

5. Roth EJ. Heart disease in patients with stroke: incidence, impact, and implications for rehabilitation. Part 1: Classification and prevalence. *Arch Phys Med Rehabil* 1993;74:752-60.
6. Gordon NF, Gulanick M, Costa F, et al. Physical activity and exercise recommendations for stroke survivors: an American Heart Association scientific statement from the Council on Clinical Cardiology, Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention; the Council on Cardiovascular Nursing; the Council on Nutrition, Physical Activity, and Metabolism; and the
7. Stroke Council. *Circulation* 2004;109:2031-41.  
van Wijk I, Kappelle LJ, van Gijn J, et al. Long-term survival and vascular event risk after transient ischaemic attack or minor ischaemic stroke: a cohort study. *Lancet* 2005;365:2098-104.
8. Mouradian MS, Majumdar SR, Senthilselvan A, et al. How well are hypertension, hyperlipidemia, diabetes, and smoking managed after a stroke or transient ischemic attack? *Stroke* 2002;33:1656-9.
9. Suskin N, MacDonald S, Swabey T, et al. Cardiac rehabilitation and secondary prevention services in Ontario: recommendations from a consensus panel. *Can J Cardiol*. 2003;19:833-8.
10. Goldstein LB, Adams R, Appel L, et al. Primary prevention of ischemic stroke: A statement for healthcare professionals from the Stroke Council of the American Heart Association. *Circulation* 2001;103:163-82.
11. Pearson TA, Blair SN, Daniels SR, et al. AHA Guidelines for Primary Prevention of Cardiovascular Disease and Stroke: 2002 Update: Consensus Panel Guide to Comprehensive Risk Reduction for Adult Patients Without Coronary or Other Atherosclerotic Vascular Diseases. American Heart Association Science Advisory and Coordinating Committee. *Circulation* 2002;106:388-91.
12. Rosengren A, Hawken S, Ounpuu S, et al. Association of psychosocial risk factors with risk of acute myocardial infarction in 11119 cases and 13648 controls from 52 countries (the INTERHEART study): case-control study. *Lancet* 2004;364:953-62.
13. Barnett PA, Spence JD, Manuck SB, Jennings JR. Psychological stress and the progression of carotid artery disease. *J Hypertens* 1997;15:49-55.
14. Lichtman JH, Blumenthal JA, Frasere-Smith N, et al. Depression and coronary heart disease: recommendations for screening, referral, and treatment: a science advisory from the American Heart Association Prevention Committee of the Council on Cardiovascular Nursing, Council on Clinical Cardiology, Council on Epidemiology and Prevention, and Interdisciplinary Council on Quality of Care and Outcomes Research: endorsed by the American Psychiatric Association. *Circulation* 2008;118:1768-75.
15. Everson SA, Roberts RE, Goldberg DE, Kaplan GA. Depressive symptoms and increased risk of stroke mortality over a 29-year period. *Arch Intern Med* 1998;158:1133-8.
16. Sacco RL, Adams R, Albers G, et al. Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack: a statement for healthcare professionals from the American Heart Association/American Stroke Association Council on Stroke: co-sponsored by the Council on Cardiovascular Radiology and Intervention: the American Academy of Neurology affirms the value of this guideline. *Circulation* 2006;113:409-449.
17. Smith SC Jr, Allen J, Blair SN, et al. AHA/ACC guidelines for secondary prevention for patients with coronary and other atherosclerotic vascular disease: 2006 update: endorsed by the National Heart, Lung, and Blood Institute. *Circulation* 2006;113:2363-72.
18. Stone JA, Arthur HM, Second Edition. Canadian Guidelines for Cardiac Rehabilitation and Cardiovascular Disease Prevention: Enhancing the Science, Refining the Art, 2004. Canadian Association of Cardiac Rehabilitation 2004; Winnipeg, Manitoba.
19. Hackam DG and JD Spence. Combining multiple approaches for the secondary prevention of vascular events after stroke: a quantitative modeling study. *Stroke* 2007;38:1881-5.
20. Lennon O, Carey A, Gaffney N, et al. A pilot randomized controlled trial to evaluate the benefit of the cardiac rehabilitation paradigm for the non-acute ischaemic stroke population. *Clin Rehabil*. 2008;22:125-33.
21. Prior P, Suskin N, Hachinski V, Chan R, et al. Comprehensive cardiac rehabilitation for secondary prevention after TIA/mild stroke: update on vascular risk factors, psychological and neurocognitive outcomes. *International Journal of Stroke* 2008;3:s66.
22. Wagner EH, Austin BT, Davis C, et al. Improving chronic illness care: translating evidence into action. *Health Aff (Millwood)* 2001;20:64-78.

## Heart Disease and Stroke: Can we Bridge the Divide? – A Case Illustration

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There are between 40,000 to 50,000 strokes in Canada each year.<sup>1</sup> Up to 75% of stroke patients have a history of heart disease.<sup>2</sup> Stroke and heart disease; particularly coronary artery disease (CAD), share many of the same underlying pathophysiological mechanisms. Almost all known risk factors are common to

both conditions. These include hypertension, smoking, hyperlipidemia, diabetes, obesity, physical inactivity, and stress.<sup>2</sup> Underlying heart disease, such as atrial fibrillation, cardiomyopathy, or valvular heart disease, can result in cardioembolism which accounts for up to 15% of all strokes.

Most stroke patients are good candidates for stroke rehabilitation, including risk reduction education similar to the well established cardiac rehabilitation (CR) programs that many heart disease patients undergo. Recent studies have shown that stroke patients may be safely and feasibly included in CR.<sup>3</sup> A randomized clinical trial has shown treadmill aerobic exercise to improve both functional mobility as well as cardiovascular fitness with chronic stroke is more efficacious than conventional stroke rehabilitation in terms of improvements in peak VO<sub>2</sub> and 6 minute walk tests.<sup>4</sup> Presently, stroke patients do not routinely participate in a CR program unless they have concomitant heart disease.

Stroke patients have unique limitations imposed upon them by their condition, which requires recognition by CR professionals. While traditional CR principles remain, individualized tailoring of the CR program may be necessary to maximize the participation in a CR program.

Case Study – Right middle cerebral artery stroke and mitral valve repair Mr. T.M. is a 44-year-old professional who had a severe ischemic right middle cerebral artery stroke. He concurrently had bacterial endocarditis of his mitral valve (MV), and subsequently underwent MV repair. He had extensive inpatient and outpatient stroke rehabilitation, including physical, occupational, recreational, and psychological intervention. Several months later he was referred for CR.

Upon starting in the CR program, it was learned that prior to his stroke he was a relatively fit and active man who exercised regularly. His blood investigations revealed: low density lipoprotein cholesterol (LDL-C) 3.4 mmol/L, triglycerides 1.8 mmol/L, high-density lipoprotein (HDL-C) 0.9 mmol/L and, a fasting plasma glucose of 4.8 mmol/L. He smoked 1 pack of cigarettes a day for the last 15 years and drank about 1-2 glasses of wine per week.

Assessment at intake: height 180 cm, weight 78 kg, body mass index of 24 kg/m<sup>2</sup>, waist circumference 88 cm. Despite significant functional gains after his stroke rehabilitation, he had persistent left sided sensory and motor impairments. The left distal upper limb dystonia was managed with intermittent Botox injections. His gait and balance assessments were satisfactory, scoring 56/56 on the BERG balance test, and 28/30 on functional gait assessment. Both scores did not suggest an increased risk of falls. His late onset post-stroke seizures were

controlled with Dilantin. He was independent in activities of daily living and could walk up to 1 mile comfortably.

Medications included Aspirin, Metoprolol, Dilantin, and Zopiclone prn. His goals for CR were to improve his physical fitness and endurance as well as to regain some of his prior active lifestyle such as returning to the gymnasium.

He underwent a 12-week CR program, which included exercise testing, and an exercise prescription tailored to his goals and his abilities. He received individualized counselling on smoking cessation, diet, coping strategies for his stroke and his heart condition. His supportive wife attended many of the sessions with him. While he was often frustrated with his condition, he was not clinically depressed.

Exercise testing with a standard Bruce protocol was stopped when weakness in his left arm and leg worsened. He exercised 7 minutes, achieving a heart rate (HR) of 155 bpm (87% maximum predicted HR) and 8.7 METS which was below the 10th percentile for his age group. He had an appropriate blood pressure response and no significant ECG changes.

Based on this stress test, the following exercise prescription was formulated: 3 sessions per week, each beginning with a 5 minute slow warm up walk on the treadmill followed by cardiorespiratory training; 15 minutes jogging on the treadmill and 15 minutes on the bike at an intensity based on a target heart rate (THR) of 60-75% HR maximum or a rate of perceived exertion of 13, and concluding with 5 minutes of warm down and stretching. Four weeks later, arm exercises were added: 1 set of 8-10 repetitions in each of 8 different upper limb exercises with light weights at 50% of his 1 repetition maximum. At 8 weeks, the intensity of his cardiorespiratory component was increased with a new THR of between 70-85% HR maximum.

At his six month stress test, he completed 8 minutes of the Bruce protocol achieving 10.1 METS and a HR of 173 bpm (97% maximum predicted HR). His left arm was also noted to be stronger. The dystonia improved after several botox treatments. His lipid profile improved, LDL-C 2.4 mmol/L, HDL-C 1.1 mmol/L, and he successfully quit smoking. He was unable to resume his previous job due to both physical and cognitive impairments. He is currently volunteering in his father's company hoping

to expand his role as he continues to strive for further improvement. He feels more confident now and is able to play with and supervise his children. Walking is now his main source of physical activity, which he does on most days of the week for at least 30 min a day in addition to lifting free weights at home.

## Discussion

Stroke patients with concomitant heart disease can benefit from a structured CR program. There are many barriers for a stroke survivor to adopt regular physical activity including lowered confidence, lack of knowledge regarding their ability to exercise, and access to exercise facilities. There is a definite role for CR in these individuals in helping them overcome the issues with confidence and knowledge while teaching them how to exercise to improve their endurance and functional mobility as well as lower their overall vascular risk. Studies have also shown regular aerobic exercise may significantly improve cognitive function and delay progression of vascular cognitive impairment as well as Alzheimer's disease.<sup>5</sup>

A thorough neurological evaluation is essential to assess suitability for exercise as well as aid in designing a suitable exercise program. Patient candidacy for CR includes selecting those most likely to benefit from exercise training without compromising their safety. Stroke patients can have a myriad of neurological deficits, depending on the site of injury, each with its own set of issues and considerations. The ability to collaborate with the stroke rehabilitation team is considered ideal in determining candidacy as well as assistance in managing the patient. This particular patient was managed in the tertiary rehabilitation centre with dedicated stroke rehabilitation. In smaller centres, CR practitioners may have to liaise with their local physicians and therapists for help with complex neurological issues.

Increased supervision is essential in these patients. Dizziness, headaches, and limb weakness are common and increase the risk of falls or injury with exercise equipment. Seizures and use of multiple medications may further increase risk of injury and history of these must be clearly documented.

The physical fitness and capabilities of patients vary significantly. This may range from almost no residual neurological deficits to profound deficits which may exclude them from

aerobic exercise altogether. Close supervision allows individualized tailoring of their exercise prescription. In general, it is safer to start slow with shorter and more frequent bouts of low intensity exercise, not unlike that for elderly populations.

Exercise testing is recommended before commencing exercise training as most stroke patients are considered at higher risk for underlying CAD. The mode of testing would depend on the ability of the patient.

Lower limb aerobic exercises are best for improving aerobic fitness and should always be incorporated, if possible. Modifications may need to be made after taking into account balance, gait, and limb strength.

Dyslipidemia, particularly raised LDL-C, has been unequivocally shown to be linked with increased risk of recurrent stroke.<sup>6,7</sup> Lowering of LDL-C can be achieved by statins in addition to standard non-pharmacological methods.<sup>8</sup> The current Canadian target for stroke patients at risk of further vascular complications is a LDL-C level of <2.0mmol/L.<sup>9</sup>

As with all rehabilitation programs, maintenance post discharge is vital. Family support and referral to appropriate community programs is an important part of the discharge planning. Liaising with the stroke rehabilitation team at this stage should also be considered to help identify potential community resources for ongoing exercise.

## References

1. Heart and Stroke Foundation of Canada (2008). Retrieved September 9, 2008 from <http://ww2.heartand-stroke.ca/Page.asp?PageID=33&ArticleID=1078&Src=news&From=SubCategory>
2. Roth EJ. Heart disease in patients with stroke: Incidence, impact, and implications for rehabilitation. Part 1: Classification and prevalence. *Arch Phys Med Rehabil* 1993;74(7):752-60.
3. Tang A, Marzolini S, Oh P et al. Cardiac rehabilitation after stroke: characterizing resting and maximal exercise profiles. Oral presentation CACR symposium, Quebec City Oct. 2007.
4. Macko RF, Frederick MI, Forrester LW et al. Treadmill exercise rehabilitation improves ambulatory function and cardiovascular fitness in patients with chronic stroke: A randomized controlled trial. *Stroke* 2005;36:2206-11.
5. Lautenschlager NT, Cox KL, Flicker L et al. Effect of physical activity on cognitive function in older adults at risk for Alzheimer disease. *JAMA* 2008; 300(9):1027-37.
6. Sacco RL, Adams R, Albers G et al. Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack: A statement for healthcare

- professionals from the American Heart Association/ American Stroke Association Council on Stroke. *Stroke* 2006;37:577-617.
7. Amarenco P, Bogousslavsky J, Callahan A, et al. The Stroke Prevention by Aggressive Reduction in Cholesterol Levels (SPARCL) Investigators. High-dose Atorvastatin after stroke or transient ischemic attack. *N Engl J Med* 2006;355:549-59.
  8. Chaturvedi S, Zivin J, Breazna A et al. Effect of atorvastatin in elderly patients with a recent stroke or transient ischemic attack. *Neurology* 2008;DOI: 10.1212/01.wnl.0000327339.55844.1a
  9. Lau DCW, Douketis J D, Morrison KM et al. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *CMAJ* 2007;176 (suppl 8):S1-13.

## References and Reviews

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### PROSPECTIVE STUDIES

#### Increased Risk of Stroke in Patients with Coronary Artery Disease and Sleep Apnea: A 10-year Follow-up

Valham F *et al.* *Circulation* 2008;118:955-960.

Sleep apnea has been shown to be associated with cardiovascular disease and hypertension, but its effect on cardiovascular mortality is largely unknown. The purpose of this study was to assess whether sleep apnea was related to stroke, death, or myocardial infarction (MI) in patients with symptomatic coronary artery disease who were being evaluated for coronary intervention. Of the 392 patients who were followed prospectively for 10-years, sleep apnea, defined as an apnea-hypopnea index  $\geq 5$ , was recorded in 54% of patients, with stroke occurring in 12% of patients during the follow-up. Sleep apnea was associated with an increased risk of stroke in a dose response relationship. Patients with mild sleep apnea (apnea-hypopnea index of 5 to 15) had a 2.4 times increased risk of stroke, whereas patients with more severe sleep apnea (apnea-hypopnea index of 15 or more) had a 3.6 times increased risk of stroke, independent of confounding variables. Death and MI were not related to sleep apnea. Coronary interventions such as coronary artery bypass grafting or percutaneous coronary intervention were associated with longer survival but did not affect the rates of stroke. Possible factors explaining the increased risk of stroke among patients with sleep apnea include apnea-induced hypertension, nocturnal cerebral ischemia, and an increased risk of arteriosclerosis.

#### Potentially Preventable Strokes in High-risk Patients with Atrial Fibrillation who are not Adequately Anticoagulated

Gladstone DJ *et al.* *Stroke* 2009;40:DOI: 10.1161/strokeaha.108.516344.

Guidelines have strongly recommended warfarin rather than aspirin for stroke prevention in high-risk individuals, yet warfarin is often underused. This study investigated the type and intensity of antithrombotic use before ischemic stroke for patients with a known history of atrial fibrillation. The analysis was conducted on high-risk patients with atrial fibrillation for whom warfarin would be indicated and for whom there were no contraindications to anticoagulation. Analysis of data from the Registry of the Canadian Stroke Network (Ontario) demonstrated that only 40% of patients with known atrial fibrillation presenting to the hospital with a first-ever acute ischemic stroke were taking warfarin before admission, and 29% were not taking any antithrombotic prophylaxis. Of those taking warfarin, 74% had a sub-therapeutic international normalized ratio (INR) (median of 1.6) at admission. For patients presenting with acute ischemic stroke with known atrial fibrillation and a history of ischemic stroke or transient ischemic attack, 43% were not taking warfarin before admission, 68% had a sub-therapeutic INR at admission, and 15% of patients were not taking any antithrombotic therapy. The authors suggest that the underuse of warfarin may be related to both patient and physician decisions (e.g., INR monitoring, drug and food interactions, and potential bleeding risk). However, they also indicate that opportunities are being missed to prevent stroke in eligible patients with atrial fibrillation and that knowledge-translation strategies are needed to facilitate compliance with evidence-based guidelines.

#### Short-term Changes in and Predictors of Participation of Older Adults after Stroke Following Acute Care or Rehabilitation

Desrosiers J *et al.* *Neurorehabil Neural Repair* 2008;22:288-297.

Little is known about the participation in daily activities and social roles after stroke and its