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Physical Activity in Hospitalized Persons with Dementia: Feasibility and Validity of the MotionWatch 8

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Abstract

Persons with dementia are at high risk for hospital -acquired disability, associated with low physical activity during hospitalizations. To determine the effectiveness of efforts to increase physical activity a valid and reliable measurement approach that is required. Data from an ongoing cluster randomized clinical trial examined the feasibility and validity of the MotionWatch8 (MW8) triaxial actigraphy device. Regression analysis was used to evaluate the association of MW8 data with participants' physical function and the association of moderate activity measured by MW8 with participants' return to baseline function. Time in low activity (β =.17, t (255)=2.9, p =.004), and time in moderate activity (β =.14, t (255)=2.4, p=.017) were associated with function. Engagement in moderate physical activity was associated with return to baseline function at discharge (Wald χ^2= 4.10, df=1, p=.043). The study provides preliminary support for the feasibility and validity of the MW8 in hospitalized persons with dementia.

Keywords

physical activity; hospitalized older adults; dementia; actigraphy

Introduction

Hospital – acquired disability (HAD), defined as functional loss that is acquired during hospitalization, occurs in over 30 percent of hospitalized adults age 65 and above, with most older adults (70–80%) not returning to baseline function in mobility and other activities of daily living (Buurman et al., 2011; Covinsky, Pierluissi, & Johnston, 2011; Zisberg, Shadmi, Gur-Yaish, Tonkikh, & Sinoff, 2015). The risk for HAD is higher in persons with dementia,

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who are twice as likely to be hospitalized as compared to those without dementia (AA, 2020; Phelan, Borson, Grothaus, Balch, & Larson, 2012). The consequences of HAD in persons with dementia are an increased risk for hospital readmission, emergency department use, morbidity, long-term care placement, and earlier mortality (AA, 2020; Black et al., 2012). Factors associated with failure to return to baseline function by discharge include lower baseline functional status (two weeks prior to admission), activities of daily living (ADL) function on admission, and higher comorbidity, and cognitive impairment. However, interventions to promote self-care and physical activity in routine interactions during hospitalizations have demonstrated less functional loss, from baseline to discharge (Boltz, Chippendale, Resnick, & Galvin, 2015). To determine the effectiveness of efforts to increase physical activity, including mobility and self -care, a reliable and valid measurement approach is required. Data collection must also be acceptable to persons with dementia, who are already stressed by the unfamiliar hospital, environment, disruption in routine, the acute illness, and often, the presence of delirium (Fick, Steis, Waller, & Inouye, 2013).

Paper based surveys and diaries have been used to collect physical activity data; however, self-report data are difficult to collect when the patient has cognitive impairment or is too ill to document activity (Gennuso, Matthews, & Colbert, 2015). Reliance on clinical staff to record data, especially in the hectic hospital environment, is also problematic and brief activities are easily missed by nursing staff (Brown & Werner, 2008; Brown, Roth, & Allman, 2008). Video recording has been used to monitor activity but can be considered intrusive (Weinger, Gonzales, Slagle, Syeed, 2004). An alternative is the use of accelerometers, external sensing devices worn on either the wrist or ankle, leg, or around the waist. Accelerometers automatically measure movement during various activities throughout the day (Chakravarthy & Resnick, 2017). This approach aims to simplify measurement for both the patient and the clinical staff, while improving the quality and reliability of the data (Baley & Wyatt, 2018).

In small samples, accelerometers have been noted to be valid measures of mobility in hospitalized older adults (Baldwin, Parry, Norton, Williams, & Lewis, 2020). For example, the use of wireless monitors attached to the thigh and ankle accurately evaluated mobility based upon position change (Brown, Roth, & Allman, 2008). The ActiGraph GT3X, was worn on the ankle in hospitalized older adults to reliably monitor steps taken (Pavon et al., 2020). Additionally, the Actical worn on the ankle of a cognitively intact, relatively high functioning sample of older adults provided preliminary evidence to support the recommendation of 900 steps per day for the prevention of HAD (Agmon et al., 2017). However, these studies did not focus on an evaluation of accelerometry in hospitalized persons with dementia.

The MotionWatch8 (MW8) referred to as the next generation of actigraph (CamNtech, n.d.) uses a triaxial accelerometer and has a built in ambient light sensor and event marker, and provides an option for long-term recording with no interruptions for battery charging. The MW8 accelerometer is comfortable for patients with dementia to wear as it is similar to wearing a watch, and was reliable and valid when used with a sample of older adults with cognitive impairment living in long-term care (Resnick et al. 2018). Another advantage of the MW8 is that it can evaluate vigorous, moderate, low, and sedentary activity types

based on individual gait speed, allowing for a more nuanced appraisal of physical activity (Chakravarthy & Resnick, 2017). These activity levels provide points of reference that can be compared to the guidelines established by the U.S. Department of Health and Human Services (2018) recommending at least 150 minutes per week of moderate level physical activity (i.e., greater than or equal to three metabolic equivalents or including activities such as walking at 100 steps per minute). Thus, moderate activity which burns 3.5–7 kcal/min and includes such things as walking briskly (3–4 mph) or climbing up the stairs is more likely to prevent a decline in function. (Resnick, Galik, Gruber-Baldini, & Zimmerman, 2011).

Given the advantages of the MW8 over other objective measures of physical activity, the purpose of this study was: 1) describe physical activity, using the MW8 in hospitalized persons with dementia; 2) consider the feasibility of collecting MW8 data in hospitalized persons with dementia; and 3) examine the validity of MW8 data. Feasibility was defined as the willingness of the participant to wear the MW8 throughout the hospital stay and the reasons for missing data. Validity was defined based on hypothesis testing. We hypothesized that there would be: 1) a statistically significant relationship between the MW8 outcomes of time in sedentary activity, time in low activity, time in moderate activity, and function based on the Barthel Index; 2) a statistically significant relationship between the MW8 measure of moderate activity and return to baseline function.

Methods

Design

This was a descriptive study using data from an ongoing cluster randomized clinical trial (ClinicalTrials.gov identifier: NCT03046121), testing the efficacy of Fam-FFC (Family-centered Function-focused Care) (Boltz et al., 2018). That trial is testing the efficacy of Fam-FFC (Family-centered Function-focused Care) to improve: 1) the physical and cognitive recovery in hospitalized persons living with Alzheimer's disease and related dementias (ADRD) during hospitalization and the 60-day post-acute period; and 2) FCG preparedness and experiences. The intervention creates an enabling milieu for the person with ADRD through environmental and policy assessment/modification, staff education, unit-based champions, and individualized goal setting that focuses on functional recovery. In this patient/family-centered care approach, nurses purposefully engage family caregivers in the assessment, decision-making, care delivery and evaluation of function-focused care during hospitalization and the 60-day post-acute period. The study was approved by a university -based Institutional Review Board.

Setting/Sample

The first 321 enrolled patients from six medical units in three hospitals (two units per hospital) were included, including one large academic medical center, a medium-sized teaching hospital, and a small community hospital, located in Pennsylvania. We also recruited family caregivers (FCGs) in the parent study, but they are not the focus of this secondary analysis. Patients were eligible to participate if they were age ≥ 65 years, spoke English or Spanish, screened positive for dementia on the Montreal Cognitive Assessment (MoCA ≤ 25) (Nasreddine et al., 2005) and AD8 ≥ 2 (Galvin, Roe, Xiong, & Morris, 2006),

had a diagnosis of very mild to moderate stage dementia as confirmed by a score of 0.5 to 2.0 on the Clinical Dementia Rating Scale (CDR) (Morris, 1997), and had a FCG as the designated study partner for the duration of the study. Patients were excluded from the study if they had any significant neurological condition associated with cognitive impairment other than dementia (e.g., brain tumor), a major acute psychiatric disorder, had no FCG to participate, and were enrolled in a hospice. We also excluded patients admitted from a nursing home as the parent study included prevention of long-term nursing stays as one of the intervention's objectives, and measured as a secondary outcome.

A total of 1514 pre-screened individuals (based on age and evidence in documentation of ADRD) were eligible to approach for consent and additional screening. The reasons for 320 not being approached included: a) patient not available (n=36, 11%), b) patient discharged (n= 161, 50%), c) unable to reach legally authorized representative for consent (n=105, 33%), and other reasons related to scheduling (n=18, 6%). Of the 1194 that were approached, 426 (36%) consented. The major reason for non-consent (n= 768) were patient refusal (n=392, 51%) and FCG refusal (n=386, 37%). One hundred and five (25%) who consented were not enrolled due to: not passing the dementia screening (n=38, 36%), patient (n=21 [20%]) FCG withdrawal (n=28, 27%), or transfer off the unit (n=17, 16%). A total of 321 dyads (27% of those approached) enrolled in the study. We had baseline data on 321 enrolled patients and MW8 data on 259 (81%) of the enrolled participants (121 [47%] in the control arm and 138 [53%] in the intervention arm.

Measures

Sample characteristics, co-variates in the study, included age, gender, race, ethnicity, comorbidity, cognition, and delirium severity. Comorbid conditions were classified with the Charlson Comorbidity Index, a weighted index that accounts for both the number and seriousness of different co-morbid diseases (Charlson, Pompei, Ales, & MacKenzie, 1987). The Charlson Comorbidity Index is a valid and reliable measure of disease burden (van Doorn et al., 2001). Cognition was assessed with the Montreal Cognitive Assessment (MoCA), a cognitive screening tool that measures executive function, orientation, memory, abstract thinking, and attention and demonstrates excellent sensitivity and specificity, differentiating between mild cognitive impairment, no dementia, and dementia (Nasreddine et al., 2005). The MoCA has been validated in culturally diverse populations and differing educational levels (Berstein et al., 2011).

Delirium severity was measured with an additive score from the four items of the Confusion Assessment Method Severity (CAM-S) Short Form (Inouye et al., 2014). Acute onset and fluctuating course is scored as no (0) or yes (1). Inattention and disorganized thinking are each scored as "absent" (0 points), present in mild form (1 point), or present in severe form (2 points). The fourth item, altered level of consciousness, is scored as alert or normal (0 points), vigilant or lethargic (1 point), and stupor or coma (2 points). Scores range from 0 (no delirium) to 7, with a higher score indicating greater severity of delirium. The CAM-S Short Form has demonstrated strong psychometric properties and associations with important clinical outcomes, including length of stay, functional decline, nursing home placement, and death (Inouye et al., 2014).

Function

Physical function was evaluated using the Barthel Index, a ten-item measure of activities of daily living (ADL; Mahoney & Barthel, 1965). There is sufficient evidence for the reliability and validity of the Barthel Index when used with older adults, individuals with progressive neurological conditions (Resnick & Daly, 1997), and using proxy respondents to report the functional abilities of persons with dementia (Ranhoff, 1997). Items are evaluated based upon the degree of assistance required. Scores range from 0 (total dependence in all ADLs) to 100 (total independence). Admission function was evaluated within 48 hours of admission, reported by the patient's nurse. Return to baseline function was evaluated comparing discharge function (evaluated with 24 hours of discharge, reported by the FCG) and baseline function (reported by FCG as the status two weeks prior to admission on enrollment to the study). Return to baseline (yes/no) was scored as yes if the participant's functional status was the same as baseline, within five points or less than baseline, or greater than baseline. We added the treatment arm (intervention versus control) as a co-variate when we evaluated return to baseline function, given that the intervention may have influenced this outcome.

The MotionWatch 8

The MW8 is a lightweight, water-proof monitoring device that contains a miniature accelerometer. The device is worn on the wrist. Measurement and recording of physical movement of the wrist provides a close correlation to whole body movement during daily activities and sleep with established reliability and validity in older adults living in the community and long-term care facilities (Chakravarthy & Resnick, 2017; Resnick et al., 2018) The data are sampled at 50 Hz and processed into "epochs" of one minute. Counts are the unit of measurement used to evaluate activity, calculated as the number of times the waveform crosses 0 for each period being evaluated. These data are stored in an internal nonvolatile memory and then downloaded at the end of the study period for each participant. It is recommended that the wearer walk at a moderate level of activity for five minutes so that individual reference levels can be calculated; however our participants were not able to accomplish this task so we adopted an alternative approach recommended by Landry and colleagues (Landry, Falck, Beets, & Liu-Ambrose, 2015) and utilized in other studies (Chakravarthy & Resnick, 2017; Resnick et al., 2018). Prior study (Landry et al., 2015) cut points were used with individuals in this study (sedentary ≤178 counts per minute, light ≥179–561 counts per minute, moderate ≥562 counts per minute, and vigorous ≥1,020 counts per minute) and were examined for relationship with function. We evaluated return to baseline function using moderate activity because moderate activity has been shown to have a clear and positive impact upon function (Resnick, Galik, Gruber-Baldini, & Zimmerman, 2011).

Procedures

After consent and screening for eligibility, baseline data for 259 participants was collected by trained research staff blind to treatment condition. Demographic and descriptive information was extracted from the electronic health record, including age, gender, race, ethnicity, and diagnoses/ co-morbidity. The MoCA exam was conducted by a research staff

member and current ADL function was acquired from the FCG. These data as well as the observational measure of delirium was acquired during the application of the MW8, within 48 hours of admission, and prior to the implementation of the Fam-FFC intervention. The intent was for the patient to wear the device for a minimum of 24 hours. The baseline of patient assessment measures took approximately 20 minutes on average to acquire and there was less than 5% missing data for all data.

Analysis

Descriptive statistics were used to describe the sample and physical activity of the participants, using SPSS Version 26 (IBM Corp, Armonk, NY). Feasibility was evaluated by tracking the utilization of MW8 and the reasons for missing data, including feasibility of its use. Construct validity was evaluated based on four linear regression analyses. Age, gender, race, and co-morbidity were not significantly associated with function and were therefore not controlled for in the model. Controlling for cognition ($r = -.147$, $p = .018$) and delirium ($r = -.145$, $p = .01$), MW8 measures of time in sedentary, low, and moderate activity were examined for association with function. Collinearity Statistics, tolerance and the variance inflation factor *(*VIF*),* were also examined to determine if the data met the assumption of collinearity. A tolerance of less than 0.20 or 0.10 and/or a VIF of 5 or 10 and above was considered indicative of a multicollinearity problem (Draper & Smith, 2003).

Predictive validity was evaluated based on a logistic regression model to determine if there was a statistically significant relationship between the MW8 time in moderate activity and return to baseline function. Cognition ($r = -.130$, $p = .038$) and delirium severity ($r = -.180$, $p = .05$) were significantly associated with return to baseline function and were therefore controlled for in the model. Age, gender, race, and co-morbidity were not significant and therefore not included. As stated, return to baseline function could also be influenced by treatment effects; thus, we evaluated this but found no association so did not include this in the model. MW8 time in moderate activity was regressed onto the dependent variable, return to baseline function (yes or no), controlling for cognition. The Hosmer-Lemeshow Goodness of Fit index was used to evaluate if the model fit the data. The Hosmer-Lemeshow statistic indicates a poor fit if the significance level is less than .05 (Lemeshow & Howsmer, 1982). A $p \leq .05$ was used for all other analyses.

Results

Sample Description

As shown in Table 1, the majority of the 259 participants in the sample was female (60.2%), non-Hispanic (99%), and had a mean age of 81.36 (SD=8.24). The sample had almost equal numbers of Black (49.8%) and White participants (47.9%). The overall mean score for the MoCA was 10.73 (SD = 6.94), indicating significant cognitive impairment, and the mean Charlson co-morbidity score was 3.83 (SD=2.42). The admitting diagnoses included altered mental status (n=32, 12%), pneumonia/ respiratory failure (n= 31, 12%), falls/syncope (n= 25, 10%), heart failure (n=27, 10%), respiratory failure (n= 20, 8%), urinary tract infection (n= 23, 9%), other infections (n= 17, 7%), metabolic conditions (n= 19, 7%), cardiac problems (n= 19, 7%), gastro-intestinal conditions (n=18, 7%), cancer

(n=14, 6%), arthritis (n=8, 3%), and other (n= 6, 2%). The sample demonstrated low levels of delirium severity (mean= 1.37, SD= 1.68). Participants had moderate functional impairment upon admission with a Barthel Index score of 59.78 (SD=27.99). The mean baseline (pre-admission) function was 76.1 (SD=28.85) and the mean discharge function was 69.22 (SD=25.54), with 45% (n= 117) returning to baseline function by discharge.

Feasibility of MW8 Use

Of the 321 participants enrolled, 259 participants worse the MW8. There were 62 (19%) individuals in which MW8 data was not obtained. The reasons included: 1) patient refusal of the MW8 (n= 28, 9%), 2) FCG refusal of the MW8 (n=5, 1%), 3) scheduling of diagnostic procedures at the time the evaluator was onsite to place the MW8 (n=19, 6%) and 4) logistical problems including the MW8 being removed early by staff (n= 4) or patients (n=2), and getting lost (n=1), or the data was not uploaded due to evaluator error (n= 3). The participants wore the MW8 for 34.5 hours (SD= 23.46) on average (median=25.0). There was no difference in age, co-morbidity, cognition, delirium, or function among those who were or were not willing to wear the MW8. Those participants who were white and female were more likely to wear the MW8.

Models: Function and Change in Function

Controlling for cognition and delirium, time in low activity minutes was significantly associated with function and accounted for 3% of the variance in that outcome (β =.17, t (255) =2.9, p =.004). Time in moderate activity minutes was significantly associated with function and accounted for 2% of the variance in that outcome (β =.14, t (255)=2.4, p=.017). Time in sedentary activity did not enter the regression model and was not significantly associated with function based on the Barthel Index.

Controlling for cognition and delirium engagement in moderate physical activity, measured by the MW8, was significantly associated with return to baseline function at discharge. Those who engaged in moderate activity were 98% more likely to return to baseline or improve in function at discharge (Wald χ^2= 4.10, df =1, p=.043). There was a good fit of the data to the model (χ^2 = 6.21, p=.62).

Discussion

Our findings demonstrated evidence to support the feasibility and validity of the MW8 as a method of collecting physical activity data in hospitalized older adults with dementia. The majority of participants were willing to wear the device throughout their hospital stay. This is better than findings associated with the waist -worn Actigraph use among persons with dementia while living in assisted living (Galik, Resnick, Lerner, Hammersla, & Gruber-Baldini, 2015). The biggest challenges for use were around refusals from patients and families thus, future research should explore reasons for refusals and consider how to best educate patients and family members on its advantages and comfort of use, to enhance acceptability. Additionally, increased flexibility of the evaluators' schedule including to return to the settings to place MW8 at times the patient most likely was available (e.g.,

evenings) may facilitate application of the MW8 closer to admission, increase wearing time, and accommodate scheduling of diagnostic tests.

Our findings mostly supported our hypothesis that MW8 time in low activity and time in moderate activity (but not sedentary activity) was associated with physical function. These results are consistent with validity testing of MW8 data conducted with assisted living residents (Resnick, Boltz, Galik, Fix, & Zhu, 2020) and add to the evidence of the construct validity of MW8, specifically in hospitalized persons with dementia. Future research that compares observation of physical activity or completion of a diary of activity with MW8 data during hospitalization, as done in prior, long-term care research (Chakravarthy & Resnick, 2017) is warranted to strengthen the evaluation of validity.

Our findings supported our second hypothesis, demonstrating that moderate activity level is associated with the return to baseline function. These findings are corroborated by the inverse results of previous work with hospitalized older adults that showed that low physical activity (900 steps a day threshold), as measured by ActiGraph GT3X, was associated with hospital-acquired disability (Pavon et al., 2020). Our study extends this line of inquiry by providing preliminary evidence specifically in persons with dementia, that MW8 provides a valid approach to measuring physical activity, by level of activity. Further research is recommended that examines level of activity using MW8, with outcomes including functional decline, falls, and delirium.

Our study showed that hospitalized older adults spent the majority of their time in sedentary activity, consistent with other research that examined mobility in hospitalized older adults (Brown et al.,2008; Zisberg et al., 2015). The results are a liberal assessment of physical function given that we used the cutoffs prescribed by Landry and colleagues (2015) which are adjusted for an older adult population. Individuals with dementia are at higher risk for delirium and functional decline, which are synergistic in their occurrence, progression, and response to intervention. Therefore, the findings underscore the need for systemic approaches that promote physical activity including mobility.

Limitations

This study was limited by a sample in three hospitals in the same state; thus, the findings cannot be generalized to all hospital settings. Our study did not evaluate the reliability of MW8 data including the stability of physical activity over time, which would need to consider changes in patient acuity and the effect of treatments such as physical therapy and symptom management that can influence physical activity. The study also did not examine other unknown factors that may influence physical activity such as pain and behavioral symptoms, as well as the physical and social environment. Furthermore, we recognize that wearing the MW8 on the wrist may bias the findings in that intensity of the activity may have overestimated physical activity in cases where the involved wrist was the predominant source of physical activity, and underestimated physical activity associated with walking. Despite these limitations, the study provides some preliminary support for the feasibility and validity of the MW8 in hospitalized persons with dementia and suggests the need for ongoing research to support the value of this measure.

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Table 1

Description of the Sample

Variable			
		n (%)	
Female		156 (60.2)	
Race			
Black		124 (49.8)	
White		129 (47.9)	
Non-Hispanic		3 (1.0)	
	Minimum	Maximum	Mean (SD)
Age	65.00	103.00	81.36 (8.24)
Cognition (MoCA)	0	25.00	10.73 (6.94)
Co-morbidity	1.00	12.00	3.83 (2.42)
Delirium Severity (CAM-S)	0	7.00	1.37 (1.68)
Baseline function	3.00	100.00	76.10 (28.85)
Admission function	3.00	100.00	59.78 (27.99)
Discharge function	3.00	100.00	69.22 (25.54)

Table 2

Mean Time in Daily Activity

Physical Activity	Mean	SD	Median
Sedentary minutes	1771.7	1328.1	1382.0
Low activity minutes	201.7	127.4	192.0
Moderate activity minutes	6.9	19.9	0
Vigorous activity minutes	.83	4.5	0

Table 3

Regression of Physical Activity with Physical Function

Physical Activity	B	β	*t (p)*	95% Confidence Level	
				Lower	Upper
Sedentary activity	.001	.001	.721(.472)	−.002	.003
Low activity	.04	.17	2.9 (.004)	.01	.06
Moderate activity	.20	.14	2.4 (.017)	.04	.36
Vigorous activity	.43	.07	1.2 (.227)	−.27	1.14

Table 4

Logistic Regression Model: Physical Activity with Return to Baseline Function

Physical Activity	B	Wald	*df*	*p*	Exp(B)	95% Confidence Interval	
						Lower	Upper
Cognition	.011	.033	1	.744	.989	.928	1.055
Delirium severity	.102	.631	1	.427	.903	.702	1.162
Moderate activity	.019	4.108	1	. 043	.981	.963	.999