Speed-dependent body weight supported sit-to-stand training in chronic stroke: A case series

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BACKGROUND

- Persons with stroke often have limitations in sit to stand (STS) performance due to impairments in motor control, strength and balance (Cameron 2003).
  - These STS limitations increase physical inactivity (Monger 2002), care burden (Granger 1993) and fall risk (Cheng 1998).
- It is well accepted that repetitive, challenging task-specific practice improves motor function and promotes neural reorganization after stroke (e.g. Forrester 2008).
  - However, repetitive STS training is often unfeasible due to rapid fatigue, especially for those who require STS assistance.
  - Mechanical body weight support (BWS) allows persons with stroke to perform greater repetition of *gait* practice due to decreased fatigue (Barbeau 2003).
  - Hypothetically, the use of BWS during *STS* training should similarly allow greater repetition of *STS* practice.
- Like BWS, a speed-dependent protocol may also enhance post-stroke STS training.
  - Speed-dependent *treadmill* training, which involves maximum speed ambulation for 10 second bouts, has been shown to be efficacious (Pohl 2002).
  - A similar protocol might be beneficial for STS training because:
    - Persons with stroke often exhibit slow force recruitment during STS (Cheng 1998).
    - Faster force generation during STS yields more effective use of available strength (Monger 2002) and is associated with decreased fall risk (Cheng 1998).

PURPOSE

To examine the feasibility and outcomes of speed-dependent BWS STS training for two adults with chronic stroke who initially required moderate assistance for STS.

METHODS

Subject characteristics: Both subjects were male, had left sided ischemic stroke, ambulated household distances with devices and used a wheelchair in the community.

	Age (years)	Weight (lbs)	Years post stroke	Stroke location	Comorbidities	Walking aids
S1	75	189	2.3	Cerebrum	HTN, depression	Front-wheeled walker
S2	68	220	8.7	Brainstem	HTN, depression, DM, left patellofemoral OA	AFO, pyramid cane

Study Design: Pre/post test case series. Subjects had BWS STS training for 45 to 60 minutes, 3x/week, discontinued when the subject was able to perform three STSs independently in less than 30 seconds.

Intervention: Each session began with a 15 min warm up of self paced STS repetitions with >50% BWS. For the remainder of the session, subjects performed sets of STS repetitions at maximum speed with rest until full recovery in between sets. Training progressed by gradually decreasing BWS to zero for each hand position, starting with hands placed on the apparatus handlebars, advancing to chair arm rests and finally to the subject's thighs.

Outcome Measures: Administered by the same rater at pre and post testing:

Three Repetition Sit to Stand Test (3RSTS) – Timed task in which the subject stands up from a chair and sits back down three times in a row. Modified version of the Five Repetition STS Test (Mong 2010).

Gait Parameters - Measured by the GaitRite electronic walkway (Bilney 2003).

Mobility Domain of the Stroke Impact Scale (SIS-Mobility) – Stroke specific quality of life questionnaire with 8 items assessing mobility ranked on a 5 point scale (Duncan 1999).

RESULTS

Table 2. Outcome measure changes

Outcome measure	Subject	PRE	POST	Change
3RSTS (s)	1	18	8	- 10
	2	40	21	- 19
Gait velocity (m/s)	1	.172	.236	+.064
	2	.249	.417	+.168
Cadence (steps/min)	1	72.3	78.8	+6.5
	2	57.6	73.6	+16.0
Affected step length (cm)	1	12.7	17.6	+4.9
	2	29.7	37.7	+8.0
Less-affected step length (cm)	1	15.9	18.2	+2.3
	2	22.2	29.8	+7.6
Affected single-limb support time (% gait cycle)	1	13.4	17.6	+4.2
	2	16.4	22.4	+6.0
Less-affected single-limb support time (% gait cycle)	1	33.9	36.4	+2.5
	2	31.4	32.4	+1.0
SIS-Mobility (0-100)	1	78	88	+10
	2	63	66	+3

Subjects consistently exhibited more symmetrical lower extremity (LE) weight bearing with BWS compared to manual assist (clinical observation).

With BWS, S1 and S2 performed an average of 95 and 72 STS reps/session, respectively

Subject exercise responses for blood pressure, heart rate and oxygen saturation were always within normal limits. During the first week of training, both participants reported some delayed onset muscle soreness, which lasted up to two days.

After eight and eleven sessions respectively, subjects 1 and 2 had changed from moderate assist to independent in STS and had improved in all measured outcomes (Table 2). Both subjects also reported that they no longer needed help to stand up at home and that they felt more confident in their balance.

DISCUSSION

- Speed-dependent BWS STS training appears to be feasible in chronic stroke, even for persons with functional limitations, deconditioning and some comorbidities.
- The intervention was associated with improvement in STS independence and speed, gait velocity, cadence, step length, single-limb support time and quality of life.
- Enhanced brain plasticity and motor learning are potential mechanisms underlying the observed outcomes.
  - BWS enabled each subject to perform over 750 total STS repetitions while being constantly challenged to increase speed.
    - Consistent with motor learning principles of task specificity, repetition and intensity (Forrester 2008, Hubbard 2009).
  - Observations of more symmetrical LE weight bearing during training and greater gait improvements on the affected (vs. less affected) side after training suggest that the intervention may target the affected LE
    - Similar to upper extremity forced use interventions which have been shown to drive neural reorganization (Hubbard 2009, Sawaki 2008).
- Potential transfer effect from post-stroke STS training to gait and balance outcomes has precedent
  - Increased gait velocity after conventional STS training and step ups (Monger 2002)
  - STS training improved balance (Tung 2010, Cheng 2001) and decreased fall risk (Cheng 2001).

Limitations:

- Case studies can not determine intervention efficacy, only possible outcomes.
- No long term follow up

References available by handout