The added value of monitoring physical behaviour for an assessment protocol for stroke rehabilitation in a rehabilitation centre: a cross-sectional, observational study

Master thesis

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“ONDERGETEKENDE

Joris Cornelis Huijser,

bevestigt hierbij dat de onderhavige verhandeling mag worden geraadpleegd en vrij mag worden gefotokopieerd. Bij het citeren moet steeds de titel en de auteur van de verhandeling worden vermeld.”

Examiner

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SAMENVATTING

Doelstelling

Beweeggedrag van patiënten na een beroerte verandert vaak als gevolg van fysieke beperkingen. Veranderd beweeggedrag kan leiden tot verminderde zelfstandigheid en participatie, dat gerelateerd is aan kwaliteit van leven. Beweeggedrag kan gemeten worden met beweegsensoren. De relatie tussen beweeggedrag en veelgebruikte capaciteitsuitkomstmaten als loopvaardigheid, balans en motorische beperking (MB) is onduidelijk. Ook is de belasting van het monitoren van beweeggedrag en de ervaren toegevoegde waarde voor de zorgprofessional onbekend. Deze studie is bedoeld om te bepalen wat de toegevoegde waarde van monitoring van beweeggedrag is als onderdeel van een meetprotocol voor de revalidatie van mensen met een beroerte in een revalidatiecentrum.

Methode

Bij 15 patiënten met een beroerte is een eenmalige beoordeling van percentage van tijd van fysiek actief zijn (beweeggedrag), de 10m looptest (loopvaardigheid), Berg Balance Schaal (balans), en de Motricity Index (MB) gedaan. Beweeggedrag werd gedurende 7 dagen, 24 uur per dag gemeten met een Activ8 beweegsensor. Met de Pearson's correlatie coëfficiënt werd de relatie tussen beweeggedrag en loopvaardigheid, balans en MB bepaald. Met behulp van vragenlijsten werd gevraagd naar de ervaren toegevoegde waarde voor fysiotherapeuten en naar de belasting voor patiënten en verpleegkundigen. Alle vragen werden ordinaal gescoord met 5 punten per vraag en werden gemiddeld per groep.

Resultaten

Er is geen correlatie tussen beweeggedrag en loopvaardigheid (r=-0,255, p=0,360), balans (r=0,234, p=0,402) en MB (r=0,356, p=0,192). Gemiddelde scores van vragen naar belasting voor verpleegkundigen (1,0 en 1,0 punt) en patiënten (1,13 en 1,32 punten) zijn laag. De ervaren toegevoegde waarde voor fysiotherapeuten was neutraal (3 en 2,5 punten).

Conclusie

Monitoring van beweeggedrag is mogelijk van toegevoegde waarde voor een meetprotocol

voor de revalidatie van mensen met een beroerte.

Klinische relevantie

Monitoren van beweeggedrag is een kleine last voor patiënten en zorgverleners. Monitoren van beweeggedrag heeft een uitkomstmaat die mogelijk niet gerelateerd is aan veelgebruikte capaciteitsuitkomstmaten.

ABSTRACT

Aim

Physical behaviour (PB) of patients after stroke often changes as a result from physical impairments. Changes in PB may lead to lower levels of independence and participation, which are related to quality of life. Activity monitors can measure PB. The relationship between PB and usual care assessments of capacity such as walking ability (WA), balance, and motor impairment (MI) is unclear. Also, physical and mental burdening of monitoring PB, and the experienced added value for the health professional is unknown. This study aims to determine the added value of monitoring PB for an assessment protocol for stroke rehabilitation at a rehabilitation centre.

Methods

For 15 patients with stroke, a single assessment of percentage of time of being physically active (PB), the 10m walking test (WA), Berg Balance Scale (Balance), and Motricity Index (MI) was done. PB was measured for 7 days, 24 hours per day with an Activ8 activity monitor. Pearson's correlation coefficient assessed the relationship between PB and WA, balance, and MI. Questionnaires assessed the experienced added value of monitoring PB for physical therapists, and physical and mental burdening for patients and nurses. Questions were scaled ordinally with 5 points per question, and averaged per group.

Results

The correlation between PB and WA (r=-0,255, p=0,360), balance (r=0,234, p=0,402), and MI (r=0,356, p = 0,192) is absent. Mean scores for questions regarding burdening for nurses (1,0 and 1,0 points) and patients (1,13 and 1,32 points) are little . The experienced added value for physical therapists (3 and 2,5 points) is neutral.

Conclusion

Monitoring PB may be an added value for an assessment protocol for stroke rehabilitation.

Clinical relevance

Monitoring PB is of little burdening and hindering for patients and caregivers. Monitoring PB provides an outcome measure that may be unrelated to frequently used outcome measures for capacity.

Keywords: Stroke, Physical Activity, Rehabilitation, Activity Monitor, physical capacity

INTRODUCTION AND RATIONALE

Stroke is a frequently occurring disease [1]. Each year, approximately 28 per 100.000 people in the Netherlands suffer their first stroke [1]. Of these patients, 46% return directly to their home after hospital stay, 14% are discharged to a rehabilitation centre, and 31% are discharged to a nursing home [2].

Symptoms after stroke are diverse, and can result in both cognitive and physical impairments [3]. Physical impairments commonly involve paresis, paralysis, and spasticity, which can result in declined balance control, motor impairment (MI), and declined walking ability (WA) [4].

Impairments of body function and capacity may have consequences for the physical behaviour (PB) of patients with stroke [5]. PB postulates the activities, postures, and movements that people perform in daily life [6]. Patients may become less active, as certain activities, like walking, may become painful or cost more energy [7]. These changes in PB may lead to a lower level of independence and participation, which are related to quality of life (QoL) [8]. Therefore, determining PB is important during stroke rehabilitation [9].

In stroke rehabilitation, assessment instruments are used to generate outcome measures which are intended to quantify a patient's performance or health status, based on standardised evaluation protocols [10]. Outcome measures are often used to enhance and support clinical decision making in developing a plan of care and setting goals [10]. Subsequently, periodic use of outcome measures may lead to modifications of a patient's plan of care, allow determination of change over time, and the effectiveness of an intervention [10].

Most physical assessments in stroke rehabilitation focus on WA, balance, and MI [6, 11]. However, monitoring PB provides an outcome which is thought to be related to independence in activities of daily living and QoL [8]. PB can be monitored with activity monitors [12]. Activity monitors are easy to use, and provide valid, reliable measures for PB [12]. Therefore, periodic use of monitoring PB as part of standardised assessment protocols might be of added value for stroke rehabilitation [9, 10].

WA, balance, and MI are classified as body function and capacity of activities according to the International Classification of Functioning Disability and Health (ICF) [6]. However, according to the ICF, PB is classified as the performance of activities. Lindeman et al. has found a strong relationship between balance and gait speed (classified as capacity of activities), and being physically active (classified as performance of activities) [13]. Nonetheless, Shaughnessy et al. suggests that survey-based measures of mobility and timed walking tests may not capture elements of ambulatory PB [14]. Therefore, the relationship between classes of the ICF remains unclear.

Since PB is classified as a separate class in the ICF (performance of activities) [6], and because the relationship with body function and capacity is inconclusive [13, 14], monitoring PB may be of added value for the health professional. However, the added value of monitoring PB also depends on physical and mental burdening of usage of instruments of PB, and on experienced value of the health professional [5]. Therefore, this study aims to determine the added value of monitoring PB for an assessment protocol for stroke rehabilitation.

Research question(s):

Primary research question: what is the relationship between PB, and WA, balance, and MI?

Secondary research question: what is the added value of monitoring PB for the health professional, and how much physical and mental burdening does this require for patients and caregivers?

METHODS

Study design

An observational, cross-sectional study was conducted between January and August 2014 in a rehabilitation centre in Rotterdam, the Netherlands. In this study, inpatients and outpatients with stroke were asked to participate. In the rehabilitation centre, all study procedures were part of usual care.

Subjects

Patients were eligible to participate if they were aged between 18-70 years, inpatients or outpatients at a rehabilitation centre, physically impaired as a result from stroke, and able to walk independently with or without assistive devices as evaluated with the Functional Ambulation Categories (> 2) [15]. Exclusion criteria were medical conditions unrelated to stroke but heavily influencing the general health condition, severe cognitive impairment, and insufficient understanding of the Dutch or English language.

All eligibility criteria were determined by the attending physicians and physical therapists at the rehabilitation centre. After determining that patients were eligible to participate, they were informed about the study, provided with an informational letter, and asked to participate. After patients had agreed to participate, they were referred to one researcher (JH) who verified all eligibility criteria. Written informed consent was obtained from all patients prior to participation.

Convenience sampling was used for the inclusion of patients. In procedure of creating a study sample, it was attempted to get a heterogeneous sample with respect to time since admission. Therefore, the duration of being admitted to the Rehabilitation Centre varied among the patients.

Sample size calculation

Sample size calculation was performed using G-power 3.1.5, assuming β = 0.80 and α (two-sided) = 0.05. Pearson's correlation association was used to compute the required sample size with a correlation for physical capacity (balance and gait speed) and PB of r = 0,443 [13]. A sample size of 13 patients is required to reject the null-hypothesis: the relationship between PB, and WA, balance and MI is strong. Additionally, expecting an attrition rate of 10% [13], the total sample size should contain 15 patients.

Procedures

Primary objective

The primary objective was to determine the relationship between PB, and WA, balance, and MI. Therefore, the main study parameters are outcome measures for PB, WA, balance, and MI.

Physical behaviour:

The PB of patients with stroke was determined with Activ8 activity monitors. The Activ8 is a recently developed activity monitor that detects whether a person lies, sits, stands, walks, cycles, or runs per minute [16]. The output of the Activ8 system presents percentages of each minute, for all body postures and movements. The Activ8 appears to be a valid instrument to quantify body postures and movements in healthy subjects [16]. The outcome measure for PB has been determined as the percentage of total time (24 hours per day, 7 days per week) a patient is physically active [5]. A patient is physically active while standing up, walking, cycling or running [5]. In order to determine the percentage of total time of being physically active, first, total times for all body postures and movements were calculated per day and per week. After, total time for standing up, walking, cycling and running per day and per week was divided by total time per day and per week respectively.

Walking ability:

The WA ability of patients with stroke was determined with the 10m walking test (10MWT).

With this measurement, a patient's comfortable walking speed over 10 meters will be timed [17]. This test classifies the speed of comfortable walking which is highly correlated with quality of walking [17]. The test shows good reliability and validity for patients with stroke [17].

Balance:

The balance of patients with stroke was determined with the Berg Balance Scale (BBS). The BBS is a 14-item assessment scale for functional balance [18]. Each task is rated from 0 to 4, yielding a possible maximum score of 56 points [18]. Higher scores indicate better balance [18]. The BBS shows good interrater, intrarater, and concurrent reliability in patients with stroke [18].

Motor impairment:

The amount of MI of patients was determined with the Motricity Index (MoI). The MoI is a widely used, valid and reliable measure for the assessment of a patient's motor capacity in patients with stroke [19]. It is a brief assessment method for MI that scores the level of hemiparesis from 0 (paralysis) to 100 (normal strength) [19].

Secondary objective

A secondary objective was to assess the burdening and the experienced added value of monitoring PB. In order to do so, three self-reported Dutch questionnaires, one for patients, one for nurses, and one for physical therapists, were developed (appendix 1, 2 and 3). All questionnaires, adapted from Davies et al. [20], assess the response to 10 statements on several topics on a 5-point Likert scale. For patients, topics were hindering in daily life, effort of applying and wearing the activity monitors, physical discomfort due to the activity monitors, and excessive duration of the measuring period. For physical therapists, topics were usability for physical therapy practice, experienced added value, clarity of data of PB, and time and effort of using data of PB. For nurses, topics were time and effort of monitoring patients to wear the activity monitors, length of wearing time, effort of applying activity monitors, and frequency of re-applying activity monitors. For all statements, responses range from "strongly disagree" to "strongly agree", respectively.

Study procedures

After signing informed consent, one researcher (JH) conducted the 10m WT, BBS, and the MoI. Furthermore, the Activ8 was attached to the front of the upper leg with incision foil that is water resistant and breathable (figure 1). Patients were informed not to remove the Activ8 for an entire weak, with the exception of when the incision foil needed replacement. Additional incision foil was provided to patients and attending nurses. After one week [20], the data recordings for that week with the Activ8 were imported on a computer.

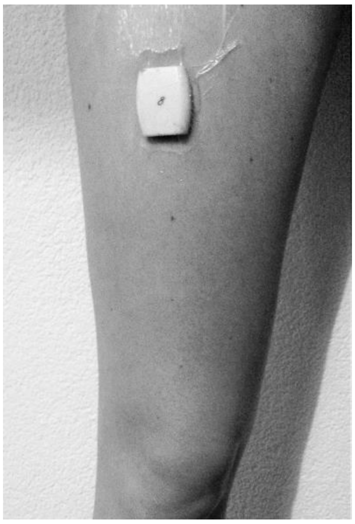

Figure 1: Attachment of the Activ8

Each patient enrolled in this study was asked to fill in the self-reported questionnaire (appendix 1) after they had completed wearing the activity monitor for a week. For four nurses, a convenience sample of attending nurses was asked to fill in the developed self-reported questionnaire for nurses (appendix 2). Additionally, four physical therapists were provided with data of PB of patients that they attended to. Data of PB contained percentages of total time their patients sat or lied, stood, walked, cycled, and ran, for separate days, and the total of 7 days. These data were displayed both graphically (pie-charts) and numerally (tables). After that, they were asked to fill in the developed self-reported questionnaires for physical therapists (appendix 3).

Statistical analysis

Descriptive analysis was performed for baseline characteristics using frequencies and percentages for categorical variables and mean and standard deviation for continuous variables. Pearson's correlation association was used to determine the relationship between PB, and WA, balance, and MI. All statistical analyses were performed using SPSS 19 for windows.

All questionnaires assessed statements regarding topics on a 5-point Likert score, in which "strongly disagree" collected 1 point up to "strongly agree", which collected 5 points. For the topics for patients and nurses, lower scores indicate fewer burdening and hindering. For the topics for physical therapists, higher scores indicate greater added value and usability. For each topic, points regarding the several statements were summarized and averaged.

RESULTS

Fifteen patients with stroke participated in this study. All demographic and anthropometric data are provided in table 1. The study sample was heterogeneous with respect to time since admission. All patients have completed the 10m WT, BBS, and the MoI. However, only 13 patients have completed wearing the Activ8 for 7 consecutive days. Of the patients that weren't able to complete the 7 days of wearing the Activ8, one patient had taken a bath and assumed that the device was broken and stopped using the device. The other patient's skin got irritated by the incision foil and therefore decided to stop wearing the Activ8. However, of these patients, one patient has worn the Activ8 for two days and one patient has worn the Activ8 for three days. Furthermore, based on percentages of being physically active per day, data between days didn't fluctuate much. Therefore, it has been decided to include their data in all analyses.

Table 1 Demographic and anthropometric characteristics of the study population

N = 15	Mean, #/#	SD	Min/max
Age (years)	53,5	9,6	37/68
Male/female	5/10		
Height (cm)	176,6	9,6	150/190
Weight (kg)	82,1	11,5	69/105
Inpatients/outpatients	13/2		
Days after admission	47,5	41,8	8/168
Percentage physically active	13,9	7,5	0,7/27,4
• Inpatients (N=13)	13,4	7,7	0,7/27,4
• Outpatients (N=2)	17,0	6,1	12,7/21,3
BBS	50,4	7,9	29/56
MoI	61,5	18,4	14,2/76,9
10MWT	14,0	5,7	6,1/23,9

N = number of patients; SD = Standard deviation; cm = centimeter; kg = kilogram; BBS = Berg Balance Scale; MoI = Motricity index; 10MWT = 10m walking test

Primary objective

On average, patients were physically active for 13,9% of total time (SD 7,5%, range 0,7%-27,4%). Between days, being physically active varied with SD 8,4%. For inpatients, being physically active had a larger range but a smaller mean (range 0,7%-27,4%, mean 13,4%, SD 7,7%) than outpatients (range between 12,7 and 21,3, mean 17,0, SD 6,1%). A pie-chart of body postures and movements for all patients is provided in figure 2. Furthermore, boxplots of percentages of being physically active for all patients, and the subset of inpatients and outpatients, are provided in figure 3.

Figure 2: Body postures and movements for all patients

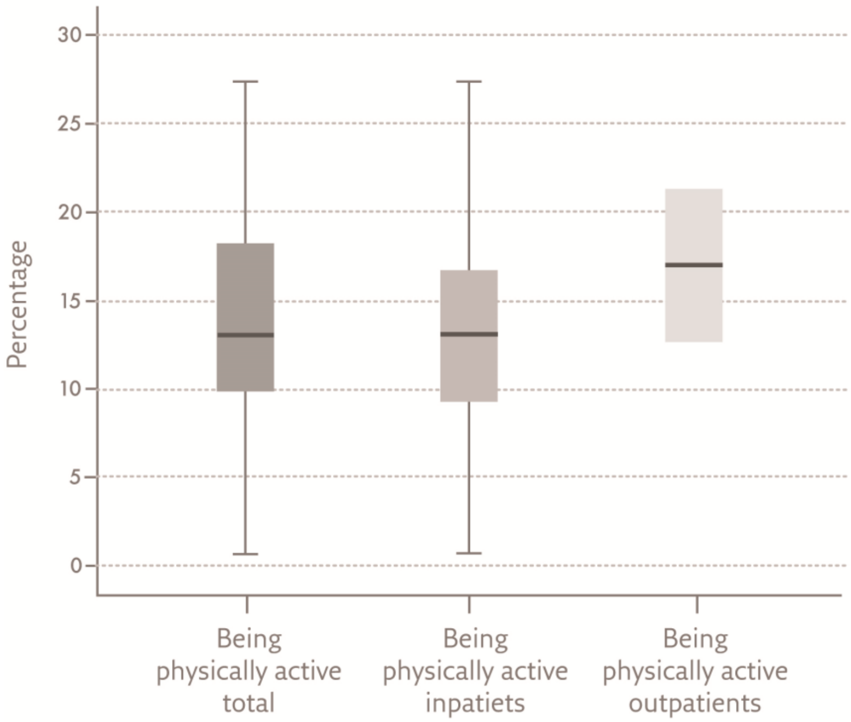

Figure 3: Being physically active for all patients, inpatients, and outpatients

The Pearson correlation between outcomes for the Activ8 and BBS was r=0,234, Activ8 and MoI was r=0,356, and Activ8 and 10MWT was r=-0,255. All correlations and their p-values are provided in table 2. Scatter plots between Activ8, and BBS, MoI, and 10MWT are provided in figure 4. The results indicated no correlation between PB, and WA, balance, and MI.

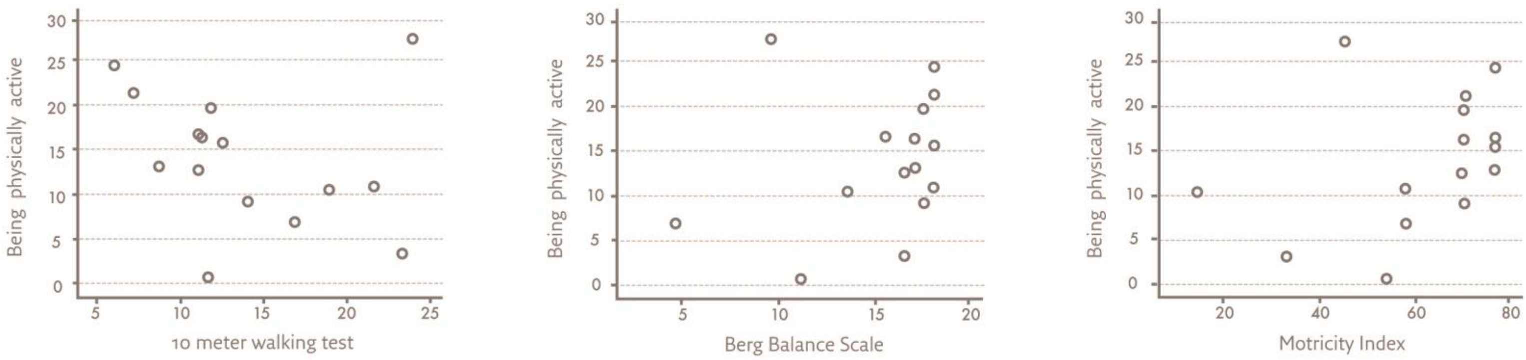

Figure 4: scatter plots between scores of Activ8, and 10MWT, BBS, and MoI

Table 2 Correlation between outcomes of the Activ8, and BBS, MoI, and 10MWT

Activ8	Pearson correlation	p-value
BBS	,234	,402
MoI	,356	,192
10MWT	-,255	,360

PB = physical behaviour; WA = Walking Ability; MI = Motror impairment; sign. = significance; BBS = Berg Balance Scale; MoI = Motricity index; 10MWT = 10m walking test

Secondary objective

All averaged points for topics per group, and their standard deviations, are provided in table 3.

Table 3 Points per group and per topic of questionnaires

Group	**Topic *(# question)***	**Averaged likert score**	**SD**
Patients	Hindering in daily life *(1, 10)*	1,1	0,3
	Effort of applying and wearing the activity monitors *(6, 7, 8)*	1,3	0,4
	Physical discomfort due to the activity monitors *(4, 5)*	1,1	0,3
	Excessive duration of the measuring period *(2, 3, 9)*	1,4	0,5
Physical therapists	Usability for physical therapy practice *(1, 10)*	3	0
	Experienced added value of monitoring PB *(2, 3, 4, 7)*	2,5	0,5
	Clarity of data of PB *(8, 9)*	3,3	0,6
	Time and effort of using data of PB *(5, 6)*	3,1	1,4
Nurses	Time and effort of monitoring patients to wear the activity monitors *(1, 4, 7, 10)*	1	0
	Length of wearing time *(2, 3)*	1	0
	Effort of applying activity monitors *(5, 9)*	1	0
	Frequency of re-applying activity monitors *(6, 8)*	1	0

SD = standard deviation

Patients

One patient didn't complete wearing the active8 for 7 days due to physical discomfort. However, mean points of all patients for physical discomfort of 1,1, and hindering in daily life of 1,1 points, indicated little physical discomfort and hindering in daily life. Of all topics for patients, mean points for effort of applying and wearing of 1,3, and excessive duration of the measuring period of 1,4, were the highest. All mean points indicate little discomfort, hindering, and effort of monitoring PB for 7 consecutive days.

Nurses

Four nurses filled out the questionnaires for nurses. However, these nurses all deliberated with some colleagues. All nurses indicated 1 point, which is the least of points, for all topics. This indicates that none of the nurses experienced supervising patients, and helping them with the application of the activity monitors if necessary, for 7 consecutive days, as a burden.

Physical therapists

Regarding the topic of usability of monitoring PB for physical therapy practice, physical therapists all indicated 3 points. Therefore, their opinion on usability of data of PB for their practice is neutral. Their opinion on experienced added value, with 2,5 points, is slightly less than neutral. Points regarding clarity of data of 3,3, and time and effort of usage of data of PB of 3,1 are slightly more than neutral. However, open statements of all physical therapists indicated that they were insecure about the ability to implement a single assessment of monitoring PB in their practice.

DISCUSSION

The aim of this study was to determine the added value of monitoring PB for an assessment protocol for stroke rehabilitation in a rehabilitation center. The results showed that there is no relationship between PB, and WA, balance, and MI. This might indicate that monitoring PB may provide an outcome for the rehabilitation of patients with stroke that is unrelated to frequently used assessment instruments. However, based on the scatter plots of figure 4, one patient with a percentage of being physically active of over 25% was an outlier in all correlation analyses. Correlation analysis without data of this patient would have concluded a correlation between PB, and WA, balance, and MI. Nonetheless, no errors during monitoring PB of this patient have been reported and data should therefore be included for this study.

The results of this study seem to contradict with the results of Lindeman et al., who found a relationship between PB (cumulative walking time), and gait speed and balance [13]. One of the explanations might be that in that study, PB was expressed by cumulative walking time, whereas in our study, PB was the combination of walking, standing, and cycling. Steps after stroke were found to be strongly correlated to FIM mobility scores [14]. Furthermore, the relationship between walking speed and the 6-Minute Walk Test on the one hand, and walking activity is also found after stroke [21, 22]. Nonetheless, in a stroke study of Mudge et al., a weak relationship was reported between the 10MWT and walking activity [22]. Our study used the 10MWT for the assessment of WA. Furthermore, our study did not investigate the relationship between WA and solely walking activity, but a larger range of body postures and movements.

The relationship between PB on the one hand, and body function and capacity on the other, outside the area of WA, is also diverse. For example, a study by Michielsen et al. used activity monitors that were worn on the upper extremity [23]. Despite a small sample size, their study found a quite strong but non-linear relationship between performance and capacity of activities [23]. However, in this study, monitoring PB focused on hand function and the amount of upper-limb usage. Manns et al. also used activity monitors that were attached to the lower extremity and found no correlation between walking activity and physical functional performance [24]. To our knowledge, studies regarding the relationship between PB and MI do not exist. Similarly, besides the findings by Lindeman et al., the relationship between PB and balance is not or scarcely studied. However, Mansfield et al. identified balance as a potential confounder for ambulatory behaviour [9]. Therefore, our study contributes on knowledge about the relationship between PB, and balance and MI.

Regarding the added value of monitoring PB for an assessment protocol, our study indicated that physical therapists experienced monitoring PB of neutral added value. However, open statements of physical therapists indicated that they were insecure about the ability to include a single assessment of PB in their therapy. For this study, PB has been determined by a single assessment. Periodic use of standardized assessment protocols, which is the background of our study, has proven to be useful for clinical decision making in determining change over time and the effectiveness of interventions [10]. Therefore, if monitoring PB will be implemented in an assessment protocol for stroke rehabilitation, PB will automatically be determined periodically. Given the open statements that were given, we feel that it is uncertain whether therapists were aware that this is the eventual aim of measuring PB. This might have biased their experienced added value of monitoring PB negatively.

Other studies have found that feedback of monitoring PB is beneficial for health professionals and patients in stroke rehabilitation [9, 12, 14, 21, 25]. Monitoring PB may prove useful in evaluating rehabilitation outcomes by augmenting conventional assessment instruments [21, 25, 26]. Subsequently, PB may be used for feedback on amount of walking and other physical activities in the community outside of the rehabilitation center [14, 25]. Also, monitoring PB may be used to promote and facilitate walking and other activities for recovery after stroke [9, 21]. Lastly, monitoring PB might even be used as a predictive value for the recovery of physical impairments after stroke [26]. Therefore, this study's results contribute on knowledge of the added value of monitoring PB in an assessment protocol for stroke rehabilitation.

Our study indicated that monitoring PB is of little burden and hinder for both patients and caregivers, which is consistent with findings of other studies [5, 12]. However, nurses didn't need to help or alert any patients in (re-)applying activity monitors. That might explain the low scores and variability (mean 1,0, SD 1,0) for burdening on the questionnaires for nurses.

In procedure of creating a study sample, it has been achieved to get a heterogeneous sample with respect to time since admission. Therefore, the study sample represents patients in several stages of stroke rehabilitation. This was thought to be beneficial in order to determine the added value of monitoring PB in several stages of stroke rehabilitation [12].

Study limitations

Our study used the Activ8 system for monitoring PB. Although the Activ8 has shown to be reliable for the detection of body postures and movements of healthy persons, the validation for patients with stroke has yet to be done. Therefore, conclusions regarding outcomes for PB have to be cautious.

In this study, all patients were in a process of stroke rehabilitation, which included scheduled time periods for physical and occupational therapy. Therefore, a limitation for this study is that PB wasn't purely voluntary, ambulatory behaviour. However, PB may be used for both feedback of ambulatory behaviour and for evaluating rehabilitation outcomes [25], hence, this limitation might be small.

Both inpatients and outpatients have been included. Between inpatients and outpatients, a different amount of time of physical and occupational therapy is scheduled. Also, outpatients are in a different stage of stroke and participate in a different setting from inpatients. Nonetheless, monitoring PB may be useful for feedback of physical activities both inside and outside of the rehabilitation center [14, 25]. Therefore, in order to determine the added value of monitoring PB for an assessment protocol for stroke rehabilitation, our findings might still be useful. Furthermore, voluntary behaviour is largest in a patient's home environment [12, 14]. Accordingly, perhaps future research will indicate that monitoring PB is of largest added value in a patient's home environment.

All activity monitors were applied on the right leg, despite of a patient's hemiparetic side. Therefore, some patients have had the activity monitor on the hemiparetic side while others didn't. This might have biased the classification for body postures and movements because patients might use their lower extremities asymmetrical [3].

Two patients didn't wear the activity monitor for 7 days. However, these data have been included in all data analysis. Arguments for including these data were on a basis of clinical expertise. The activity monitors have been worn for two and three days and data between days were quite stable. Therefore, it has been assumed that data for PB were representative for the natural PB of these patients. Also, other studies have used data of PB of patients with stroke of three days or less [13, 27].

Future research

Future studies should be conducted to determine the validity of the Activ8 system for monitoring PB of patients with stroke. Furthermore, knowledge on the validity of the Activ8 for monitoring PB of patients with stroke may elucidate the findings of our study.

We recommend that future research should be done to determine the added value of monitoring PB for an assessment protocol with a longitudinal study. Other studies have found that feedback of PB may be used to promote and facilitate physical activities for recovery after stroke [9, 21]. Our cross-sectional results for the added value are promising and the addition of multiple assessments might enlarge the observed added value for several purposes.

Also, we recommend that studies shall be done to determine certain benchmarks for PB of patients with stroke. This might enlarge the value of a single assessment of PB for the health professional for clinical decision making in developing a plan of care and setting goals.

Conclusion

This study has shown that monitoring physical behaviour of patients with stroke provides an outcome that might be unrelated to outcomes for walking ability, balance, and motor impairment. Therefore, monitoring physical behaviour might augment conventional assessment instruments in stroke rehabilitation. Also, this study indicates that monitoring physical behaviour for one week, is of little burdening and hindering for both patients and caregivers. Therefore, we conclude that monitoring physical behaviour may be of added value for an assessment protocol for stroke rehabilitation in a rehabilitation center.

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APPENDIX 1: Dutch questionnaire for patients

1. Het dragen van de beweegsensor heeft mij niet gehinderd in mijn normale dagelijkse activiteiten

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

2. Het 7 dagen achtereenvolgend dragen van de beweegsensor was te lang

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

3. Het 24 uur achter elkaar dragen van het apparaat was te lang

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

4. Het dragen van de beweegsensor was oncomfortabel

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

5. Het dragen van de beweegsensor was pijnlijk

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

6. Het heeft mij weinig moeite gekost om het apparaat een week lang te dragen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

7. Het heeft mij veel moeite gekost het apparaat 24 uur per dag te dragen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

8. Het is mij gelukt het apparaat de hele dag door te dragen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

9. Als het aan mij gevraagd werd, zou ik nog een keer een week lang, 24 uur per dag het apparaat dragen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

10. Ik vind het belastend om het apparaat een week lang, 24 uur per dag te dragen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

Waarom vindt u het wel of niet belastend om de beweegsensor een week lang, 24 uur per dag te dragen?

___

___

___

APPENDIX 2: Dutch questionnaire for Physical Therapists

1. De informatie van de beweegsensor kan ik gebruiken voor diagnostiek/behandeling

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

2. De informatie van de beweegsensor is te beperkt om van toegevoegde waarde te kunnen zijn voor mijn fysiotherapeutisch handelen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

3. Het is het waard om tijd en geld te investeren in het implementeren van de beweegsensor in het standaard meetprotocol in het Rijndam Revalidatiecentrum

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

4. Het zou mijn fysiotherapeutische zorg verbeteren als de beweegsensor onderdeel wordt van het standaard meetprotocol

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

5. Het kost veel tijd om gegevens van de beweegsensor te gebruiken voor mijn fysiotherapeutische diagnose, behandeling

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

6. De gegevens uit de beweegsensor zijn te uitgebreid om efficiënt te kunnen gebruiken tijdens mijn dagelijks fysiotherapeutisch handelen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

7. Ik vind dat de beweegsensor onderdeel moet worden van de standaard fysiotherapeutische zorg in het Rijndam revalidatiecentrum

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

8. De gegevens uit de beweegsensor zijn duidelijk en uitgebreid genoeg

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

9. De gegevens uit de beweegsensor zijn makkelijk te begrijpen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

10. Het kost mij veel moeite om de gegevens van de beweegsensor te gebruiken in mijn dagelijks fysiotherapeutisch handelen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

Waarom vindt u dat de beweegsensor wel of niet onderdeel moet worden van het standaard meetprotocol?

APPENDIX 3: Dutch questionnaire for nurses

1. Het heeft veel moeite gekost om erop toe te zien dat patiënten de beweegsensor een week lang droegen

   1 2 3 4 5

   Volledig niet mee eens — Volledig mee eens

2. Het 7 dagen achtereenvolgend toezien op het dragen van de beweegsensor was te lang

   1 2 3 4 5

   Volledig niet mee eens — Volledig mee eens

3. Het 24 uur achter elkaar toezien op het dragen van het apparaat was te lang

   1 2 3 4 5

   Volledig niet mee eens — Volledig mee eens

4. Het heeft veel extra tijd gekost om erop toe te zien dat de beweegsensor een week lang gedragen werd

   1 2 3 4 5

   Volledig niet mee eens — Volledig mee eens

5. Het heeft weinig moeite gekost om de beweegsensor op het bovenbeen van een patiënt vast te plakken

   1 2 3 4 5

   Volledig niet mee eens — Volledig mee eens

6. De beweegsensor moest vaak opnieuw worden vastgeplakt

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

7. Patiënten moesten vaak herinnerd worden om de beweegsensor te dragen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

8. De folie waarmee de beweegsensor vastgeplakt zat liet weinig los

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

9. De beweegsensor moest vaak worden verwijderd om de patiënt te kunnen verzorgen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

10. Het kost weinig tijd en moeite om ervoor te zorgen dat alle patiënten de beweegsensor een week lang dragen

1 2 3 4 5

Volledig niet mee eens Volledig mee eens

Waarom vindt u het wel of niet belastend om erop toe te zien dat patiënten de beweegsensor een week lang, 24 uur per dag dragen?