February 14th, 2022

STROKE SPECIAL INTEREST GROUP

Academy of Neurologic Physical Therapy

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- Elections information now available: Sign up to run for ANPT or SIG Office! **Nominations Due March 21, 2022**

Stroke Corner Article Review: The Value of High Intensity Locomotor Training in Acute Injury

Thanks to Katie Newhouse, DPT, NCS for completing this week's review

The Value of High Intensity Locomotor Training Applied to Patients With Acute-Onset Neurologic Injury

Article reference: Fahey, M.F., Brazg, G., Henderson, C.E., et al. The Value of High Intensity Locomotor Training Applied to Patients with Acute-Onset Neurologic Injury. Archives of Physical Medicine and Rehabilitation, 2021.

Link: https://doi.org/10.1016/j.apmr.2020.09.399

Background/Purpose:

· Long-standing research in animal models and humans with stroke or incomplete SCI (iSCI) indicate that specific physical training variables, such as the specificity and amount of practice, may influence neurologic recovery and locomotor function.

· More recent data highlight the contributions of exercise intensity, as estimated indirectly by cardiovascular exertion, as potentially more important than previously considered.

· Confusion regarding the definitions of intensity and safety concerns have limited the implementation of exercise intensity during physical rehabilitation of patients with neurologic injury.

· The purpose of this **review** is to delineate some of the evidence regarding the effects of exercise intensity during locomotor training in patients with stroke and iSCI.

Results of interest:

Definitions of intensity during gait rehabilitation interventions

· **Intensity:** the rate of work or power output. Can be manipulated during locomotor training by increasing walking speeds or altering the loads carried.

· **Exercise intensity** is often estimated by the rate of oxygen consumption (VO2), and measured indirectly using measure of HRs.

· **HR reserve**: Maximum HR-resting HR

· HRmax can be calculated by age predicted maximum HR, however, this can be inaccurate in the neurologic population due to inter-subject variability or the use of medications (ie, Beta Blockers).

· In experimental studies with initial graded exercise tests, max HRs achieved during testing are often used instead of age-predicted. However, pts with LE weakness are limited by the inability to generate sufficient neuromuscular power, and associated cardiovascular responses may also be limited. Therefore, the max HRs achieved during testing may be lower than actual HRmax.

ACSM v10 (2018) Exercise Intensity			
Definition	**%HRR**	**%HRmax**	**RPE (6-20)**
Very light/Sedentary	<30	<57	<9
Light	30-39	57-63	9-11
Moderate	40-59	64-76	12-13
Hard/Vigorous	60-84	77-95	14-17
Very Hard to maximal	85-100	96-100	18-20

· For the purpose of this review, high-intensity training is defined as the categories of hard/vigorous and very hard to maximal.

Evidence and mechanisms underlying high-intensity training

· Two studies compared higher vs lower intensity training on walking function in individuals post stroke while trying to match the total work performed or amount of stepping practice. Ivey et al randomized participants post stroke to an experimental group that performed treadmill training intensities (80%-85% HR reserve) and a control group that performed treadmill training at lower speeds at lower HR reserve (50%), but for longer durations to ensure nearly equivalent total work or energy expenditure. The experimental intervention resulted in significantly greater gains in VO2peak but no differences in clinical measures of walking function.

· In a crossover RCT by Holleran et al, treadmill and over ground walking activities at high (70%-80% HR reserve) vs low-to-moderate intensities (30%-40% HR reserve) were compared by matching training speeds consistent with low intensity training. To achieve higher exercise intensities at relatively slow treadmill speeds, the authors manipulated the biomechanical demands of walking by altering loads or applying resistance to the trunk and limbs. For example, patients in the experimental group wore a weighted vest (10% body weight). In addition, leg weights (5-10 lbs) were applied to the paretic limb, and elastic resistance was applied at the trunk to increase propulsive demands. Using this design, the authors were able to match the amount of stepping practice between training paradigms to isolate the effects of intensity on outcomes. Significantly, greater gains in the 6MW and peak treadmill speeds were observed with higher vs lower intensity training, with differences in gains between groups related to exercise intensity achieved.

· Recent studies suggest that higher intensity training activities can be practiced over ground in contexts that more closely simulate conditions encountered during community mobility, which can elicit substantial gains in walking function.

Mechanics underlying gains after high-intensity training

· The primary mechanism traditionally believed to contribute to improved locomotor function is enhanced cardiopulmonary function (VO2peak).

· Previous meta-analyses have suggested 10%-30% improvements in VO2peak in pts with chronic or subacute stroke after high-intensity training. These gains were related to increased power output (eg, higher treadmill speeds), indicating that improved

aerobic capacity underlies these changes.
· However, some high-intensity training paradigms result in minimal gains in VO2peak, and associations between clinical walking outcomes and VO2peak are often inconsistent across studies. Differences between studies may be due in part to the observation that improved gait efficiency, or reduced VO2 for a given workload, may contribute to improved locomotor performance in selected patients. For example, gains in locomotor efficiency may allow faster walking speeds at lower energetic requirements, thereby masking potential gains in VO2peak if evaluated during graded treadmill testing. Improvements in efficiency can be quantified by decreases in VO2 at treadmill speeds matched to pretraining speeds.
· Selected studies indicate that the improved VO2 is due to improved cardiovascular function, including some evidence for reduced HR, improved atrial emptying during exercise, and improved vascular flow at rest and during exercise.
· Other changes, such as improvements in blood flow distribution, cardiac output, or stroke volume, commonly seen in neurologically intact individuals may be inferred by the gains in VO2peak, but have not been delineated in specific patient populations.
· Additional respiratory alterations can facilitate observed changes and include increased pulmonary capacity (higher peak ventilation rates), improved ventilatory efficiency (reduced ventilation at matched speed), and reduced ratio of CO2 production and O2 consumption, which is an indicator or substrate utilization and greater efficiency of O2 utilization.
· High-intensity training is also associated with changes in neuromuscular function. Improved neuromuscular control and coordination are primary mechanisms underlying gains in walking performance (speed) and likely account for gains in aerobic capacity and efficiency.
· Improvements in peak locomotor function appear to be associated with gains in bilateral LE force generating capacity.

Safety of high-intensity training
· Primary concern is the ability to reach the targeted HR ranges during training in pts with elevated risks of additional cardio or cerebrovascular events.
· Most high-intensity protocols use a pretraining exercise test with metabolic and ECG assessment supervised by trained personnel to ensure safety. Using guidelines for termination, the peak HR responses are often used to guide HR ranges for exercise prescription and the potential risks appear to be minimal with subsequent training.
· A recent meta-analysis suggesting positive outcomes for aerobic training paradigms indicated limited adverse consequences across more than 20 independent investigations in patients with stroke.
· Graded exercise testing in patients with stroke is not always feasible. Additional guidelines have been articulated to minimize these concerns, with specific recommendations to limit exercise training intensity to RPE up to 11-14 (range, 6-20) and HRs up to 55% to 80% HRmax.
· If graded exercise testing is performed without recommended monitoring, previous guidelines suggest maximum HRs reach up to 85% of age-predicted HR max.
· More recent guidelines suggest the potential benefits of higher intensity activities may be warranted given the limited risk, although HRs and other vital signs should be monitored continuously.

Does high-intensity training reinforce abnormal motor behaviors?
· Previous research suggests increased involuntary neuromuscular activity of paretic UE and LE during performance of activities at higher intensities or increased difficulty. Examples: hip and knee extension, hip adduction, with ankle PF and inversion. To address this bracing or taping is allowed to mitigate risk of injury.
· Another concern is development of maladaptive neuromuscular responses with

high-intensity training. However, there are no research findings to indicate that allowing abnormal stepping practice reinforces abnormal kinematic patterns compared to alternative strategies. Previous work suggests that training at higher aerobic intensities (ie, speeds) appears to result in selected improvements, and not degradation, of movement quality as measured by kinematic assessments. With repeated training, improvements in measures of interlimb and intralimb coordination are observed.

· One study suggests that specific “maladaptive” kinematic patterns were not reinforced with training, but rather utilized only to ensure limb clearance at higher speeds.

· There may be limited negative consequences of performing high-intensity training, considering the potential functional and cardiovascular benefits observed.

Implementation of high-intensity training in the clinical setting

· **Equipment:** treadmill with lower-cost safety harness may be sufficient. Recumbent stepping or cycling equipment can be utilized as an alternative, although task specific walking is recommended when available to maximize gains. If a harness system is required for over ground walking and a BWS system is not available, a Hoyer lift may be modified to allow safe performance of stepping practice.

· **Personnel:** If an emphasis is not placed on normalizing gait patterns, which requires extensive personnel, aerobic training can be performed with minimal assistance. Emphasis is placed on ensuring continuous stepping and to maximize volitional activity to achieve higher intensities. Alternatives also include elastic assistance can be considered as opposed to a second person assist with limb swing.

Measurement of training intensity

· **HR:** Target of up to 80%-85% of age-predicted HRmax. However, cardiovascular responses in the neurologic population can vary substantially from age-predicted responses. Factors to consider: altered autonomic responses to exercise, increased risk of cardiovascular disease, or use of medications that alter HRs and BP responses.

· **RPE:** Use of RPE often recommended as a surrogate measure of intensity. RPE 11-14 (6-20) previously recommended as target. Recent studies have used higher ranges without significant adverse effects. This requires further research.

· An alternative measure of intensity that can be considered is steps/min in patients s/p stroke and iSCI.

o For individuals walking at 0.4-0.8 m/s: steps less than 70 steps/min=low or light intensity, 70-90 steps/min= moderate intensity, and 90+ step/min=higher or vigorous intensity.

o For individuals walking at speeds greater than 0.8 m/s: steps less than 80 steps/min=low or light intensity, 80-100 steps/min= moderate intensity, and 100+ steps/min=high intensity.

Clinical Implications:

· Available data suggest that training of walking tasks at moderate to higher intensity result in significant improvements in walking function in neurologically impaired patients. Greater changes are typically observed compared with conventional rehabilitation strategies or low-intensity walking exercise.

· Concerns regarding safety of such training may be mitigated by pervious data demonstrating the relatively low risk of higher intensity interventions. Continuous vitals monitoring is recommended. Use your clinical judgment regarding the need for an overhead harness system or use of support personnel for safety.

· Greater benefits of high intensity training may be realized with practice of tasks more specific to community mobility demands.

· Normalizing walking patterns during high-intensity training may not be as important as previously theorized.

· If graded exercise testing is not feasible, consider limiting exercise training intensity to RPE up to 11-14 (range, 6-20) and HRs up to 55% to 80% HRmax.

We Need You: Volunteers Needed to Review the Evidence for Stroke SIG Members!

Do you like to keep up with the latest stroke-related research?

The Stroke Corner Newsletter benefits from volunteers who review stroke-related research for our members.

We provide interesting articles (or you can propose articles you want to read!) and a template, you provide a summary for our members.

We ask for a minimum of a review once per quarter (more is welcome!) and a one-year commitment to joining our Stroke Corner evidence review team.

To join, contact us at strokesig@gmail.com

Run for Office!
ANPT and Special Interest Group Elections

Plan ahead and consider running for a position on the Stroke SIG board!

The following Stroke Special Interest Group are open:

- Chair Elect
- Vice Chair
- Nominating Committee

Nominations are due March 21, 2022 and you are encouraged to self-nominate. The nomination link is now live on the ANPT Elections Webpage.

Elections will be held April 4 - May 4, 2022. Three year terms begin July 1, 2022.

All Stroke SIG board positions involve attendance at monthly meetings and leadership of one of our Stroke SIG initiatives, such as our podcast, Student Corner, Social media, or weekly newsletter. Nominees must be Academy of Neurologic PT Members in good standing.

For more information on Stroke SIG initiatives, visit our page here.

Don't hesitate to reach out to our Nominating Committee for more information at strokesig@gmail.com

Nominating Committee Members:

- Rachel Prusynski (Chair)
- Ginny Little
- Mackenzie Wilson

ELECTIONS WEBSITE

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