Title: Does participation in standardized aerobic fitness training during in-patient stroke rehabilitation promote engagement in aerobic exercise after discharge? A cohort study

Running head: Physical Activity Post-Stroke

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Disclosures: This study was funded by the Ministry of Health and Long-Term Care – Ontario Stroke Network (OSN1101-000117). The authors acknowledge the support of Toronto Rehabilitation Institute. Equipment and space have been funded with grants from the Canada Foundation for Innovation, Ontario Innovation Trust and the Ministry of Research and Innovation. Preliminary results were presented at the Third Canadian Stroke Congress, 2 October 2012.

Keywords: Aerobic Exercise; Stroke; Rehabilitation; Health Planning Guidelines; Physical Activity; Exercise Therapy; Self Report

ABSTRACT

Objective: To determine if attending an aerobic fitness program during in-patient stroke rehabilitation is associated with increased participation in physical activity after discharge. **Design:** This was a prospective cohort study. Patients who received in-patient stroke rehabilitation and were discharged into the community (n=61; mean age=65) were recruited. 35 participants attended a standardized aerobic fitness program during in-patient rehabilitation, whereas 26 did not. The Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) and adherence to the American College of Sports Medicine (ACSM) guidelines were assessed up to six months post-discharge. **Results:** Subjects in the fitness group had similar PASIPD scores and adherence to ACSM guidelines to the non-fitness group up to six months post-discharge. There was no significant correlation between volume of exercise performed during the in-patient program and amount of physical activity post-discharge. **Conclusion:** Participation in an in-patient fitness program did not increase participation in physical activity post-discharge in individuals with stroke. A new model of care that encourages patients to pursue physical activity post-discharge and reduces the potential barriers to participation should be developed.

INTRODUCTION

Individuals with stroke typically have poor aerobic capacity, which impairs their ability to perform activities of daily living.¹ Best practice guidelines for stroke care state that participation in aerobic exercise which is adapted to co-morbidities and functional limitations is recommended post-stroke.² Aerobic exercise increases aerobic capacity and endurance post-stroke.³ Aerobic exercise can also reduce stroke and cardiovascular disease risk factors,^{4,5} reduce systolic blood pressure,³ decrease the energy cost of hemiparetic gait,⁶ and enable the performance of daily activities at a lower percentage of aerobic capacity.⁶

Despite the benefits of aerobic exercise post-stroke, and that clinicians consider aerobic fitness an important part of stroke rehabilitation,⁷ time spent within the target heart rate training zone during physiotherapy and occupational therapy sessions is not sufficient to achieve lasting cardiovascular benefits.^{8,9} Barriers to implementing aerobic exercise in in-patient rehabilitation may include: lack of time in physiotherapy sessions;¹⁰ focus on improving sensorimotor control and functional outcomes during limited physiotherapy time;¹ or limited knowledge of aerobic exercise prescription in this complex sub-acute clinical population.^{11,12} Furthermore, patients with hemiparesis or impaired balance often need adapted equipment for exercise, such as recumbent steppers or treadmills with a harness safety system, which are not widely available.

To help address these challenges, we established a standardized aerobic training program for patients attending in-patient rehabilitation post-stroke. One goal of this program was to increase aerobic fitness during in-patient rehabilitation. However, significant aerobic adaptations may not be achieved during in-patient rehabilitation due to short lengths of stay and relatively low volumes of aerobic exercise.¹³ Therefore, a second possible benefit of an aerobic training program during in-patient rehabilitation is increased self-efficacy for and knowledge about exercise¹⁴ such that participants will be more likely to participate in physical activity after discharge. Indeed, 80% of individuals who completed the in-patient aerobic fitness program stated that they planned to continue to exercise post-discharge.¹³

The purpose of this study is to determine if attending a fitness program during in-patient stroke rehabilitation is associated with greater engagement in physical activity post-discharge from rehabilitation. Specific objectives are to determine if: 1) individuals who attended an aerobic fitness program during in-patient rehabilitation were more physically active post-discharge than individuals who did not attend the fitness program; and 2) volume of exercise performed during the fitness program correlated with physical activity post-discharge. We hypothesized that participation in structured aerobic activity during inpatient rehabilitation would lead to increased physical activity (amount and intensity) post-discharge. Secondly, we predicted that increased in-patient participation in aerobic activity would positively correlate with more exercise post-discharge.

METHODS

Participants

This study was a secondary analysis of data collected for a study of balance and falling up to six-months post-discharge from in-patient stroke rehabilitation.¹⁵ Sixty-one individuals with stroke were recruited at discharge from in-patient rehabilitation between October 2010 and June 2012 and consented to participate in the study. Patients were included in the original study if they experienced a stroke and completed a balance assessment in a specialized clinic prior to discharge home from in-patient rehabilitation. Patients who could stand independently for 30 seconds were referred to the clinic by their treating physiotherapists. Participants were excluded from the current study if they had an incomplete data set. The study was approved by the hospital's research ethics board, and all subjects provided informed consent.

Of the 61 participants included in the study, 35 were enrolled in an aerobic fitness program during in-patient rehabilitation, whereas 26 did not participate in the fitness program. Acute or unstable

cardiovascular conditions were the primary reasons for non-referral to the fitness program.¹³ To characterize the participants the following variables were obtained from patient health records: age, sex, body mass index, stroke location and type, Berg balance scale scores,¹⁶ National Institutes for Health stroke scale scores,¹⁷ Clinical Outcomes Variables Scale scores,¹⁸ diagnosis of hypertension, and diagnosis of cardiac disease. We selected items 1; 2 & 3; and 9 & 10 on the NIH score to determine whether participants had cognitive, visuospatial, or communication impairments at discharge which could become barriers to exercise post-discharge.

In-patient fitness program

Patients were referred to the aerobic fitness program by their primary treating physiotherapists. Patients initially completed a sub-maximal aerobic capacity assessment based on an adapted YMCA protocol,¹⁹ which was used to determine exercise prescription. Each tri-weekly fitness session was supervised by a physiotherapist and a trained assistant. Patients generally exercised for 10-30 minutes, at an intensity lower than 60% (for patients taking beta-blockers) or 70% of age-predicted maximum.²⁰ Specific parameters of exercise for each patient were determined by an individualized exercise prescription written by his/her physiotherapist. Heart rate and rating of perceived exertion²¹ were recorded at rest, every 5 minutes during exercise and at the end of a 2 to 3-minute recovery period. Training parameters (i.e. workload and exercise duration) were recorded at the end of the session. Blood pressure was taken at rest and at the end of training unless the primary physiotherapist requested that it should be measured more frequently.

The overall exercise volume performed by participants during participation in the fitness program was calculated as a product of intensity (percentage of maximum heart rate) and duration of each session summed across the total number of sessions for each participant. Heart rates during each fitness session, excluding cool down, were averaged and calculated as a percentage of maximum heart rate to calculate intensity. Maximum heart rate was estimated as $207 - 0.67 \times \text{age}$.²⁰ Due to the heart-rate-lowering effects of beta-blockers, exercise volume was calculated using a modified estimated maximum for those participants taking beta-blockers (9/35 participants in the fitness group); that is: $164 - 0.7 \times \text{age}$.²²

Physical activity post-discharge

Participants were contacted via telephone three times in the 6-months post-discharge from in-patient rehabilitation (i.e. approximately every two months) to obtain information regarding self-reported physical activity. The Physical Activity Scale for Individuals with Physical Disabilities (PASIPD)²³ was completed at each time point. The PASIPD is a 13-item questionnaire that includes 6 questions related to leisure time activity, 6 questions about household activities, and one question concerning occupational activity. Participants were asked to report how often they took part in these activities and the duration of participation in each activity over the past 7 days. The PASIPD requires that participants indicate a range of frequency and duration of participation in activities; i.e. frequency of 1-2 days, 3-4 days or 5-7 days and duration of <1 hour, 1-2 hours 2-4 hours or more than 4 hours. For the purpose of determining adherence to physical activity guidelines (see below) participants were asked to recall the specific frequency and duration of physical activity (e.g. a participant who selected 3-4 days for <1 hour would then indicate that they exercised for 30 minutes on three days); this specific information was not used to calculate the overall PASIPD score.

PASIPD scores were calculated by multiplying the metabolic equivalent for time associated with the intensity of each activity by the average number of hours spent doing the activity over the course of the week, as described by Washburn et al.²³ The results for each item were then summed across items 2 to 13 to obtain a total PASIPD score. We also isolated information from the questions regarding moderate and strenuous intensity exercise (items 4 and 5) and walking (item 2) to determine if participants met the American College of Sports Medicine (ACSM) exercise recommendations. ACSM

guidelines state that adults should engage in at least 150 minutes of moderate-intensity exercise per week (64-76% maximum heart rate), or at least 75 minutes of vigorous-intensity exercise per week (77-95% maximum heart rate).²⁴ Exercise recommendations can be met through 30-60 minutes of moderate-intensity exercise (five days per week) or 20-60 minutes of vigorous-intensity exercise (three days per week).²⁴ If participants could not recall the exact frequency and duration of each activity, then we used the average of the range of frequency and duration to determine whether participants met ACSM guidelines (e.g. if a participant selected 1-2 days for 1-2 hours, we assumed participation in 1.5 days of activity for 1.5 hours). If it was unclear whether a participant had done enough exercise because they selected “<1 hour” and were unable to recall the specific amount of time, then we assumed that the participant did not meet ACSM guidelines. We were unable to determine if walking was of at least ‘moderate’ intensity; therefore, we determined adherence to ACSM guidelines both with and without walking included.

Upon discharge, patients were typically provided with education about the benefits of continued exercise and were instructed to perform a series of home exercises by their physiotherapists. These exercises varied as a function of patient goals and the therapist’s choice of exercise. Most patients were also referred to out-patient physiotherapy. Participation in out-patient physiotherapy varied over the 6-months post-discharge due to variations in service delivery (e.g. waiting lists). Both home exercises and out-patient physiotherapy are captured by the PASIPD. However, home exercise or physiotherapy may not be reflected in adherence to ACSM guidelines as the PASIPD considers physiotherapy to be ‘light’ activity.

Data analysis

One-way analysis of variance (ANOVA) or chi square tests were performed to compare characteristics of patients who attended fitness program with those who did not. A two-way repeated measures ANOVA was performed to compare PASIPD scores and adherence to ACSM guidelines at the three time-points post-discharge and between the two groups (fitness and non-fitness). Data were rank-transformed prior to analysis to account for the non-normal distribution of the PASIPD scores. Spearman’s correlation was used to determine the relationship between volume of physical activity performed during in-patient rehabilitation and PASIPD scores. Logistic regression was also used to determine the relationship between volume of physical activity performed during in-patient rehabilitation and adherence to ACSM guidelines. For this analysis the PASIPD scores and ACSM analyses were taken from the first time-point (approximately 6-8 weeks post-discharge) as this questionnaire was answered closest to discharge from fitness program and it was assumed that any effects from participating in the fitness program would be strongest closer to the discharge date. An alpha value of 0.05 was considered significant for all statistical tests.

Power analysis was conducted (version 9.2; SAS Institute Inc., Cary, NC, USA) to determine if the sample size was sufficient for the current study. A previous study reported a difference of 7 on the PASIPD between individuals who self-report as ‘not active at all’ or ‘moderately active’;²³ therefore, we assumed a 7-point between-group difference on the PASIPD would be meaningful. We expected, from our previous work, that at least 80% of participants would exercise post-discharge and, therefore, adhere to ACSM guidelines. Power analyses were conducted using the mean and standard deviation (PASIPD scores) or proportions (ACSM adherence) for the non-fitness group at time 1 post-discharge. For power analyses, alpha was 0.05 and one-tailed t-test (PASIPD scores) or chi-square (ACSM adherence) was used.

RESULTS

On average, participants in the fitness group were discharged at 44 days post-stroke, whereas those in the non-fitness group were discharged on average at 61 days post-stroke ($p=0.021$). There were no other statistically significant differences between the fitness and non-fitness groups on variables at time of

discharge from in-patient rehabilitation (Table 1), although there was a trend towards an increased frequency of diagnosis of hypertension among individuals who were not referred to the fitness program compared to those who were ($p=0.069$).

Table 1: Subject characteristics at time of discharge from inpatient rehabilitation. Values presented are means (standard deviation) or counts (percentage). Note that percentage estimates may be subject to rounding errors. P-values are for the one-way ANOVA or chi-square test comparing the two groups.

	Fitness group (n=35)	Non-fitness group (n=26)	p-value
Sex (number)			
Men	24 (69)	16 (62)	0.57
Women	11 (31)	10 (38)	
Age (years)	65 (13)	66 (13)	0.74
Body mass index (kg/m^2)	27.4 (6.1)	26.7 (5.0)	0.67
Affected hemisphere (number)			
Right	9 (26)	11 (42)	0.30
Left	18 (51)	12 (46)	
Both	8 (23)	3 (12)	
Stroke type (number)			
Ischemic	29 (83)	22 (85)	0.53
Hemorrhagic	5 (14)	2 (8)	
Transforming to hemorrhagic	1 (3)	2 (8)	
Time post-stroke at discharge (days)	44 (14)	61 (38)	0.021
Berg balance scale (score)	46.8 (8.3)	46.1 (12.6)	0.31
National Institutes of Health stroke scale (score)	3.1 (2.2)	3.7 (3.3)	0.47
Clinical Outcomes Variables Scale (score)	75.8 (11.8)	74.0 (14.3)	0.58
Hypertension (number)	19 (54)	20 (77)	0.069
Cardiac disease (number)	9 (26)	11 (42)	0.17
Cognitive impairment (number)	6 (17)	2 (7.7)	0.28
Visual impairment (number)	8 (23)	2 (7.7)	0.11
Communication impairment (number)	14 (40)	13 (50)	0.44

Participants in the fitness group attended on average 5.6 sessions (standard deviation (SD): 3.6 sessions; range: 1-18). Patients generally exercised on recumbent steppers for an average of 17.4 minutes (SD: 5.5 minutes; range: 7 – 30 minutes), and an average intensity of 55.6% (SD: 10.4%; range: 28 – 74%) of maximal heart rate. The average length of session was calculated without including the 2 or 3 minutes spent at the end of each session for cool down.

There was no significant group-by-time interaction for PASIPD scores ($p=0.50$) or adherence to ACSM guidelines (with walking: $p=0.46$, without walking: $p=0.13$). With respect to the group differences in activity after discharge, in contrast to our hypothesis, there were no differences in PASIPD scores ($p=0.18$) or rates of adherence to ACSM guidelines (with walking: $p=0.46$; without walking: $p=0.13$) between groups for all time points combined (Table 2). The average PASIPD scores were 9.7 (SD: 7.4) for the fitness group and 7.8 (SD: 6.7) for the non-fitness group. In addition, there was no significant correlation between volume of physical activity performed by each participant in the in-patient aerobic fitness program and PASIPD scores ($\rho=-0.23$, $p=0.18$; Figure 1). Likewise, increased volume of exercise during the fitness program did not increase the likelihood of adhering to ACSM guidelines. For every one unit increase in exercise volume (e.g. additional 2 minutes of exercise at 50% maximum heart rate) the odds of meeting with ACSM guidelines with walking was 1.00 (confidence interval=[0.93, 1.07], $p=0.97$) and the odds of meeting the ACSM guidelines without walking was 0.98 (confidence interval=[0.91, 1.06], $p=0.62$).

Table 2: PASIPD scores and adherence to ACSM guidelines up to 6 months post-discharge. Values presented are means (standard deviation) for PASIPD scores or the percentage of participants who met the ACSM guidelines, with and without walking included as a 'moderate' physical activity. P-values from the two-way ANOVA are presented for the group-by-time interaction effect, the main effect for time, and the main effect for group.

	Fitness group	Non-fitness group	Interaction (p-value)	Time (p-value)	Group (p-value)
PASIPD (score)					
Time point 1	10.3 (7.7)	7.7 (7.1)	0.50	0.95	0.18
Time point 2	8.8 (6.6)	7.3 (4.2)			
Time point 3	9.8 (8.1)	8.4 (8.3)			
ACSM guidelines (with walking)					
Time point 1	69	62			
Time point 2	69	77	0.46	0.22	0.89
Time point 3	74	77			
ACSM guidelines (without walking)					
Time point 1	26	12			
Time point 2	17	19	0.13	0.93	0.81
Time point 3	17	23

Figure 1. Volume of exercise during in-patient rehabilitation and Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) score at the first time point (approximately 6-weeks post-discharge). Exercise volume was calculated as a product of intensity (percentage of maximum heart rate) and duration of each session summed across the total number of sessions for each participant. From Spearman's correlation, there was no significant relationship between exercise volume and physical activity ($\rho=-0.23$, $p=0.18$).

With the sample size used, we had 96% power to detect a 7-point difference in PASIPD scores between the groups at time 1. For adherence to ACSM guidelines, power to detect a difference between groups such that 80% of those in the fitness group met the guidelines was 46% with walking and >99% without walking. We would have required a sample size of 158 to show a meaningful significant difference between groups for adherence to ACSM guidelines with walking, with 80% power and alpha of 0.05.

DISCUSSION

In contrast to the hypotheses it appears that individuals who participate in a standardized aerobic exercise group during in-patient rehabilitation are just as likely to participate in physical activity after discharge as those who received standard care. There was no evidence that either the amount or the intensity of community physical activity was different between the group who attended the fitness program and the group who did not. Additionally, there was no relationship between volume of training

during in-patient rehabilitation and physical activity after discharge among those who had received standardized exercise training.

One possible explanation for the absence of group differences could be that all individuals increased their activity after discharge (e.g. high activity levels for both groups). However the average PASIPD scores up to 6-months post-discharge were very low for both groups. The scores from this study for both groups were low even compared to scores obtained from individuals with disabilities who self-report as “not active at all” (average PASIPD scores: 13.2²³). This revealed that even those in the standardized aerobic exercise group had very low levels of activity post-discharge. What are the possible reasons for this apparent reduction in activity levels within the fitness group, even when they indicate they are motivated to continue to exercise?¹³ The emergence of barriers to participation in physical activity when individuals are discharged from the in-patient rehabilitation potentially limit activity participation.²⁵ Furthermore, individuals may not feel confident in continuing the program without the support of the clinical staff. The aerobic exercise group was monitored by a physiotherapist and trained assistants. Therefore, participants may have viewed exercise as something that required supervision by a trained professional, not something that they can do by themselves.²⁵ Additionally, the modality of training in the in-patient facility benefited from availability of adapted exercise equipment. Individuals may not have access to necessary adaptive equipment and few fitness facilities in the community cater to individuals with stroke.²⁶ The current standardized exercise program, while supporting engagement in exercise early after stroke, does not likely prepare them well enough for independent participation in exercise after discharge. It is also possible that the volume of exercise completed during in-patient rehabilitation was not sufficient to promote behavioural change. Participants were not given the opportunity to meet ACSM guidelines for exercise during the in-patient fitness program, although they did meet guidelines outlined by the Canadian Best Practice Recommendations for Stroke Care. It may be argued that it is unreasonable to expect patients to meet ACSM guidelines following discharge if they were not met during the fitness group. However, we expected that following discharge, patients would increase their aerobic capacity so as to at least come closer to meeting ACSM guidelines. Contrarily, our results indicate that those who exercised more during the aerobic fitness group were not more likely to exercise after discharge. Furthermore, participants did not increase activity participation over time.

One general concern may be that the two groups in the study were created based on referral to the fitness program. The only difference between the groups at the time of entry into the study (i.e. discharge from in-patient rehabilitation) was time post-stroke; individuals not referred to the fitness program were discharged later post-stroke than the fitness group. Therefore, time post-stroke is the sum of length of stay in acute care and length of stay in in-patient rehabilitation. Generally, lower-functioning individuals have a longer length of stay in acute care. Target discharge date from in-patient rehabilitation is partly influenced by the patient’s functional level on admission with generally only small changes made to the discharge date as the patient progresses with rehabilitation. Therefore, the lower time-post stroke in the fitness group does not necessarily indicate that participation in the fitness group was associated with shorter length of stay, but rather it indicates that those not referred were lower-functioning than those referred to the group at the time of admission. However, other measures were similar between the two groups at discharge, indicating that participants who were not referred to the fitness program improved functionally such that they were similar to those who had completed the fitness group by the time they were discharged. While the groups were generally similar in most characteristics, a trend towards a greater prevalence of hypertension was observed in the non-fitness group. This trend may reflect the primary reason for non-referral to the aerobic fitness group; that is, cardiac issues. It is also possible that individuals in the non-fitness group would have been appropriate for the fitness program but declined participation. It is likely that these individuals would be averse to aerobic exercise and less likely to exercise after discharge than those in the fitness group. However, despite these limitations there was no difference in exercise participation post-discharge between the two

groups and, more importantly, both groups were low in activity. This reinforces the idea that regardless of the profile of the individuals (i.e. with or without contraindications to exercise) the physical activity profile after discharge from stroke rehabilitation is generally low.

This study involved secondary analysis data from a study examining the relationships between measures of balance and falls post-discharge. To participate in the primary study, individuals were required to be able to stand independently. Therefore, the sample recruited for the primary study may be higher functioning than the general stroke population being discharged home from in-patient rehabilitation. Furthermore, data that could have helped to explain physical activity post-discharge, such as pre-morbid physical activity, family/caregiver support, availability of exercise equipment and facilities, and mood^{25,27,28} were not collected as part of the primary study. It is entirely possible that patterns of lifetime activity, reflected by premorbid activity levels, may importantly influence patterns of activity after stroke. Further study of such barriers to physical activity may inform strategies to help to increase exercise participation post-stroke. In this study, there was no difference in the level of cognitive, visual, and communication impairment between groups at discharge. Both groups therefore faced the same potential barriers to exercise post-discharge.

While the measures of self-reported activity used in the current study are not ideal, they are unlikely to have accounted for the inability to detect difference between the groups or account for the low overall activity levels. The PASIPD score has been validated against activity measured using accelerometers,²⁷ but participants may over-estimate physical activity when self-reporting.²⁸ Overall, our view is that the recorded levels of activity from the present study do reveal an important problem in that even with the availability of a standardized in-patient exercise program that this may not help to augment physical activity after discharge.

The study is partially limited by a small sample size; PASIPD scores and adherence to ACSM guidelines were higher at most time points for the fitness group than the non-fitness group but the differences were not statistically significant. Results of a power analysis indicated that we had a sufficient number of participants to show a meaningful between-group difference in all primary outcomes except for adherence to ACSM guidelines with walking included (power=46%). Caution should be taken when interpreting these results.

The significant concern is that any potential benefits from exercise initiated within in-patient rehabilitation will be lost in the early stages after discharge when activity levels are so low. Continued participation in exercise promotes recovery post-stroke,²⁹ and may help to mitigate secondary stroke risk.^{4,5} Programs such as a community exercise groups are an effective strategy to improve aerobic fitness in chronic stroke.^{3,6} However, stroke-specific community programs are costly to run and may not be sustainable in the long-term. Therefore, exercise programs should equip individuals with stroke with the knowledge and tools needed for life-long participation in physical activity. Such programs should address known barriers to physical activity post-stroke;^{25,30,31} that is these programs should: educate participants regarding the benefits of exercise; teach participants how to prescribe, monitor and progress their own physical activity; help participants to identify and address individual barriers to physical activity participation; and aid participants to develop the skills to navigate community-based exercise options. We are presently investigating the potential to incorporate such strategies into our current fitness program in order to possibly increase physical activity post-discharge.

A unique aspect of this study was the attention paid to the intensity of activity as determined by adherence to ACSM guidelines. This was evaluated by including and excluding walking as moderate intensity exercise for each patient. At the first time-point (approximately 6-8 weeks post-discharge), adherence to ACSM guidelines was 66% for all participants when including walking and 20% when excluding walking. These results indicate that walking is the primary form of physical activity for ambulatory stroke survivors. While brisk walking is considered moderate intensity exercise² with health benefits³² the intensity of walking activity is not evaluated in the PASIPD questionnaire. ACSM recommendations for aerobic activity state that moderate intensity exercise is achieved at $\geq 64\%$ of

maximum heart rate.²⁴ It is not clear if this target heart rate was achieved when walking. Furthermore, ACSM guidelines focus on intentional exercise rather than general physical activity.²⁴ The PASIPD questionnaire does not distinguish between walking as a mode of exercise and walking as a mode of transportation; walking done specifically for exercise may be more intense than walking for transportation. A modified version of the PASIPD that identifies walking activity that is potentially beneficial for aerobic fitness may be required.

ACSM guidelines were used as an outcome measure for this study because they are specific quantitative and qualitative guidelines previously supported for prescription of cardiovascular exercise post stroke.³⁰ It could be argued that ACSM guidelines are not appropriate for individuals with stroke in the sub-acute stage of recovery; indeed, evidence suggests that performance below ACSM targets can elicit benefits.³³ However, it is also noteworthy that there is significant variation in recommendations across different sources, such as those from the American Heart Association³⁴ or the Canadian Stroke Network.² Clear and consistent practice guidelines are warranted to assist clinicians in the safe and effective prescription of exercise for patients post-stroke.

Conclusions

This study found that participation in an aerobic fitness program during in-patient stroke rehabilitation was not associated with increased engagement in physical activity following discharge. Since the duration of in-patient rehabilitation is typically not long enough to bring about changes in aerobic fitness, future studies should examine programs of care that may increase participation in exercise post-discharge. This may be achieved, in part, by training and resources that may reduce potential barriers to exercise in the community.

REFERENCES

1. Ivey FM, Macko RF, Ryan AS, Hafer-Macko CE. Cardiovascular health and fitness after stroke. *Top Stroke Rehabil.* 2005;12:1-16.
2. Lindsay MP, Gubitz G, Bayley M, Hill MD, Davies-Schinkel C, Singh S, Phillips S. *Canadian best practice recommendations for stroke care (Update 2010)*. Ottawa, Ontario Canada: Canadian Stroke Network;2010.
3. Potempa K, Lopez M, Braun LT, Szidon JP, Fogg L, Tinknell T. Physiological outcomes of aerobic exercise training in hemiparetic stroke patients. *Stroke.* 1995;26:101-105.
4. Lee CD, Folsom AR, Blair SN. Physical activity and stroke risk: a meta-analysis. *Stroke.* 2003;34:2475-2481.
5. Middleton LE, Corbett D, Brooks D, Sage MD, MacIntosh BJ, McIlroy WE, Black SE. Physical activity in the prevention of ischemic stroke and improvement of outcomes: a narrative review. *Neurosci Biobehav Rev.* 2013;37:133-137.
6. Macko RF, Smith GV, Dobrovolsky CL, Sorkin JD, Goldberg AP, Silver KH. Treadmill training improves fitness reserve in chronic stroke patients. *Arch Phys Med Rehabil.* 2001;82:879-884.
7. MacKay-Lyons M, Thornton M, MacDonald A. Cardiovascular fitness training for a patient in the early stages of recovery post-stroke. *Physiother Canada.* 2011;63:377-382.
8. Prajapati SK, Mansfield A, Gage WH, Brooks D, McIlroy WE. Cardiovascular responses associated with daily walking in sub-acute stroke. *Stroke Res Treat.* 2013;2013:612458.
9. Kuys S, Brauer S, Ada L. Routine physiotherapy does not induce a cardiorespiratory training effect post-stroke, regardless of walking ability. *Physiother Res Int.* 2006;11:219-227.
10. MacKay-Lyons MJ, Makrides L. Cardiovascular stress during a contemporary stroke rehabilitation program: is the intensity adequate to induce a training effect? *Arch Phys Med Rehabil.* 2002;83:1378-1383.
11. Paley CA. A way forward for determining optimal aerobic exercise intensity? *Physiotherapy.* 1997;83:620.

12. Lamb S, Frost H. Exercise - the other root of our profession. *Physiotherapy*. 1993;79:772.
13. Biasin L, Mansfield A, Inness EL, Brunton K, Fraser JE, Mileris R, Bayley M, Brooks D, McIlroy WE. Integrating aerobic training into clinical practice within a sub-acute stroke rehabilitation program: a feasibility study. *Stroke*. 2011;42:e607-608.
14. Shaughnessy M, Michael K, Resnick B. Impact of treadmill exercise on efficacy expectations, physical activity, and stroke recovery. *Journal of Neuroscience Nursing*. 2012;44:27-35.
15. Mansfield A, Wong J, Biasin L, Brunton K, Fraser JE, Bayley M, McIlroy WE, Inness EL. Do measures of reactive balance control predict falls in individuals with stroke returning to the community? Proceedings of the International Society for Posture and Gait Research; 2012 24-28 June; Trondheim, Norway.
16. Berg KO, Wood-Dauphinee SL, Williams JJ, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Public Health*. 1992;83:S7-11.
17. Brott T, Adams HP, Olinger CP, Marler JR, Barsan WG, Biller J, Spilker J, Holleran R, Eberle R, Hertzberg V. Measurements of acute cerebral infarction: a clinical examination. *Stroke*. 1989;20:864-870.
18. Seaby L, Torrance G. Reliability of a physiotherapy functional assessment used in a rehabilitation setting. *Physiother Can*. 1989;41:264-270.
19. Beekley MD, Brechue WF, deHoyos DV, Garzarella L, Werber-Zion G, Pollock ML. Cross-validation of the YMCA submaximal cycle ergometer test to predict VO₂ max. *Res Q Exerc Sport*. 2004;75:337-342.
20. Robergs RA, Landwehr R. The surprising history of the "HRmax=220-age" equation. *Official Journal of the American Society of Exercise Physiologists*. 2002;5.
21. Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc*. 1982;14:377.
22. Brawner CA, Ehrman JK, Schairer JR, Cao JJ, Keteyian SJ. Predicting maximum heart rate among patients with coronary heart disease receiving beta-adrenergic blockade therapy. *American Heart Journal*. 2004;148:910-914.
23. Washburn RA, Zhu W, McAuley E, Frogley M, Figoni SF. The Physical Activity Scale for Individuals with Physical Disabilities: development and evaluation. *Arch Phys Med Rehabil*. 2002;83:193-200.
24. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee I-M, Nieman DC, Swain DP. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43:1334-1359.
25. Rimmer JH, Wang E, Smith D. Barriers associated with exercise and community access for individuals with stroke. *J Rehabil Res Dev*. 2008;45:315-322.
26. Fullerton A, Macdonald M, Brown A, Ho P-L, Martin J, Tang A, Sibley KM, McIlroy WE, Brooks D. Survey of fitness facilities for individuals post-stroke in the Greater Toronto Area. *Appl Physiol Nutr Metab*. 2008;33:713-719.
27. van der Ploeg HP, Streppel KR, van der Beek AJ, van der Woude LH, Vollenbroek-Hutten M, van Mechelen W. The Physical Activity Scale for Individuals with Physical Disabilities: test-retest reliability and comparison with an accelerometer. *J Phys Act Health*. 2007;4:96-100.
28. Berg vd, L'Ortye AA, Nieuwenhuijsen C, Nooijen CF, Bergen MP, Stam HJ, Bussman JB. Validation of the Physical Activity Scale for Individuals with Physical Disabilities. *Arch Phys Med Rehabil*. 2011;92:923-928.
29. Pang MYC, Eng JJ, Dawson AS, Gylfadóttir S. The use of aerobic exercise training in improving aerobic capacity in individuals with stroke: a meta-analysis. *Clin Rehabil*. 2006;20:97-111.
30. Damush TM, Plue L, Bakas T, Schmid A, Williams LS. Barriers and facilitators to exercise among stroke survivors. *Rehabil Nurs*. 2007;32:253-262.

31. Zalewski KR, Dvorak L. Barriers to physical activity between adults with stroke and their care partners. *Top Stroke Rehabil.* 2011;18:666-675.
32. Kingwell BA, Jennings GL. Effects of walking and other exercise programs upon blood pressure in normal subjects. *The Medical Journal of Australia.* 1993;158.
33. Paffenbarger RS, R.T. H, Wing AL, Lee I-M, Jung DL, Kampert JB. The association of changes in physical-activity level and other lifestyle characteristics with mortality among men. *N Engl J Med.* 1993;328:538-545.
34. Gordon NF, Gulanick M, Costa F, Fletcher G, Franklin BA, Roth EJ, Shephard T. Physical activity and exercise recommendations for stroke survivors. *Stroke.* 2004;35:1230-1240.