Inactive and Alone
Physical Activity Within the First 14 Days of Acute Stroke Unit Care

Julie Bernhardt, PhD; Helen Dewey, PhD; Amanda Thrift, PhD; Geoffrey Donnan, MD

Background and Purpose—One way that stroke units may improve outcome is by reducing complications of immobility through early mobilization; however, this intervention needs testing. The purpose of this study was to determine the physical activity patterns of stroke patients managed within acute stroke units as a first step in developing an early mobilization protocol.

Methods—We recruited 64 patients within 14 days after stroke from 5 metropolitan stroke units and observed them for 2 consecutive days at 10-minute intervals between the hours of 8 AM and 5 PM. At each observation, we ascertained physical activity, location, and other person(s) present. Therapists recorded therapy details.

Results—The 58 patients who completed the study had a mean age of 71.3 years. Stroke severity ranged from mild (National Institutes of Health Stroke Scale score, 1) to severe (score, 27), and mean time after stroke at observation was 5.6 days (range, 0 to 13 days). Only 9 patients were restricted to bed. During the therapeutic day, patients spent >50% resting in bed, 28% sitting out of bed, and only 13% engaged in activities with the potential to prevent complications and improve recovery of mobility. Patients were alone >60% of the time.

Conclusions—This is the first multicenter study of physical activity early after stroke. We believe the next step is to conduct a randomized controlled trial to evaluate the effect of increased levels of physical activity early after stroke compared with current standards of care. (Stroke. 2004;35:1005-1009.)

Key Words: early ambulation ■ rehabilitation ■ stroke ■ stroke units

It is now well established that treatment in stroke units results in fewer deaths and lower levels of dependency. However, the mechanism underlying this result is not clearly understood. Nor do we know whether the stroke unit effect results from particular components of care or the total package. One way that stroke unit care may prevent death and reduce disability is through more aggressive detection and treatment of secondary complications such as orthostatic blood pressure problems, infection, deep venous thrombosis, and other complications of immobility. Complications of immobility have been estimated to account for as many as 51% of deaths in the first 30 days after first-ever ischemic stroke. Although the true contribution of immobility to complications and death is difficult to quantify, there is evidence that patients managed in a stroke unit promoting early mobilization had fewer deaths and better outcome than patients managed in general medical wards without early mobilization. There is indirect evidence that the reduction of complications through early mobilization may play an important role in this outcome.

Surprisingly little information exists about very early mobilization after stroke. A randomized controlled trial is required to obtain evidence about this intervention. A preliminary step to undertaking such a study is to obtain baseline information about acute stroke patient activity. These data could then be used to inform the development of a mobilization protocol for a randomized controlled trial. Therefore, the purpose of this study was to investigate the physical activity patterns of patients managed in a representative sample of acute stroke units. The specific aims were (1) to quantify the amount and nature of physical activity of patients 14 days after stroke, (2) to describe the location of activity and people present, and (3) to identify factors that might influence levels of physical activity.

Methods

Study Population and Setting
Our study population comprised stroke patients managed in 5 of the 7 acute stroke units in metropolitan Melbourne, Australia (population, 3.2 million). The stroke units, in large teaching hospitals, exhibited many characteristics of organized stroke units and were actively involved in research.

Study Design
This study was an open observational behavioral mapping study. Except for those patients receiving palliative care, all cases of
Patients were classified according to the Oxfordshire Community Stroke Project classification.\textsuperscript{12} Neurological impairment was determined with the National Institutes of Health Stroke Scale (NIHSS)\textsuperscript{13} obtained retrospectively from medical records.\textsuperscript{14} Patients were grouped into mild (NIHSS <8), moderate (NIHSS, 8 to 16), and severe (NIHSS >16) stroke categories.\textsuperscript{15}

### Other Prespecified Data

We recorded whether English was the patient’s first language (EFL), level of function at the time of observation using the Acute Stroke Mobility Scale,\textsuperscript{16} living arrangements, and mobility before admission. Previous mobility was ascertained from the patient or family and was categorized as independent, supervised, or dependent.

### Data Management and Statistical Analysis

The database (Microsoft Access 97) was designed to automatically calculate the highest level of activity (AC, 0 to 4) in every 10-minute interval. AC data were pooled across sites and over days. We report average activity in each of the ACs over the 2 days of observation. We examined whether activity levels differed significantly across the days of observation using 2-way analysis of variance (ANOVA). Stepwise binomial logistic regression analysis, retaining only those terms significant at $P<0.05$, was used to examine factors that might predict either no activity (AC, 0) or high activity (AC, 3 and 4). Factors included age, stroke unit, NIHSS, Acute Stroke Mobility Scale walking score, first stroke, days after stroke, and amount of time that family was present. Number of days after stroke was further examined by use of 1-way ANOVA after patients were grouped into 3 time epochs: 0 to 3, 4 to 7, and 8 to 14 days. The influence of EFL on physical activity was analyzed by use of 1-way ANOVA, and differences in time that family were present for EFL and non-EFL patients were examined by use of Student’s $t$ test. Therapist contact is reported in mean minutes of therapy per intervention.

An interobserver reliability study was conducted before data collection. Four patients were observed concurrently (and independently) by 2 raters after 1 hour of training. Weighted kappa statistic ($\kappa_w$) was used to test the association between raters; the modified McNemar test was used to identify systematic bias between observers.\textsuperscript{17} Systat version 10 (SPSS Inc) was used for all analyses.

### Results

Stroke unit characteristics are summarized in Table 2. Average length of stay ranged from 6 to 14 days, with differences explained in part by variations in access to rehabilitation and nursing home facilities (data not shown).

### Patient Characteristics

All patients with stroke (n=66) were approached, and 64 (97.0%) agreed to participate in the study. Five patients were

### Tables

#### Table 1. Observed Activity, Nominated Class, and AC

<table>
<thead>
<tr>
<th>Observed Activity</th>
<th>Activity Class</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>No active motor</td>
<td>No activity</td>
<td>0</td>
</tr>
<tr>
<td>Talk/read/watch TV</td>
<td>Nontherapeutic action</td>
<td>1</td>
</tr>
<tr>
<td>Eat with unaffected hand</td>
<td>Nontherapeutic action</td>
<td>1</td>
</tr>
<tr>
<td>Sit supported in bed</td>
<td>Nontherapeutic action</td>
<td>1</td>
</tr>
<tr>
<td>Sit supported out of bed</td>
<td>Therapeutic, minimal</td>
<td>2</td>
</tr>
<tr>
<td>Transfer (with hoist)</td>
<td>Therapeutic, minimal</td>
<td>2</td>
</tr>
<tr>
<td>Roll and sit up</td>
<td>Therapeutic, moderate</td>
<td>3</td>
</tr>
<tr>
<td>Sit, no support</td>
<td>Therapeutic, moderate</td>
<td>3</td>
</tr>
<tr>
<td>Transfer feet on floor</td>
<td>Therapeutic, moderate</td>
<td>3</td>
</tr>
<tr>
<td>Standing activities</td>
<td>Therapeutic, high</td>
<td>4</td>
</tr>
<tr>
<td>Walk</td>
<td>Therapeutic, high</td>
<td>4</td>
</tr>
</tbody>
</table>

AC indicates activity category.

#### Table 2. Stroke Unit Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke beds, n</td>
<td>20</td>
</tr>
<tr>
<td>Average length of stay, d</td>
<td>14.0</td>
</tr>
<tr>
<td>Patients recruited, n</td>
<td>19</td>
</tr>
<tr>
<td>Staff:patient ratios</td>
<td></td>
</tr>
<tr>
<td>Nurse</td>
<td>1:4</td>
</tr>
<tr>
<td>Physiotherapist</td>
<td>1:10</td>
</tr>
<tr>
<td>Occupational therapist</td>
<td>1:14</td>
</tr>
<tr>
<td>Speech and language therapist</td>
<td>1:22</td>
</tr>
<tr>
<td>Therapy room present</td>
<td>No</td>
</tr>
<tr>
<td>Rest period enforced</td>
<td>No</td>
</tr>
</tbody>
</table>

Stroke beds, n 20 12 12 10 6
Average length of stay, d 14.0 7.0 10.5 6.2 8.6
Patients recruited, n 19 13 9 14 9
Staff:patient ratios
Nurse 1:4 1:4 1:4 1:4 1:4
Physiotherapist 1:10 1:11 1:12 1:10 1:12
Occupational therapist 1:14 1:11 1:12 1:12 1:14
Speech and language therapist 1:22 1:23 1:24 1:20 1:20
Therapy room present No No No No No
Rest period enforced No Yes No Yes No

Confidential stroke admitted <14 days after first or recurrent stroke were included. Approval for this study was obtained from the medical ethics committee of each institution, and informed consent was obtained.

### Observational Technique and Duration

The study was undertaken between November 2001 and May 2002. Observations were conducted on 2 consecutive days from 8 AM to 5 PM, ie, the most active part of a patient’s day. Patients were observed every 10 minutes for 4 randomly scheduled 10-minute breaks. At each time point, the observer recorded patient activity, the person attending the patient, and the patient’s location. Patients were not followed off the ward nor intruded on if behind closed curtains. However, once patients were again visible, the patient or caregiver was questioned with a standard format to determine activity in the unobserved period. Observations lasted for ~1 minute per patient, and the highest level of activity was recorded. The route through the ward remained consistent across days. We made observations at each stroke unit on 2 separate occasions. Patients were monitored for changes in medical state leading to bed rest. We informed patients that we would monitor their activity. Staff were told that we aimed to review stroke unit processes. Therapists recorded the content and duration of every patient interaction.\textsuperscript{8} Descriptive information about each unit was obtained by questionnaire.

### Categories of Activity

At each observation, 11 physical activities could be recorded. These activities were similar to those in previous rehabilitation studies that used behavioral mapping,\textsuperscript{9,10} except for sitting out of bed, which we classified as a therapeutic activity (nontherapeutic in previous postacute research). The 11 physical activities\textsuperscript{9,10} were grouped into 5 prespecified activity categories (ACs) judged by experienced clinicians to reflect the degree of physical work during the activities. These were (1) no activity, (2) nontherapeutic actions, (3) minimal therapeutic activity, (4) moderate therapeutic activity, and (5) high therapeutic activity (Table 1).

### People Present During Activity

The 11 categories included family (immediate and other visitors), nursing and medical staff, therapists, interpreters, porters, etc.

### Location of Activity

The 5 categories were bedroom, hall, bathroom, therapy area, and off ward.

### Other Definitions

We used the World Health Organization definition of stroke.\textsuperscript{11} Patients were classified according to the Oxfordshire Community.
discharged early, and 1 was referred for palliative care. The characteristics of the remaining 58 patients (Table 3) are similar to other stroke unit populations.\textsuperscript{6,18} Brain imaging (CT or MRI) was performed in 95.0% of cases.

**Patients Restricted to Bed**

Over the 20 observation days, only 9 patients were restricted to bed. Reasons for restricting mobility included unstable blood pressure (n=3), reduced consciousness (n=2), pulmonary emboli (n=1), chest infection (n=2), and bleeding complications after cystoscopy (n=1).

### TABLE 3. Patient Characteristics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong> mean (SD, range)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>71.3</td>
</tr>
<tr>
<td>SD</td>
<td>12.6</td>
</tr>
<tr>
<td>Range</td>
<td>30–96</td>
</tr>
<tr>
<td>Men</td>
<td>29 (50.0)</td>
</tr>
<tr>
<td>EFL</td>
<td>26 (44.8)</td>
</tr>
<tr>
<td>First-ever stroke</td>
<td>38 (65.5)</td>
</tr>
<tr>
<td><strong>Time since stroke, d</strong></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>5.6</td>
</tr>
<tr>
<td>SD</td>
<td>0.4</td>
</tr>
<tr>
<td>Range</td>
<td>1–13</td>
</tr>
<tr>
<td><strong>Stroke type</strong></td>
<td></td>
</tr>
<tr>
<td>Infarct</td>
<td>51 (88.0)</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>7 (12.0)</td>
</tr>
<tr>
<td><strong>NIHSS</strong></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>9.7</td>
</tr>
<tr>
<td>SD</td>
<td>3.2</td>
</tr>
<tr>
<td>Range</td>
<td>1–27</td>
</tr>
<tr>
<td><strong>OCSP infarct classification</strong></td>
<td></td>
</tr>
<tr>
<td>LACI</td>
<td>19 (32.8)</td>
</tr>
<tr>
<td>PACI</td>
<td>19 (32.8)</td>
</tr>
<tr>
<td>POCI</td>
<td>5 (8.6)</td>
</tr>
<tr>
<td>TACI</td>
<td>8 (13.8)</td>
</tr>
<tr>
<td><strong>Side of hemiparesis</strong></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>26 (44.8)</td>
</tr>
<tr>
<td>Right</td>
<td>32 (55.2)</td>
</tr>
<tr>
<td><strong>Prestroke accommodation</strong></td>
<td></td>
</tr>
<tr>
<td>Home alone</td>
<td>14 (24.1)</td>
</tr>
<tr>
<td>Home with family</td>
<td>39 (67.3)</td>
</tr>
<tr>
<td>Hostel</td>
<td>5 (8.6)</td>
</tr>
<tr>
<td><strong>Prestroke mobility</strong></td>
<td></td>
</tr>
<tr>
<td>Independent no aids</td>
<td>35 (60.3)</td>
</tr>
<tr>
<td>Independent with aid</td>
<td>22 (38.0)</td>
</tr>
<tr>
<td>Dependent</td>
<td>1 (1.7)</td>
</tr>
</tbody>
</table>

n=58.

OCSP indicates Oxfordshire Community Stroke Project; LACI, lacunar infarcts; PACI, partial anterior circulation infarcts; POCI, posterior circulation infarcts; and TACI, total anterior circulation infarcts.

### Physical Activity

The proportion of time in each AC is shown in Figure 1. Patients engaged in moderate (AC, 3) or high (AC, 4) activities for only 12.8% of the therapeutic day (8 AM to 5 PM). Fifty-three percent of the time, patients were resting in bed. A further 6.0% of the time, patients were away from the ward, primarily for investigations (5.0%). This pattern of activity was not substantially altered by removing those patients who were restricted to bed. In those not restricted to bed (n=49), the proportion of time spent in bed (AC, 0) was 3.8% less than for the total group; however, high-level activity (AC, 3+4) increased by only 1.1% (ie, made up 13.9% of the therapeutic day). These apparent differences in activity were not statistically significant (P>0.47 in all cases). We were unable to ascertain activity on only 25 occasions (0.4% of observations).

There was no interaction effect (P=0.96) between days of observation and physical activity, indicating that patient activity on days 1 and 2 was similar.

### Contact With Others

Patients were alone for 60.4% of the time (Figure 1). A further 15.3% of the time, family or friends were the only people present. Non-EFL patients were less likely to be alone with family present for 24.0% of the day. Although the difference in family presence between EFL and non-EFL groups was statistically different (t=−2.59, P=0.01), EFL was not predictive of high or low physical activity. Therapist contact constituted only 5.2% of the day. The average length of treatment provided by therapists was 22.8 minutes (occupational therapy), 32.5 minutes (speech and language therapy), and 24.0 minutes (physical therapy).

### Location of Activity

Patients were in or beside their beds for 88.5% of observations and spent only 0.2% of time in a therapy area (Figure 1). The location of patients was unknown in <0.1% of observa-

\[\text{Figure 1. Physical activity, people present, and location data from observations between 8 AM and 5 PM averaged across all cases. A, Proportion of day spent in each AC (AC, 0 to 4); B, people present during activity; C, location of activity.}\]
only 1.0% of the therapeutic day in bed and 84.0% of the day

“In bed” activities (AC, 0+1) are collapsed into 1 category. "In bed" activities (AC, 0+1) are collapsed into 1

groups. “In bed” activities (AC, 0+1) are collapsed into 1

resulted in only a 1.1% increase in higher levels of activity.

Patients who were restricted to bed on medical advice

whether structure, process, or patient tolerance is responsible

factors (NIHSS, 8 to 16), and severe (NIHSS >16) stroke patient

categories. Patients with severe stroke (NIHSS >16) spent 95.5% of the
day in bed, whereas the highest proportion of moderate and high
therapeutic activity (21.1%) was exhibited by patients with mild strokes (Figure 2). Using logistic regression, we
found that higher NIHSS on admission (P<0.001) and low
Acute Stroke Mobility Scale walking scores at the time of
observation (P=0.008) were associated with low levels of
activity. Those with high levels of physical activity were
more likely to be younger (P=0.019), have lower NIHSS
(P=0.003), and have a high walking score (P<0.001). Stroke
unit location, whether the stroke was first or recurrent, and
amount of time that the family was present did not predict
physical activity levels.

The number of days after stroke did not influence
physical activity. Patients in the early time epoch (≤3 days, n=12)
were no less active than those observed later after stroke
(P≥0.13).

A close association between the 2 observers was found for
AC, location, and person present, with k never <0.67
(range, 0.67 to 1.00) and no evidence of bias between
observers (P>0.50 always).14

The levels of moderate and high activity observed were lower
than expected (12.8%). Even those patients with mild stroke
spent only 11.3% of the active day walking, and removal of
patients who were restricted to bed on medical advice resulted in only a 1.1% increase in higher levels of activity.
Whether this constitutes acceptable levels of activity is unclear because we have yet to determine the level of activity that might be reasonable for patients very early after stroke.

There are no comparable published data from other stroke units to allow direct comparison. In the other early behavioral
mapping study,19 patients (2 to 5 weeks after stroke) spent
only 1.0% of the therapeutic day in bed and 84.0% of the day

sitting. These figures are vastly different from our own in
which average time after stroke was 5.6 days. It is unclear
whether structure, process, or patient tolerance is responsible
for the low activity levels in our study. Certainly, there were
limited opportunities for movement away from the bedside, reflected in the high proportion of time patients spent in their
rooms (88.5%), and nursing and allied health staffing levels
were less than previously reported20 or recommended.21
Nevertheless, we were surprised that patients spent >60% of
the therapeutic day alone.

With respect to time after stroke, the activity of patients
observed within the first few days was not significantly
different from that observed within the first week or later.
High-level activity was uniformly low. However, had we
recruited more patients within the first few days after stroke
or a higher proportion of patients with severe stroke (n=6),
we may have found even lower levels of activity.

It is also important to acknowledge that any observational
study has the potential for bias. Staff or patient behavior
may have been altered by the observers’ presence. In general,
we would expect activity to increase in response to observation.
If this were the case, activity levels may be overestimated.
Conversely, our assumption that patients away for tests had
no activity may be incorrect. However, given that patients
were away for tests only 5.0% of the time, this is unlikely
to have altered the interpretation of our results.

The high levels of bed rest (>50%) found among participants
should be cause for concern given the negative effects of
bed rest.22 Most patients (84.5%) were free to move out of
bed if they chose or were assisted to do so. Interestingly, of
the 9 patients restricted to bed on medical advice, 2 were
restricted because of conscious state alone. Proponents
of early mobilization do not view reduced consciousness as a
reason for bed rest. Rather, they consider that movement can
help to “wake them up.”23

It may be useful to consider the dramatic change in
management of patients with acute myocardial infarction that
has occurred over the past 50 years. Early mobilization after
uncomplicated acute myocardial infarction was proposed in
1951.24 Before this, patients were prescribed 6 to 8 weeks of
bed rest to allow time for myocardial healing and scar
formation.25 Complications of bed rest, together with “harmful
psychological effects,” prompted a change in approach.26
There is still some debate about the content, intensity, and
exact timing of early mobilization programs27; however,
guidelines now propose 12 hours of bed rest after uncomplic-
ated acute myocardial infarction,28,29 with early mobilization
and early discharge considered the norm.

Stroke patients are unlikely to represent a special group
requiring long periods of bed rest to promote recovery.
Although there is some evidence that early or forced activa-
tion after cerebral infarct in rats can lead to an increase in
lesion volume,30,31 increased tissue loss does not necessarily
equate to poorer outcome.32 In fact, early training can
improve outcome despite increases in lesion volumes in the
training group.33 It is more likely that stroke patients would
also benefit from early mobilization. Although early mobil-
ization is only 1 component of stroke unit care, it may be an
important factor in improved outcomes.7 Previous investiga-

![Figure 2. Average activity levels of mild (NIHSS <8), moderate (NIHSS, 8 to 16), and severe (NIHSS >16) stroke patient groups. "In bed" activities (AC, 0+1) are collapsed into 1 category.](http://stroke.ahajournals.org/doi/figure/10.1161/01.STR.0000159187.77166.9E)
tions comparing early mobilization with general medical ward care.\textsuperscript{53} Found deaths at 1 to 3 weeks after stroke to be reduced from 14\% to 8\% and found a 3- to 6-point improvement in Scandinavian Stroke Scale impairment scores over the same period.\textsuperscript{34} These studies provide evidence that interventions applied in the first few weeks after stroke may improve short-term outcomes with possible long-term benefits. The task remains for us to test a mobilization protocol in a randomized controlled trial. The data gathered from the present study have informed the early mobilization trial. For example, we now know that it is not just patients with moderate and severe strokes who are inactive for much of the day. The trial sample will therefore include patients across the severity spectrum. In addition, we now recognize the activity limitations imposed by the physical environments of the stroke units and are seeking ways to overcome them. Most important, we have baseline data about when, how much, and what sort of activity occurs early after stroke. The trial mobilization protocol in the intervention arm of the study will seek to substantially improve activity across all of these levels.

Acknowledgments

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References

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