weekends</td>
<td>6.5 (10.7)</td>
<td>6.3 (12.8)</td>
<td>11.5 (15.1)</td>
<td>6.4 (5.3)</td>
<td>0.942</td>
</tr>
</tbody>
</table>

Values are median (interquartile range) of observations. See Table 1 for descriptors. AC indicates activity category.
People Present
Participants were alone for just under half of the working day (46.9% [28.2] of observations or 4.0 hours/d). There were no between-group differences in the time spent alone on weekdays, but participants in the circuit class therapy arm of the trial spent more time in the presence of a therapist when compared with participants in the usual care or 7-day-week therapy arms of the trial (P=0.013; Table 4). There were no between-group differences in the time spent alone or in the presence of a therapist on weekends.

Discussion
Both group circuit class therapy and 7-day-week therapy led to increases in the dosage of physiotherapy provided to people receiving inpatient rehabilitation after stroke. When compared with usual care, providing physiotherapy in group circuit classes increased physiotherapy time by >22 hours in 4 weeks and providing weekend physiotherapy resulted in 3 hours of additional therapy time in the same period. Both circuit class therapy and 7-day-week therapy led to participants being more active during physiotherapy sessions, and a similar amount of time spent active outside of therapy sessions. On weekdays, circuit class participants spent significantly more time in therapy areas than either usual care or 7-day-week therapy participants. On weekends, 7-day-week therapy participants spent significantly more time in the therapy area than participants in other trial arms. Participants were alone for almost half the working day, regardless of the model of physiotherapy service delivery.

A recent meta-analysis of 80 trials that compared different dosages of physiotherapy after stroke reported a mean of 17 hours additional therapy time provided to people in the intensive arm of the trials. Of the 80 trials included in this review, only 316–18 reported a therapy dosage >22 hours. Therefore, the additional therapy time provided to participants in the circuit class therapy arm of our trial exceeds the therapy contrast reported in the majority of previous therapy dosage studies.

As expected, the increase in physiotherapy time led to participants spending more time engaged in therapeutic activity during physiotherapy sessions, but the increase in therapy-related activity was lower than expected. On weekdays, circuit class therapy participants spent =80 more minutes in physiotherapy sessions but only accumulated 20 more minutes of therapy-related activity. On weekends, 7-day-week therapy participants spent, on average, 42 more minutes in physiotherapy sessions and accumulated 20 more minutes of therapy-related activity. Outside of physiotherapy sessions, participants spent little time standing or walking and this did not differ between arms of the trial. In fact, activity levels for all participants were alarmingly low. When compared with observations of stroke survivors in acute hospitals in Australia, participants in our study were standing or walking for only 5 minutes more each day (median 8.2% of observations or 42 minutes/d compared with 6.8% of observations or 37 minutes/d).14 Similarly, our participants were less active than stroke survivors in rehabilitation centers in Sweden,6,7 where participants were observed to be standing or walking for 13% of observations or =66 minutes a day.

It is possible that increased activity during physiotherapy sessions may mean that stroke survivors need to rest more outside of therapy sessions to compensate. This theory aligns with a concept known as the activitystat, which suggests that all individuals operate from a set point of activity levels, and increasing levels of activity in 1 domain (eg, taking up a new exercise regimen) will be compensated for by a decrease in another domain (eg, less time in incidental activity or chores) to maintain an overall stable level of activity and energy expenditure.19 The finding that activity levels outside of therapy was similar across the intervention and control arms of the trial suggest that factors other than energy conservation are the dominant drivers of activity outside of therapy sessions.

If meaningful activity is the primary driver of positive cortical reorganization after stroke,1,20 particularly in the first few months after stroke when the cortex is most receptive to change and recovery of walking ability is the primary goal for many stroke survivors early after stroke, spending only 42 minutes a day in an upright position may not be an adequate stimulus for optimal recovery. It is possible that increasing activity levels across the day may lead to improvements in recovery of stroke survivors. It is clear from our work, and other trials, that people with stroke are most likely to be active when in the presence of a therapist, or in the therapy area.6–8,14 In this study, we found that increasing the amount of physiotherapy provided in discrete blocks of time each day does not lead to proportional increases in activity time across the day. Therefore, we need to know more about the drivers of activity outside of therapy sessions. Stroke severity and walking ability have been shown to be related to activity levels in rehabilitation.6,7 The relative influences of hospital policies and practices as well environmental drivers for activity are less well understood.

Strengths and Weaknesses
We relied on therapists’ reports of physiotherapy time and therapists are known to overestimate therapy time by \(\approx 30\%\).21 The magnitude of overestimation does not differ when therapy is provide in individual or group sessions22 and would therefore not have differed between control and intervention groups.

Behavioral mapping is a unique method of measuring activity that allows the exploration of contexts of activity across the day by linking activity data to location and people present. However, it is labor intensive and therefore expensive to conduct and provides only a low-resolution picture of activity (based on 1 observation every 10 minutes). Wearable activity monitors are becoming lower in cost and provide a higher resolution picture of activity but are unable to provide details about the context of activities.

We did not collect data on participants’ level of function and walking ability at the time of mapping. This means that we were unable to investigate the role of individual patient factors, such as level of walking ability, on activity levels. Finally, we did not include measures of participant-reported fatigue so we cannot elucidate the degree to which fatigue influenced activity levels in this study.
Acknowledgments
We thank participating stroke survivors and the staff at the participating trial sites (Hampstead Rehabilitation Centre Adelaide, Repatriation General Hospital Adelaide, St Margaret’s Rehabilitation Hospital Adelaide, Osborne Park Hospital Perth and Royal Park Campus, and Royal Melbourne Hospital Melbourne).

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Disclosures
None.

References
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