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Patient active time during therapy sessions in postacute rehabilitation: Development and validation of a new measure

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ABSTRACT

Background and purpose: The accurate measurement of therapy intensity in post-acute rehabilitation is important for research to improve outcomes in this setting. We developed and validated a measure of Patient Active Time during physical (PT) and occupational therapy (OT) sessions, as a proxy for therapy intensity.

Methods: This measurement validity study was carried out with 26 older adults admitted to a Skilled nursing facility (SNF) for post-acute rehabilitation with a variety of main underlying diagnoses, including hip fracture, cardiovascular diseases, stroke, and others. They were participants in a randomized controlled trial that compared an experimental high-intensity therapy to standard-of-care therapy.

Patient Active Time was observed by research raters as the total number of minutes that a patient was actively engaging in therapeutic activities during PT and OT sessions. This was compared to patient movement (actigraphy) quantified during PT/ OT sessions using data from 3-dimensional accelerometers worn on the patient's extremities at least 1 session/ week.

Results: Activity measures were collected for 105 therapy sessions in 25 patients. Patient active time had high interrater reliability in both PT (ICC=0.995, $p < 0.001$) and OT (ICC=0.95, $p=0.012$). Active time was highly correlated with actigraphy in both PT ($r=0.73$, $p<0.001$) and OT ($r=0.60$, $p<0.001$) and discriminated between a high-intensity experimental condition and standard of care rehabilitation: in PT, 46.7 ± 12.5 min versus 19.8 ± 10.1 min ($p<0.001$) and in OT, 47.9 ± 12.5 versus 24.2 ± 5.9 min ($p<0.001$).

Conclusions: Systematic observation of patient active time provides an objective, reliable and valid index of physical activity during PT and OT treatment sessions that has utility as a proxy measure of treatment intensity. This measure could be used to differentiate higher from lower therapy treatment

amounts and to help determine the optimal level of therapy activity for patients in post-acute and other settings.

Key Words: Physical Therapy, Occupational Therapy, Rehabilitation, Skilled Nursing Facilities, Actigraphy

Figures and Tables: 1 figure

Abbreviations:

PT Physical Therapy

OT Occupational Therapy

SNF Skilled Nursing Facility

INTRODUCTION

One tenet of medical rehabilitation is the importance of treatment intensity in physical therapy (PT) and occupational therapy (OT) sessions. This issue is particularly relevant in post-acute rehabilitation for two reasons. First, treatment intensity is determined by site of care. Post-acute rehabilitation in an inpatient rehabilitation facility is considered more intensive than in a skilled nursing facility (SNF) because more time is spent in daily PT and OT sessions.[1] Second, more scheduled therapy time is associated with better functional outcomes in older adults who have suffered disabling medical events such as stroke and hip fracture[2-6] From this has been inferred that higher intensity post-acute rehabilitation produces better outcomes and therefore, higher (or more optimal) therapy intensity is itself a goal of research and quality improvement efforts in this setting.[7]

However, hours of scheduled therapy time may be an inaccurate measure of intensity, as patients may be inactive during significant proportions of their scheduled therapy sessions.[8,9] This concern about inadequate intensity in the post-acute care setting is one of the key concerns raised by the Medicare Payment Advisory Commission and has received increasing scrutiny by federal and state auditors.[10] At present, there is no set threshold for PT or OT session intensity in most settings, nor is there a consensus for measuring intensity. Currently, the only intensity guidelines for the post-acute rehabilitation setting are for inpatient cardiac and stroke rehabilitation[11-13] and these guidelines pertain only to aerobic exercise. These guidelines prescribe an intensity range of 40-60% of maximal oxygen uptake level, the measurement of which is difficult in many post-acute rehabilitation settings. The typical post-acute rehabilitation setting, with its wide range of impairment groups, comorbidities (including cognitive and emotional impairments), functioning, and therapeutic activities in typical post-acute settings, may be too heterogeneous for a physiological measure of intensity that is feasible and valid for research[6], let alone real world clinical practice.

An alternative to measuring intensity is quantifying the amount of time a person is active during each therapy session. For example, some of us have quantified amount of therapy for stroke and traumatic brain injury by counting repetitions.[14-16] Similarly, a few studies have used accelerometry to measure movement during rehabilitation as an estimate of treatment amount.[8,17]

Our research group recently developed an objective measure of therapy activity, Patient Active Time, as a proxy measure for therapy intensity, as part of an intervention development project. That intervention, Enhanced Medical Rehabilitation, is a set of patient engagement skills for PT and OT to increase the intensity of therapy sessions in post-acute rehabilitation.[18,19] The purposes of this research report are to: 1) describe the reliable measurement of Patient Active Time, 2) determine the relationship between Patient Active Time and accelerometry recordings, to examine concurrent validity, and 3) determine whether Patient Active Time measurement can discriminate between two groups of patients who received different intensity levels of therapy, to examine discriminative validity.[20] We hypothesized that Patient Active Time (a) could be measured with good inter-rater reliability; (b) would correlate highly with actigraphy counts demonstrating concurrent validity, and (c) would be higher during high-intensity therapy sessions than standard of care sessions. Such results would demonstrate that it is feasible to measure Patient Active Time as a proxy for therapy intensity in the post-acute rehabilitation setting.

METHODS

Participants

Twenty-six older adults who had been admitted to a SNF following discharge from an acute care hospital participated in this study. Written informed consent for participation in the study was obtained

from each patient, in accordance with procedures approved by the university's Institutional Review Board. The inclusion criteria were: 65 years of age or older and admitted to the SNF for post-acute care PT and OT, with at least a 2 week expected stay. The exclusion criteria were: inability or unwillingness to provide informed consent; medical illness that would prevent study participation or accurate data collection (e.g., highly unstable cardiac illness such that early rehospitalization was expected); metastatic cancer or estimated survival was limited; or dementia.

As part of the research project , participants were randomized on a 1:1 basis to receive either Enhanced Medical Rehabilitation or standard-of-care therapy throughout their SNF stay as previously described.[19] Briefly, those in the Enhanced Rehab group received therapy from therapists (1 PT, 1 OT, 1 PTA, 1 OTA) trained to provide more intense and more engaging medical rehabilitation. The result of this training and supervision was that the Enhanced Rehab therapists consistently used motivational principles in interacting with patients during all PT and OT sessions, and consistently pushed for more effortful therapy.[21]

Measures

Patient Active Time. Patient Active Time was defined as the total time when the participant was moving or actively performing an exercise or activity during a treatment session. Time was recorded with a stopwatch by research staff, either through direct observation or from a videotape. Examples of time included were: 1) participant is scooting to the edge of the bed, getting ready for a transfer, 2) participant is practicing walking with the assistance of their physical therapist, 3) participant is practicing grooming activities at the bathroom sink with the assistance of their occupational therapist, 4) participant is performing isometric exercises. Time when the participant was inactive such as sitting or lying, quietly was not included in the Patient Active Time measurement. Examples of time not included were: 1) participant is resting after a bout of quadriceps strengthening exercises, 2) participant

is passively having his or her hamstrings stretched by their therapist, 3) participant is sitting quietly in a comfortable, well-supported position, listening to the therapist explain the next activity that they will perform, 4) participant is sitting and discussing adaptive equipment needs for home safety. Note that measurements of active vs. inactive time do not attempt to make a judgment call as to the quality or appropriateness of that activity or inactivity (e.g., whether a patient spent "too long" resting or whether time spent by therapists educating a patient is less valuable than time spent getting the patient to perform an activity) but instead to simply quantify the active time. The times the participant was active during the session were summed and the total was the Patient Active Time. This was expressed in total minutes per session.

Patient active time measures were sampled from one or more PT and one or more OT sessions per week for each participant during their SNF stay. This sampling pattern allowed for a representative sample of therapy sessions for each participant without undue burden created by constant observation. For a subset of ten sessions (5 PT and 5 OT), Patient Active Time was assessed by two independent raters in order to examine the inter-rater reliability of the measure.

Accelerometry. To examine the concurrent validity of Patient Active Time, we simultaneously used accelerometry measurements. During the same sessions when Patient Active Time was recorded, participants wore four accelerometers (Gulf Coast Data Concepts, LLC, Waveland, MS, USA) (one on each wrist and each ankle). The accelerometers record counts of accelerations (1 count = magnitude of acceleration (>0) g for 0.025 seconds) in 3 dimensions at a frequency of 40Hz. The accelerometers were attached via Velcro to an adjustable wrist and ankle bands and were worn for the duration of the treatment session.

Accelerometry data were downloaded after each treatment session and analyzed with custom-written MATLAB software. Signals from four accelerometers were collected and converted to 3

dimensional components of acceleration. The magnitude (square root of x2+y2+z2) of the acceleration vector was calculated and subtracted (corrected) by 1 for gravity for each accelerometer. Then the area under the corrected acceleration curve, which is equal to the magnitude of movement velocity, was calculated. Signals from the 4 accelerometers were summed. Thus the value derived from the 4 accelerometers for each person indicated the total change in velocity across all 4 segments and was used is an index of the intensity of movement made by a patient during a therapy session.

Data Analysis

Systat version 13.0 was used to perform all of the statistical analyses; data were normally distributed. Intraclass correlation coefficients were computed to assess inter-rater reliability for Patient Active Time. Pearson correlation coefficients were used to evaluate the strength of the relationship between Patient Active Time and Accelerometry. Discriminative validity was examined by testing for group differences between the Enhanced Rehab group and the standard-of-care group with Student t-tests. Data are presented as means $\pm$ standard deviations, unless otherwise indicated.

RESULTS

This sample has previously been described.[19] Briefly, the mean age was 77 years and 74% of the sample was female. Racial distribution was 48% Caucasian, 48% African-American, and 4% Asian. Participants had multiple medical impairments, cognitive status that ranged from unimpaired to mildly impaired, and an initial Barthel Index score of 30 indicating severe disability. Most were unable to walk without assistance at the time of admission. Patient Active Time and accelerometry were obtained simultaneously during 94 therapy sessions (47 PT sessions and 45 OT sessions) across the 26 participants.

Interrater reliability: The intraclass correlation coefficient (ICC) between two independent raters for Patient Active Time was 0.995 ($p < 0.001$) for 5 PT sessions and 0.95 ($p=0.012$) for 5 OT sessions, indicating excellent inter-rater reliability.

Concurrent validity: The correlation between Patient Active Time and accelerometry counts was $r = 0.73$ ($p < 0.001$) for the PT sessions and $r = 0.60$ ($p<0.001$) for the OT sessions, indicating moderate to good concurrent or convergent validity (ref: Kraemer article AJGP).

Discriminative validity: Patient Active Time was significantly higher in the patients randomized to Enhanced Medical Rehabilitation, compared to patients randomized to standard of care therapy. As Figure 1 shows, the Enhanced Rehab group had higher Patient Active Times in PT ($p < 0.001$) and OT ($p < 0.001$) than the standard therapy group These differences mirrored the actigraphy data: the total area under the acceleration curve was approximately doubled in the high-intensity group compared to the standard-intensity group for both PT and OT (PT: Enhanced Rehab, $6.04 \times 10^4 \pm 1.14 \times 10^4$ vs. standard, $3.07 \times 10^4 \pm 0.80 \times 10^4$; $p<0.001$; OT: Enhanced Rehab, $4.54 \times 10^4 \pm 1.29 \times 10^4$ vs. standard, $2.25 \times 10^4 \pm 0.77 \times 10^4$; $p<0.001$).

DISCUSSION

We developed Patient Active Time as an objective measure that can be used to characterize the intensity of PT and OT sessions. It has good interrater reliability and good concurrent (convergent) validity as demonstrated by the high correlation with actigraphy. This observation builds on similar work which observed active time and accelerometer data in 5 patients during PT treatment sessions.[17] We did find a higher correlation with accelerometry in PT than OT sessions; this may be due to the more exercise-based nature of PT in post-acute rehabilitation. Patient Active Time scores also discriminated

between Enhanced Medical Rehabilitation (the experimental therapy format designed to increase therapy intensity) and standard-intensity PT or OT, demonstrating discriminative validity.

What is ultimately needed is predictive validity, not just of this new measure of Patient Active Time, but of the ability of differences of therapy intensity to produce differential outcomes in post-acute rehabilitation. For future research about the efficacy of various rehabilitation interventions, we suggest that measurement of Patient Active Time could serve as a proxy measure of treatment intensity. Patient Active Time can be used in a heterogeneous sample of patients, as we did in this pilot study, and it may be more feasible than accelerometry, because it does not require specialized equipment or interfere with practicing basic activities of daily living (such as bathing). This would be helpful for research studies of rehabilitative interventions to show, for example, that an interventions designed to increase the intensity of therapy actually are doing so in an objective, measurable way. A promising preliminary finding from this study is that individuals in a SNF post-acute care setting are capable of higher PT and OT session activity than is currently being provided in standard rehabilitation. Measuring Patient Active Time would also be important for research evaluating the optimal levels of activity for different patient groups and levels of care. Studies with larger samples, conducted in a variety of settings, are needed to further demonstrate the generalizability and utility of this new measure for the post-acute and other settings. Finally, caution is needed with respect to measuring Patient Active Time (or any intensity measure) for clinical purposes such as quality assurance, and this measurement should not be taken as a suggestion that some non-active times (e.g., resting or receiving counseling) are an unimportant part of rehabilitation. Further work would need to be done to determine whether Patient Active Time could be used as clinical tool, and if so, whether its measurement could be reliably obtained by treating clinicians. In summary, Patient Active Time is a valid and reliable objective measure of PT and OT session activity that could be a useful proxy for therapy intensity in the post-acute rehabilitation setting.

Suppliers

a. Miniature 3-axis accelerometer data logger X6-2mini set at high Gain with sampling rate of 40 Hz.

   Gulf Coast Data Concepts, LLC, 611 Nicholson Ave., Waveland, MS 39576 USA.

b. Mathworks, 3 Apple Hill Drive, Natick, MA 01760-2098 USA.

c. Systat version 13.0, Systat Software, Inc. 225 W. Washington St., Ste 425, Chicago, IL 60606.

Figure Legend

Figure 1.

Patient Active Time (min) for Enhanced Medical Rehabilitation (n=59) versus Standard of care (n=46) occupational and physical therapy (OT and PT) sessions. Data presented as mean $\pm$ SD, $p<0.001$ for both (OT and PT) comparisons of Enhanced with standard of care rehabilitation.

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