

## Review Article

# Physical Activity in Hospitalised Stroke Patients

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The aim of this paper was to examine the amount and type of physical activity engaged in by people hospitalised after stroke. *Method.* We systematically reviewed the literature for observational studies describing the physical activity of stroke patients. *Results.* Behavioural mapping, video recording and therapist report are used to monitor activity levels in hospitalised stroke patients in the 24 included studies. Most of the patient day is spent inactive (median 48.1%, IQR 39.6%–69.3%), alone (median 53.7%, IQR 44.2%–60.6%) and in their bedroom (median 56.5%, IQR 45.2%–72.5%). Approximately one hour per day is spent in physiotherapy (median 63.2 minutes, IQR 36.0–79.5) and occupational therapy (median 57.0 minutes, IQR 25.1–58.5). Even in formal therapy sessions limited time is spent in moderate to high level physical activity. Low levels of physical activity appear more common in patients within 14 days post-stroke and those admitted to conventional care. *Conclusions.* Physical activity levels are low in hospitalised stroke patients. Improving the description and classification of post stroke physical activity would enhance our ability to pool data across observational studies. The importance of increasing activity levels and the effectiveness of interventions to increase physical activity after stroke need to be tested further.

## 1. Introduction

The most beneficial time to commence rehabilitation and physical activity after stroke has not yet been established; however improved outcome is associated with earlier initiation of rehabilitation [1]. Favourable outcomes have been reported in stroke units where patients are helped to get out of bed within the first 48 hours of admission and continue this frequently until discharge [2, 3], and early start to activity is recommended in many guidelines [4–6]. However, the practice remains controversial [7, 8] and early commencement of physical activity is the subject of clinical trials [9–11]. Increased activity in the first six months after stroke has been found to improve functional outcome [12], but once again the optimal dose of physical activity necessary to aid recovery after stroke is unclear.

Physical activity is defined here as any bodily action produced by the skeletal muscles requiring more energy expenditure than at rest and therefore can include low level tasks such as actively maintaining sitting posture in a chair. However the effect of increasing therapy is enhanced if it

involves the practice of higher level, functional activities such as standing and walking [1, 13].

Given the growing interest in promoting physical activity after stroke apparent within the literature and in clinical guidelines [4–6], it is important to understand what activity patients already undertake following their stroke, both throughout the day and during therapy time. The purpose of this paper was to examine common methods of monitoring activity in hospitalised stroke patients and summarise the amount and type of physical activity undertaken by stroke patients managed in a range of hospital settings. We were also interested in where patients were most active and who was with them during activity.

## 2. Methods

*2.1. Literature Search.* A search of the EMBASE, Medline, PubMed, AMED, and CINAHL databases was carried out up until the end of October 2010 to ascertain observational studies investigating the amount and type of physical activity in hospitalised stroke patients. The search was restricted

to observational studies as this is a common method of activity monitoring used in clinical practice. Although we were interested in publications investigating physical activity early after stroke (within 14 days), any study conducted in a hospital-based setting, at any time point in the care continuum, could be included. Combinations of the following search terms were used to locate potentially relevant studies: stroke, physical activity, mobilisation, rehabilitation, inpatient, hospital, early, acute, observation, observational study. Further literature was sourced from scans of the reference lists of selected publications. Potential studies were determined from review of the title and abstract.

**2.2. Selection of Literature.** Studies selected for inclusion in the review were prospective observational studies which employed methods such as behavioural mapping, therapist report, or video recording to determine the amount and type of physical activity undertaken by the stroke patients. Patients could be admitted to any inpatient service that managed stroke patients, including general medical wards, aged care units, neurology wards, mixed rehabilitation wards, and stroke units (acute, comprehensive, or rehabilitation).

Publications were included in the review if they described the physical activity undertaken either throughout the entire day or, alternatively, during formal therapy time alone. Publications in which only the amount of total therapy time and not the type of activity undertaken was reported were excluded.

**2.3. Data Extraction and Analysis.** The type of activity reported from each study was categorised as either general patient activity or therapy-specific activity. For studies that reported general patient activity we extracted data regarding patient activity undertaken throughout the day. For studies that investigated therapy-specific activity only we extracted data on the patient's activity during formal therapy sessions only. As the focus of this paper was on physical activity, only records from physiotherapy and occupational therapy sessions were obtained for the therapy-specific data, since these disciplines are known to concentrate more on physical function.

Data extracted from the included publications regarding the type of activity undertaken by stroke patients was grouped under four categories reflecting the physical demands of the activity.

- (i) *Nil physical activity*: sleeping and other nontherapeutic activities while resting in bed including passive recreation such as reading, watching TV, talking, and eating.
- (ii) *Low physical activity*: including sitting supported out of bed and self-care.
- (iii) *Moderate physical activity*: including sitting unsupported and transferring without hoist equipment.
- (iv) *High physical activity*: including activities involving standing and walking.

The amount of time spent in different types of activities was extracted and calculated as a proportion of total observation time for each individual study. For the general patient activity studies the locations in which these activities took place and the people present when they occurred was also extracted and expressed as a proportion of observation time. In the therapy-specific activity studies we determined the minutes of therapy per session and minutes of therapy per day. Wherever possible we extracted information about the study settings, patient characteristics, and study methods and procedures. To summarise data across studies we calculated medians and 25th and 75th percentiles (IQR).

We further categorised studies into hospital setting (general rehabilitation, stroke units, or conventional care) and time of observation (<14 days). General rehabilitation units were defined as units which provided only rehabilitation (not acute care) for both stroke and nonstroke diagnoses. This included mixed rehabilitation wards that accepted both neurological and nonneurological conditions.

Stroke unit care was defined as a geographically discrete unit which only admitted stroke patients. This included stroke rehabilitation wards for patients transferred from acute care usually at least one to two weeks poststroke, acute stroke wards which provided only acute care for patients usually within one to two weeks poststroke, and comprehensive stroke wards which combined both acute care and rehabilitation.

Conventional care units included any acute service which admitted both stroke and nonstroke diagnoses. This included general medical wards which could admit a range of medical conditions, elderly care units which specifically admitted elderly patients with various medical conditions, or general neurology wards which admitted patients with a range of neurological diagnoses.

Again, data were summarised across studies and medians and 25th and 75th percentiles (IQR) are reported. Statistical comparison between settings was not suitable as insufficient data were available to adequately adjust for important factors that may influence activity such as stroke severity.

### 3. Results

Forty-one potentially relevant studies were identified from a review of the title and abstract. Seventeen of these studies were excluded, eight of which did not provide sufficient information about the type of activity [14–21], five reported data already reported in another included publication [1, 22–25], two reported the frequency of different types of activities but not the total amount of time [26, 27], one study was a retrospective study [28], and one study included both stroke and other neurological diagnoses in the same data set [29].

Of the 24 included publications patient activity was observed throughout the day in 15 studies [30–44], and patient activity was observed in therapy sessions only in 10 studies [32, 45–53], with one publication examining patient activity during both the whole day and in therapy time alone [32]. All included studies reported the proportion of time spent in activities of interest across the whole

TABLE 1: General patient activity studies.

Study	Patients	Organisation of care categories	Behavioural mapping procedure for individual patients
Bear-Lehman et al. [30] <sup>a</sup>	Rehabilitation inpatients	SU	8 am–4 pm, every 30 mins, for 1 weekday and 1 weekend day
Bernhardt et al. [31]	Acute (<14 d) inpatients	SU (<14 d)	8 am–5 pm, every 10 mins, for 2 consecutive weekdays
Bernhardt et al. [32] <sup>b</sup>	Acute (<14 d) inpatients	SU (<14 d)	8 am–5 pm, every 10 mins, for 1 weekday
De Weerd et al. [33] <sup>c</sup>	Rehabilitation inpatients	SU	8.30 am–5.10 pm, every 10 mins, for 1 weekday
De Weerd et al. [34]	Rehabilitation inpatients	SU	8.30 am–5.10 pm, every 10 mins, for 2 weekdays in 1st observation period, 1 weekday in 2nd period
De Wit et al. [35] <sup>d</sup>	Rehabilitation inpatients	SU	7 am–12 pm or 12 pm–5 pm or 5 pm–10 pm, every 10 mins, for 1 weekday
Esmonde et al. [36]	Rehabilitation inpatients	SU	9 am–5 pm, average every 10.8 mins, for 4–9 weekdays
Keith [37]	Rehabilitation inpatients	SU	8.15 am–16.15 am every 30 mins, for 5 consecutive weekdays
Keith and Cowell [38]	Rehabilitation inpatients	SU, GRU	8.30 am–4.30 pm, every 8 mins, for 2 weekdays
Lincoln et al. [39]	Rehabilitation inpatients	SU	8.30 am–4.30 pm, average every 30 mins, for 3 consecutive days
Lincoln et al. [40]	Rehabilitation Inpatients	SU, CCU	6 am–2 pm or 8.30 am–4.30 pm or 2 pm–10 pm, ~ every 10 mins, for 3 days
Mackey et al. [41] <sup>e</sup>	Rehabilitation inpatients	GRU	7 am–7 pm, every 10 mins, for 3-4 weekdays and both weekend days
Pound et al. [42]	Inpatients	SU, CCU	7.30 am–3.30 pm or 9.30 am–5.30 pm or 2.30 pm–10.30 pm, ~ every 20 mins, for 1 weekday
Tinson [43] <sup>e</sup>	Inpatients	CCU	9 am–1 pm or 1 pm–5 pm, every 30 mins, for 4 weekdays, plus 9 am–5 pm, every 30 mins, for 1 weekend day
Wellwood et al. [44]	Acute (<14 d) inpatients	SU, CCU (<14 d)	8 am–5 pm, every 10 mins, for 1 weekday

<sup>a</sup>Data for stroke patients only, excludes weekend data; <sup>b</sup>data for Trondheim patients only; <sup>c</sup>data for Switzerland patients only; <sup>d</sup>excludes 5 pm–10 pm data; <sup>e</sup>excludes weekend data; GRU: general rehabilitation unit (includes mixed rehabilitation units); SU: stroke unit (includes acute stroke units, comprehensive stroke units and stroke rehabilitation units); CCU: conventional care unit (includes general medical wards, elderly care units and general neurology wards); <14 d—all patients observed within 14 days of stroke.

study population. Few studies reported standard error or deviations preventing meta-analysis of these studies.

### 3.1. General Patient Activity

**3.1.1. Activity Monitoring Method.** All 15 of the included studies which examined patient activity throughout the day used a behavioural mapping method (structured observation) to determine patient activity (Table 1). Ten of the studies reported good interrater reliability with the behavioural mapping method [30, 31, 33–36, 38, 42, 44]. The remaining studies did not report reliability, and no studies tested the validity of behavioural mapping.

The behavioural mapping procedures varied across studies (Table 1). Days of observation ranged from 1 to 9 days (median 2 days). The time across which mapping was carried out on observation days ranged from 4 to 12 hours each day (median 8 hours) and the frequency of observations ranged from every 8 to 60 mins (median 10 minutes). Most studies focused on a normal working day, with observations taking place on weekdays, commencing between 8 am and 9 am and finishing between 4 pm and 5.30 pm. However four studies included weekday mapping outside the normal working day hours [35, 40–42]. Three studies also included mapping on weekends [30, 41, 43] but for the purpose of the current

paper weekend data were excluded where possible in order to allow a more accurate comparison of data across studies.

**3.1.2. Participants Monitored.** All study participants were hospitalised and in most studies only stroke patients were examined. One study compared hospitalised stroke patients with other neurological and nonneurological diagnoses [30]; however only the data for the stroke patients were included in the current paper.

The reported average or median age of the patients varied significantly across the studies, ranging from 52 to 80 years. Most of the studies had broad inclusion criteria, suggesting representative patient samples. Comparison of patient severity across the studies was difficult as a large range of measures were used to describe the impairment or disability of the monitored group. These included the National Institute of Health Stroke Scale (NIHSS), the Barthel Index, and the Functional Independence Measure (FIM). Most studies appeared to include patients from across the spectrum of stroke severity. In two studies patients needed to have a specified minimum impairment level to be included, thereby excluding very mild patients [35, 43]. In two studies very severe patients with low function, decreased consciousness, or ongoing acute medical issues were excluded [40, 43].

The majority of studies investigated patients who were in the “rehabilitation phase” of their admission. The concept of a “rehabilitation phase” was not well defined across studies; therefore for the purpose of the current paper it was presupposed to imply that the patients were considered to be medically stable, not requiring acute medical intervention, and the primary purpose of ongoing hospitalisation was rehabilitation. The exact days after stroke at the time of observation were only reported in five studies [31, 32, 34, 36, 39]. The remainder investigated activity in patients who were assumed to be between several weeks to several months following stroke. Three studies specifically focused on acute patients within 14 days of their stroke [31, 32, 44]. Two included studies may have investigated both acute and rehabilitation patients; however insufficient information was provided to confirm patient acuity [42, 43].

**3.1.3. Care Settings.** In 85% of the studies physical activity monitoring was conducted in a stroke unit setting. This was usually a stroke rehabilitation unit, but acute and comprehensive stroke unit settings were described in a small number of publications [31, 32, 44]. Some studies also investigated physical activity in mixed rehabilitation units, general medical wards, elderly care units, and general neurology wards.

In 12 of the included publications activity monitoring was conducted on several groups of patients who were grouped based on diagnosis, the period of observation, the site where the unit was based, the organisation of care, or the structure of the unit. The data for each separate group are presented in Table 2. Where the same patient group was analysed in another included study these data are reported only once. Where the group did not include stroke patients these data were excluded leaving a total of 35 patient groups ( $n = 639$ ) across the 15 included publications.

TABLE 2: Included studies showing number of included patients and reason for grouping.

Study	Patient group	$n$
Bear-Lehman et al. [30]	Stroke patients	7
Bernhardt et al. [31]	Full sample	58
Bernhardt et al. [32]	Trondheim unit	37
De Weerd et al. [33]	Swiss unit	8
De Weerd et al. [34] <sup>1</sup>	1st observation period	22
De Weerd et al. [34] <sup>2</sup>	2nd observation period	16
De Wit et al. [35] <sup>A</sup>	Belgium unit	40
De Wit et al. [35] <sup>B</sup>	United Kingdom unit	40
De Wit et al. [35] <sup>C</sup>	Switzerland unit	40
De Wit et al. [35] <sup>D</sup>	German unit	40
Esmonde et al. [36]	Full Sample	17
Keith [37] <sup>1</sup>	1st observation period	24
Keith [37] <sup>2</sup>	2nd observation period	23
Keith & Cowell [38] <sup>A</sup>	Unit A	22
Keith & Cowell [38] <sup>B</sup>	Unit B	21
Keith & Cowell [38] <sup>C</sup>	Unit C	20
Lincoln et al. [39] <sup>1</sup>	1st observation period	15
Lincoln et al. [39] <sup>2</sup>	2nd observation period	15
Lincoln et al. [40] <sup>A</sup>	Stroke unit	39
Lincoln et al. [40] <sup>B</sup>	Conventional Care Unit	37
Mackey et al. [41] <sup>A</sup>	Unit A	8
Mackey et al. [41] <sup>B</sup>	Unit B	8
Pound et al. [42] <sup>A</sup>	Stroke Unit	12
Pound et al. [42] <sup>B</sup>	Elderly Care Unit	12
Pound et al. [42] <sup>C</sup>	General Medical Ward	12
Tinson [43]	Full sample	15
Wellwood et al. [44] <sup>A</sup>	United Kingdom unit	8
Wellwood et al. [44] <sup>B</sup>	France unit	8
Wellwood et al. [44] <sup>C</sup>	Lithuania unit	8
Wellwood et al. [44] <sup>D</sup>	Russia unit	7

<sup>1,2</sup> denote different time periods of observation; <sup>A,B,C,D</sup> denote different locations.

**3.1.4. Physical Activity.** The activity of interest varied across studies; for example, some authors were interested only in the time patients spent inactive [30], while others were interested in the time patients spent engaged in moderate to high activity only [37]. Classification of the type of activity also varied across the included studies. In cases where activity over the entire observation period was not reported, or where observation points were missing due to patients moving away from the ward, we have grouped these together under the category “unobserved or unreported”. In many studies it was not possible to distinguish between moderate and high level activities according to our predetermined categories. However, in all cases it was clear that the activities *at least* met the moderate category; therefore we elected to combine moderate and high level activities into the one category (moderate-high activity) for reporting purposes. We included participation in formal therapy and self-practice

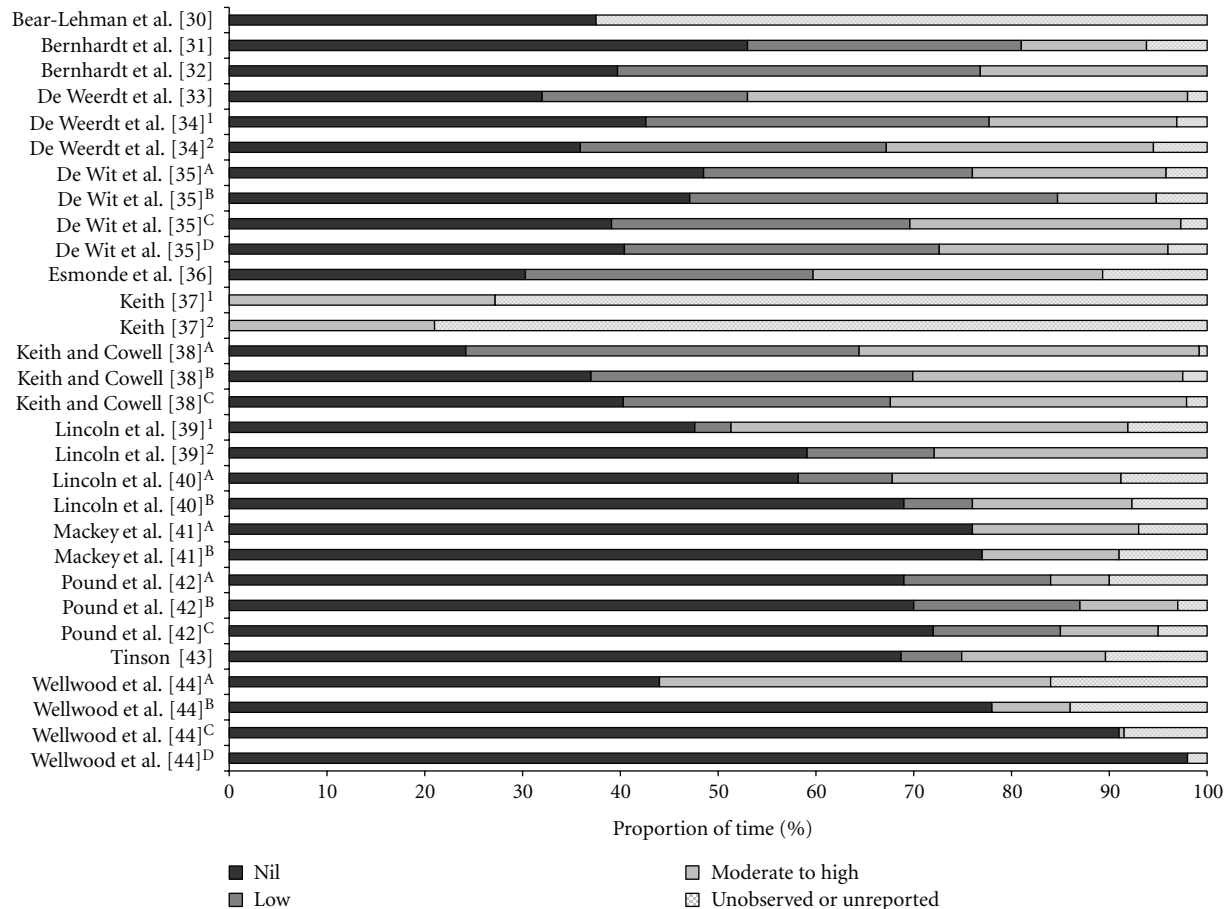


FIGURE 1: Physical activity across the day. 1 and 2 denote different time periods of observation; A, B, C, and D denote different hospital locations.

of therapy exercises in this moderate to high level activity category.

The proportion of time patients spent in the specified activity categories (nil, low, moderate-high) from each study is summarised in Figure 1. Patients were inactive or involved in nontherapeutic activity (nil activity) for between 24.2% and 98.0% of the day, with a median of 48.1% of the day spent inactive (IQR 39.6% to 69.3%). In comparison much less time tended to be spent in low physical activity (median 27.5%, IQR 13.0% to 32.2%) and even less still in moderate to high physical activity (median 21.0%, IQR 12.8% to 27.7%).

**3.1.5. People Present.** The proportion of time patients spent alone was reported for 14 of the 15 behavioural mapping studies. On average, patients were alone for approximately 50% of each observed day (median 53.7%, IQR 44.2%–60.6%) (Figure 2). However time spent alone was lower for two patient groups that took part in group therapy as part of their rehabilitation (17.0% [33] and 24.2% [34]).

Reporting of people present throughout the patient day varied across studies. For example, in some cases each profession was reported separately, such as nursing or physiotherapy; in other cases all therapists were grouped

under the classification of “therapists”. At times all staff were grouped together. We elected to group time with any staff member together under the heading “all treating staff”. Using this classification, treating staff may include nurses, therapists, doctors, psychologists, social workers, and any other health professionals. As not every health professional was represented in the data reports (e.g., four studies reported only time spent with therapists and nursing staff [32–34, 42]) the time spent with “all treating staff” in these studies is likely to be an underestimate. While time spent with treating staff ranged from 9.2% to 45.0% across studies, patients spent a median of 24.0% of the day (IQR 17.3%–31.1%) with a member of the clinical team.

Little time was spent with visitors (median 11.0%, IQR 9.7%–13.1%), apart from three patient groups which spent approximately one quarter of the day with visitors. This included two patient groups admitted to stroke units (23% [42] and 27% [44]) and one patient group admitted to a conventional care unit (25% [44]). Little time was also spent with other patients across studies (median 5.3%, IQR 3.6%–8.9%). However time spent with other patients was much greater for two patient groups which both took part in group therapy as part of their rehabilitation (24.0% [33] and 32.2% [34]).



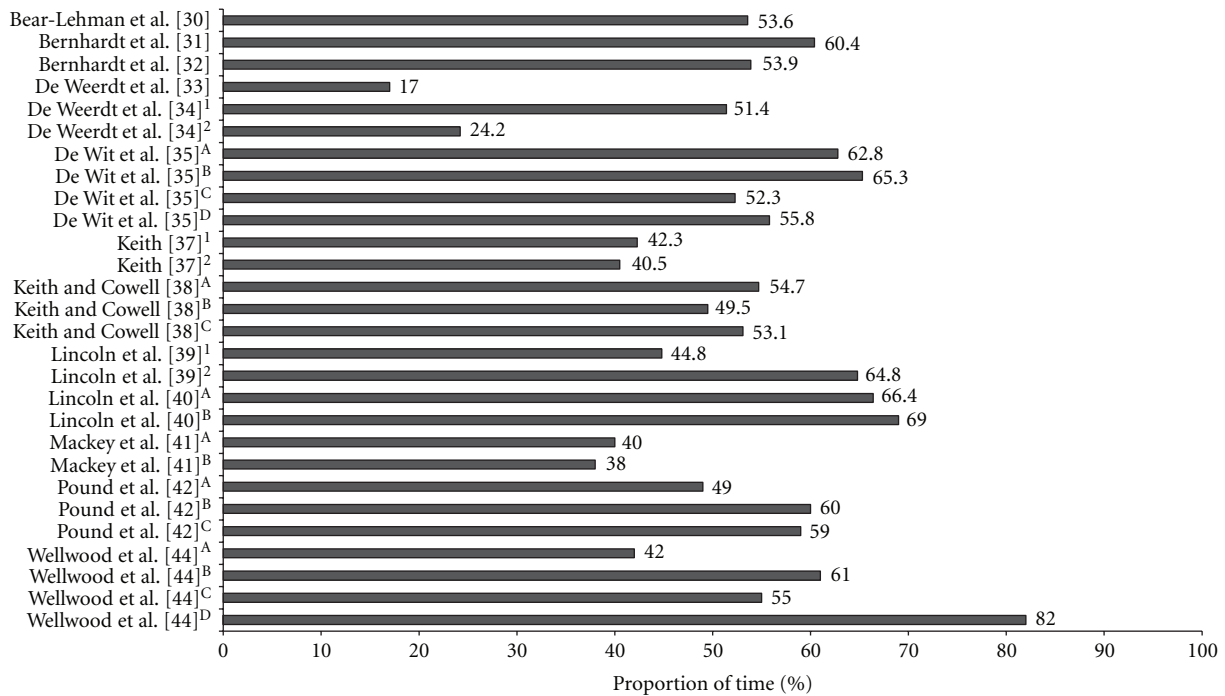


FIGURE 2: Proportion of time spent alone. 1 and 2 denote different time periods of observation; A, B, C, and D denote different hospital locations.

**3.1.6. Patient Location.** Discrepancies in the classification of patient location again made summarising data difficult. One study included time spent in lounge and dining areas with time spent in the bedroom [41], and a number of studies reported different groupings of locations such as bathrooms, corridors, lounge areas, and dining rooms. As illustrated in Figure 3 most studies reported that patients spent a substantial proportion of the day in their bedroom (median 56.5%, IQR 45.2%–72.5%). Very little time was spent in therapy areas (median 6.4%, IQR 3.4%–14.7%). However in a number of studies it was reported that therapy often took place in other areas such as the bedroom, hallway, lounge, or off the ward [32, 37, 39].

**3.1.7. Organisation of Care and Time after Stroke.** Variation in activity, time alone and with others, and location when data were grouped across the different patient settings and from an early time post stroke are presented in Figure 4. Patients within 14 days of their stroke and those managed in conventional care wards appear to spend a greater proportion of the day inactive (median 65.5%, IQR 46.3% to 87.8% and median 71.0%, IQR 69.3% to 86.3%, resp.). They also appear to spend a greater proportion of time alone (median 57.7%, IQR 54.2% to 60.9% and median 60.0%, IQR 59.0% to 69.0%, resp.). Patients admitted to conventional care appeared to spend less time with treating staff (median 15.0%, IQR 15.0% to 22.0%) than those admitted to stroke units or general rehabilitation (Figure 2). There did not appear to be any differences in time spent with staff based on the acuity of stroke. Patients observed within 14 days after stroke appeared to spend the most time by their

bedside (median 82.1%, IQR 78.8% to 85.3%). They were also less frequently observed in therapy areas (Figure 4). The two studies that included details of the time patients within 14 days after stroke spent in therapy areas reported figures of only 0.2% [31] and 3.9% [32] of the day. Patients admitted under stroke unit care appeared to spend the least amount of time bedside (median 49.1%, IQR 35.2% to 62.9%). Patients admitted to general rehabilitation units appeared to spend the most time in the therapy area (median 12.5%, IQR 11.8%–13.3%).

### 3.2. Therapy Specific Activity

**3.2.1. Activity Monitoring Methods.** Ten studies were identified which examined the physical activity undertaken by patients specifically during therapy time (Table 3). Various methods of observation were used to determine patient activity including behavioural mapping, therapist report, and video recording. The number of therapy sessions observed also varied across studies, ranging from single sessions to all sessions across the length of admission. High interrater reliability was reported for the behavioural mapping method in two publications [32, 46]. Reliability was not reported in the remaining behavioural mapping studies, and there were no reports of the validation of mapping procedures. Video recording was also reported to have good interrater reliability in two studies [48, 51] and good intrarater reliability in another study [49], but again validity was not tested. The reliability of the therapist report method was not reported in any publication; however two studies reported that validity had been previously established for this method [32, 46].

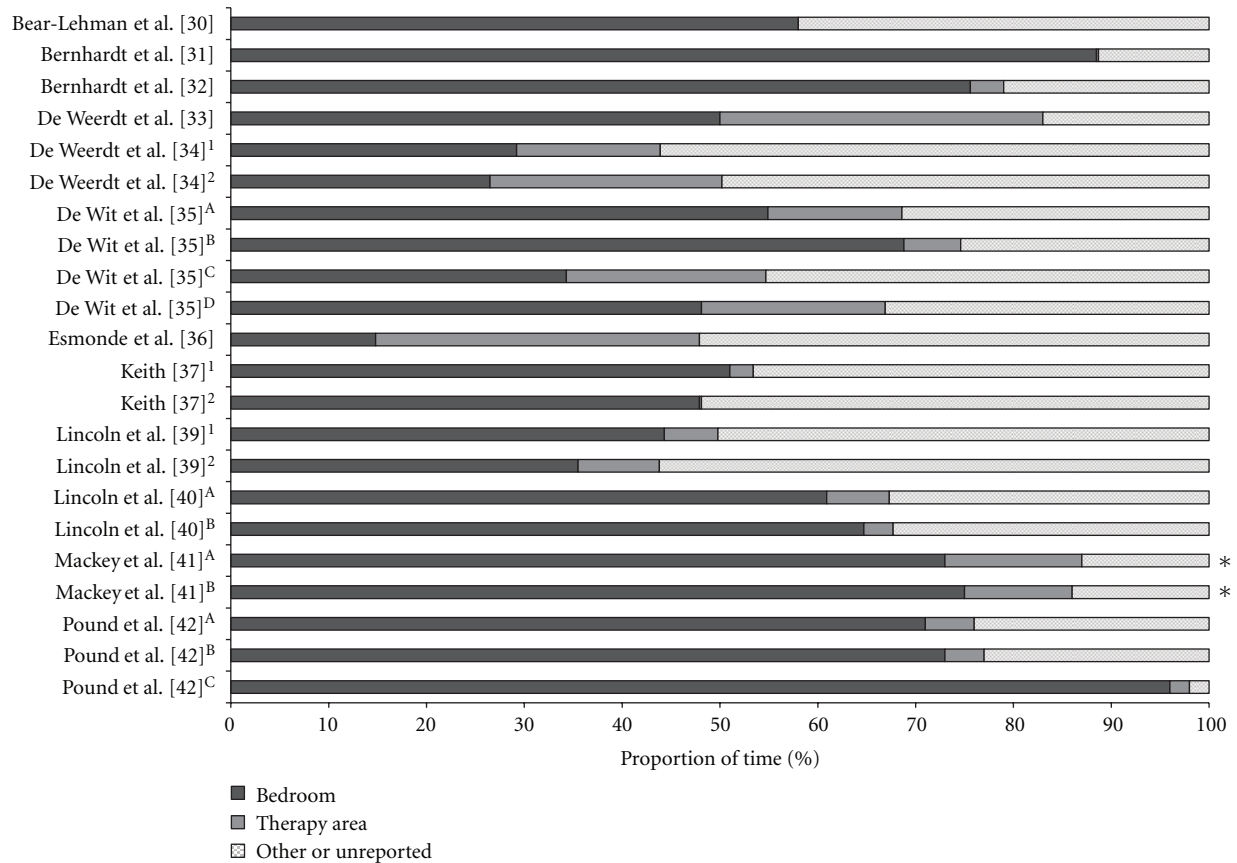


FIGURE 3: Patient location. 1 and 2 denote different time periods of observation; A, B, C, and D denote different hospital locations; \*bedside time includes time in lounge and dining areas.

**3.2.2. Participants Monitored.** Patients were in the “rehabilitation phase” of their stroke recovery in the majority of studies; however once again this concept was not well defined across publications, and the exact time following stroke at the commencement of observation could only be determined from five studies [32, 46, 47, 51, 53]. All studies examining rehabilitation patients were carried out in either mixed rehabilitation units or stroke rehabilitation units. Two studies examined acute stroke patients (within 14 days after stroke) in either acute or comprehensive stroke unit settings [32, 46].

The average ages of patients across the therapy-specific studies ranged from 62.7 to 76.5 years. Stroke severity was again difficult to compare across studies due to the variety of impairment measures used. One study only reported data for less severe strokes during the second week of admission to rehabilitation [47] and in another study patients were excluded if they were unable to walk at least 14 meters with minimal assistance [49], thereby limiting the data to milder strokes for these two studies. In contrast De Wit et al. [48] excluded patients with a low level of motor impairment, thereby excluding the less severe strokes.

**3.2.3. Therapy Settings.** Five studies examined activity during both occupational therapy and physiotherapy sessions, four studies examined physiotherapy sessions alone, and

one study investigated only occupational therapy sessions (Table 3). For the purpose of the current paper, occupational therapy and physiotherapy data are presented separately for each study, with the exception of one study [45] where only pooled therapy data was available (Table 4). Data from individual therapy sessions and from group therapy sessions are also presented separately for one study [49]. Four studies compared different patient groups based on the site where the unit was based or the total length of rehabilitation admission. Where available, the data for each group is presented separately in the current paper however patient groups were excluded where the same group was analysed in a previous study. Sample sizes for each data subset varied from 11 to 972 across the included studies.

**3.2.4. Therapy Intensity.** From the data available in each publication therapy intensity was determined in terms of minutes of therapy per session or minutes of therapy per day (Table 4). In all but one study this was determined separately for occupational therapy or physiotherapy. Median session time was 40.6 (IQR 31.4–45.7) minutes for physiotherapy and 35.8 (IQR 29.8–38.7) minutes for occupational therapy. Patients in the acute phase of stroke tended to have shorter therapy sessions [32, 46] (Table 4). Daily therapy time showed considerable variation for physiotherapy (median 63.2 minutes, IQR 36.0–79.5) and occupational therapy

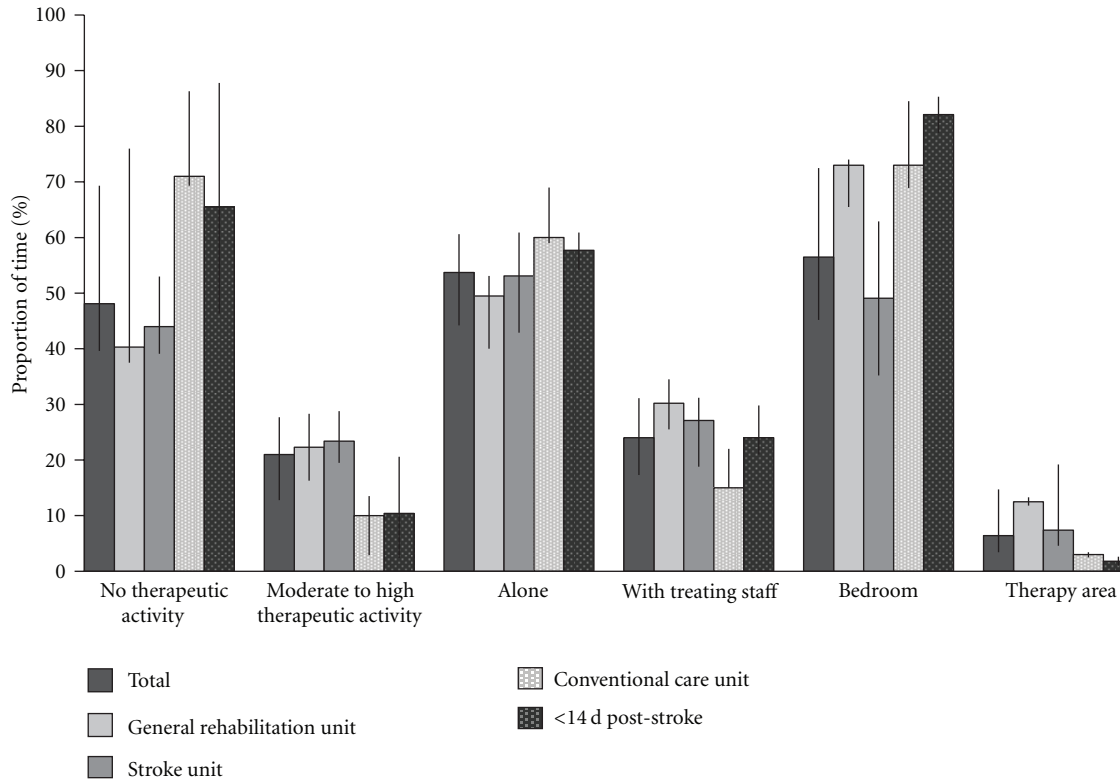


FIGURE 4: Patient activity, people present, and location according to organisation of care and time after stroke. median and IQR.

(median 57.0 minutes, IQR 25.1–58.5). This variation existed even across the acute stroke patients alone, with one study of acute strokes reporting a daily therapy time of only 18.1 minutes of physiotherapy and 10.7 minutes of occupational therapy [46] compared to another study reporting 57.4 minutes per day of physiotherapy [32].

**3.2.5. Therapy Activity.** The type of physical activity undertaken by stroke patients during therapy time was grouped in the same activity categories as for general patient activity. Although data were incomplete in some publications and there were differences in the classification of the type of activity across the included studies, in general it was possible to extract and classify activity into nil, low and moderate-high categories.

Figure 5 illustrates the proportion of time spent in the different activity levels from each study. Although the majority of reported activity in therapy time was in the low and moderate to high categories, in four studies patients were still inactive for more than 20% of therapy time [45, 46, 49, 51]. This included one study where patients were recorded as having nil physical activity for 58% of the therapy session [45]. A greater proportion of time appears to be spent in moderate to high physical activity during physiotherapy sessions compared to occupational therapy sessions.

Only one study focused on patients within 14 days of their stroke, and the proportion of moderate to high physical activity undertaken during therapy time from this study did not appear to be very different from the other studies [46].

**3.2.6. Upper Limb Therapy.** In six of the included publications the proportion of therapy time specifically spent treating the upper limb (Figure 6) was reported. Upper limb treatment time accounted for a median of 16.0% of therapy time (IQR 6.9%–22.9%).

## 4. Discussion

This paper has identified a range of methods applied across a number of hospital settings to monitor physical activity after stroke. Behavioural mapping, using structured observation at regular intervals throughout the day, was commonly employed in these studies and is reported to be reliable. In order to capture “typical” patient activity, all studies carried out mapping during the “usual working day” when patients are most active. In some studies patients were also mapped on weekends and after hours. Observations were most frequently carried out every 10 minutes, suggesting that this time frame was considered frequent enough to minimise missed activity, but not so frequent that observations were no longer feasible. Behavioural mapping was also used to monitor therapy specific activities; however as observations only occur on an intermittent basis, video recording and therapist report were also used and may provide a more accurate means of evaluating physical activity during formal therapy time.

Despite the similarity in activity monitoring procedures, there was large variation across publications in the way in which activity was categorised. Classification of the locations



TABLE 3: Therapy-specific activity studies.

Study	Method	Procedure	Therapy	Patient type	Organisation of care	<i>n</i>
Ada et al. [45]	Behavioural mapping	Every 10 mins for all sessions across 3-4 weekdays	PT and OT	Rehabilitation inpatients	GRU	16
Bernhardt et al. [46]	Behavioural mapping and therapist report	Mapping every 10 mins plus therapist report, for all sessions across 2 weekdays	PT and OT	Acute inpatients	SU	58
Bernhardt et al. [32] <sup>a</sup>	Behavioural mapping and therapist report	Mapping every 10 mins plus therapist report, for all sessions over 1 weekday	PT	Acute inpatients	SU	37
Bode et al. [47] <sup>b</sup>	Therapist report	All therapy sessions across admission recorded, but data only reported for 2nd week	PT and OT	Rehabilitation inpatients	GRU	101
De Wit et al. [48]	Video recording	Single OT and single PT session	PT and OT	Rehabilitation inpatients	SU	60
Elson et al. [49]	Video recording	Single individual session and single group session	PT	Rehabilitation inpatients	GRU	15
Jette et al. [50]	Therapist report	All therapy sessions across admission	PT	Rehabilitation inpatients	GRU	972
Kuys et al. [51]	Video recording and heart rate monitoring	Single session	PT	Rehabilitation inpatients and outpatients	GRU	30
Latham et al. [52]	Therapist report	All therapy sessions across admission	OT	Rehabilitation inpatient	GRU	954
McNaughton et al. [53] <sup>c</sup>	Therapist report	All therapy sessions across admission	PT and OT	Rehabilitation inpatient	GRU	130

<sup>a</sup>Data for Trondheim patients only; <sup>b</sup>data for less impaired patients only, during second week of inpatient rehabilitation admission; <sup>c</sup>data for New Zealand patients only; GRU: general rehabilitation unit (includes mixed rehabilitation units); SU: stroke unit (includes acute stroke units, comprehensive stroke units and stroke rehabilitation units); OT: occupational therapy; PT: physiotherapy.

in which activity took place, as well as the people with whom it took place also varied across studies. This variation made comparison of patient activity across studies difficult and required us to make a number of assumptions when extracting data. Recreation, relaxation, and leisure activities were classified as nontherapeutic in terms of physical activity since recreation was commonly described as including activities such as reading, watching TV, watching others, and social interaction [42, 43]. Furthermore, patients were assumed to be in sitting when being transported or involved in self-care, which is commonly the case, and were therefore classified in the low activity category. Formal therapy and self-exercise described in five of the general activity studies [33–38] was classified in the moderate to high level activity category, since the majority of therapy time was spent with physiotherapists and occupational therapists who focus largely on physical function. However, data from the therapy-specific studies suggests that a considerable amount of therapy may have taken place with the patient involved in low or even no physical activity. It is not surprising that a proportion of therapy time is spent with patients inactive (during rest) or engaged in low levels of physical activity. The assumption that all ‘formal therapy and self-exercise’ was at a moderate to high level is likely to have resulted in a small overestimate of overall activity across the day. Within

the therapy-specific studies in which therapy content was often reported, we classified impairment-focused therapy such as stretching, passive movements, selective movement facilitation, strengthening, and balance work as low physical activity and therapy described only as functional activity as moderate to high physical activity. This seems a very reasonable approach to classification of activity within therapy in the face of poor definition; nevertheless, it is also possible that the classification assumptions led to over- or underestimation of patient activity.

The use of assumptions to help summarise available data is not ideal. It became apparent early in the conduct of this paper that there is an urgent need for researchers to provide clear description of the activities observed, or better still, for the development and use of a standard classification system for physical activity categories for people after stroke. Such a system should probably be based to a larger extent on how hard the patients must work to engage in different levels of activity and include energy expenditure expressed as METS. However, while such a classification system exists in healthy subjects [54], further research on the energy expenditure of people with stroke during activity at different stages in recovery is needed. Until then, activity classification, particularly of observed activity, will continue to rely on clinical judgment.

TABLE 4: Therapy activity patient groups and therapy intensity.

Study	Therapy	Patient group	Setting	<i>n</i>	Minutes per session	Minutes per day
Ada et al. [45]	PT and OT	Full sample	Rehabilitation	16		64.0
Bernhardt et al. [46]—PT	PT	Full sample	Acute	58	24.5	18.1
Bernhardt et al. [46]—OT	OT	Full sample	Acute	58	22.8	10.7
Bernhardt et al. [32]	PT	Trondheim	Rehabilitation	37	27.6	57.4
Bode et al. [47]—2 wks PT	PT	2 week admission	Rehabilitation	34		69.0
Bode et al. [47]—3 wks PT		3 week admission	Rehabilitation	27		93.0
Bode et al. [47]—4 wks PT		4 week admission	Rehabilitation	19		93.0
Bode et al. [47]—5 wks PT		5 week admission	Rehabilitation	11		75.0
Bode et al. [47]—2 wks OT	OT	2 week admission	Rehabilitation	34		57.0
Bode et al. [47]—3 wks OT		3 week admission	Rehabilitation	27		57.0
Bode et al. [47]—4 wks OT		4 week admission	Rehabilitation	19		69.0
Bode et al. [47]—5 wks OT		5 week admission	Rehabilitation	11		60.0
De Wit et al. [48]—B, PT	PT	Belgium	Rehabilitation	15	46.0	
De Wit et al. [48]—UK, PT		United Kingdom	Rehabilitation	15	43.0	
De Wit et al. [48]—S, PT		Switzerland	Rehabilitation	15	44.8	
De Wit et al. [48]—G, PT		Germany	Rehabilitation	15	33.0	
De Wit et al. [48]—B, OT	OT	Belgium	Rehabilitation	15	36.4	
De Wit et al. [48]—UK, OT		United Kingdom	Rehabilitation	15	35.2	
De Wit et al. [48]—S, OT		Switzerland	Rehabilitation	15	40.4	
De Wit et al. [48]—G, OT		Germany	Rehabilitation	15	28.0	
Elson et al. [49]—indiv PT	PT	Individual therapy	Rehabilitation	15	30.9	
Elson et al. [49]—group PT		Group therapy	Rehabilitation	15	52.7	
Jette et al. [50]	PT	Full sample	Rehabilitation	972	51.6	
Kuys et al. [51]	PT	Full sample	Rehabilitation	30	39.4	39.4
Latham et al. [52]	OT	Full sample	Rehabilitation	954	38.1	41.9
McNaughton et al. [53]—PT	PT	New Zealand	Rehabilitation	130		15.3
McNaughton et al. [53]—OT	OT	New Zealand	Rehabilitation	130		6.9

OT: occupational therapy, PT: physiotherapy.

Regardless of these limitations some consistent trends in patient activity were revealed across the studies reviewed. A large proportion of stroke inpatient time is spent inactive or involved in nontherapeutic activity. Comparatively little time appears spent involved in moderate to high level physical activities such as standing and walking. Additionally hospitalised stroke patients tend to spend most of their time alone and in their bedroom area. Although few studies investigated patients in the acute phase of their stroke, it appears that this lack of activity and isolation are especially prevalent for patients within 14 days of stroke compared to those at later stages of recovery. The current paper suggests that hospitalised stroke patients are involved in an average of approximately one hour per day of formal physiotherapy and one hour per day of formal occupational therapy. Even during this time it was reported in a number of studies that patients were involved in little or no physical activity for part of the session. Patients frequently spent less than half their therapy time involved in moderate to high physical activities such as standing and walking, and even less time was spent on therapy for the upper limb.

It appears that patient activity may be influenced by the organisation of care. Patients admitted to conventional care units such as general medical wards, elderly care units, or

general neurology wards appeared to be inactive, alone, and in their bedroom area for longer than patients admitted to stroke units or general rehabilitation units. Patients admitted to stroke units appeared to spend the most time involved in moderate to high physical activity and the least time located in bedside areas when compared with patients admitted to conventional care or general rehabilitation. These apparent differences however may be simply due to case-mix variation across the different samples studied. Further comparison across settings could provide insights into the barriers or facilitators to activity in different organisational settings. However this would require standard data to be available from each study to allow for adjustment for important patient and setting factors that may influence activity. The absence of even a common measure of stroke severity across studies hampered further exploration of these data.

Patients did appear to be more active during formal therapy time, and it is tempting to suggest that increasing the time spent in formal therapy may help to increase physical activity in hospitalised stroke patients. Group therapy may be one approach to increasing formal therapy time. Patients participating in group therapy were found to be involved in more formal therapy and more physical activity [33, 34, 37, 49] and to spend less time alone [33, 34]; however

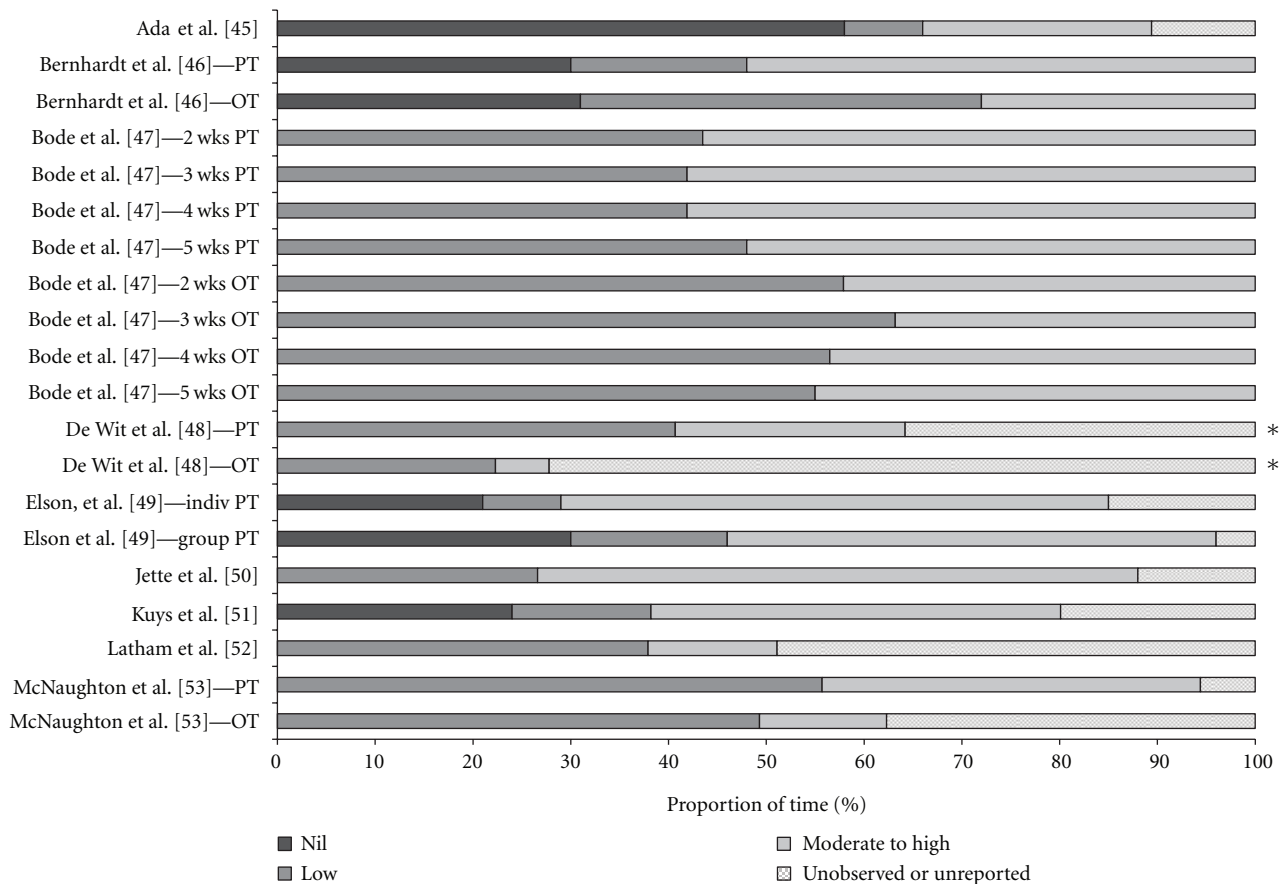


FIGURE 5: Therapy activity. \*Data pooled across sites by authors of original study.

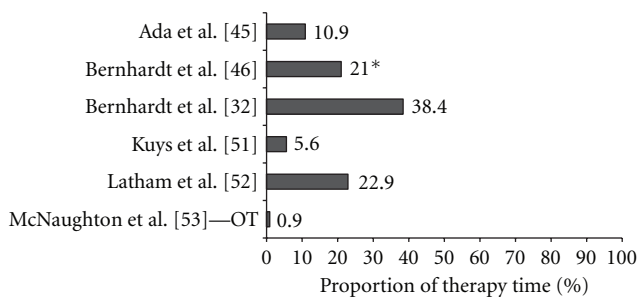


FIGURE 6: Upper limb therapy. \*Affected upper limb use across physiotherapy, occupational therapy, and speech therapy time.

the proportion of time spent in high level activities such as walking was reported to be lower during group therapy than in individual sessions [49]. More structured therapy sessions with a formal schedule were also suggested as a means of increasing therapy time [35, 37]; however Mackey et al. [41] found that this made no difference to overall patient activity. In reality, we do not know the optimal dose or intensity of activity that stroke patients should engage in during the hospitalised phase of their care to help their recovery. Nevertheless, the low levels of physical activity commonly found in these studies suggest that more could be done.

Increasing formal therapy time is only one way in which physical activity could be improved. Greater involvement of nontherapy staff, particularly nursing staff, in facilitating patient activity may help to increase physical activity in hospitalised stroke patients [32, 43]. This may be promoted through the education and training of nontherapy staff in facilitating patient activity [32, 40] and through therapists working together with other staff [32].

The current paper found that a median of less than one quarter of patient time was spent with treating staff. A number of authors suggest that increasing self-directed patient activity could be another means of increasing physical activity [29, 30, 33, 39, 40, 43]. Greater self-directed activity may be encouraged with patient education and instruction in self-directed exercises [30, 35] and activity diaries [29, 43]. Environmental modifications to promote self-directed activity are recommended [32, 35–38]. In addition greater family involvement [29, 33, 36, 40, 43] and the introduction of an activities coordinator [29, 39] are also suggested to assist with self-directed activity.

## 5. Conclusions

Physical activity is commonly monitored in hospitalised stroke patients using behavioural mapping which is easy to

conduct and which provides a rich source of data across a day. The use of accelerometers, step counters, and other devices is becoming more frequent and may provide more accurate monitoring of activity after stroke, although their reliability, accuracy in very low functioning patients, ease of use, and the comfort of patients when wearing the device need to be considered. Unlike accelerometers, observation also provides the researcher with information about the location of patients when they are active and who was with them during the activity. This paper has shown however that considerable improvements to how activity is described and classified would greatly improve our ability to compare activity across populations, settings, or time points in the recovery pathway. This paper has highlighted that many patients are inactive and alone while in hospital, and while we have summarised suggestions as to how patient activity can be increased, the importance of improving activity levels and the effectiveness of interventions to increase physical activity after stroke need to be tested further.

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