Repetition Matters: Number Of Steps In Outpatient Physical Therapy With Technology-Assisted Gait Training Interventions

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OBJECTIVES:

Clinical research aimed at determining the most effective means of rehabilitation for patients poststroke is of growing concern. Stroke is currently the third leading cause of mortality in the United States, accounting for roughly one in every seventeen deaths.[1] Strokes lead to neurological changes that often result in some degree of disability. Three out of four individuals who have experienced a stroke will have an impaired ability to perform basic functional activities, with transfers and walking being most severely affected.[2] Early intervention from physical therapy has been shown to improve functional gains following a stroke which explains the vast amount of research being conducted in order to determine the most effective form of intervention.[3]

It is important to understand the basis of the cortical reorganization that follows a stroke in order to best tailor beneficial interventions. Evidence has demonstrated that the functional gains made after cortical and subcortical damage are largely related to neuroplasticity. Plasticity allows new connections to be formed, latent connections to be unmasked, and existing connections to be strengthened. Research has shown that the length of time spent practicing high-intensity, task specific activities is directly correlated to the functional recovery seen in individuals admitted after experiencing a stroke.[3] Gait training in an outpatient setting typically incorporates 501 steps per session according to an observational study conducted in 2009 by Lang et al. The researchers concluded that conventional therapy, in this population, does not incorporate enough task-specific practice of ambulation to stimulate cortical changes associated with the brain's neuroplastic principles.[4] Results from a study comparing the amount and type of practice between the stroke and traumatic brain injury populations further supports Lang, et al.'s finding of less than necessary repetitions in terms of steps, and proposes that further research into treatment delivery methods is necessary to increase the functional recovery following a brain injury.[5]

The purpose of the present study is to determine if the number of steps per session in outpatient gait interventions using technology differ from the number of steps per session provided in conventional therapy for patients receiving physical therapy after stroke. The use of advanced technology including robotics, exoskeleton devices, and body-weight support with a treadmill has been speculated to provide task-specificity, intensity, and repetition to traditional gait training interventions. Although some studies report number of steps achieved using these devices anecdotally, none have determined if this number is actually greater than conventional gait training. In addition, there is some support that additional repetition of stepping in therapy sessions may carryover to greater daily stepping outside of physical therapy[6] of advanced technology.

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METHODOLOGY:

A convenience sample of one stroke survivor was used to count number of steps per session in outpatient therapy utilizing advanced technology for gait training interventions. The subject was a 57-year-old Caucasian male admitted to outpatient rehabilitation services at Sheltering Arms with severe left hemiplegia and partial visual deficits secondary to a large middle cerebral artery distribution embolic stroke. He was severely hemiplegic with early spastic tone noted in left lower extremity and dense upper extremity paralysis. Left inattention was also noted with partial hemi sensory loss.

His medical problem list included the following:

- Organic heart disease with cardiomegaly with recent echocardiogram demonstrating moderate left ventricle hypertrophy with mild asymmetric septal hypertrophy with marked global hypokinesus with markedly reduced left ventricle ejection fraction
- Atrial fibrillation with paroxysmal atrial flutter- status post ICD placement and recent cardioversion.
- Sleep apnea with the use of a CPAP at home.
- Reactive depression following the stroke.
- Post-stroke, subacute onset of cerebral edema treated with steroids.

His past medical history was reported as follows:

- Coronary artery disease with hypertrophic cardiomyopathy
- He has dyslipidemia which was being medically managed prior to admission

His social history was reported as follows: non-smoker, occasional cigar in the past, does not drink regularly, works in the IT department doing computer programming. He lives with his wife in a two-story home with four steps to enter.

A step activity monitor (SAM), which is noted to be reliable and valid, was used to record number of steps per session during gait interventions that incorporate technology to avoid error in data collection.[7] Data (number of steps per session) from the subject was averaged for four sessions. The average was compared to results from Lang, et al. using an unpaired t-test of unequal variances to determine if a difference exists between groups. In the Lang, et al. observational study repetitions were counted for various activities including gait. Trained observers counted the number of steps taken in therapy sessions at several different clinic sites with data collected from 312 separate sessions. One of the limitations noted in their study was a possible overestimation of steps taken due to observational error.

The Berg Balance Screen (BBS) and the Timed up and Go (TUG) were selected as functional outcome measures to demonstrate minimal detectable change (MDC). The MDC for the timed up and go (TUG) has been determined to be 2.9 seconds for stroke survivors.[8] The BERG balance scale has an MDC of 6.9 for stroke survivors, with a more specific MDC of 8.1 for those who ambulate with assistance.[9]

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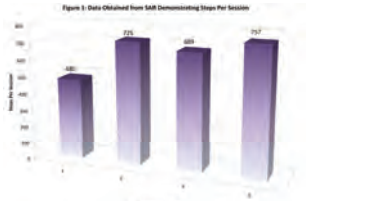
RESULTS:

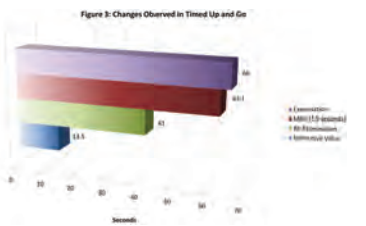
The subject participated in over three weeks of outpatient therapy. He completed four sessions in the recorded period using advanced technology for gait training. The technology used was an advanced body weight support system and split-belt treadmill. The number of steps per session for each of the four observed sessions is shown in **Figure 1.** The mean of our subject's steps per session was 663±125. This represents 162 greater steps than results reported by Lang, et al. as seen in **Figure 2**. There was a significant increase in the number of steps per session in the outpatient interventions utilizing advanced body weight support and treadmill for gait training (p>.0001).

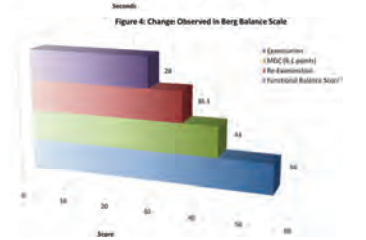
Outcome measures improved from baseline scores to current findings with minimal detectable changes observed in both. The TUG score upon evaluation was 66 seconds and improved to 41 seconds after 4 treatment sessions incorporating technology, as seen in **Figure 3.** The BBS score improved from 28 points on evaluation to 44 points out of a possible 56 points, as seen in **Figure 4.**

CONCLUSIONS:

There is an extensive body of evidence demonstrating the need for high-repetition, high-intensity interventions in order to see neural reorganization which translates into functional recovery of gait. This study shows the use of technology does produce more repetitions of stepping in outpatient therapy. Limitations of the present study include the sample size of a single subject with limited number of observed sessions. Also, the methods of the present study differ from the comparison study (Lang, et al.) which used trained observers to count number of steps per session. Future studies could address the limited sample size, include inpatient settings, and include observation of steps per session using a SAM in the same institution for patients receiving conventional interventions.







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