Exercise Training and Recreational Activities to Promote Executive Functions in Chronic Stroke: A Proof-of-concept Study

Teresa Liu-Ambrose, PT, PhD,*†‡§ and Janice J. Eng, PT/OT, PhD†||

Background: Stroke survivors represent a target population in need of intervention strategies to promote cognitive function and prevent dementia. Both exercise and recreational activities are promising strategies. We assessed the effect of a 6-month exercise and recreation program on executive functions in adults with chronic stroke. *Methods:* A 6-month ancillary study within a multicentre randomized trial. Twenty-eight chronic stroke survivors (ie, ≥12 months since an index stroke) were randomized to 1 of 2 experimental groups: intervention (INT; n = 12) or delayed intervention (D-INT; n = 16). Participants of the INT group received a 6-month community-based structured program that included 2 sessions of exercise training and 1 session of recreation and leisure activities per week. Participants of the D-INT group received usual care. The primary outcome measure was the Stroop Test, a cognitive test of selective attention and conflict resolution. Secondary cognitive measures included set shifting and working memory. Mood, functional capacity, and general balance and mobility were additional secondary outcome measures. *Results:* Compared with the D-INT group, the INT group significantly improved selective attention and conflict resolution ($P = .02$), working memory ($P = .04$), and functional capacity ($P = .02$) at the end of the 6-month intervention period. Improved selective attention and conflict resolution was significantly associated with functional capacity at 6 months ($r = .39$; $P = .04$). *Conclusions:* This is the first randomized study to demonstrate that an exercise and recreation program can significantly benefit executive functions in community-dwelling chronic stroke survivors who are mildly cognitively impaired—a population at high-risk for dementia and functional decline. Thus, clinicians should consider prescribing exercise and recreational activities in the cognitive rehabilitation of chronic stroke survivors. **Key Words:** Exercise—socialization—executive functions—chronic stroke.

Introduction

Stroke is the number one cause of neurologic disability worldwide and is characterized by both cognitive and motor impairments, which contribute to functional dependence and reduced quality of life. Critically, cerebrovascular disease—such as stroke—is the second most

From the *Aging, Mobility, and Cognitive Neuroscience Laboratory; †Department of Physical Therapy; ‡Brain Research Centre, Vancouver Coastal Health Research Institute; §Centre for Hip Health and Mobility, Vancouver Coastal Health Research Institute, University of British Columbia; and ||Rehab Research Laboratory, GF Strong Rehab Centre, Vancouver, British Columbia, Canada.

Received November 7, 2013; revision received March 25, 2014; accepted August 1, 2014.

The Canadian Stroke Network provided funding for this study. TLA is a Canada Research Chair Tier II in Physical Activity, Mobility, and Cognitive Neuroscience and was supported by a Michael Smith Foundation for Health Research Scholar Award, a Canadian Institutes of Health Research New Investigator Award, and a Heart and Stroke Foundation of Canada's Henry JM Barnett's Scholarship.

Address correspondence to Teresa Liu-Ambrose, PT, PhD, 212-2177 Wesbrook Mall, Vancouver, BC V6T 1Z3, Canada. E-mail: teresa.ambrose@ubc.ca.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2014.08.012

common cause of dementia.[1] Specifically, having a stroke doubles one's risk for dementia.[2] Thus, stroke survivors represent a target population in need of intervention strategies to promote cognitive function and prevent dementia.

Impaired executive functions are one of the most common cognitive consequences of stroke; 19%-75% of stroke survivors have impaired executive functions.[3] Executive functions are higher order cognitive processes that include the ability to concentrate, attend selectively, plan, and strategize. Critically, executive functions play a significant role in determining functional recovery after stroke.[4,5] Thus, promoting executive functions after stroke is of significant clinical importance.

Current evidence from randomized controlled trials suggests that targeted exercise training—including aerobic exercise, resistance training, and balance exercises—is an effective strategy to promote executive functions in older adults.[6-8] However, there is insufficient quality evidence for targeted exercise training as an effective strategy to promote cognitive function in stroke survivors[9-11]—especially among those with chronic stroke (ie, ≥12 months since an index stroke). Yet, up to 30% of stroke survivors develop dementia or cognitive impairment 15 months after stroke.[12] To our knowledge, only 1 randomized controlled trial to date has been conducted to primarily examine the effect of targeted exercise training on cognitive function in this population.[13]

Engagement in intellectual and social activities (eg, Bridge, Charades, volunteering, and so forth) may also promote cognitive function in chronic stroke survivors. This hypothesis is supported by evidence from both animal[14] and human studies.[15,16] In a community-based cohort of 1203 nondemented individuals, Fratiglioni et al[16] demonstrated that an extensive social network protects against dementia. Specifically, a poor or limited social network increased the risk of dementia by 60%.

We previously demonstrated that a 6-month exercise and recreation program could promote executive functions in chronic stroke survivors.[17] However, our previous work used a single group pretest/post-test design and this is a significant limitation. This is also a key limitation of recent published studies examining the effect of targeted exercise training on cognitive function in chronic stroke survivors.[18,19]

To extend our previous work, we conducted an ancillary proof-of-concept study within a Canadian multicentre randomized trial aimed at enhancing life participation after stroke, known as "Getting On with the Rest of Your Life after a Stroke." The primary objective of this multicentre study was to determine the extent to which participation in life's roles can be optimized through the provision of a community-based structured program providing the opportunity for physical activity, leisure, and social interaction. The primary objective of our ancillary study was to assess if an exercise and recreation program could significantly improve executive function in adults with chronic stroke compared with a delayed intervention group (ie, control). Secondary outcomes measures of interest include mood, functional capacity, and general balance and mobility.

Methods

Study Design

The "Getting On with the Rest of Your Life" study (http://clinicaltrials.gov; NCT01085240) had 6 Canadian study sites in total and used a randomized, single-blinded, cross-over design (Fig 1, A). Specifically, participants were randomized to 1 of 2 experimental groups (ie, intervention [INT] or delayed intervention [D-INT]). There was a 6-month lag between the 2 experimental groups. For each experimental group, there was a 9-month intervention period with a 6-month follow-up period (ie, 15 months in total). Throughout the intervention period, assessments occurred every 3 months with blinded assessors. A single assessment occurred at the end of the 6-month follow-up period. For our ancillary proof-of-concept study, we collected additional outcome measures from the University of British Columbia site and analyzed the data acquired from the first 6 months of the randomized trial (Fig 1, B). We restricted our ancillary proof-of-concept study to the first 6 months because the delayed intervention group (ie, wait-list control) began their intervention at that point in time.

Participants

We recruited participants through advertisements in local newspapers and community centers. We included those who had a single stroke greater than or equal to 1 year onset and had completed their rehabilitation, lived in their own home, were 19 years of age and older, and were able to walk more than 10 m independently (with or without walking aids). We excluded those could not safely participate in a physical activity program (eg, serious cardiac disease).

Figure 2, the consort flow diagram, shows the number of participants in the treatment arms at each stage of the study. Ethical approval was obtained from the local university and hospital review boards. The study was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. All participants provided written informed consent.

Sample Size

We highlight this was a proof-of-concept study. However, we did calculate a sample size based on our previous work on exercise and cognitive function.[7,17] We estimated the INT group will improve 10% on the Stroop Test, our primary measure of executive functions, whereas the D-INT group will remain the same after 6 months.