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Walking and Sitting Time after a Stroke: A Comparison of Shifts and Changes over Time within an Acute Care Setting

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Featured Application: Facilitating activity during the evening shift and reducing reliance on sitting as the major means of performing out-of-bed activity are possible avenues to increase overall physical activity among patients post-stroke in acute hospital settings.

Abstract: Early activity post-stroke reduces secondary complications and improves rehabilitation outcomes. This study aimed to describe the physical activities of stroke patients in an acute hospital setting, compare activity patterns between working shifts, and assess associations between activity and clinical status. Twenty-one patients (mean age 69.4 ± 33.4 years,13 men) admitted due to acute ischemic stroke wore activity monitors for two weeks or until discharge. During the morning and evening shifts, the activity monitor collected daily data on walking and body position. The study discovered that patients' overall activity levels were low and that activity was higher during morning shifts than evening shifts (sitting time: 185.31 ± 109.31 min and 91.8 ± 98.46 min, $p = 0.002$; number of steps: 58.3 ± 32.73 and 30.4 ± 17.6 steps, $p < 0.001$). Upright and sitting time increased in morning shifts ($p = 0.002$), while the number of steps increased in both morning and evening shifts ($p = 0.002$). In the evening shift, there was a fair ($r = 0.28$, $p = 0.02$) positive correlation between grip strength and the number of steps, such that patients with higher grip strength took more steps. In addition, there were poor ($r = -0.2$, $p = 0.02$) correlations between motor function (Trunk Control Test and Functional Ambulation Category) and time in an upright position, such that patients with lower functional ability sat longer. Clinical characteristics and level of activity did not show any other correlations. To conclude, the main out-of-bed activity of patients was sitting during morning shifts. The findings highlight the temporal differences in activity throughout the day, as well as the disconnect between clinical characteristics and activity levels.

Keywords: activity monitor; stroke; early mobilization; hospital setting; physical therapy

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1. Introduction

Early activity post-stroke reduces secondary complications, reduces hospital length of stay [1], improves long-term functional outcomes [2,3], and possibly builds self-efficacy toward self-management [4]. Early post-stroke activity refers to any out-of-bed activity, including supported sitting, transfers, standing, and walking, performed within 24–48 h post-stroke [5,6]. Clinical practice guidelines (CPG) recommend that mobilization should be frequent, short, and occur daily [5].

Engaging individuals in early activity post-stroke depends on the routines in the acute hospital setting because this is where patients' care typically starts. Regardless of variability in hospitalization duration and setting, acute hospital settings are expected to implement treatment protocols that enable and facilitate out-of-bed activities in the early post-stroke period.

In-hospital physical activity may be viewed in a broader context, regardless of medical diagnosis. This topic has been recognized as having great importance due to the negative effects of low mobilization on many health and function domains [7,8] and since a growing body of evidence suggests that engaging in progressive activity promotes post-operative recovery and prevents adverse events during acute illness [9,10]. Despite this, recent systematic reviews have revealed that the inpatient population (e.g., surgical, medical, or intensive care) spends approximately 90% to 100% of their hospital stay lying in bed or sitting and, in most cases, performs less than 1000 steps [11,12].

The most common tools for monitoring activity in people post-stroke are a behavioral mapping, which is based on structured observation of the patient, and accelerometry [13]. Observation methodology provides rich information, although the capacity to capture activity patterns throughout the entire day is limited because it requires the physical presence of an observer. Alternatively, accelerometry allows continuous measurement of activity and quantification of body posture and activities. Several studies established the face validity of accelerometry in people post-stroke.

Body position and mobility in people post-stroke have been monitored primarily during the sub-acute and chronic phases. Studies conducted in an acute hospital setting showed that, broadly speaking, patients were inactive [11,12,14–16]. Patients in the first- and second weeks post-stroke stayed in their room more than 80% of the active daytime (8:00–17:00), they remained in bed 50% of the time, and remained in supported sitting for 4–28% of the time. Only 2–17% of the time was spent on upright activities that included walking and standing [14–16], although walking involved less than 100 steps [17]. An exception was a study that showed that patients in the acute stroke unit were active 45% of the day [18], demonstrating that this designated setting enables a higher level of activity. These empirical findings indicate a gap between the established importance of early and frequent activity and clinical practice. A comprehensive description of the activity of patients post-stroke in an acute hospital setting, which includes the distribution and duration of activity periods over the entire length of the day, the duration of activity periods, and the change in activity over time, may shed light on specific factors that hinder higher levels of activity in such settings for post-stroke patients (e.g., specific times during the day in which activity is very low).

The goal of the current study was to characterize stroke patients' activity patterns using accelerometers in an acute hospital inpatient setting and to analyze the recorded activity with respect to meaningful clinical contextual and non-contextual factors, e.g., comparing work shifts (morning and evening) and testing associations with patients' clinical status. Specific aims were to (1) characterize and compare activity in morning and evening shifts, with regard to the type of activity and changes over hospitalization duration and (2) evaluate correlations between activity levels and patients' demographic and clinical characteristics in morning and evening shifts.

2. Materials and Methods

2.1. Study Design

A prospective observational study that monitored physical activity in people after ischemic stroke while they were in a Stroke and Neurology Department.

2.2. Participants

Patients aged 18 or older admitted to a Cerebrovascular Disease (Stroke) Department during a 7-month period were enrolled in the study. Inclusion criteria were ischemic stroke as indicated by CT, hospital admission within 48 h of symptom onset, passing routine initial neurologic and nursing examinations within 48 h of admission, and the ability to consent. Due to the nature of the study, we were specifically interested in patients whose medical conditions allowed engagement in physical activity. Therefore, we recruited patients with mild or moderate stroke severity as indicated by a score of 5–18 on the National Institutes of Health Stroke Scale (NIHSS) [19]. Exclusion criteria were hemorrhagic stroke, terminally ill patients, who were candidates for surgery, heart failure according to the New York Heart

Association Functional Classification Category 4, Acute Coronary Syndrome, unstable hemodynamics, and fractures.

2.3. Study Setting

The study was performed at the Department of Stroke and Neurology at Tel Aviv Sourasky Medical Center. In the period of data collection, the Department of Stroke and Neurology had 1.25 physiotherapist positions (50 weekly hours) and one occupational therapist position (40 h a week). It served approximately 50 patients, half of whom were stroke patients who were admitted to the Stroke Department. The public space included the corridors of the department and a lobby immediately outside the Department. Work in the department is organized in shifts: The morning shift extends from 7:00 to 15:00 and the evening shift extends from 15:00 to 23:00. The working hours of the physical and occupational therapists extend from 8:00 to 16:00.

2.4. Stroke Department Activity-Related Care Practices and Policies

Patients after a stroke are first allowed out of bed only after a written instruction has been entered into their medical record by the attending physician. Out-of-bed sitting and activity are typically permitted if the patient meets the following medical criteria: systolic blood pressure between 120 and 220 mm Hg, oxygen saturation higher than 92%, heart rate of between 40 and 110 beats per minute, and temperature below 38.2 °C. These criteria were determined on the basis of Australian stroke guidelines (National Stroke Foundation, 2010) [20].

2.5. Study Procedures

The institutional ethical review board approved this study, and all the study procedures were conducted in accordance with the Helsinki Declaration. Patients who met the inclusion criteria and agreed to participate signed an informed consent form and were fitted with an activity monitor. Each patient wore the activity monitor for two weeks or until discharge. Demographic and health-related data were extracted from the patients' medical records and from interviews with the patient or their families. Stroke territory was determined by CT or clinical manifestation. Stroke severity and motor function were evaluated within 48 h of admission by a neurologist and the research assistant who is a physical therapist. A second evaluation of walking functional level was performed at discharge. A single research assistant performed all the motor function assessments. Figure 1 presents a flow diagram of the study procedures.

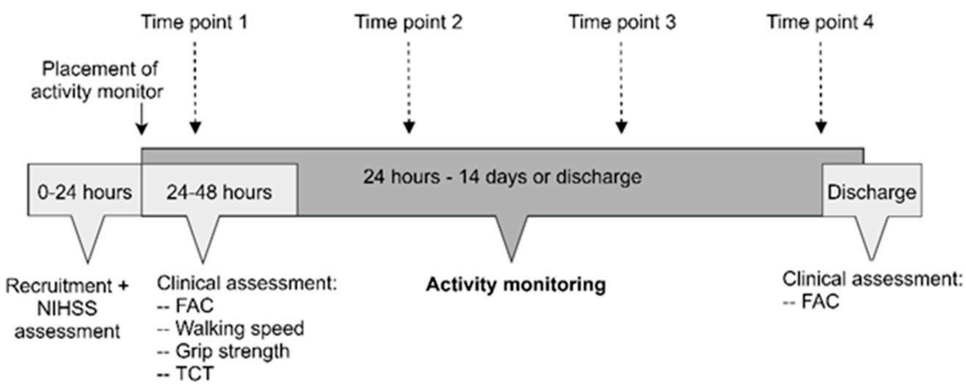

Figure 1. A flow diagram of the study procedures. FAC indicates functional ambulation category; NIHSS, National Institutes of Health Stroke Scale; and TCT, trunk control test. "Time points" are the measurement days that were used in data analysis. The figure illustrates its distribution throughout the entire measurement.

2.6. Clinical Assessment of Stroke Severity and Motor Function

Stroke severity was determined according to the NIHSS. The functional level of walking was determined according to the Functional Ambulation Category (FAC) [21] and walking speed according to the 10 Meter Walk test (10-MW) [22]. Bed mobility and sitting balance were assessed using the Trunk Control Test (TCT) [23]. Grip strength was evaluated using a hand-held dynamometer (Lafayette Instrument Company, Lafayette, LA, USA). All tests were performed according to established guidelines.

2.7. Activity Monitoring

The Dynaport MoveMonitor+ (McRoberts BV, The Hague, The Netherlands) was used for this study. It is a small (11.5 × 85 × 85 mm), lightweight (55 gr) device containing a triaxial accelerometer, a triaxial magnetometer and a gyroscope. Sampling was at 100 Hz with a range from −6 g to 6 g. The MoveMonitor+ demonstrated good construct validity when monitoring lying, sitting, and walking, and moderate for standing [24]. Its reliability, validity, and sensitivity when monitoring different body positions in young and older patients, as well as in various medical conditions and settings, ranged from reasonable to excellent [25–28].

Participants wore an elastic waist belt with the device located on the lower back. They were requested to wear the device at all times except during showering or when it was removed for data downloading.

2.8. Data Management and Outcome Variables

Data were uploaded to the manufacturer's web-based system. Using the accelerometer values and time spent in a posture, the manufacturer's algorithm (MoveMonitor version 3.0) analyzed the data to classify body postures and activities. This analysis produced information about periods of non-wearing, sitting, standing, and locomotion, and about movement parameters (i.e., length of time in each body position and number of steps).

The study statistician chose four days from the total measurement days to best represent activity during the hospitalization period when it lasted six days or more, three days when it lasted five or four days, and two days when it lasted only three days. These representative days were referred to as time points 1–4 (see Figure 1 for an illustration of the time points distribution). The use of time points throughout the hospitalization period enabled us to measure change over time. Due to the variation in hospitalization length, time points were chosen individually for each patient. For each time point, data for the morning (7:00–15:00) and evening (15:00–23:00) shifts were extracted. Separating the morning and evening shift data enabled us to get a better understanding of how activity changed throughout the day.

The variables to describe patients' activity were: (1) sitting time (in minutes), (2) time in an upright position (in minutes), (3) number of steps, (4) longest sitting period (in minutes), and longest walking period (in minutes). Time in an upright position consisted of the sum of all the positions or activities that were not lying (i.e., sitting, standing, shuffling, and walking).

2.9. Statistical Analyses

Normality was checked according to skewness or kurtosis. Sitting time and time in an upright position were normally distributed. The number of steps was analyzed assuming a Poisson distribution. Accordingly, a two-way, 4 (time point: 1,2,3,4) × 2 (shift: morning, evening) mixed-model repeated-measures analysis of variance (ANOVA) was run to analyze these data sets. Post hoc analyses were performed using the Studentized Maximum Modulus (SMM). When interaction was established, simple mean analysis was used to calculate significance. The analysis was performed using the generalized linear model Glimmix with Gaussian distribution for sitting time and Poisson distribution for the number of steps. The Friedman test was performed to test the time effect on the longest sitting period and longest walking period, which had non-normal distributions. The time effect was tested for the entire sample and per shift. If the overall Friedman test was significant, Wilcoxon signed-rank tests were performed to reveal significance between pairs of time points. A Spearman test was used to calculate correlations between clinical measures and between the clinical measures and outcome measures (daily average and shift average). Values of $r \leq 0.20$ were considered poor correlations; r = 0.21 to 0.40, fair correlations; r = 0.41 to 0.60, moderate correlations; r = 0.61 to 0.80, good correlations; and r = 0.81 to 1.00, very good correlations. A significant correlation was found between TCT and FAC, therefore only TCT was included as a covariate in the regression model of sitting time. A *p*-value of 0.05 was considered significant. Statistical analysis was performed using SAS for Windows Version 9.4.

3. Results

3.1. Participants

Twenty-four patients were recruited. Due to technical issues with the recording devices, data collection for three participants was not completed. Therefore, data of 21 patients were analyzed. Table 1 shows participants' demographics and medical information. Table 2 summarizes stroke severity and the results of the clinical tests.

Table 1. Patient demographics.

Characteristic	Mean ± SD or *n* (%)
Age, y	69.4 ± 33.4
Sex	
Males	13 (62%)
Females	8 (38%)
Pre-stroke mRS	
Independent (score 0–1)	16 (76%)
Slight disability (score 2)	1 (5%)
Moderate disability (score 3)	3 (14%)
Moderately severe disability (score 4)	1 (5%)
Side of stroke	
Right	15 (71%)
Left	6 (29%)
Stroke territory	
MCA	9 (43%)
ACA	5 (24%)
PCA	6 (28%)
Subcortical	1 (5%)
Acute stroke treatment	
tPA	10 (48%)
Endovascular procedure	4 (19%)
Family/caregiver support during hospitalization	
Yes	18 (86%)
No	3 (14%)

ACA, anterior cerebral artery; MCA, middle cerebral artery; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; PCA, posterior cerebral artery; and tPA, tissue Plasminogen activator.

3.2. Activity Monitoring

Overall, of the 21 patients, 15 had complete data set of four time points, three patients had three time points and another three patients had only two time points. Time points ranged from 24 h post-stroke to 14 days. Shifts during which the classification of body positions indicated that the device was worn for less than 85% of the time were excluded [29].

3.2.1. Sitting

Figure 2 presents sitting times by day and shift. Average sitting time during the morning shift was significantly longer than the average sitting time in the evening shift

(185.31 ± 109.31 min and 91.8 ± 98.46 min, respectively, $F_{1,39.25} = 10.53$, $p = 0.0024$). Further analysis showed that this difference was significant at all time points throughout the hospitalization period (time point 1: $p = 0.04$, time point 2: $p = 0.005$, time point 3: $p = 0.008$ and time point 4: $p = 0.017$). Average sitting time became significantly longer over the hospitalization period ($F_{3,93.63} = 3.31$, $p = 0.023$). Follow-up analyses for each shift revealed that the source of the significance was the morning shift, where mean sitting time between time point 1 and time point 2, and time point 3 ($p = 0.016$ and $p = 0.08$, respectively) increased significantly. No significant differences were found between the time points in the evening shift. There was no significant interaction effect.

Table 2. Clinical characteristics of the patients.

Patient	NIHSS (Score)	FAC Admission (Score)	FAC Discharge (Score)	Grip Strength (% from Unaffected Hand)	Walking Speed (m/s)	TCT (Score)
1	6	5	5	28%	0.51	87.5
2	5	2	2	40%	N/A	62.5
3	7	0	0	0%	N/A	12.5
4	8	0	0	0%	N/A	37.5
5	5	4	4	0%	1	100
6	10	1	5	8%	0.87	75
7	10	2	2	33%	N/A	75
8	6	2	2	54%	N/A	87.5
9	18	5	5	81%	0.87	100
10	8	0	0	71%	N/A	50
11	6	4	5	71%	0.83	100
12	10	0	0	50%	N/A	37.5
13	6	4	4	107%	1.11	100
14	5	2	2	80%	N/A	87.5
15	17	0	0	0%	N/A	37.5
16	5	3	4	90%	0.82	100
17	6	3	4	89%	0.58	100
18	5	3	5	67%	0.51	100
19	18	2	3	80%	0.33	87.5
20	5	2	2	59%	N/A	100
21	6	2	2	122%	N/A	87.5
Summary	6 (5–18)	2 (0–5)	2.5 (0–5)	63% (0–150)	0 (0–1.11)	87.5 (12.5–100)

Summary data are reported as median (max-min). FAC indicates functional ambulation category; N/A, not applicable; NIHSS, National Institutes of Health Stroke Scale; and TCT, trunk control test.

3.2.2. Upright Position

The average time in an upright position (sitting, standing, and walking) during the morning shift was significantly longer than the average time in the evening shift (202.74 ± 112.8 min and 109.32 ± 106.1 min, respectively, $F_{1,38.73} = 10.49$, $p = 0.003$). Further analysis showed that this difference was significant at all time points except time point 1 (time point 2: $p = 0.014$, time point 3: $p = 0.003$, and time point 4: $p = 0.006$). The average upright time became significantly longer over the period of hospitalization ($F_{3,91.84} = 3.72$, $p = 0.014$). Follow-up analyses for each shift revealed that the source of the significance was the morning shift, where there was a significant increase in mean upright time between time points 1 and 3 and between time points 1 and 4 ($p = 0.002$ and $p = 0.032$, respectively). No significant differences were found between time points in the evening shift. There was no significant interaction effect.

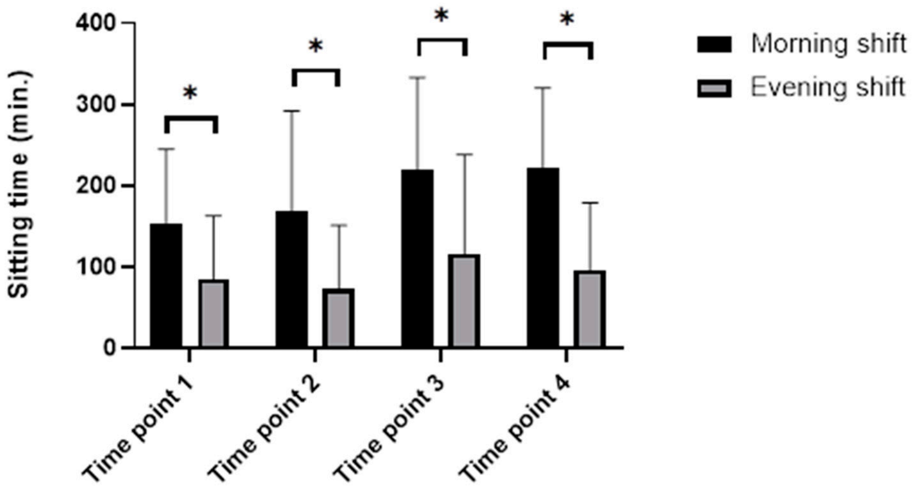

Figure 2. Mean sitting time according to shifts and time points. * time point 1: $p = 0.04$; time point 2: $p = 0.005$; time point 3: $p = 0.008$; time point 4: $p = 0.017$.

3.2.3. Walking

Table 3 shows the average number of steps by time point and shift. The average number of steps during the morning shift was significantly higher than the average number of steps in the evening shift (58.3 ± 32.73 and 30.4 ± 17.6 steps, respectively, $F_{1,103} = 11.67$, $p < 0.001$). In a follow-up analysis it was found that this difference was significant in time points 1–3 (measurement 1: $p = 0.043$, measurement 2: $p = 0.008$ and measurement 3: $p = 0.05$). Average number of steps increased significantly over the period of hospitalization ($F_{3,103} = 5.20$, $p = 0.002$). In the morning shift, the average number of steps increased significantly between time point 1 and time point 2, and time point 4 ($p = 0.001$ and $p = 0.038$, respectively). In the evening shift, the average number of steps increased significantly between time point 1 and time point 2 and time point 4 ($p = 0.009$ and $p = 0.048$, respectively). There was no significant interaction effect.

Table 3. Number of steps and longest sitting and walking periods, by time point and shift.

Shift	Time Point	Steps		Longest Sitting Time (Minutes)			Longest Walking Time (Minutes)		
		Average	Standard Error	Median	Minimum	Maximum	Median	Minimum	Maximum
Morning	**1**	38	22.28	63.29	0.00	181.85	0.11	0.00	6.21
	2	54.5	31.32	59.24	0.00	303.52	0.11	0.00	6.01
	3	59.2	35.93	109.00	0.84	314.55	0.06	0.00	1.37
	4	94.2	55.29	89.77	31.84	220.15	0.12	0.00	1.09
Evening	**1**	20.2	12.16	8.40	0.00	255.02	0.05	0.00	1.15
	2	26.3	15.6	35.26	0.00	284.25	0.09	0.00	1.22
	3	28.2	16.96	29.18	0.00	187.03	0.05	0.00	1.48
	4	57.5	35.61	44.91	0.00	84.65	0.00	0.00	1.69

3.2.4. Longest Sitting Period

The median and minimum–maximum points for longest sitting period are presented in Table 3. The longest sitting period in morning shifts was significantly higher than in evening shifts at all time points with the except of time point 1 (time point 2: S = 70.5, $p = 0.001$, time point 3: S = 30.5, $p = 0.03$, time point 4: S = 27, $p = 0.013$). There were no differences between time points ($X^2_{(3)} = 3.57$, $p = 0.31$).

3.2.5. Longest Walking Period

Median and minimum-maximum points for the longest walking period over four time points by shifts are presented in Table 3. There was a significant difference between shifts at the third time point, where the average longest walking period was higher in the morning shift than in the evening (S = 17.5, $p = 0.04$). There were no additional differences between the time points.

3.3. Correlations between Patients' Activity, Stroke Severity, and Functional Level

The relationship between stroke severity, measured by NIHSS; motor function, measured by TCT; and walking function level, assessed by FAC; and the various activity measures were examined. In the evening shift, a positive correlation was found between grip strength and number of steps, and longest walking period (r = 0.28, $p = 0.02$; r = 0.27, $p = 0.03$, respectively). There was also a negative correlation between the level of motor function and time in an upright position (for TCT: r = −0.2, $p = 0.02$; for FAC at admission: r = −0.2, $p = 0.02$), and between level of motor function and longest sitting period (for TCT: r = −0.21, $p = 0.01$; for FAC at admission: r = −0.2, $p = 0.02$). No other significant correlations were found.

4. Discussion

The goal of this study was to objectively measure the activity of post-stroke patients hospitalized in the acute hospital stroke department over time and to characterize their activity pattern as a function of activity type and distribution throughout two working shifts.

The study findings join an evolving body of knowledge about the activity of patients after stroke in acute hospital settings and add to the current knowledge on the topic by providing an objective quantification of various aspects of patients' activity patterns in a stroke department. This study also frames the findings on activity distribution within a clinical context of work shifts and in regard to the association with functional ability.

We found that the overall amount of activity was low, although activity increased over time. Analyzing activity by shift showed that sitting and overall upright time increased over time only during morning shifts, while number of steps increased over time in both the morning and the evening shifts.

The findings also demonstrated that the duration of out-of-bed sitting periods was relatively long, especially during morning shifts (median of longest sitting period ranged from 59.24 to 109 min in morning shifts and from 8.4 to 44.91 min in afternoon shifts). Thus, it seems that activity recommendations are mainly implemented in the morning by means of long periods of sitting. This pattern may reflect the challenges of implementing short and frequent periods of activity, a practice that requires significant personnel resources and changes in routine practices.

Several studies have described the temporal pattern of out-of-bed activity and showed that patients in inpatient rehabilitation were less active during the weekend [30], and that patients in acute care settings performed most of the activity in the early morning and were inactive later in the day [17]. Our findings similarly point to a lack of activity in afternoon and evening hours. Taken together, these findings suggest that a better use of evening shifts may help to achieve more activity overall. Furthermore, evening shifts may have some advantages for the implementation of activity recommendations, as less time is typically spent on medical exams and more time is devoted to family support. The development of a structured strategy to facilitate activity during the evening is warranted.

The present study revealed poor to fair correlations between functional levels and actual levels of activity. The first finding was that greater grip strength of the hemiparetic upper limb was positively correlated with the number of steps counted during the evening shift. In the evening shift, less help is available from health-related and nursing staff. Therefore, if a stroke patient's mobility depends on their ability to hold onto an assistive device such as a walker, a stronger grip may allow them to walk independently or with family supervision. A second finding shows that less mobile patients were engaged in longer periods of sitting. This finding may reflect more acute patients' dependence on departmental routines, which includes taking patients out of bed to chair in the morning and returning them at noon. This finding is consistent with a report on the association between increased duration of sitting periods, higher age, and higher stroke severity [31].

Contrary to the abovementioned correlations, no correlation was found between stroke severity, measured by the NIHSS, and the actual level of activity. This finding is consistent with previous studies [14,15,32] and may reflect the limited information that a global severity score offers with respect to very specific aspects of functioning, such as physical activity, including sitting and mobility. It should be noted, however, that the correlation analyses were somewhat limited since we included only patients with mild to moderate stroke severity.

Similarly to previous research, this study found that the activity patients performed was of low intensity and primarily comprised sitting (an average 4.5 h sitting per day between 7:00 and 23:00). In previous studies that classified stroke patients' activities by level of functioning, this type of activity was classified as a mild effort [14,32]. Findings thus indicate that the activities performed by the patients in the current study within the range of activities considered part of early mobility (including, for example, sitting out of bed, standing, walking, and going up/down stairs) were those classified as easy, with almost no performance of activities classified as moderate or high levels of exertion, such as walking. Taking into consideration the limited associations between functional level and actual activity, it seems that patients were not engaged in higher-intensity activities, regardless of their functional ability. A clearer distinction in CPG between activities of mild and moderate intensity may facilitate the implementation of activities with higher motor and metabolic demands. Also needed is an intervention protocol that aligns activity type with the patient's functional level [33,34].

In the broader perspective of in-hospital physical activity. Several interventions designed to increase in-hospital mobility have proved efficacious [35,36]. The lesson learned from these experimental interventions is that change in in-hospital activity is facilitated by a multidisciplinary approach, requires collaboration between nurses and health professionals (e.g., physical therapists, occupational therapists), and involves patient and personnel-training modules. In addition, implementation in the "real-life" clinical field requires the flexibility to adjust generic action plans to the specific context at hand, including, for example, department type (e.g., intensive care, internal medicine, neurology) and patient characteristics and values [37,38]. The findings of the current study emphasize the need to consider and modify departmental routines and to better train staff in the required standards presented in CPG.

Our study has several limitations. First, the nature of the measurement tool did not distinguish independent active sitting and sitting supported in an armchair. This is important because interventions to facilitate mobility post-stroke were specifically focused on active sitting, contrary to supported out-of-bed sitting. Second, we used MoveMonitor+ activity monitors. While the construct validity of this device to measure body positions was established [13,24], and the device was used in many research studies, it was not validated in post-stroke patients hospitalized in an acute care setting. The difficulties patients have communicating and the requirement that they are able to provide consent may have biased the recruitment of patients, which limits the generalizability of the findings. Finally, we excluded several shifts from the data analysis due to long periods of not wearing the activity monitors, mainly because of device malfunction or because the device was not returned to its place after it was removed for showering or for medical exams.

5. Conclusions

The main out-of-bed activity of patients was sitting during morning shifts. The findings highlight the temporal differences in activity throughout the day, as well as the disconnect between clinical characteristics and activity levels. Both issues draw attention to clinical routines and how they affect out-of-bed activity.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Tel Aviv Sourasky Medical Center (0787-16-TLV).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Li, Z.; Zhang, X.; Wang, K.; Wen, J. Effects of Early Mobilization after Acute Stroke: A Meta-Analysis of Randomized Control Trials. *J. Stroke Cerebrovasc. Dis.* **2018**, *27*, 1326–1337. [CrossRef] [PubMed]
2. Cumming, T.B.; Thrift, A.G.; Collier, J.M.; Churilov, L.; Dewey, H.M.; Donnan, G.A.; Bernhardt, J. Very Early Mobilization after Stroke Fast-Tracks Return to Walking. *Stroke* **2011**, *42*, 153–158. [CrossRef] [PubMed]
3. Askim, T.; Bernhardt, J.; Salvesen, O.; Indredavik, B. Physical Activity Early after Stroke and Its Association to Functional Outcome 3 Months Later. *J. Stroke Cerebrovasc. Dis.* **2014**, *23*, e305–e312. [CrossRef] [PubMed]
4. Cumming, T.B.; Collier, J.; Thrift, A.G.; Bernhardt, J. The Effect of Very Early Mobilization after Stroke on Psychological Well-Being. *J. Rehabil. Med.* **2008**, *40*, 609–614. [CrossRef] [PubMed]
5. Rudd, A.G.; Bowen, A.; Young, G.R.; James, M.A. National Clinical Guideline for Stroke: 2016. *Clin. Med.* **2017**, *17*, 154–155. [CrossRef]
6. Langhorne, P.; Stott, D.; Knight, A.; Bernhardt, J.; Barer, D.; Watkins, C. Very Early Rehabilitation or Intensive Telemetry after Stroke: A Pilot Randomised Trial. *Cerebrovasc. Dis.* **2010**, *29*, 352–360. [CrossRef] [PubMed]
7. Zisberg, A.; Shadmi, E.; Gur-Yaish, N.; Tonkikh, O.; Sinoff, G. Hospital-Associated Functional Decline: The Role of Hospitalization Processes Beyond Individual Risk Factors. *J. Am. Geriatr. Soc.* **2015**, *63*, 55–62. [CrossRef]
8. Covinsky, K.E.; Pierluissi, E.; Johnston, C.B. Hospitalization-Associated Disability. *JAMA* **2011**, *306*, 1782–1793. [CrossRef]
9. Wang, J.; Ren, D.; Liu, Y.; Wang, Y.; Zhang, B.; Xiao, Q. Effects of Early Mobilization on the Prognosis of Critically Ill Patients: A Systematic Review and Meta-Analysis. *Int. J. Nurs. Stud.* **2020**, *110*, 103708. [CrossRef]
10. Kalisch, B.J.; Lee, S.; Dabney, B.W. Outcomes of Inpatient Mobilization: A Literature Review. *J. Clin. Nurs.* **2014**, *23*, 1486–1501. [CrossRef]
11. Baldwin, C.; van Kessel, G.; Phillips, A.; Johnston, K. Accelerometry Shows Inpatients with Acute Medical or Surgical Conditions Spend Little Time Upright and Are Highly Sedentary: Systematic Review. *Phys. Ther.* **2017**, *97*, 1044–1065. [CrossRef]
12. Fazio, S.; Stocking, J.; Kuhn, B.; Doroy, A.; Blackmon, E.; Young, H.M.; Adams, J.Y. How Much Do Hospitalized Adults Move? A Systematic Review and Meta-Analysis. *Appl. Nurs. Res.* **2020**, *51*, 151189. [CrossRef] [PubMed]
13. Valkenet, K.; Bor, P.; van Delft, L.; Veenhof, C. Measuring Physical Activity Levels in Hospitalized Patients: A Comparison between Behavioural Mapping and Data from an Accelerometer. *Clin. Rehabil.* **2019**, *33*, 1233–1240. [CrossRef] [PubMed]
14. Bernhardt, J.; Dewey, H.; Thrift, A.; Donnan, G. Inactive and Alone: Physical Activity within the First 14 Days of Acute Stroke Unit Care. *Stroke* **2004**, *35*, 1005–1009. [CrossRef] [PubMed]
15. Åstrand, A.; Saxin, C.; Sjöholm, A.; Skarin, M.; Linden, T.; Stoker, A.; Roshandel, S.; Dedering, Å.; Halvorsen, M.; Bernhardt, J.; et al. Poststroke Physical Activity Levels No Higher in Rehabilitation than in the Acute Hospital. *J. Stroke Cerebrovasc. Dis.* **2016**, *25*, 938–945. [CrossRef]
16. Van de Port, I.G.L.; Valkenet, K.; Schuurmans, M.; Visser-Meily, J.M.A. How to Increase Activity Level in the Acute Phase after Stroke. *J. Clin. Nurs.* **2012**, *21*, 3574–3578. [CrossRef]
17. Mattlage, A.E.; Redlin, S.A.; Rippee, M.A.; Abraham, M.G.; Rymer, M.M.; Billinger, S.A. Use of Accelerometers to Examine Sedentary Time on an Acute Stroke Unit. *J. Neurol. Phys. Ther.* **2015**, *39*, 166–171. [CrossRef]
18. West, T.; Bernhardt, J. Physical Activity Patterns of Acute Stroke Patients Managed in a Rehabilitation Focused Stroke Unit. *BioMed Res. Int.* **2013**, *2013*, 438679. [CrossRef]
19. Williams, L.S.; Yilmaz, E.Y.; Lopez-Yunez, A.M. Retrospective Assessment of Initial Stroke Severity With the {NIH} Stroke Scale. *Stroke* **2000**, *31*, 858–862. [CrossRef]
20. National Stroke Foundation. *Clinical Guidelines for Stroke Management 2010*; National Stroke Foundation: Melbourne, Australia, 2010.

21. Holden, M.K.; Gill, K.M.; Magliozzi, M.R.; Nathan, J.; Piehl-Baker, L. Clinical Gait Assessment in the Neurologically Impaired. *Phys. Ther.* **1984**, *64*, 35–40. [CrossRef]
22. Bohannon, R.W. Comfortable and Maximum Walking Speed of Adults Aged 20–79 Years: Reference Values and Determinants. *Age Ageing* **1997**, *26*, 15–19. [CrossRef] [PubMed]
23. Collin, C.; Wade, D. Assessing Motor Impairment after Stroke: A Pilot Reliability Study. *J. Neurol. Neurosurg. Psychiatry* **1990**, *53*, 576–579. [CrossRef]
24. Fokkenrood, H.J.P.; Verhofstad, N.; van den Houten, M.M.L.; Lauret, G.J.; Wittens, C.; Scheltinga, M.R.M.; Teijink, J.A.W. Physical Activity Monitoring in Patients with Peripheral Arterial Disease: Validation of an Activity Monitor. *Eur. J. Vasc. Endovasc. Surg.* **2014**, *48*, 194–200. [CrossRef] [PubMed]
25. Valkenet, K.; Veenhof, C. Validity of Three Accelerometers to Investigate Lying, Sitting, Standing and Walking. *PLoS ONE* **2019**, *14*, e0217545. [CrossRef] [PubMed]
26. de Groot, S.; Nieuwenhuizen, M.G. Validity and Reliability of Measuring Activities, Movement Intensity and Energy Expenditure with the DynaPort MoveMonitor. *Med. Eng. Phys.* **2013**, *35*, 1499–1505. [CrossRef]
27. Storm, F.A.; Heller, B.W.; Mazzà, C. Step Detection and Activity Recognition Accuracy of Seven Physical Activity Monitors. *PLoS ONE* **2015**, *10*, e0118723. [CrossRef]
28. Dijkstra, B.; Kamsma, Y.; Zijlstra, W. Detection of Gait and Postures Using a Miniaturised Triaxial Accelerometer-Based System: Accuracy in Community-Dwelling Older Adults. *Age Ageing* **2010**, *39*, 259–262. [CrossRef]
29. van Schooten, K.S.; Pijnappels, M.; Rispens, S.M.; Elders, P.J.M.; Lips, P.; van Dieën, J.H. Ambulatory Fall-Risk Assessment: Amount and Quality of Daily-Life Gait Predict Falls in Older Adults. *J. Gerontol. Ser. A Biol. Sci. Med. Sci.* **2015**, *70*, 608–615. [CrossRef]
30. Alt Murphy, M.; Andersson, S.; Danielsson, A.; Wipenmyr, J.; Ohlsson, F. Comparison of Accelerometer-Based Arm, Leg and Trunk Activity at Weekdays and Weekends during Subacute Inpatient Rehabilitation after Stroke. *J. Rehabil. Med.* **2019**, *51*, 426–433. [CrossRef]
31. Norvang, O.P.; Hokstad, A.; Taraldsen, K.; Tan, X.; Lydersen, S.; Indredavik, B.; Askim, T. Time Spent Lying, Sitting, and Upright during Hospitalization after Stroke: A Prospective Observation Study. *BMC Neurol.* **2018**, *18*, 138. [CrossRef]
32. Lay, S.; Bernhardt, J.; West, T.; Churilov, L.; Dart, A.; Hayes, K.; Cumming, T.B. Is Early Rehabilitation a Myth? Physical Inactivity in the First Week after Myocardial Infarction and Stroke. *Disabil. Rehabil.* **2015**, *38*, 1493–1499. [CrossRef]
33. van Wijk, R.; Cumming, T.; Churilov, L.; Donnan, G.; Bernhardt, J. An Early Mobilization Protocol Successfully Delivers More and Earlier Therapy to Acute Stroke Patients: Further Results from Phase II of AVERT. *Neurorehabil. Neural Repair* **2012**, *26*, 20–26. [CrossRef] [PubMed]
34. Bernhardt, J.; Churilov, L.; Ellery, F.; Collier, J.; Chamberlain, J.; Langhorne, P.; Lindley, I.; Moodie, M.; Dewey, H.; Thrift, A.G. Prespecified Dose-Response Analysis for A Very Early Rehabilitation Trial (AVERT). *Neurology* **2016**, *86*, 2138–2145. [CrossRef] [PubMed]
35. Cohen, Y.; Zisberg, A.; Chayat, Y.; Gur-Yaish, N.; Gil, E.; Levin, C.; Rand, D.; Agmon, M. Walking for Better Outcomes and Recovery: The Effect of WALK-FOR in Preventing Hospital-Associated Functional Decline Among Older Adults. *J. Gerontol. Ser. A* **2019**, *74*, 1664–1670. [CrossRef] [PubMed]
36. Drolet, A.; DeJuilio, P.; Harkless, S.; Henricks, S.; Kamin, E.; Leddy, E.A.; Lloyd, J.M.; Waters, C.; Williams, S. Move to Improve: The Feasibility of Using an Early Mobility Protocol to Increase Ambulation in the Intensive and Intermediate Care Settings. *Phys. Ther.* **2013**, *93*, 197–207. [CrossRef]
37. Kirk, J.W.; Bodilsen, A.C.; Sivertsen, D.M.; Husted, R.S.; Nilsen, P.; Tjørnhøj-Thomsen, T. Disentangling the Complexity of Mobility of Older Medical Patients in Routine Practice: An Ethnographic Study in Denmark. *PLoS ONE* **2019**, *14*, e0214271. [CrossRef]
38. Zisberg, A.; Agmon, M.; Gur-Yaish, N.; Rand, D.; Hayat, Y.; Gil, E.; WALK-FOR Team. No One Size Fits All—The Development of a Theory-Driven Intervention to Increase in-Hospital Mobility: The "WALK-FOR" Study. *BMC Geriatr.* **2018**, *18*, 91. [CrossRef]