Based on a Health Sciences Library search, describe an intervention used for TBI to address a common problem: Body Weight-Support Treadmill Training

The ability to walk is central to all aspects of function. It helps us get where we need to go, stay active and healthy, and complete household tasks throughout a normal day. After occurrence of traumatic brain injury, ambulation is often largely affected because it is made up of so many different components. Independent, safe ambulation is a function of strength, balance, control, muscle tone, coordination, cognition, and range of motion. Each of these components is often affected after acute injury to the brain. Improving outcomes in each of these components takes time, practice, and skilled assistance from a rehabilitative team approach. It is so important for us as health professionals to be educated on the best practices and current research for treating this population because post-injury outcomes increase significantly with early improvements in cognitive status, FIM motor function, and access to care including continuity, early rehabilitation, case management, and specialized care1. Therefore, we must do our best to begin motor function rehabilitation as quickly as possible for best outcomes. The difficulty here is adopting a gait training technique that is safe for both the patient and the therapist and is efficient and effective for improving outcomes. For example, conventional gait training may require several therapists to accomplish because of the patient’s decreased cognition, coordination, balance and strength. Two therapists may be needed for support on each side, one behind following with the wheelchair, and one in front guiding the assistive device and giving verbal instructions. This method lacks efficiency of therapists and could potentially be distracting to the patient. Another option could be addressing each of the components of gait listed previously separately until improvements are demonstrated and then attempting gait. This would limit the amount of distraction; however, this neglects to use task practice as the primary mode of rehabilitation, which was found by Hubbard and colleagues to be extremely beneficial for regaining function if implemented in a way that is relevant to the patient and context, repetitive and massed practiced, aimed towards reconstruction of the whole task, and reinforced with positive feedback2.

As an attempted remedy to these roadblocks, recent research has explored the possibility of using body weight-supported treadmill training (BWSTT) for patients post traumatic brain injury. After central pattern generators were discovered through the work of Grillner with spinalized cats walking on a treadmill, ideas for gait training for patients with injury to their CNS began to develop5. Barbeau and Rossignol found that these spinalized cats could demonstrate improved quality of locomotion if they were given a locomotor training program in which the researcher gradually decreases the body weight-support while increasing the velocity of the treadmill6. If this is true for a cat, surely a similar response would occur in humans with similar injuries. This idea of gait training in rehab operates under the assumption of neuroplasticity in which the neurons and axons in the brain form new patterns and connections around the areas of injury via repetitive sensory input. When a patient’s body weight is supported and suspended over a treadmill, the sensory cues of lower extremity stepping is sent to the spinal cord, traveling to the brain, allowing for regeneration of neural connections7. Research into this topic for patients with traumatic brain injury is few and lacking in quality evidence. The evidence is varied in results regarding which is more effective: BWSTT or conventional over-ground gait training (COGT). Greater evidence exists for other neurologic conditions such as stroke, Parkinsons Disease (PD) and Cerebral Palsy. It appears that patients with each of these diagnoses show improvements in gait velocity and stride length after BWSTT as compared to COGT3.

There are several production companies that have made a device for BWSTT. Each of them look similar to the image below.

 

Figure 1 <http://www.nih.gov/news/health/feb2011/ninds-11.htm> Figure 2 <http://litegait.com/litegait.html>   
Both of these individuals look very happy to be using the body weight-supported system!

The patient is strapped into the harness system which is secured tightly just below the patient’s greater trochanters up to the xiphoid process. The harness system includes two straps that cross between their legs. This system allows for hip flexion and extension while providing a tight hold in order to support the patient’s weight. The device also has 4 adjustable straps that are hooked to the harness at the patient’s shoulders and attached to the frame of the device above the patient’s head. The device lifts the patient until their body weight is supported but their feet are still touching the ground3. The study by Visintin and Barbeau found that unweighting the patient of more than 40% of their body weight prevents heel strike8. There are handle bars in front of the patient for extra balance if necessary. The treadmill is then set to the highest velocity that the patient is comfortable with and the patient is assisted in stepping by one or more therapists as needed3. Sullivan et al found that it was more beneficial for improving patient-selected velocity to practice ambulation at normal walking speeds as compared to speeds slower than their normal9. Overtime, as the patient begins to improve, the body weight support is decreased and the velocity on the treadmill is increased until the patient is able to safely support themselves and control their balance. This should be used to practice several times per week for several weeks to show mobility improvements3.

There are several reasons why using a body weight-supported system for gait training may be more beneficial than conventional gait training for both the patient and the therapist. First, it reduces stress on the therapist. During COGT, the therapist is required to provide the assistance needed to remain erect, perform weight shifting, initiate stepping, controlling swing through, and supporting balance throughout the process of each step. This requires gait to be slowed and divided into several steps which lacks the fluidity of natural stepping. The patient’s weight on the therapist may lead to injury or increased fatigue for the therapist which would lead to less time that the therapist can physically provide assistance with gait training during each treatment session3. Having the patient’s body weight supported frees the therapist’s hands to assist with toe-off for step initiation and weight shifting to encourage natural gait. Secondly, COGT often involves use of an assistive device to provide increased stability and balance for the patient; however, retraining with a device may encourage compensatory strategies early on that are difficult to eliminate in the future and may also be a distraction for the patient3. With the body weight supported system, the harness protects against compensatory strategies such as forward flexed trunk and asymmetrical stepping as is common with use of a walker. Also, having the support of the harness system controls for aspects of gait such as strength and balance and allows the patient to repetitively practice the task as a whole3. As noted previously by Hubbard, specific task practice is one of the most beneficial methods of regaining specific function2. The body weight support system also allows the therapist to focus on aspects of gait (such as coordination and perfecting sensory cues such as knee extension during stance and knee flexion and toe clearance during swing phase) without concerns of collapse due to weakness or loss of balance. It also allows for stimulation of the central pattern generators in hopes to produce similar effects as the spinalized cat. Lastly, the amount of body weight support can be adjusted and gradually declined as the patient improves and moves closer to more challenging aspects such as balance, body control, and muscular demand3.

Hicks and Ginis note that there are also significant benefits both psychologically and physiologically to being upright and erect for patients with spinal cord injury, which is also a traumatic injury to the CNS, so perhaps may translate to patients with TBI4. Physiologically, BWSTT has been shown to improve cardiovascular health by decreasing LDL cholesterol and the ratio between total cholesterol and HDL cholesterol. It also improves glucose tolerance and insulin sensitivity. It has been shown to improve the autonomic regulation of heart rate and blood pressure as well as improved blood flow through the femoral and carotid arteries4. The lack of activity after a brain injury causes atrophy to all unused muscle groups. It is common to see a transformation of some muscle fibers into highly fatiguable type II fibers which leads to an increase in nonoxidative energy provision as opposed to the normal mitochondrial oxidative metabolism4. Furthermore, secondary to reduced muscle mass is a reduced tolerance to glucose which increases the individual’s risk for type 2 diabetes. BWSTT has been shown to increase the mean fiber area by 25% after 6 month s of BWSTT 3 times per week. The percentage of type IIa fibers, oxidative capacity, and muscle strength all increased significantly4. One would expect for bone density to increase as the body weight support is decreased over time; however, this study showed no improvements in bone mineral density after months of BWSTT. This study did not use a control group for comparison, however4. Psychologically, BWSTT has been found to have associations with increased health related quality of life (HRQOL), with significant changes in both physiological well-being and body image. This same study that found mood improvement after BWSTT also found decreased pain overall. Not only does BWSTT improve one’s independence by moving towards the ability to walk again, but it also allows the individual to stand erect, be eye level with others, and being on the way back to “normal”4. This can also be psychologically healing for the family members and caregivers of the patient because it will allow them to see the patient standing and/or walking in a controlled setting that visually reminds them of their loved-one prior to the accident. There are often several small and gradual improvements along the way in the rehabilitation process for one with a brain injury, but healing never happens as quickly as we wish. Therefore, giving the loved-ones a visual image of the mobility that is to come may instill refound hope and encouragement to continue to press forward towards the goal of normalcy.

Though at first glance, the body weight-supported system of gait training seems to be ideal for the population of patients who have experienced traumatic brain injury, further research is required to test its effectiveness in comparison to other forms of gait training in rehab in order to determine whether or not it is worth the extra time and money that it entails. The body weight- supported device takes time to set up on the patient and requires at least two therapists assistance, one for strapping the harness onto the patient correctly and attaching it to the frame and one therapist for providing balance support for the patient during set-up. Furthermore, during gait training, three therapists are often required for assistance in stepping for both legs as well as assistance for weight shifting at the pelvis. This means that the rehabilitation facility must pay not only for the device itself, but also for the income of three therapists working with only one patient. There are a few different companies that have created this gait device, but each is created slightly different and each range in price from $80,000 (Therastride)7 to 12,040 (LiteGait)10 to as low as $4,500-6,000 (Spineflex)11. These figures give evidence to the cost a rehabilitation facility would have to invest in order to provide this service. It is definitely not cheap. The question is, is it worth it?

Brown and colleagues were the first to provide a randomized controlled trial (RCT) looking at the difference between outcomes for BWSTT versus conventional over-ground gait training (COGT) for patients with traumatic brain injury. Each of the 20 participants received gait training for 14 weeks total, 2 times per week for 15 minutes. They also received 30-minutes of therapeutic exercise in addition to gait training. The authors chose this frequency of treatment based on an average treatment time in an inpatient rehabilitation facility. The duration of time since injury ranged from 7-23 years and the authors attempted to make the experimental and control groups as similar as possible by strategical randomization. The experimental group used the LiteGait device and began at 30% body weight support. As the patient was able to obtain 10 bilateral consecutive heel strikes, the support was decreased by 10%. The velocity on the treadmill was set to the fastest speed that the patient could tolerate. Participants were tested for gait speed, stride width, right-left step differential, functional reach test (FRT), functional ambulation category (FAC), and the Timed up and go test (TUG). Results showed that the only statistically significant difference between groups was the right-left step differential which improved more in the BWSTT group than the COGT group. The rest of the outcome measures did not show any statistically significant difference between groups; however, the COGT group appeared to improve slightly more than the BWSTT group on most of the other measures3.

Three years later Wilson, Powell, and colleagues completed a very similar RCT comparing the difference between BWSTT and traditional gait training for patients with TBI. 38 total participants received gait training 1 hour or less twice a week for 8 weeks, 19 participants in the experimental BWSTT group and 19 in the control group doing traditional gait training. They each also participated in additional physical therapy to fulfill their 3 hour requirement for inpatient rehabilitation. Subjects in each group were very similar. The BWSTT group used a Pneu-Weight unweighting system and decreased the body weight support as the patient felt comfortable. Patients were scored using the Functional Independence Measure (FIM), Functional Assessment Measure (FAM), Rivermead Mobility Index (RMI), Gross Motor Subscale (GMS), Standing Balance Scale (SBS), and the FAC. All 38 subjects showed improvements in each of the outcome measures; however, there were no statistically significant differences between the two groups for any of the measures. Though not statistically significant, scores on the SBS, RMI, and FIM+FAM were greater for the BWSTT group. Scores were higher for the traditional gait training group on the FAC and the GMS. The authors noted that in order to have a power of 80%, they would have needed a sample size of 5,000 subjects for this study. Therefore, their sample size was too small to show the effect that they intended so the results are not clinically significant but should be used for education on an anecdotal level as well as in combination with other research studies to assess the evidence13.

Wilson and Swaboda performed a similar study but their purpose was to compare the effect of BWSTT on an acute TBI versus a chronic TBI. They each received two 1 hour sessions of BWSTT using a modified lat-pull machine created for the study for 8 weeks. Their body weight support was decreased by increments of 10 pounds at a time. These two patients also received additional physical therapy as required by the inpatient rehabilitation facility. Results were based on scores on the Modified Ashworth Scale (MAS), Manual Muscle Testing (MMT), SBS, FAC, and the Missouri Assisted Gait Scale (MAGS). Results were not given in terms of statistical significance and initial scores before the study were not noted, making it difficult to perceive the extent of the improvements. The authors note that both patients showed improvements after BWSTT, but the patient with an acute injury showed greater improvements on the SBS than the patient with chronic injury. Furthermore, the patient with the acute injury was able to ambulate independently with a walker at the end of the study and previously required constant support of one. The patient with chronic injury improved to be able to demonstrate step initiation, swing, and balance during gait which she was previously unable to do. The vast limitations of this study decrease the applicability to a clinical setting, but could be joined with other similar research to come to a more accurate conclusion12.

In conclusion, the current literature does not give significant evidence to show that body weight-supported treadmill training is superior to conventional over-ground gait training for patients with traumatic brain injury. Most studies conclude that both groups showed improvements; however, most of the studies had both patients also participating in additional physical therapy. It is difficult to conclude that the type of gait training was the causal factor of the patients’ improvements when outcomes may have come from natural healing and other physical therapy treatments. Further research is required to make any definite conclusions about the effectiveness of BWSTT. Even if research doesn’t show that it is more beneficial than conventional gait training, rehab managers should consider all of the benefits of body weight-supported devices before making the decision whether or not to purchase the equipment. BWSTT decreases the physical stress on the therapist, is safer for the patient, allows specific task practice, and is both psychologically and psychologically beneficial for the patient and their families. I look forward to seeing further research done on this topic as a potential answer to the struggles of gait training in rehab for patients with TBI.

Sources

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