Are changes in upper extremity use during sub-acute rehabilitation after stroke associated with physical, cognitive, and social activities? An observational cohort pilot study

Gohlke, Jacob; Juul-Kristensen, Birgit; Brunner, Iris

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Are changes in upper extremity use during sub-acute rehabilitation after stroke associated with physical, cognitive, and social activities? An observational cohort pilot study

Abstract

Objectives: To investigate how changes in physical, social, and cognitive activity levels are associated with use of the affected upper extremity at different time points during inpatient rehabilitation after stroke.

Methods: In an observational longitudinal cohort pilot study activity of 14 patients with subacute stroke were registered 2-4 times during their inpatient rehabilitation from 2 pm to 8 pm. At the same time, patients wore accelerometers on both wrists to register amount of use and use ratio of the affected to the unaffected upper extremity. Before and after the observation period patients were assessed with Action Research Arm Test, Box and Blocks Test and Functional Independence Measure. Linear regression models were used to examine the influence of different categories of activities and motor function levels on affected upper extremity use.

Results. Increasing physical activity levels during rehabilitation and improvement in upper extremity motor function were associated with increased use of the affected upper extremity. Cognitive and social activity levels did not change and were not associated with affected upper extremity use.

Conclusion. Our findings suggest that the use of the affected upper extremity and a general increase in activity are associated. Facilitating both general physical activity and specific upper extremity use at a rehabilitation ward may benefit overall recovery.

Keywords

Stroke; rehabilitation; arm and hand, activity monitoring; behavioral mapping; accelerometry, physical activity
Background

Globally, around 13.6 Million people suffer from stroke every year (Feigin, Norrving, & Mensah, 2017). Two-thirds of them are left with lasting disabilities of their affected upper extremity (UE) (Kwakkel & Kollen, 2007).

In the first month after stroke the most pronounced improvements of the affected UE occur (Zeiler & Krakauer, 2013). Thereafter, the rate of improvement in motor and functional recovery decreases, but stroke survivors still experience significant improvements up to three months after stroke (Verheyden et al., 2008) and reorganization of the brain occurs even beyond the first months (Rossini, Calautti, Pauri, & Baron, 2003) However, motor function improvements are not necessarily reflected by spontaneous use of the affected UE either during inpatient rehabilitation or after discharge.

While Shim et al. found that patients with good recovery used their affected UE more than patients with only moderate recovery, other studies reported discrepancies between affected UE recovery and use (Shim, Kim, & Jung, 2014). In a study by Rand & Eng, there was no increase in daily use of the affected UE during inpatient rehabilitation, despite significant improvement in affected hand function (Rand & Eng, 2012). Furthermore, in a longitudinal study Rand & Eng found that the unaffected UE was used 3 times more than the affected UE one year after stroke (Rand & Eng, 2015).

Affected UE use has been frequently assessed with the help of wrist-worn accelerometers, which collect objective data of UE use (Bailey, Klaesner, & Lang, 2015). From these data, the use-ratio can be calculated, a measure of the affected UE use relative to the unaffected UE use (Lang, Waddell, Klaesner, & Bland, 2017). The use-ratio is largely independent of overall physical activity, but strongly correlated with other measures of affected UE use, making it a valid measure of real-world affected UE use (Uswatte et al., 2006). To achieve a normal use-ratio, the hours of affected UE should be approximately 95% of the unaffected UE activity (Bailey & Lang, 2013).

While accelerometers are only able to register physical activity, direct observation methods have been developed to capture other aspects of activity. Behavioral Mapping is a specific registration tool to capture physical, cognitive and social activity (Janssen et al., 2012). Individual patients are observed at regular intervals and the kind of activities they are engaged in, location, and people present are registered. (Fini, Holland, Keating, Simek, & Bernhardt, 2015) In previous studies, where Behavioral Mapping was applied, it was demonstrated that patients with stroke were rather inactive during their stay at rehabilitation units (Bernhardt, Dewey, Thrift, & Donnan, 2004). Long periods during waking hours were spent in bed, sedentary and alone (Fini, Holland, Keating, Simek, & Bernhardt, 2017; Janssen et al., 2014; Sjoholm et al., 2014). Patients were more active, when their family was present, implying that social activity may influence physical activity (Bernhardt, Chitravas, Meslo, Thrift, & Indredavik, 2008).

The aim of this study was to investigate, how physical, social, and cognitive activity levels are associated with use of the affected UE at different time points during inpatient rehabilitation.
We hypothesized that participation in physical and social activity would be associated with an increase in affected UE use.

The secondary aim was to investigate, how UE use-ratio and physical, social, and cognitive activity levels changed over time. We hypothesized that affected UE use and physical activity levels would increase over time.

Method

Design and setting

This study is an observational longitudinal cohort pilot study. Patients in the subacute phase, within six months after stroke (Bernhardt et al., 2017) were followed during their inpatient rehabilitation stay from admission to discharge. Data from 14 patients collected during inpatient rehabilitation from June 2017 to February 2018 are presented. The study was conducted at a designated ward at XXXXX Neurocenter and University Research Hospital in XXXXXX. The ward has 13 beds for adults with acquired brain injury, and rehabilitation is provided by a multidisciplinary team.

Eligibility criteria

Data were collected from a random convenience sample of patients admitted for rehabilitation. To allow for sufficient data collection patients with confirmed single ischemic or hemorrhagic stroke or a former stroke without motor residuals were screened for eligibility by an investigator, if they had a planned estimated length of stay for more than 16 days. They were included if they suffered from impaired UE function, defined as < 57 on Action Research Arm Test (ARAT) (Platz et al., 2005). Patients were excluded, if they had severe cognitive disorders according to neuropsychological assessment and / or defined as < 20 on Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005). Further exclusion criteria were pre-stroke conditions that substantially limited the use of the UEs.

All patients provided informed written consent and the study was approved by the Regional Ethical Committee of Central Jutland, registration number 1-10-72-403-17.

Observation, activity monitoring and assessments

Patients were observed, and their activities systematically registered with Behavioral Mapping (BM) on two to four occasions during their inpatient rehabilitation stay (Miller & Keith, 1973). On the same day, patients were asked to wear accelerometers (ActiGraph wGT3X-BT) on each wrist. Both measures were taken from 2 p.m. to 8 p.m. on weekdays. This period was chosen, because most of the day’s rehabilitative training was completed. On an average weekday, there would be only one more therapeutic activity during this period, either physiotherapy or occupational therapy or group training for ca. 60 minutes duration including transfers. There was a higher probability of registering spontaneous and not therapist-initiated use of the affected UE.
Assessments with physical and functional outcome measures were conducted twice, the first time after inclusion to the study, shortly before the first observation, and the second time before discharge from the ward. Assessors were unaware of any observation data. At baseline, also data on cognitive function and depression were collected.

**Outcome measures**

**Primary outcome**

The primary outcome was the ratio between affected and unaffected UE use (use-ratio) based on accelerometry and its change over time (Lang et al., 2017). Accelerometers (ActiGraph, wGT3X-BT; ActiGraph LLC, Pensacola, FL) were set at sampling rate of 50 Hz and placed on both wrists by an investigator, at the beginning of the observation period, and removed by staff afterwards.

Accelerometers record accelerations along three axes of UE movement. These data are combined into a vector magnitude, which gives a single value of the amount of acceleration that occurred at an instant in time (Hayward et al., 2016). These instants in time were integrated over a one second epoch and analyzed using ActiLife Software. Seconds of movement were converted into hours and minutes of UE activity for the affected and unaffected UEs. To calculate the use ratio, the hours of affected UE use were divided by the hours of unaffected UE use (Lang et al., 2017). The use ratio is expressed by a value between 0 and 1. A value of 1 indicates equal use of the UEs, while a value of 0 indicates no use of the affected UE (Lang et al., 2017). Use-ratio is a valid measure of real-world affected UE use (Lang, Wagner, Dromerick, & Edwards, 2006; Uswatte et al., 2006). It has adequate reliability and it is responsive to change in UE function in stroke patients (Uswatte et al., 2006; Urbin, Waddell, & Lang, 2015).

**Secondary outcomes**

Secondary outcomes were physical, cognitive, and social activity levels using behavioral mapping (Janssen et al., 2014). Behavioral mapping is an observational method that involves observation of an individual at regular 10-minute intervals. The observer records patient type of activity, location and people present (Fini et al., 2017). Behavioural mapping has good validity over short periods of time (Bernhardt et al., 2004). It has a high test-retest reliability and a good to very high inter-rater reliability for the categories; activity, location and people present (Bernhardt et al., 2004; de Weerdt et al., 2000; Keith & Cowell, 1987). The protocol applied by Janssen et al. (Janssen et al., 2014) was slightly modified to include categories such as body position, (standing, sitting, walking), and the UE involvement (affected, non-affected, bimanual). According to the original protocol, activities were divided into physical, social and cognitive activities. Physical activity was defined as any purposeful physical movement, including activities of daily living (ADL), personal activities of daily living (PADL), active participation in transfers, mobilizing, repositioning in bed and activity during therapy (Janssen et al., 2014). Cognitive activity was defined by any non-physical mental activity, where the patient was observed actively engaging in a mental task (Janssen et al., 2014). This category
included reading, writing/art, board games, virtual games/Wii, computer and music. Watching television was not classified as a cognitive activity.

Social activity was defined as any interaction, which involved verbal communication and / or physical contact with people present or through mobile/tablet/skype (Janssen et al., 2014).

Patients were observed every 10 minutes in a pre-defined order for a duration of approximately one minute. This resulted in a total of 37 possible observations per observation day. Observations were performed as inconspicuous as possible to avoid influencing patient behavior. In case the patient was not directly observed, the estimated activity was recorded after conferring with medical staff or visitors. Patients were marked as unobserved, if estimation of activity was not possible. Missing observations were deleted from the total number of observations made for that patient. The total amount of activity was calculated by counting the number of observations of the given activity per observation day and dividing it by the total number of times, the patient was observed that day. This was multiplied by 100 to give a percentage of how many times the patients were active relative to the total amount of observations that day.

Before the observation UE motor function and dexterity were assessed with Action Research Arm Test (ARAT) and Box and Blocks Test (BBT), respectively, while independence in activities of daily living was assessed with Functional Independence Measure (FIM) (Ottenbacher, Hsu, Granger, & Fiedler, 1996; Platz et al., 2005). Hours and minutes of affected UE use and unaffected UE use was further chosen as secondary outcome.

Baseline data on cognitive function was collected using the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005). Psychological distress was assessed with the Hospital Anxiety and Depression Scale (HADS) (Mykletun, Stordal, & Dahl, 2001). HADS is a frequently used scale for self-reported anxiety and depression. It was included because psychological distress may influence activity levels.

**Statistical Analysis**

Data was found to be normally distributed. Baseline characteristics of the patients are presented as mean, median or quantity (N), with proportions, IQR or 95% Confidence Intervals (CI). SD, maximum and minimum values are presented for data on ratio/interval-and ordinal-level. Potential missing data are assumed to be missing at random, independent of the actual values. If data on covariates were missing for an individual, he/she was discarded from the analysis.

The change in function levels from baseline to follow-up for ARAT, BBT, and FIM was calculated and tested for significance using a paired t-test. Data are presented as means with 95 % Confidence Intervals (95% CI), Standard Deviations (SD) and p-values.

The dataset was longitudinal and is considered as 2-level data, where measurement occasions (level 1) are clustered within individuals (level 2) (Simonoff, Scott, & Marx, 2013). Therefore, a multilevel statistical model was chosen, as the dataset was unbalanced the specific linear mixed effects model (using the xtmixed command) was chosen.
association between use-ratio and physical, cognitive and social activity levels was calculated in three separate models, using the use ratio as the dependent variable, and either physical, social and cognitive activity levels as fixed parts (one at a time). All models were adjusted for time since stroke in months, baseline NIHSS and ARAT. The random part consisted of random intercepts.

A secondary analysis for each secondary outcome was performed to analyze the change in secondary outcomes over time (use ratio, physical activity, social activity, cognitive activity, affected UE use and unaffected UE use). In each model the outcome in question was chosen as the dependent variable, and the fixed part consisted of time since stroke in months, adjusted for baseline NIHSS, ARAT and affected arm dominance. The random part consisted of random intercepts. The outcomes of the fixed part of the models are presented as coefficients with standard errors, p-values and 95% confidence intervals.

Statistical significance is generally set to be (p=0.05). Data were analyzed with STATA (ver. 15.0 StataCorp).
Results

*Please insert Figure 1 here*

A total of 16 patients were included in the study, two patients dropped out before or during the first observation, see flowchart Figure1. The 14 remaining patients completed a minimum of two observations, and they were followed from a period from 10 days to 4.5 months since stroke, with a mean of 1.6 months of follow up (SD=1.22). At baseline the patients had a mean time from stroke to first assessment of 31.1 days (95% CI; 10.7-51.4), a mean age of 59.5 (95% CI; 53.3-65.7). Baseline characteristics are presented in Table 1.

Physical activity levels had a significant impact on UE use ratio, which increased with higher physical activity levels. The use ratio increased with 0.0036 (95% CI; 0.001-0.006) per 1 % increase in physical activity levels (p=0.001). Cognitive and social activity levels did not impact use ratio (table 2).

**Change in secondary outcomes over time**

UE use ratio increased with 0.11 (95% CI; 0.05-0.17) per month since stroke onset (p=<0.001). Physical activity levels increased with 11 % (95% CI; 3.2-18.8) per month since stroke onset (p=0.006), but there was no increase in social or cognitive activity levels over time. The amount of unaffected UE use increased with 0.22 hours (95% CI; 0.07-0.37) per month since stroke onset (p=0.003), where the amount of affected UE use increased with 0.39 hours (95% CI; 0.24-0.54) per month since stroke onset (p=<0.001) (Table 3).

**Changes in function**

Functional levels increased significantly from baseline to follow-up. Patients experienced an increase in arm motor function (ARAT) of mean 13.9 points (95% CI; 5.5-22.4) (p=0.003). Correspondingly, hand dexterity (BBT) improved significantly, (p=0.002) and independence in activities of daily living (FIM) increased (p=0.005), for details see Table 4.
Discussion

In this pilot study, we found that increasing physical activity levels during rehabilitation were associated with increased use of the affected UE. This is an interesting finding, as it suggests, that the use of the affected UE can be increased, if the patients are more physically active in general.

This change occurred simultaneously with significant improvement in function levels as assessed with ARAT, BBT and FIM. Improved function is expected, as most of the spontaneous recovery tends to occur within the first 3 months after stroke onset (Cramer, 2008). In this study, most patients experienced an improvement of arm motor function, dexterity and independence in activities of daily living, which provides the opportunity and ability to be more active at discharge. This is in contrast with a previous study, where improved UE motor function did not translate into increased affected UE use (Rand & Eng, 2012). One of the reasons may be that the expectancy to be as independent as possible may have led to compensation by the unaffected limb. The fact that our patients improved both functional independence and affected UE use may suggest a greater awareness of the importance of affected UE use among patients and staff.

Hidaka et al. showed in a data driven model, that the amount of affected UE use in a prior time point had a positive effect on achieved affected UE function in a later time-point, measured from hospitalization to 2 years post stroke (Hidaka, Han, Wolf, Winston, & Schweighofer, 2012). Consequently, if a higher level of physical activity would encourage UE use, or vice versa, opportunities for more physical activity during rehabilitation should be offered. Since this is an observational study, we cannot rule out an inverse covariance, i.e. that increased use of the affected UE may result in in more general physical activity. Either way, facilitating general or specific UE activity may benefit overall recovery. Environmental enrichment during rehabilitation has further been shown to increase physical activity (Rosbergen et al., 2017).

In this study, we found no association between UE use ratio and social or cognitive activity. The patients had generally low levels of cognitive activity, accounting for only 9.6 % of the total observations. This could be attributed to the way cognitive activity is conceptualized in BM, e.g. as not comprising conversations and TV, which in some cases could be considered cognitive activities.

Social activity levels contributed to around 37.6 % of the observed activities in patients but did not change during hospitalization. This is in line with a previous study, where the patients were socially active for around 32 % of the observed day and no change in social activity levels were found over during hospitalization (Janssen et al., 2014). A recent study demonstrated that social activity can be increased by providing scheduled communal activities (Rosbergen, Grimley, Hayward, & Brauer, 2018).

The main limitation of this pilot study is the small sample size of 14 patients. Patients were observed with different intervals between observations and a difference in the number of observations. The primary reason for this was the observations with behavioral mapping, as they were very time and labor intensive (Fini et al., 2015).

Another limitation of behavioral mapping is the low sampling rate of 10 min., where there is an underlying assumption that the observed activity was continued until the next observation. (Fini et al., 2015) This could over or under-estimate the activity levels. Continuous monitoring of patients could overcome this bias, but due to limited resources this was not possible.
The presence of an observer may potentially have modified patient behavior (Skarin et al., 2013). This could lead to an overestimation of activity levels, as these would increase in the presence of the observer (Skarin et al., 2013). However, observations were made as unobtrusive as possible.

The positive influence of physical activity on UE use ratio could partly be explained by the categorization of physical activity in behavioral mapping. The amount of UE activity (bimanual, affected UE and unaffected UE use) is included in overall physical activity levels. Both accelerometry of the UEs and behavioral mapping measure some of the same aspects of physical activity. Consequently, an increase in the affected UE use would be registered by both measurement methods, which could lead to a falsely higher association. However, behavioral mapping consists of many other elements of physical activity such as walking and transfers, which is not measured by the accelerometer derived use ratio.

While accelerometry provides objective data of UE use and use ratio affected by the presence of an observer, it cannot differentiate between purposeful and non-purposeful movements and does not account for the quality of the movement or the context of the movement (Hayward et al., 2016). This makes it difficult to interpret, which UE movements the patients perform, in which context or with which purpose (Fini et al., 2015). Therefore, a combination of BM and accelerometry provides some insight in which factors may facilitate affected UE use.

**Implications for Physiotherapy Practice**

In this study, we found an association between UE use ratio and physical activity levels in hospitalized stroke patients. There was no association between UE use ratio and social or cognitive activity levels. Both UE use ratio (affected UE use) and physical activity levels increased significantly over time. This could indicate that affected UE use can be increased by facilitating general physical activity during rehabilitation, e.g. through group activities. Larger studies would be needed to confirm these preliminary findings.

**Disclosure statement**

The authors report no conflict of interest.
References


evidence from the extremity constraint-induced therapy evaluation trial. *Archives of Physical Medicine and Rehabilitation, 87*(10), 1340-1345. doi:10.1016/j.apmr.2006.06.006


Table 1: Baseline Characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Median/Mean/N</th>
<th>Proportion (%)/(IQR)/(CI)</th>
<th>Max</th>
<th>Min</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male)</td>
<td>7</td>
<td>50.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Age</td>
<td>59.5</td>
<td>(53.3-65.7)</td>
<td>74</td>
<td>43</td>
<td>10.8</td>
</tr>
<tr>
<td><strong>Stroke type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infarction</td>
<td>11</td>
<td>78.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>3</td>
<td>21.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Time since stroke to first assessment (days)</strong></td>
<td>31.1</td>
<td>(10.7-51.4)</td>
<td>127</td>
<td>8</td>
<td>35.2</td>
</tr>
<tr>
<td><strong>Dominant arm before stroke (right)</strong></td>
<td>14</td>
<td>100.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>NIHSS acute</strong></td>
<td>10.5</td>
<td>[5-18]</td>
<td>34</td>
<td>1</td>
<td>8.9</td>
</tr>
<tr>
<td>NIHSS mild (≤8)</td>
<td>6</td>
<td>42.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NIHSS moderate (8-16)</td>
<td>4</td>
<td>28.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NIHSS severe (&gt;16)</td>
<td>4</td>
<td>28.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>mRS inclusion</td>
<td>4</td>
<td>[3-4]</td>
<td>2</td>
<td>4</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Use-ratio</strong></td>
<td>0.54</td>
<td>(0.4-0.7)</td>
<td>0.19</td>
<td>1.41</td>
<td>0.34</td>
</tr>
<tr>
<td><strong>Affected UE use (hours)</strong></td>
<td>1.12</td>
<td>(0.8-1.4)</td>
<td>0.25</td>
<td>2.44</td>
<td>0.55</td>
</tr>
<tr>
<td><strong>Unaffected UE use (hours)</strong></td>
<td>2.16</td>
<td>(1.9-2.4)</td>
<td>1.32</td>
<td>3.10</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Physical activity (%)</strong></td>
<td>34.9</td>
<td>(28.2-41.6)</td>
<td>18.9</td>
<td>62.2</td>
<td>12.8</td>
</tr>
<tr>
<td><strong>Social activity (%)</strong></td>
<td>36.7</td>
<td>(28.8-45.1)</td>
<td>10.8</td>
<td>62.2</td>
<td>15.9</td>
</tr>
<tr>
<td><strong>Cognitive activity (%)</strong></td>
<td>8.34</td>
<td>(4.8-11.9)</td>
<td>0.00</td>
<td>27.0</td>
<td>6.73</td>
</tr>
<tr>
<td><strong>ARAT</strong></td>
<td>27.9</td>
<td>(14.6-41.1)</td>
<td>53</td>
<td>0</td>
<td>23.0</td>
</tr>
<tr>
<td><strong>BBT</strong></td>
<td>18.1</td>
<td>(7.6-28.5)</td>
<td>49</td>
<td>0</td>
<td>18.1</td>
</tr>
<tr>
<td><strong>FIM</strong></td>
<td>86.8</td>
<td>(71.2-102.3)</td>
<td>126</td>
<td>51</td>
<td>25.7</td>
</tr>
<tr>
<td><strong>MoCA</strong></td>
<td>29</td>
<td>[24-30]</td>
<td>30</td>
<td>21</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>HADS-anxiety</strong></td>
<td>4.5</td>
<td>[2-5]</td>
<td>13</td>
<td>0</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>HADS-depression</strong></td>
<td>3</td>
<td>[2-5]</td>
<td>10</td>
<td>1</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Health Stroke Scale. mRS= modified Ranking Scale. HADS= Hospital Anxiety and Depression Scale. MoCA=Montreal Assessment of Cognitive Abilities. FIM=Functional Independence Measure. ARAT=Action Research Arm Test. BBT=Box and Block Test.

Table 2: Association between use-ratio and activity levels
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>95% CI</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity</td>
<td>0.0036</td>
<td>0.001 - 0.006</td>
<td>0.001</td>
<td>0.001*</td>
</tr>
<tr>
<td>Social activity</td>
<td>0.0023</td>
<td>-0.0005 - 0.005</td>
<td>0.001</td>
<td>0.109</td>
</tr>
<tr>
<td>Cognitive activity</td>
<td>0.0018</td>
<td>-0.003 - 0.006</td>
<td>0.002</td>
<td>0.422</td>
</tr>
</tbody>
</table>

SE=Standard error, 95 % CI= Confidence interval, *(p<0.05)

**Table 3: Change in primary and secondary outcomes pr. month since stroke**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Coefficient</th>
<th>95% CI</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in use-ratio</td>
<td>0.11</td>
<td>0.05 – 0.17</td>
<td>0.03</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Change in physical activity (%)</td>
<td>11.0</td>
<td>3.24 – 18.8</td>
<td>3.97</td>
<td>0.006*</td>
</tr>
<tr>
<td>Change in social activity (%)</td>
<td>-3.34</td>
<td>-9.01 – 2.40</td>
<td>2.93</td>
<td>0.254</td>
</tr>
<tr>
<td>Change in cognitive activity (%)</td>
<td>0.62</td>
<td>-3.53 – 4.78</td>
<td>2.12</td>
<td>0.770</td>
</tr>
<tr>
<td>Change in affected UE activity (hours)</td>
<td>0.39</td>
<td>0.24 - 0.54</td>
<td>0.08</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Change in unaffected UE activity (hours)</td>
<td>0.22</td>
<td>0.07 - 0.37</td>
<td>0.07</td>
<td>0.003*</td>
</tr>
</tbody>
</table>

SE=Standard error, 95 % CI=Confidence interval, *= (p<0.05)

**Table 4: Change in function level (Baseline to post observation)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th>95% CI</th>
<th>SD</th>
<th>Follow-up</th>
<th>95% CI</th>
<th>SD</th>
<th>Change score</th>
<th>95% CI</th>
<th>SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>1.04</td>
<td>(0.4 – 1.7)</td>
<td>1.2</td>
<td>2.29</td>
<td>(1.6 – 3.0)</td>
<td>1.2</td>
<td>1.25</td>
<td>(1.6 – 3.0)</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>ARAT</td>
<td>27.9</td>
<td>(14.6 – 41.1)</td>
<td>23</td>
<td>41.8</td>
<td>(31.1 – 52.4)</td>
<td>19</td>
<td>13.9</td>
<td>(5.5 – 22.4)</td>
<td>15</td>
<td>0.003*</td>
</tr>
<tr>
<td>BBT</td>
<td>18.1</td>
<td>(7.6 – 28.5)</td>
<td>18</td>
<td>33</td>
<td>(21.6 – 44.4)</td>
<td>20</td>
<td>14.9</td>
<td>(6.8 – 23.0)</td>
<td>14</td>
<td>0.002*</td>
</tr>
<tr>
<td>FIM</td>
<td>86.8</td>
<td>(71.2 – 102)</td>
<td>26</td>
<td>104.2</td>
<td>(89.5 – 119)</td>
<td>24</td>
<td>17.4</td>
<td>(6.3 – 28.5)</td>
<td>18</td>
<td>0.005*</td>
</tr>
</tbody>
</table>

CI = Confidence Interval 95 %, SD= standard deviation, Time = Time in months since stroke onset, ARAT=Action Research Arm Test, BBT=Box and Blocks Test, FIM=Functional Independence Measure, *= p < 0.005