AEROBICS

AEROBIC EXERCISE RECOMMENDATIONS TO OPTIMIZE BEST PRACTICES IN CARE AFTER STROKE

Marilyn Mackay-Lyons, Richard Macko, Janice Eng, Sandra Billinger, Charlene Hafer-Macko, Neville Suskin, Ada Tang, Nick Giacomantonio, Peter Prior, Marion Che, Alex Dromerick, Marianne Thornton, Robert Reid, Karen Unsworth, Christine LaGrand, Wanda Firth, Marion Che

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AEROBIC EXERCISE RECOMMENDATIONS TO OPTIMIZE BEST PRACTICES IN CARE AFTER STROKE (AEROBICS)

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<table>
<thead>
<tr>
<th>Consensus Panel Members</th>
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<tbody>
<tr>
<td>Sandra Billinger*</td>
<td>Physical Therapist, Assistant Professor, Director, REACH Laboratory, University of Kansas Medical Center, Kansas City, KS</td>
</tr>
<tr>
<td>Alex Dromerick</td>
<td>Neurologist, Associate Medical Director, National Rehabilitation Hospital, Professor of Rehabilitation Medicine and Neurology, Vice-Chair and Chief of Rehabilitation, Georgetown University School of Medicine, Washington, DC</td>
</tr>
<tr>
<td>Janice Eng*</td>
<td>Physical Therapist, Professor, Department of Physical Therapy, University of British Columbia, Vancouver, BC</td>
</tr>
<tr>
<td>Wanda Firth</td>
<td>Dietician, Program Manager, Community Cardiovascular Hearts in Motion, Queen Elizabeth II Health Sciences Centre, Halifax, NS</td>
</tr>
<tr>
<td>Nick Giacomantonio</td>
<td>Cardiologist, Director of Cardiac Rehabilitation and Community Cardiovascular Hearts in Motion Program, Associate Professor, Dalhousie University School of Medicine, Halifax, NS</td>
</tr>
<tr>
<td>Charlene Hafer-Macko*</td>
<td>Neurologist, Associate Professor, University of Maryland School of Medicine, Director of Exercise Physiology, Muscle Biology, and Metabolism Core for the Baltimore Veterans Affairs Maryland Exercise and Robotics Center of Excellence, Baltimore, MD</td>
</tr>
<tr>
<td>Christine LaGrand</td>
<td>Senior Policy Analyst, Heart and Stroke Foundation of Canada, Ottawa, ON</td>
</tr>
<tr>
<td>Marilyn MacKay-Lyons, Chair*</td>
<td>Physical Therapist, Associate Professor, School of Physiotherapy, Dalhousie University, Halifax, NS</td>
</tr>
<tr>
<td>Richard Macko, Co-Chair*</td>
<td>Neurologist, Professor and Academic Director of Rehabilitation Medicine, University of Maryland School of Medicine, Director of Veterans Affairs Maryland Exercise and Robotics Center of Excellence, and Research Director, Geriatrics Research, Education and Clinical Center, Baltimore, MD</td>
</tr>
<tr>
<td>Peter Prior</td>
<td>Psychologist, Cardiac Rehabilitation and Secondary Prevention Program, London Health Sciences Centre, Adjunct Clinical Professor, Department of Psychology, University of Western Ontario, London, ON</td>
</tr>
<tr>
<td>Robert Reid</td>
<td>Psychologist, Associate Director, Minto Prevention and Rehabilitation Centre, University of Ottawa Heart Institute, Ottawa, ON</td>
</tr>
<tr>
<td>Neville Suskin*</td>
<td>Cardiologist, Medical Director, London Health Sciences Centre Cardiac Rehabilitation and Secondary Prevention Program, Associate Professor of Medicine, Epidemiology and Biostatistics, University of Western Ontario; London, ON</td>
</tr>
<tr>
<td>Ada Tang</td>
<td>Physical Therapist, Post-doctoral Fellow, Department of Physical Therapy, University of British Columbia, Vancouver, BC</td>
</tr>
<tr>
<td>Marianne Thornton</td>
<td>Doctoral Student, School of Physiotherapy, Dalhousie University, Halifax, NS</td>
</tr>
<tr>
<td>Karen Unsworth</td>
<td>Program Coordinator, London Health Sciences Centre Cardiac Rehabilitation Program, London, ON</td>
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*Members of AEROBICS Recommendations Development Working Group
FUNDING
The development of the AEROBICS Recommendations was funded by the Nova Scotia Health Research Foundation, the Canadian Institutes of Health Research, the Heart and Stroke Foundation of Canada and the Faculty of Health Professions, Dalhousie University. The development of the recommendations was not influenced by the views and interests of the funders.

EDITORIAL INDEPENDENCE
The AEROBICS Recommendations have not been influenced by views of the funding bodies. None of the Consensus Panel members or external reviewers disclosed competing interests. Input of panelists and reviewers was based on their individual expertise and experiences; it did not represent formal endorsement by the institution of employment.

BACKGROUND AND METHODS
Introduction
There is sound evidence indicating that the majority of stroke survivors have very low levels of cardiovascular fitness. Moreover, many survivors are limited in their ability to perform activities of daily living, which, over time, leads to further physical deconditioning and sedentary lifestyles. Consequently, there may be an even greater reduction in fitness levels that can worsen disability and increase recurrent stroke risk. Aerobic exercise can break this relentless cycle by increasing aerobic capacity, improving and reducing the risk of co-morbidities, and enhancing the quality of life of stroke survivors.

Recent clinical guidelines have recommended that cardiovascular fitness training be a part of routine stroke rehabilitation and long-term management. As well, the new standards from the stroke specialty panel of the Commission for Accreditation of Rehabilitation Facilities (CARF) include plans for prevention of physical inactivity and physical deconditioning as important components of best care. However, specific screening and exercise prescription protocols are lacking in these guidelines, resulting in limited implementation of the recommendations. Furthermore, many clinicians deem fitness training unsafe for individuals post-stroke, partly because they lack safe and effective screening and exercise prescription protocols to guide clinical decision making. Unfortunately, this lack of clear direction means that individuals post-stroke are currently being deprived of an intervention with demonstrated potency to restore and maintain physical and mental functions. In addition, exercise has been shown to reduce vascular risk factors and enhance secondary prevention in patients with coronary heart disease, a population who share common risk factors and pathophysiology with patients post-stroke or transient ischemic attack (TIA). To “reach” clinicians, we must incorporate current best evidence from stroke and cardiac rehabilitation and secondary prevention research into clinical protocols designed to enhance cardiovascular fitness training post-stroke.

Purpose, Scope and Target Audiences
The main purpose of the Aerobic Exercise Recommendations to Optimize Best Practices In Care after Stroke (AEROBICS) project is to consolidate what is known about aerobic exercise for people after stroke or TIA into a concise and user-friendly set of recommendations for clinicians. The ultimate objective is to promote implementation of aerobic exercise interventions after a
A cerebrovascular event through knowledge translation and professional development of health care professionals involved in stroke care. Clinical implementation of the recommendations will help not only to narrow the gap between evidence and practice but also to reduce current variability and uncertainty regarding aerobic exercise in clinical practice.

The recommendations are supported by the highest quality of evidence available relevant to the utilization of aerobic exercise interventions in stroke management across stroke severity (i.e., TIA, non-disabling, moderate, and severe) and across the continuum of post-stroke recovery (i.e., acute, rehabilitation, community reintegration, and long-term adaptation).

The target audiences for the recommendations are health professionals who are involved in care of patients post-stroke and TIA across the health care continuum (from acute to home and community) as well as health administrators and managers responsible for the coordination and delivery of services.

**Development of the AEROBICS Recommendations**

The development of the AEROBICS Recommendations was guided by the Appraisal of Guidelines Research and Evaluation Consortium ([www.agreetrust.org](http://www.agreetrust.org)). The AGREE Consortium has identified six domains in recommendation development: (i) scope and purpose of the recommendations, (ii) stakeholder involvement, (iii) rigor of development, (iv) clarity and presentation, (v) applicability, and (vi) editorial independence. An iterative and pragmatic approach was used in developing the recommendations — proposing clinically feasible responses to clinically meaningful questions, with vetting by a consensus panel, external reviewers, and stroke survivors ([Figure 1](#)).

**Literature Synthesis**

The first step in the development of the recommendations was to produce a literature synthesis of findings from clinical trials, case series, systematic reviews, meta-analyses, and existing guidelines that address the role of aerobic exercise in stroke management. Topics of interest in the synthesis included physiological and functional benefits, indications and contraindications for aerobic exercise stress testing and interventions after stroke, as well as considerations regarding implementation across severity of stroke and the continuum of post-stroke care. Several databases were searched — PubMed, CINAHL, PEDro, Cochrane Central Register of Controlled Trials — for entries from 1970-2010 using the following key words: stroke, transient ischemic attack, exercise therapy, physical fitness, assessment, outcomes.

To assess the rigor of the research findings from individual intervention studies, we used the levels of evidence (LOE) outlined in [Table 1](#). Level I studies produce the strongest and most definitive evidence. Level II studies produce tentative conclusions. Levels III and IV suggest relationships but preclude conclusions regarding causation. No conclusions regarding treatment efficacy can be drawn from Level V evidence.
Figure 1. The process for development of the AEROBICS Recommendations
AEROBICS Best Practice Recommendations

Drafting the Recommendations

An inter-professional consensus panel was established that was comprised of Canadian and American experts representing physical therapy, stroke neurology, cardiology, psychology, nutrition, and health policy. A 3-day Consensus Workshop was held to draft the AEROBICS Recommendations. Worksheets of specific questions derived from the literature synthesis related to screening, testing, and prescription of aerobic exercise interventions were distributed to the consensus panel in advance of the Workshop. At the Workshop, 18 recommendations were drafted — seven screening and testing recommendations and 11 prescription recommendations. The need to consider each recommendation from both the patients' and providers' perspectives was emphasized.

Each recommendation was assigned a LOE using the classification developed by Guyatt, as adapted for the 2010 Canadian Best Practice Recommendations for Stroke Care (Table 2). Determination of the LOE was guided by the strength of the evidence from stroke-specific literature as well as relevant research findings involving other adult populations. Brief justification is provided regarding the LOE for each recommendation.

Table 1. Levels of Evidence of a Single Intervention Study

<table>
<thead>
<tr>
<th>LOE</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>• Systematic reviews of randomized controlled trials (RCTs) • Large RCTs (n&gt;100)</td>
</tr>
<tr>
<td>2</td>
<td>• Smaller RCTs (n&lt;100) • Systematic reviews of cohort studies • “Outcomes research” (very large ecologic studies)</td>
</tr>
<tr>
<td>3</td>
<td>• Cohort studies (with concurrent control group) • Systematic reviews of case control studies</td>
</tr>
<tr>
<td>4</td>
<td>• Case-series • Cohort study (with historical, not concurrent control group) • Case-Control Study</td>
</tr>
<tr>
<td>5</td>
<td>• Expert opinion • Case study or report • Bench research • Expert opinion based on theory or physiologic research • Common sense or anecdotes</td>
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Table 2. Levels of Evidence Assigned to the Recommendations

<table>
<thead>
<tr>
<th>LOE</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Evidence from RCTs or meta-analyses of RCTs.</td>
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<tr>
<td>B</td>
<td>Single RCT or well-designed observational study with strong evidence; or well-designed cohort or case-control analytic study; or multiple time series or dramatic results of uncontrolled experiment.</td>
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<tr>
<td>C</td>
<td>At least one well-designed, non-experimental descriptive study (e.g., comparative studies, correlation studies, case studies) or expert committee reports, opinions and/or experience of respected authorities, including consensus from development and/or reviewer groups.</td>
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</table>
**Operational Definitions**

For the purposes of this project, the following terms were defined to ensure consistency of interpretation:

- **Aerobic exercise** (aerobic or cardiovascular training) - Planned, structured, and repetitive physical activity performed for extended periods of time at sufficient intensity to improve or maintain physical fitness.

- **Continuum of stroke care** - Integrated system of care provided to individuals post-stroke from stroke symptom onset to long-term adaptation and reintegration into the community or assisted-living settings.

- **Heart rate reserve (HRR)** - Difference between maximal heart rate and resting heart rate.

- **Physical activity** - Bodily movement produced by skeletal muscle contraction that substantially increases energy expenditure, either in brief bursts of low to high intensity or long, sustained periods of lower intensity, depending on the type of activity and the person’s fitness level. Physical activity in daily life can be categorized as occupational, athletic, conditioning, household, or other activities.

- **Pre-participation screening** - Evaluation of the readiness of individuals for safe participation in aerobic training through identification of increased risk for exercise-related adverse events and medical contraindications for exclusion from exercise programs.

**Abbreviations**

- 6MWT – Six-Minute Walk Test
- ACSM – American College of Sports Medicine
- AEROBICS - Aerobic Exercise Recommendations to Optimize Best Practices In Care after Stroke
- DM - diabetes mellitus
- HRmax – maximum heart rate
- HRrest – resting heart rate
- HRR – heart rate reserve
- LOE – level of evidence
- PARmed-X - Physical Activity Readiness Medical Examination
- RCT - randomized controlled trials
- RPE – rating of perceived exertion
- TIA – transient ischemic attack
- VO\textsubscript{2}max – maximum oxygen consumption

**Refining the Recommendations**

A Recommendations Development Working Group, consisting of six members of the consensus panel, was formed to further develop each recommendation, using the template developed for the Canadian Best Practice Recommendations for Stroke Care. In addition to each recommendation, the rationale underlying it is presented in terms of its potential impact and its relevance to stroke care delivery or patient outcomes. System implications refer to the structures and operational strategies needed to ensure effective implementation of the recommendations. Performance measures provide managers, administrators, and health care providers with strategies for implementation and for measuring and monitoring the impact of the recommendations. Accompanying the Performance measures section is the subsection Measurement notes, where potential data sources, methods to enhance data collection, challenges to data access, and data
quality issues are identified. The *summary of the evidence* section summarizes the strongest evidence available related to each recommendation.

After incorporating feedback from the Recommendations Development Working Group, input from the entire consensus panel was solicited, and the draft recommendations were revised accordingly.

**External Review of the Recommendations**

The revised draft Recommendations were then sent to an international group of 12 external experts for their perusal and commentary (*Table 3*). The external reviewers were also asked to evaluate the Recommendations using the Appraisal of Guidelines Research and Evaluation tool (AGREE II)¹ (*Table 4*). The scores ranged from a low of 71% for the *Stakeholder Involvement* domain to a high of 86% for the *Scope and Purpose* domain. However, the AGREE Consortium has not set minimum domain scores to differentiate between high quality and poor quality guidelines.¹

<table>
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<th>Table 3. External reviewers and focus group participants</th>
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<tr>
<td><strong>External Reviewers</strong></td>
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<tr>
<td>Dina Brooks</td>
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<td>Pamela Duncan</td>
</tr>
<tr>
<td>Ésmé French</td>
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<tr>
<td>Fred Ivey</td>
</tr>
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<td>Michal Katz-Leurer</td>
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<tr>
<td>Olive Lennon</td>
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<td>Alison McDonald</td>
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<tr>
<td>Gillian Mead</td>
</tr>
<tr>
<td>Anita Mountain</td>
</tr>
<tr>
<td>Elliot J. Roth</td>
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<tr>
<td>Katherine Sullivan</td>
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<td>Jacqueline Tetro</td>
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</table>

**Focus Group Members**

| George Croucher                                          | Community-dwelling stroke survivor |
| Susan Croucher                                           | Caregiver |
| Brenda Medynski                                          | Community-dwelling stroke survivor |
| Margaret Perron                                          | Community-dwelling stroke survivor |
| Dave Sharp                                               | Community-dwelling stroke survivor |
A focus group consisting of four stroke survivors and one caregiver was held to seek out the views of people representing the target patient population (see Table 4). Feedback from the expert reviewers and stroke survivors were integrated into the Recommendations.

Table 4. External Review of Recommendations Using the Appraisal of Guidelines Research and Evaluation (AGREE II) Instrument

<table>
<thead>
<tr>
<th>Domain</th>
<th>Items</th>
<th>Score</th>
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</table>
| Scope and purpose           | 1. The overall objective(s) of the guideline is (are) specifically described.  
2. The health question(s) covered by the guideline is (are) specifically described.  
3. The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described. | 86%   |
| Stakeholder involvement     | 4. The guideline development group includes individuals from all the relevant professional groups.  
5. The views and preferences of the target population (patients, public, etc.) have been sought.  
6. The target users of the guideline are clearly defined. | 71%   |
| Rigor of development        | 7. Systematic methods were used to search for evidence.  
8. The criteria for selecting the evidence are clearly described.  
9. The strengths and limitations of the body of evidence are clearly described.  
10. The methods for formulating the recommendations are clearly described.  
11. The health benefits, side effects, and risks have been considered in formulating the recommendations.  
12. There is an explicit link between the recommendations and the supporting evidence.  
13. The guideline has been externally reviewed by experts prior to its publication.  
14. A procedure for updating the guideline is provided. | 79%   |
| Clarity and presentation    | 15. The recommendations are specific and unambiguous.  
16. The different options for management of the condition or health issue are clearly presented.  
17. Key recommendations are easily identifiable. | 81%   |
| Applicability               | 18. The guideline describes facilitators and barriers to its application.  
19. The guideline provides advice and/or tools on how the recommendations can be put into practice.  
20. The potential resource implications of applying the recommendations have been considered.  
21. The guideline presents monitoring and/or auditing criteria. | 75%   |
| Editorial independence      | 22. The views of the funding body have not influenced the content of the guideline.  
23. Competing interests of guideline development group members have been recorded and addressed. | 82%   |

Finalizing the Recommendations

The revised AEROBICS Recommendations were distributed to Consensus Panel members for their approval. In addition, each panelist was asked to assign one of two grades of strength (i.e., strong or weak). As indicated by Brozek and colleagues, "High quality evidence doesn’t necessarily imply strong recommendations, and strong recommendations can arise from low quality evidence." pg 925 A strong recommendation denotes that the desirable effects of the
recommendation clearly outweigh the undesirable effects, and a weak recommendation signifies that the benefits of the recommendation are less certain, either due to low-quality evidence or a close balance between desirable and undesirable effects. In determining the strength of a recommendation, several factors were considered — quality of evidence, benefits versus risks, patients' preferences and values, relevance and importance from clinicians' perspectives, and use of limited resources (i.e., feasibility, personnel, time, equipment, space). In cases where <80% agreement was reached among the panelists regarding the strength of a recommendation, the recommendation was revised based on the panelists' feedback, and the panelists were asked to reassess its strength. Initially, consensus (i.e., ≥80% agreement) was not reached on 4 of the 11 recommendations (1.5, 1.6, 2.4, 2.9); however, it was reached after revisions were made. Seventeen of 18 recommendations were rated as strong. Recommendation 1.5 was rated as weak because concern regarding the current lack of evidence to support the recommendation outweighed considerations related to use of limited resources.

Disseminating the Recommendations

The AEROBICS Recommendations were distributed to the organizations that funded the study. We are currently exploring the possibility of publishing an executive summary of the Recommendations in a peer-reviewed journal as well as posting the recommendations on central guideline repository websites such as the Canadian Stroke Strategy, the World Stroke Organization, the National Guidelines Clearing House, the Canadian Association of Cardiac Rehabilitation, and the Canadian Physiotherapy Association. In addition, we will communicate with the American Stroke Association, the National Stroke Association, the American Physical Therapy Association, the American Society of Neurorehabilitation, the American College of Rehabilitation, and the Veterans Health Care System of the United States of America. The draft recommendations were briefly discussed with CARF International to discuss strategies to address the new stroke care standards. The final recommendations have been presented at international, national, provincial, regional, and local meetings of relevant health care professionals and educators across health care disciplines and across the continuum of care.

Implementation strategies will need to be investigated in order to maximize the clinical utility of the AEROBICS Recommendations. A multi-disciplinary team has been formed to explore computer-supported clinical pathways for the integration of similar best practices based on these recommendations in the Veterans Affairs Health Care System in the United States. Integral aspects of such proposals will include plans for professional training, generation of standardized protocols to optimize treatment fidelity and safety, and development of validated benchmarks to assess impacts across the continuum of stroke recovery care.

Updating the Recommendations

Given that the literature and clinical practice are constantly evolving, a formal bi-annual review process will be established in order to revise the existing AEROBICS Recommendations on the basis of new evidence and guidelines.
## AEROBIC RECOMMENDATIONS AT A GLANCE

### SECTION 1. PRE-PARTICIPATION SCREENING FOR AEROBIC TRAINING AFTER STROKE OR TIA

<table>
<thead>
<tr>
<th>1.1 Who should be considered for participation in aerobic training after stroke or TIA?</th>
<th>All patients following a cerebrovascular event (stroke or TIA) should be considered for potential participation in aerobic exercise interventions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2 When should an individual post-stroke or TIA be screened for possible participation in aerobic training?</td>
<td>Patients should be screened for aerobic training as early as possible after onset of a cerebrovascular event (stroke or TIA) and when the patient is medically stable in terms of cardiovascular, hemodynamic, and neurological status. To ensure continuity of appropriate interventions, screening should be repeated at transition points along the continuum of stroke care based on the individual’s changing neuromotor and cardiopulmonary capacities to participate in aerobic training.</td>
</tr>
<tr>
<td>1.3 Who should determine if an individual post-stroke or TIA is ready to begin aerobic training?</td>
<td>Pre-participation evaluation for aerobic training after stroke or TIA should be provided by appropriately qualified health care professionals, consistent with their scope of practice and practice setting.</td>
</tr>
<tr>
<td>1.4 What patient information is needed to determine if an individual post-stroke or TIA is ready to begin aerobic training?</td>
<td>Before engaging in aerobic training, all individuals post-stroke or TIA must undergo a screening assessment to identify medical conditions that require special consideration or constitute a contraindication to exercise. Information to support screening should include: (i) General patient information: demographics, medical history, medications, cardiac history, seizure history, diabetes control, presence of anemia, lifestyle habits (smoking, physical activity). (ii) Assessment of contraindications to exercise testing and training. (iii) Evaluation of level of motor recovery, mobility, balance, swallowing status, and ability to express pain or distress and follow instructions for safe participation in an exercise program.</td>
</tr>
<tr>
<td>1.5 When is an exercise stress test indicated in pre-participation screening for aerobic training after stroke or TIA?</td>
<td>An exercise stress test should be an integral component of pre-participation screening for aerobic training after stroke or TIA. However, if the targeted intensity of the planned training program is light (e.g., &lt;45% of predicted heart rate reserve) and the participant is without symptoms or a known history of cardiovascular disease and has a normal resting ECG, an alternative, clinically-based submaximal test may be an option.</td>
</tr>
<tr>
<td>1.6 How should exercise testing, as a component of the pre-participation screen for aerobic training after stroke or TIA, be conducted?</td>
<td>A peak effort symptom-limited protocol should be used whenever possible. The exercise test should be administered by appropriately trained and experienced health care professionals with direct access to physician support and an external defibrillator. The patient should be on usual medications, avoid any strenuous activity for 24 hours prior to testing, and avoid a heavy meal, caffeine, or nicotine within 2 to 3 hours of testing. If low-intensity aerobic exercise (e.g., &lt;45% of predicted heart rate reserve) is planned for a participant who is without symptoms or a known history of cardiovascular disease and who has a normal resting ECG, a submaximal test that demonstrates the cardiopulmonary tolerance at the planned intensity of exercise training, such as the Six Minute Walk Test or Shuttle Walk Test, may be an option.</td>
</tr>
</tbody>
</table>
1.7 What should be monitored during a screening exercise stress test?
Heart rate and electrical activity of the heart should be continuously monitored using electrocardiography during exercise stress testing. Blood pressure monitoring and rating of perceived exertion should be done intermittently throughout the test, often at each stage of an incremental exercise protocol. Monitoring should continue after termination of the test until baseline values are approximated.

SECTION 2. PRESCRIPTION OF AEROBIC EXERCISE INTERVENTIONS AFTER STROKE OR TIA

2.1 How does aerobic training fit into the overall management of patients after stroke or TIA?
Aerobic training should be incorporated into a comprehensive, inter-professional program of stroke rehabilitation, vascular risk reduction, and secondary stroke prevention. Aerobic training should be implemented as part of an overall exercise program that may also include, but is not limited to, muscle strengthening and task-oriented training of motor control, balance, gait, and functional use of the upper extremity. Physical activity designed to maintain cardiovascular fitness is an important aspect of community reintegration after stroke.

2.2 Where should aerobic exercise interventions be conducted?
Aerobic exercise programs can be administered in a variety of barrier-free and accessible settings: hospital, outpatient clinics, community, and home. Training of high-risk individuals must be done in a setting with immediate access to external defibrillation and emergency medical response. For lower-risk individuals, supervised home-based aerobic exercise programs may be a safe and effective option.

2.3 Who should design and supervise the aerobic exercise intervention?
An aerobic exercise program for a person post-stroke should be designed by an appropriately qualified health care professional. The level of supervision is determined by the health care professional based on the individual participant's health condition. High-risk individuals require constant supervision, whereas low-risk individuals with demonstrated ability to exercise safely and effectively may require only intermittent supervision. Supervision may be provided by the qualified health care professional or an exercise instructor who has been trained by the health care professional. Progression of the exercise program should be monitored by the health professional.

2.4 What format (individual, group) should be used for aerobic training after stroke or TIA?
Aerobic exercise interventions can be conducted in either an individual (one-on-one) or group format, with the ratio of participant to supervising personnel determined by the severity of the participant's neurological and cardiac status, as well as the planned exercise intensity and mode of training.

2.5 What mode of exercise should be used for aerobic training after stroke or TIA?
A variety of exercise modes can be used to induce an aerobic training effect. Task-specific exercise that activates large muscle mass is recommended.

2.6 Over what period of time should the aerobic training sessions be conducted?
A minimum of 8 weeks of aerobic exercise is recommended to achieve a clinically meaningful training effect. However, physical activity should be sustained indefinitely to ensure maintenance of health benefits.

2.7 How frequently should aerobic exercise interventions be conducted after stroke or TIA?
Although physical activity should be done “most days of the week” for general health, structured aerobic exercise should be conducted a minimum of 3 days/week. On the other days of the week, participants are encouraged to engage in lighter forms of physical activity.
2.8 How long should each aerobic exercise session be?
Aerobic exercise sessions of $\geq 20$ minutes are recommended, depending on exercise frequency and intensity. In addition, warm up and cool down periods of 3-5 minutes are advised. A gradual progression in the duration may be required, starting with bouts of 5 minutes or less, or intervals of rest or lower-intensity exercise, as needed.

2.9 What intensity of aerobic exercise should be used?
Intensity of aerobic exercise must be determined on an individual basis, depending on response to the exercise stress test, health status (neurologic status, cardiac and other co-morbidities), and planned exercise frequency and duration. Frequent heart rate monitoring and periodic blood pressure monitoring are recommended for safety and assurance that exercise is being performed at the planned intensity. Surrogate markers of intensity such as rating of perceived exertion (RPE) should be used, particularly when the linear relationship between cardiopulmonary exertion and heart rate is compromised by medication or autonomic dysregulation.

Low intensity exercise: $<45\%$ of HRR or RPE$_{0.10}$ $<4$ or RPE$_{0.20}$ of $<10$
Moderate intensity exercise: $45-60\%$ of HRR or RPE$_{0.10}$ of $4-5$ or RPE$_{0.20}$ of $11-13$
High-intensity exercise: $>60\%$ of HRR or RPE$_{0.10}$ $\geq 6$ or RPE$_{0.20}$ of $\geq 14$
Exercise intensity should be progressed as tolerated by the participant.

2.10 What clinical outcome measures should be used to monitor the effect of aerobic exercise interventions?
Outcome measures that reflect patient-oriented goals of aerobic exercise interventions should be conducted periodically to monitor change over time, progress the intervention, or transition to other interventions or physical activities. Measures to consider include assessments of cardiovascular health (e.g., blood pressure, blood lipids, fasting plasma glucose, waist circumference, medication adherence, tobacco use), cardiovascular endurance/functional capacity (e.g., 6-Minute Walk Test, Shuttle Walk Test, heart rate at a fixed submaximal workload, daily step counts) and other health domains (e.g., mobility, goal attainment, emotional wellbeing, quality of sleep and quality of life).

2.11 What are strategies to overcome barriers to participant engagement in aerobic training after stroke or TIA?
A participant-focused approach, endorsed by all relevant health care providers, should be used to encourage sustained involvement in aerobic exercise interventions. A planned and gradual transition from participation in a structured clinical program of aerobic exercise to less structured, more self-directed engagement in physical activity at home or in the community may facilitate the lifestyle changes needed for long-term commitment. Multiple strategies to deal with specific barriers related to health care providers, the environment, and participants are recommended.
**AEROBICS RECOMMENDATIONS**

**SECTION 1. PRE-PARTICIPATION SCREENING FOR AEROBIC TRAINING AFTER STROKE OR TIA**

<table>
<thead>
<tr>
<th>Best Practice Recommendation 1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Who should be considered for participation in aerobic training after stroke or TIA?</strong></td>
</tr>
<tr>
<td>All patients following a cerebrovascular event (stroke or TIA) should be considered for potential participation in aerobic exercise interventions.</td>
</tr>
<tr>
<td><strong>LOE:</strong> A (Several RCTs have demonstrated a broad range of benefits of aerobic exercise after stroke and TIA.)</td>
</tr>
<tr>
<td><strong>Strength of Recommendation:</strong> Strong</td>
</tr>
</tbody>
</table>

**Rationale**

Given the wide range of known and potential benefits of aerobic exercise for individuals post-stroke (Box 1.1), little justification exists for not incorporating aerobic exercise interventions into the care of the majority of cases. Physical inactivity is an independent risk factor for vascular disease, including stroke. Physical impairments (e.g., muscle weakness, impaired balance, changes in muscle tone) associated with stroke further restrict mobility and physical activity. In addition, the majority of individuals post-stroke also present with co-morbidities (e.g., hypertension, diabetes mellitus (DM)). Physical inactivity compounds secondary body composition abnormalities – which include hemiparetic muscle atrophy, increased intramuscular area fat, and shift to fast twitch muscle phenotype – increases fatigue, decreases oxidative capacity, and increases insulin resistance. These abnormalities are linked to high prevalence (~75%) of impaired glucose tolerance and DM in stroke survivors, conditions that prospectively predict two and threefold recurrent stroke risk, respectively. Aerobic exercise has been shown to improve indices of insulin sensitivity, reversing impaired glucose tolerance and type-2 DM in up to 58% of stroke cases. As well, there is emerging evidence that comprehensive cardiac rehabilitation administered early after TIA or mild non-disabling stroke is feasible and effective in improving exercise capacity and cardiovascular risk factor profile.

**System Implications**

- Routine pre-participation screening protocols for aerobic exercise interventions need to be established.
- Screening and subsequent prescription of regular exercise should be considered as a component of secondary stroke prevention.

**Performance Measures**

Percentage of individuals after stroke or TIA who are screened for aerobic exercise interventions.

**Measurement Notes**

Data gathering regarding screening for aerobic exercise interventions requires a chart review or consistent use of reliable workload measurement tools.

**Summary of the Evidence**

Age, gender, and stroke severity are among the factors to consider with respect to appropriateness of participating in aerobic exercise post-stroke. Although the effects of age and gender on response to aerobic exercise have not been systematically investigated in the stroke population, neither age nor gender has been found to influence trainability in the non-disabled population (LOE: 3). The position of the American College of Sports Medicine (ACSM) is that age should not be considered a barrier to exercise because improvements can be achieved at any age. Very few adverse events have been
reported in post-stroke training studies, most of which have involved participants with a mean age of 60-70 years. An upper age limit was not an exclusion criterion in any of these studies. Thus, it is assumed that men and women of any age post-stroke are likely to benefit from aerobic exercise interventions.

In terms of stroke severity, most post-stroke exercise training studies involved people with mild to moderate stroke. Recently, the feasibility, safety, and effectiveness of a program of aerobic exercise-based cardiac rehabilitation was demonstrated in a single cohort of 100 patients after recent non-disabling stroke or TIA with a high prevalence of modifiable vascular risk factors: sedentary lifestyle (61%), dyslipidemia (74%), hypertension (70%), DM (22%), obesity or excess weight (80%), and smoking history (70%) (LOE: 4). Consistent with the excellent safety record of cardiac rehabilitation, no adverse events were associated with treatment, and significant intake-to-exit changes were reported for exercise capacity (+31.4%; p<0.001), total cholesterol (-0.30 mmol/L; p=0.008), and TC/HDL ratio (-11.6%; p<0.001). Katz-Leurer et al. included people with more severe impairment in a trial of early aerobic training in subacute stroke survivors (LOE: 2). At the end of the program, the researchers found significant differences in the exercise stress test time between groups stratified by stroke severity. However, regardless of stroke severity, significant improvements were found in step climbing and non-significant improvements in walking time and distance. Another study by Katz-Leurer and colleagues, investigating patients with stroke severities ranging from mild to severe, reported no adverse events during a subacute aerobic exercise training program. Collectively, the findings suggest that aerobic training can be implemented safely across the spectrum of stroke severity.
Box 1.1 Potential benefits of aerobic training post-stroke

In determining whether an individual is a candidate for aerobic training, the potential benefits of the intervention relevant to that individual should be considered. The following is a summary of potential benefits for which some evidence has been documented regarding the stroke population.

Vascular risk reduction (LOE: B)

- Blood pressure
  - Reduction in systolic blood pressure (SBP) at a fixed submaximal workload \(^{36}\) (LOE: 2)
  - Reductions in resting SBP and diastolic blood pressure (DBP) \(^{20}\) (LOE: 3)

- Lipid profile
  - Improved total cholesterol and total cholesterol/high-density lipoprotein ratio \(^{14}\) (LOE: 4)
  - Improved total cholesterol and low-density lipoprotein cholesterol \(^{20}\) (LOE: 3)
  - Improved high-density lipoprotein cholesterol \(^{37}\) (LOE: 4)

Insulin sensitivity

- Reduced insulin secretion \(^{19}\) (LOE: 3)
- Reduced fasting glucose and 3-hour insulin response \(^{13}\) (LOE: 2)
- Reversal of impaired glucose tolerance and type-2 DM, based on oral glucose tolerance test \(^{13}\) (LOE: 2)

Systemic and cerebrovascular hemodynamics

- Improved femoral artery hemodynamics \(^{38}\) (LOE: 4)
- Improved bilateral lower extremity vasomotor reactivity \(^{39}\) (LOE: 2)
- Improved endogenous fibrinolysis profiles \(^{40}\) (LOE: 4)

Cardiac function

- Improved left ventricular contractility for individuals with coronary artery disease \(^{37}\) (LOE: 3)

Exercise capacity and energy expenditure (LOE: A)

- Improved peak oxygen consumption in subacute period of recovery after stroke \(^{18}\) (LOE: 2) and chronic post-stroke period \(^{36}\) (LOE: 2), \(^{41}\) (LOE: 2), \(^{27}\) (LOE: 3) \(^{42}\)
- Decreased steady-state oxygen consumption at submaximal workload \(^{41}\) (LOE: 2)
- Improved maximal workload \(^{26}\) (LOE: 2)
- Decreased energy expenditure of walking \(^{28}\) (LOE: 4), \(^{43}\) (LOE: 4)

Muscle strength and motor function of hemiparetic extremities (LOE: B)

- Improved eccentric torque of hamstring musculature \(^{44}\) (LOE: 4)
- Higher composite lower extremity strength \(^{27}\) (LOE: 2), \(^{17}\) (LOE: 2)
- Higher composite muscle strength of upper and lower extremities \(^{45}\) (LOE: 5)
- Improvements in lower-extremity Fugl-Meyer scores \(^{24}\) (LOE: 2)

Balance and mobility (LOE: B)

- Improved balance \(^{24}\) (LOE: 2), \(^{18}\) (LOE: 3), \(^{19}\) (LOE: 4), \(^{25}\) (LOE: 2), \(^{46}\) (LOE: 4), \(^{47}\) (LOE: 4) \(^{48}\)
- Enhanced gait pattern \(^{49}\) (LOE: 4), \(^{45}\) (LOE: 5) \(^{50}\)
- Increased walking speed \(^{18}\) (LOE: 2), \(^{24}\) (LOE: 4), \(^{25}\) (LOE: 2), \(^{27}\) (LOE: 3), \(^{40}\) (LOE: 5) \(^{23}\)
- Increased walking endurance \(^{18}\) (LOE: 2), \(^{24}\) (LOE: 4), \(^{25}\) (LOE: 3), \(^{19}\) (LOE: 2), \(^{41}\) (LOE: 3), \(^{22}\) (LOE: 4), \(^{50}\) (LOE: 5) \(^{23}\)

Cognition (LOE: B)

- Reduced response time on a serial reaction timed task and repeated sequence task tested in the non-affected hand \(^{15}\) (LOE: 2)

Emotional well being (LOE: C)

- Reduced depressive symptoms \(^{19}\) (LOE: 3)

Quality of life (LOE: D)

- Improved performance satisfaction regarding activities of daily living \(^{25}\) (LOE: 4)

Employment status (LOE: C)

- Relationship found between level of physical fitness post-stroke and return to fulltime employment \(^{45}\) (LOE: 4)

Note: To date, no trials have demonstrated that aerobic exercise contributes to survival after stroke or to prevention of secondary stroke and cardiac events after initial stroke. Further studies are also needed to establish whether aerobic exercise after stroke provides benefit to body composition, quality of sleep, functional independence, fall risk, and discharge destination.
Best Practice Recommendation 1.2

When should an individual post-stroke or TIA be screened for possible participation in aerobic training?

Patients should be screened for aerobic training as early as possible after onset of a cerebrovascular event (stroke or TIA) and when the patient is medically stable in terms of cardiovascular, hemodynamic, and neurological status. To ensure continuity of appropriate interventions, screening should be repeated at transition points along the continuum of stroke care based on the individual’s changing neuromotor and cardiopulmonary capacities to participate in aerobic training.

LOE: B (Several RCTs have demonstrated safe and effective application of aerobic exercise interventions early after stroke. However, the LOE was downgraded due to lack of trials comparing aerobic training initiated early versus late after stroke or TIA.)

Strength of Recommendation: Strong  
Agreement among panelists: 80%

Rationale
Given the wide-ranging benefits that aerobic exercise may offer to individuals post-stroke or TIA (see Box 1.1), there are no compelling reasons to delay screening for participation in aerobic training once the individual is medically stable. Further, since exercise confers health benefits even years after stroke, aerobic training can be introduced at any point in the health care continuum, regardless of how much time has elapsed since the original stroke event.

System Implications
• Education of health care providers regarding the need for screening and reassessment for aerobic exercise interventions across the continuum of stroke care.

Performance Measures
• Time from point of medical stability following stroke or TIA to initiation of pre-participation screening and implementation of aerobic exercise interventions, if appropriate.
• Percentage of persons post-stroke or TIA who undergo screening for aerobic training at each transition point along the continuum of stroke care: during inpatient rehabilitation, outpatient and ambulatory clinics (including secondary stroke prevention clinics), and/or following discharge in the community.

Summary of the Evidence
As a consequence of spending as much as 45% of the day resting in bed (LOE: 4), patients in the early post-stroke period are at risk of rapid decreases in aerobic capacity (LOE: 4). Formal exercise testing using open circuit spirometry reveals that cardiovascular fitness levels are approximately half of age- and gender-matched sedentary controls (LOE: 3) and that fitness levels improve minimally in the interval between one and six months post-stroke (LOE: 4). Furthermore, reduced free-living ambulatory activity levels are related to poor fitness levels after stroke (LOE: 4). To prevent the multiple problems associated with the deconditioned state, early intervention is recommended. Few adverse events have been reported in numerous exercise training studies of people post-stroke at various stages of recovery, including acute, subacute, and chronic.
### Best Practice Recommendation 1.3

**Who should determine if an individual post-stroke or TIA is ready to begin aerobic training?**

Pre-participation evaluation for aerobic training after stroke or TIA should be provided by appropriately qualified health care professionals, consistent with their scope of practice and practice setting.

<table>
<thead>
<tr>
<th>LOE: C (Expert opinion based on standard practice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength of Recommendation: Strong</td>
</tr>
</tbody>
</table>

### Rationale

Stroke survivors present with a diversity of sensory-motor impairments, neuro-cognitive deficits, and co-morbidities that need to be considered in the selection of evaluation strategies for determination of safety and suitability for exercise stress testing and aerobic training. Therefore, health care professionals with the academic training, clinical knowledge, and skills required to make sound clinical judgments should determine readiness of people post-stroke to engage in aerobic training. It is important to keep in mind that the potential benefits of aerobic exercise most often exceed the potential risks.

### System Implications

- Development and delivery of an educational program to train appropriate health care providers to perform exercise screening tests for aerobic exercise interventions.
- Access to appropriately trained health care providers (e.g., neurologists, cardiologists, physical therapists, psychiatrists, kinesiologists, exercise physiologists).

### Performance Measures

- Availability of appropriately trained health care providers to conduct exercise screening tests in facilities offering aerobic exercise interventions for people after stroke or TIA.

**Measurement Notes**

Data gathering in regards to personnel qualifications requires an operations/administration audit.

### Summary of the Evidence

The personnel qualifications required to determine the readiness of a patient post-stroke to participate safely in aerobic exercise interventions have not been systematically studied.
### Best Practice Recommendation 1.4

**What patient information is needed to determine if an individual post-stroke or TIA is ready to begin aerobic training?**

Before engaging in aerobic training, all individuals post-stroke or TIA must undergo a screening assessment to identify medical conditions that require special consideration or constitute a contraindication to exercise. Information to support screening should include:

1. **General patient information**: demographics, medical history, medications, cardiac history, seizure history, diabetes control, presence of anemia, lifestyle habits (smoking, physical activity).
2. **Assessment of contraindications to exercise testing and training**.
3. **Evaluation of level of motor recovery, mobility, balance, swallowing status, and ability to express pain or distress and follow instructions for safe participation in an exercise program**.

**LOE:** A (The majority of RCTs on aerobic exercise post-stroke involved broad screening protocols to ensure safety of participants.)

**Strength of Recommendation:** Strong  
**Agreement among panelists:** 100%

**Rationale**

Because of the prevalence of associated health conditions, cardiovascular co-morbidities, and stroke-related functional impairments, pre-participation screening for aerobic training post-stroke warrants careful attention. Prescription of an effective and individualized aerobic exercise program should only be done after careful clinical evaluation, including risk stratification. The principal purpose of screening is to determine whether aerobic training is indicated and will be safe for a particular individual. Given that most patients post-stroke are deconditioned, it is reasonable to assume that most would benefit from enhanced physical activity. However, proper screening assesses whether potential participants are free of health/medical conditions that could be adversely affected by the physiological stresses imposed by aerobic exercise. Further, by ascertaining the patient's baseline status in terms of cardiovascular fitness and vascular risk factors, screening is also useful in guiding clinical decision making regarding goal setting, exercise prescription, and level of supervision required.

Screening protocols must include the appropriate information to ensure sound decision making about safe participation in and prescription of aerobic training after Stroke or TIA. Because of the systemic nature of impairments typically associated with stroke, multiple factors must be considered. At the same time, the screening process should not be so onerous as to become a significant barrier to participation. Assessment of baseline status should include the information noted above. Details of medications (i.e., indications, response, and side effects) that can influence the test protocol and the response to the exercise are important to note. The Physical Activity Readiness Medical Examination (PARmed-X) ([Appendix A](#)) may be a useful tool to support screening of people post-stroke living in the community. Laboratory tests, including echocardiograms, pulmonary function tests, investigations of peripheral vascular function, blood chemistry tests, bone density measures, radiographs, scans, thyroid function tests, and glucose tolerance tests are useful but may not be routinely available.

**System Implications**

- Access to the assessment procedures and medical records needed for pre-participation screening.
- Provision of aphasia-friendly materials to ensure that patients with non-verbal communication but sufficient comprehension are not excluded during the screening process.

**Performance Measures**

Extent of missing data on the pre-participation screening form.
Summary of the Evidence
Below is an overview of considerations referred to in the literature regarding pre-participation screening for aerobic training after stroke or TIA. It is important to note that, in order to control for confounding influences, eligibility criteria used in exercise trials are often stricter than what would be necessary in clinical practice.

Blood pressure
For cardiac populations, either resting SBP >200 mmHg or resting DBP of >110 mmHg has been deemed a contraindication for exercise or physical activity. Katz-Leurer and colleagues (LOE: 2) adhered to the ACSM criteria in screening patients for participation in an early post-stroke training study, as did Tanne et al. (LOE: 2) in an exercise trial involving people after minor ischemic stroke. In contrast, in a community-based trial, Stuart and colleagues (LOE: 3) chose more conservative exclusion criteria: resting SBP >160 or resting DBP >95 mmHg. Other investigators indicated that “uncontrolled hypertension” was an exclusion criterion. For patients on vasodilators, calcium channel blockers, angiotension-converting enzyme inhibitors, and α- and β-adrenergic blockers, the BP response may be attenuated and, consequently, cannot be accurately predicted.

Body weight
Physical activity has been recommended as a component of post-stroke weight management and obesity prevention. Only one post-stroke study was cited in which patients were excluded based on excessive body weight (defined as >110 kg (LOE:2). Among the post-stroke training studies reviewed, the highest mean body mass index reported was 32.8m^2/kg (LOE:2). Availability of personnel and equipment to accommodate bariatric patients is an important management consideration.

Glucose tolerance/DM
The ACSM recommends conducting a thorough medical evaluation on individuals with DM before they engage in vigorous exercise. Because hypoglycemia is a common problem for people with DM, rapid decreases in blood glucose may occur during exercise, causing shakiness, weakness, and abnormal sweating as well as neuroglycopenic symptoms (e.g., confusion, disorientation). Consequently, blood glucose should be monitored before and following exercise testing and training, especially in the early stages. Only one training study (LOE: 2) used an exclusion criterion with respect to diabetes control, excluding patients early post-stroke with blood sugar levels consistently higher than 13.9 mmol/L (250 mg/dl).

Cardiac disease
A number of the post-stroke training studies excluded people with serious associated heart disease. In their trial of people within one month of stroke, Duncan and colleagues (LOE: 2) defined “serious cardiac conditions” as: (i) conditions requiring hospitalization for heart disease within 3 months, (ii) active angina, (iii) serious cardiac arrhythmias, (iv) hypertrophic cardiomyopathy, (v) severe aortic stenosis, (vi) pulmonary embolus, or (vii) infarction. Ramas and colleagues also found that people post-stroke with cardiovascular co-morbidities were often excluded in studies involving gait training. Likewise, the review by Pang and colleagues found that most studies involved people post-stroke who did not have unstable or serious cardiovascular conditions.

Carotid stenosis
Carotid stenosis is frequently seen in people with coronary artery disease and is a strong independent predictor of recurrent stroke or TIA. It is not listed by the ACSM as a contraindication; however, Ivey and colleagues stated that hemodynamically significant carotid stenosis should be regarded as a relative contraindication to maximal exercise testing. In one of their studies, two of a total of 111 patients in the...
chronic post-stroke period (<2%) were excluded from participation in an aerobic training study due to carotid stenosis. The rationale for exclusion was that exercise-induced dysrhythmias or other abnormal cardiac responses to exertion can produce rapid reductions in blood pressure that could potentially decrease cerebral blood flow across a fixed stenosis. For individuals with carotid stenosis who are not operative candidates, best clinical judgment of the risk-benefit ratio should be made on an individual basis with appropriate medical consultation. Careful cardiopulmonary monitoring is recommended to assure hemodynamic tolerance to the prescribed exercise intensity.

**Atrial fibrillation (AF)**

Both persistent and paroxysmal AF are strong predictors of recurrent stroke, particularly in older adults, and sometimes coexist with carotid stenosis. Exercise training in patients with AF has received little attention in the literature. Only a few post-stroke training studies excluded people who presented with AF or other arrhythmias. Vanhees et al. reported that, although AF adversely affects exercise performance, it does not preclude the beneficial effects of CV training and, as a result, should not be a contraindication to exercise.

**Seizure activity**

During the acute phase of ischemic stroke, partial or secondary generalized seizures may occur. Rimmer and colleagues reported that one participant out of a group of 35 experienced a mild seizure during a 12-week training program. While the relationship between epilepsy and exercise remains a subject of controversy, reduced incidence of seizures while exercising has been well documented. On the other hand, Durstine reported that vigorous exercise may trigger seizures in deconditioned individuals and warned that some anticonvulsant medications may produce symptoms ranging from loss of coordination to lethargy. The ACSM's position is that individuals with epilepsy are able to engage in exercise but that the risks depend on the type of seizure and type of exercise. Protective strategies (e.g., wearing hip protectors, exercise in a supported position) should be used during aerobic training if seizure activity is a possibility.

**Arthritis**

The ACSM recommended reviewing orthopedic problems such as arthritis, joint swelling, and other conditions that may limit ambulation or present challenges during exercise testing. Investigators running post-stroke training studies have used the following as exclusion criteria: inflammatory or degenerative joint diseases, limiting arthritis, significant musculoskeletal problems from conditions other than stroke, musculoskeletal impairments or pain that would limit pedaling ability, and severe pain on weight bearing. Although presence of severe arthritic conditions involving the lower extremity joints can limit participation in aerobic training after stroke, availability of water-based exercise reduces that limitation.

**Baseline exercise capacity/activity tolerance**

Only one post-stroke training study specified a minimum activity tolerance level as an inclusion criterion: specifically, an activity tolerance of 60 minutes with rest intervals (LOE: 4). Nonetheless, the extent of impairment in baseline activity tolerance may impact aerobic exercise outcomes. In a study involving sedentary and moderately obese females, participants who had lower aerobic capacity at baseline demonstrated the greatest improvements of aerobic capacity at the end of the study. Consistent with this finding, Pang and colleagues (LOE: 1) noted in their meta-analysis that acute stroke survivors had greater improvements in peak oxygen consumption ($V_{O2peak}$) compared to subacute and chronic stroke survivors. The authors suggested that this outcome may have been due to the lower baseline aerobic capacity of the patients early post-stroke as well as superimposed natural stroke recovery.

**Motor control of hemiparetic extremities**

Impaired neuromotor control is one of the contributing factors to functional limitations in stroke survivors because these impairments may limit or restrict movements required to attain cardiorespiratory improvements. In their training study involving patients early after stroke, Tang and colleagues...
(LOE: 3) used a Chedoke-McMaster Stroke Assessment (CMSA) leg impairment score of at least 3 (marked spasticity and weakness) but less than 7 (normal limb movement) as an inclusion criterion. However, in clinical settings with access to exercise training modalities that accommodate both ambulatory and nonambulatory patients, the level of baseline motor control should not be considered a limitation to participation in aerobic exercise.

**Cognitive and communication status**

More than 60% of stroke survivors have cognitive disabilities that may decrease the likelihood of successful rehabilitation outcomes. Several training studies used exclusion criteria related to cognitive and language impairments because these deficits could potentially compromise ability to provide informed consent and to report adverse exercise-induced symptoms. Most used minimum scores on the Folstein Mini-Mental State Examination (out of 24) – <16, 18, and <24 – sometimes with adjustments for lack of formal education. Many studies operationally defined the ability to safely participate in exercise from a cognitive perspective as the ability to follow three-step commands and to interact with the exercise tester, trainer, or instructor to indicate discomfort or distress. Clinically, to ensure safe participation in exercise testing and aerobic exercise, the participant should be able to express pain or distress and follow simple instructions.

**Emotional wellbeing**

Depression is common post-stroke and can be a substantial barrier to long-term engagement in physical activity. Although assessment of post-stroke depression by a trained professional is recommended, there is no consensus on the most appropriate screening tool for this purpose. Some of the training studies reviewed excluded patients with untreated major depression. However, there is growing evidence that exercise can reduce depressive symptoms in patients post-stroke who do not have major depression.

**Balance**

Balance impairments post-stroke may result in difficulties in performing functional tasks (e.g. sitting, standing, and walking) due to the lack of postural stability. Although balance deficits may represent barriers to safe participation in exercise testing and training, the use of safety harnesses and supported exercise modes reduce safety concerns. Nevertheless, caution is needed regarding locomotor task practice in the free-living environment, where increased falls have been reported among more severely gait-impaired participants post-stroke.

**Mobility**

Several investigators have identified various minimal distances of continuous ambulation as an eligibility criterion: ability to take at least one step with or without assistance, to walk independently 5 metres (16.4 feet), to walk independently 7.6 metres (25 feet), to walk 15.2 metres (50 feet) with or without an assistive device, and to walk independently with or without an assistive device. Stuart used gait speed as a inclusion criterion: ability to walk independently at a speed of 30-90 cm/sec for six minutes, with or without an assistive device. In the clinical setting, however, a range of exercise training modes are available to accommodate patients with various types of mobility restrictions.

**Other neurologic conditions**

Special considerations should be made for other neurologic conditions superimposed on stroke deficits. For example, Parkinson’s Disease may introduce additional concerns for testing and training due to abnormalities of gait and autonomic dysfunction.
<table>
<thead>
<tr>
<th>Signs and symptoms</th>
<th>Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction</td>
<td>Acute myocardial infarction</td>
</tr>
<tr>
<td>Angina</td>
<td>Unstable angina (not controlled with medication/intervention)</td>
</tr>
<tr>
<td>Cardiac arrhythmias</td>
<td>Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic compromise</td>
</tr>
<tr>
<td>Resting ST segment displacement</td>
<td>&gt;1mm displacement in more than one lead</td>
</tr>
<tr>
<td>Heart failure</td>
<td>Uncontrolled symptomatic heart failure</td>
</tr>
<tr>
<td>Aortic stenosis</td>
<td>Symptomatic severe aortic stenosis</td>
</tr>
<tr>
<td>Large vessel intracranial stenosis</td>
<td>Severe stenosis</td>
</tr>
<tr>
<td>Aortic dissection</td>
<td>Acute aortic dissection</td>
</tr>
<tr>
<td>Myocarditis/pericarditis</td>
<td>Suspected or known acute myocarditis or pericarditis</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Resting SBP &gt;200 mmHg or resting DBP &gt;110 mmHg</td>
</tr>
<tr>
<td>Pulmonary embolus or infarction</td>
<td>Acute pulmonary embolus or pulmonary infarction</td>
</tr>
<tr>
<td>Metabolic diseases</td>
<td>Uncontrolled diabetes, thyrotoxicosis, or myxedema</td>
</tr>
<tr>
<td>Acute systemic infection</td>
<td>Accompanied by fever, body aches, or swollen lymph glands</td>
</tr>
<tr>
<td>Impaired cognitive function</td>
<td>Only if inability to understand risks associated with exercise and/or to express pain or distress presents a safety concern</td>
</tr>
<tr>
<td>Dysphasia</td>
<td>Inability to understand risks associated with exercise and/or to express pain or distress</td>
</tr>
<tr>
<td>Emotional distress/psychosis</td>
<td>Significant emotional distress</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Severe motion-induced dizziness/vertigo</td>
</tr>
<tr>
<td>Arthritis</td>
<td>Severe pain on weight bearing or exercise</td>
</tr>
<tr>
<td>Seizures</td>
<td>Uncontrolled seizure disorder</td>
</tr>
</tbody>
</table>
### Best Practice Recommendation 1.5

**When is an exercise stress test indicated in pre-participation screening for aerobic training after stroke or TIA?**

An exercise stress test should be an integral component of pre-participation screening for aerobic training after stroke or TIA. However, if the targeted intensity of the planned training program is light (e.g., <45% of predicted heart rate reserve) and the participant is without symptoms or a known history of cardiovascular disease and has a normal resting ECG, then an alternative clinically-based submaximal test may be an option.

<table>
<thead>
<tr>
<th>LOE: C (Expert opinion - use of a planned exercise intensity of 45% of predicted heart rate reserve as the threshold for requiring an exercise stress test has not been validated in people after stroke or TIA.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength of Recommendation: Weak*</td>
</tr>
</tbody>
</table>

* The majority of consensus panel members felt that concern about the current lack of evidence to support the recommendation outweighed considerations related to use of limited resources and practicality.

### Rationale

Exercise testing assists in the diagnosis of asymptomatic and symptomatic coronary artery disease, evaluation of cardiorespiratory fitness, and assessment of the safety of physical exertion. The results of testing can also provide objective data for interpretation of cardiopulmonary and hemodynamic responses to exercise and prescription of a safe, effective, and individualized aerobic exercise program. As such, a stress test can yield useful information for any person after stroke or TIA, regardless of the planned intensity of the exercise program since abnormal cardiovascular responses may occur even at low exercise intensities. However, mandating that a pre-participation stress test must be done in all cases could impose a significant clinical barrier to implementation of aerobic training programs that would be counterproductive to the goal of optimizing physical activity after stroke. The above recommendation of using the planned training intensity to determine the need for stress testing is based on the relationship between exercise intensity and risk of cardiovascular events: low intensity exercise has the lowest risk and high intensity exercise has the highest risk. An existing guideline states, "From a practical standpoint, it may not be possible, for a variety of reasons, for many stroke patients to perform an exercise test before they begin an exercise program. For patients for whom an exercise ECG is recommended but not performed, lighter-intensity exercise should be prescribed. The reduced exercise intensity may be compensated for by increasing the training frequency, duration, or both." However, care must be taken to ensure that low-intensity exercise is not prescribed simply to circumvent the need for an exercise stress test.

### System Implications

Timely access to exercise testing, when indicated.

### Performance Measures

- Percentage of patients who have been appropriately tested according to relevant clinical criteria.
- Time between exercise test requisition and actual scheduling of exercise test.

### Summary of the Evidence

The usefulness of exercise stress testing as a pre-participation screen has been well documented in the cardiac rehabilitation literature but not in the stroke literature. In a trial by Prior and colleagues (LOE: 4) involving people early after mild stroke or TIA, baseline peak exercise testing revealed ST...
Segment shifts of ≥1mm in 15 of 94 (16%) of participants and angina in 5 (5.3%). Patients with Duke Treadmill Scores (a measure of mortality based on total exercise capacity, ST shift, and the presence of non-limiting or limiting angina) of 2 (2%), 49 (52%), and 43 (46%) were categorized at high (≥5%), intermediate (1%), and low (0.25%) risk for a fatal cardiovascular event over the next year. In their “Call for action” paper, Piepoli and colleagues (LOE: 5) recommended that, prior to beginning physical activity, symptom-limited maximal exercise testing should be mandatory to assess exercise capacity and exercise-induced ischemia in patients with DM. However, given the high prevalence of DM in the stroke population (on the order of 25%) and the often limited availability of exercise testing, this recommendation may be unworkable in some clinical settings.

Alternatives to standardized stress tests as pre-participation screens for aerobic training post-stroke have not been investigated. Recommendation 1.5 suggests using planned exercise intensity to determine the threshold for stress testing for asymptomatic individuals after stroke or TIA. HRR (Box 1.5) is a valid indicator of exercise intensity because a certain percentage of HRR is the equivalent of the same percentage of the oxygen consumption reserve (%VO₂R, the difference between maximum oxygen consumption (VO₂max) and resting oxygen consumption). The minimum effective training intensity for very unfit individuals is 30% of VO₂R, which approximates 30% of HRR. Balady and colleagues classified low-intensity exercise as being <45% of HRR.

---

**Box 1.5 Calculation of heart rate reserve (HRR)**

Heart rate reserve is maximum heart rate (HRmax) minus resting heart rate (HRrest):

\[
HRR = HRmax - HRrest
\]

HRrest should be measured following a minimum of 5 minutes of quiet sitting (i.e., no movement or talking), either manually for 60 seconds or using a heart rate monitor.

HRmax is best obtained directly from a maximal exercise test. Alternatively, HRmax can be predicted using a formula. Traditionally, the formula HRmax(pred) = 220 – age has been used, but a more accurate estimation is obtained using the formula:

\[
HRmax(pred) = 206.9 - (0.67 \times \text{age})^{89}
\]

If the patient is on a beta-blocker, then the estimation of HRmax needs to be adjusted using the formula:

\[
HRmax(pred) = 164 - 0.7 \times \text{age}^{89}
\]

Target heart rate for aerobic training prescription is calculated using the Karvonen formula:

\[
HR = HRrest + (X \% \text{ of HRR})
\]

X is selected based on the planned exercise intensity: low intensity = <45%, moderate intensity = 45% - 60% and high intensity = >60%.
**Best Practice Recommendation 1.6**

**How should exercise testing, as a component of the pre-participation screen for aerobic training after stroke or TIA, be conducted?**

A peak effort symptom-limited protocol should be used whenever possible. The exercise test should be administered by appropriately trained and experienced health care professionals with direct access to physician support and an external defibrillator. The patient should be on usual medications, avoid any strenuous activity for 24 hours prior to testing, and avoid a heavy meal, caffeine, or nicotine within 3 hours of testing.

If low-intensity aerobic exercise (e.g., <45% of predicted heart rate reserve) is planned for a participant who is without symptoms or a known history of cardiovascular disease and has a normal resting ECG, a submaximal test that demonstrates the cardiopulmonary tolerance at the planned intensity of exercise testing, such as the Six Minute Walk Test or Shuttle Walk Test, may be an option.

**LOE: C (Expert opinion)**

**Strength of Recommendation: Strong**  
**Agreement among panelists: 80%**

**Rationale**

The type of exercise test used depends on several factors, including the targeted exercise intensity of aerobic training, availability of appropriate equipment and personnel, and the population to be tested. Regardless of the test used, the patient should become familiar with the equipment and testing protocol prior to performing the actual test.

**System Implications**

- Availability of equipment and trained personnel for exercise testing.
- Availability of emergency equipment (e.g., paging system, emergency medical cart, sugar source for individuals with DM) to ensure prompt medical response to adverse events during testing.
- Scheduling of safety and calibration check of equipment.

**Performance Measures**

- Percentage of people post-stroke who received an exercise stress test prior to participation in aerobic training programs involving intensities >45% HRR.
- Percentage of people post-stroke who received an alternative exercise test prior to participation in aerobic training programs involving intensities <45% HRR.

**Measurement Notes**

- Data from maximal exercise tests include peak heart rate, % predicted maximal heart rate, peak blood pressure, peak rating of perceived exertion, exercise time, presence and type of electrocardiogram (ECG) abnormalities.
- Data from submaximal exercise tests include heart rate, blood pressure, rating of perceived exertion at a fixed workload, presence and type of ECG abnormalities.

**Summary of the Evidence**

Ideally, exercise stress tests should be preceded by a 3-5 minute warm up at a metabolic rate about twice resting level (i.e., 2 metabolic equivalents (METS)) to prevent premature and excessive local muscle fatigue. Similarly, testing should be followed with a 3-5 minute cool down to support venous return to prevent pooling of blood in the peripheral vasculature and a subsequent drop in DBP. However, for very de-conditioned patients, a shorter warm up at a lower intensity may be indicated to avoid rapid onset of fatigue.
**Maximal exercise tests** are used to measure the limits of responding to the physiological stresses imposed by dynamic exercise. These tests are highly sensitive in diagnosing coronary artery disease in asymptomatic individuals.\(^{16}\) Because maximal testing requires patients to exercise until volitional fatigue, medical supervision is advised, particularly for high-risk individuals (symptomatic, or known cardiac, pulmonary, or metabolic disease).\(^{16}\) The optimal duration of a maximal exercise test is 8-12 minutes. The test should begin at low workloads, using small workload increments between progressive stages of the test (i.e., ramp or step protocol),\(^{91}\) alternatively, a discontinuous, progressive protocol (i.e., with rests between stages) can be used but is less common. The ACSM\(^{16}\) cautions that older individuals and individuals with mobility limitations or with chronic medical conditions may not be able to perform the vigorous-intensity exercise required for standard maximal exercise testing protocols. Further, there is evidence of increased mortality and cardiovascular event risk during exercise testing in these populations,\(^{16}\) although few adverse events and no deaths have been reported during testing of people post-stroke. For example, Ivey and colleagues\(^{68}\) reported that no serious adverse events occurred during >400 peak exercise tests in patients with hemiparetic stroke.

The definitive index of cardiovascular fitness, VO\(_2\)\(_{\text{max}}\)\(^{92}\) can be measured during maximal exercise testing, although more often in research than in clinical practice. Peak exercise intensity and total exercise time are not reliable indicators of maximal effort because they are dependent on the test protocol.\(^{93}\) Because a linear relationship exists between VO\(_2\) and heart rate, peak heart rate achieved during a maximal exercise test can be used to estimate VO\(_2\)\(_{\text{max}}\). However, while VO\(_2\) is relatively impervious to testing conditions, heart rate is markedly affected by various factors (e.g., anxiety, dehydration, changes in body temperature, exercise mode), thus limiting the accuracy of the estimation.\(^{94}\) In fact, discrepancies between VO\(_2\)\(_{\text{max}}\) estimated using heart rate data and measured VO\(_2\)\(_{\text{max}}\) in individuals with low exercise capacity can be as high as 25%.\(^{95}\)

The mode of testing (e.g., motor-driven treadmills, mechanically-braked cycle ergometers, stepping machines, arm crank, arm-leg ergometers) affects VO\(_2\)\(_{\text{peak}}\) values, with treadmill testing eliciting the greatest metabolic response. Cycle ergometer tests yield 90-95%\(^{96}\) and arm crank tests ~70% of VO\(_2\)\(_{\text{peak}}\) achieved using a treadmill test.\(^{94}\) Furthermore, arm cranking activates a smaller muscle mass than treadmill or cycle ergometry testing, thereby limiting the reduction in total peripheral resistance and increasing the blood pressure response. Maximal exercise tests that have been specifically adapted for the stroke population are outlined in **Box 1.6a**. Treadmills and cycle ergometers (mechanically and electronically braked cycle ergometers) are the most commonly used modes of maximal exercise testing.\(^{16}\) The ACSM\(^{16}\) advises against use of electronically braked cycle ergometers because they cannot be calibrated. For individuals post-stroke with moderate to severe balance impairments, a cycle ergometer modality may be more suitable than a treadmill.\(^{96,97}\) Also, cycle ergometry may provide more reliable blood pressure measurements and ECG recording because there is less arm and torso movement.\(^{96,97}\) The treadmill is a testing mode familiar to most individuals because the muscle activation closely resembles the mobility patterns utilized in everyday living.\(^{79}\) Also, unlike cycle ergometry, termination of treadmill exercise tests is less likely to be due to leg muscle fatigue.\(^{96}\) Nonetheless, treadmill exercise tests may pose a greater risk of patient injury than cycle ergometer modalities.\(^{96}\) In individuals with neuromuscular conditions, impaired motor and postural control may preclude the use of standard treadmill testing protocols. An alternative protocol uses a body weight support system to permit safe and valid exercise testing early after stroke.\(^{98}\)

**Submaximal exercise tests** (**Box 1.6b**) can be used for screening if low-intensity training is planned.\(^{16}\) Advantages of submaximal exercise tests over maximal tests include less expensive administration, lower physical exertion, and reduced risk of adverse events.\(^{99}\) The main goal of either single-stage or multistage submaximal exercise tests is to determine the heart rate response to submaximal work rates and predict VO\(_2\)\(_{\text{max}}\) by extrapolating the relationship between heart rate and VO\(_2\) to the age-predicted maximal heart rate.\(^{16}\) Testing protocols, such as the Åstrand-Ryhming Nomogram,\(^{100}\) estimate VO\(_2\)\(_{\text{max}}\) from heart rate measurements taken at a fixed work rate or test duration at a given power output on a
cycle ergometer or at a given grade and speed on a treadmill. However, these protocols have not been validated in the stroke population, and the accuracy of using heart rate to determine VO$_2$max is limited.$^{95}$

According to the ACSM,$^{16}$ maximal treadmill testing protocols can be applied to submaximal exercise testing, with termination of the test when the target percentage of predicted maximal heart rate has been attained. The ACSM$^{16}$ advises that the stages of the test should be at least three minutes to ensure that the patient achieves a steady-state heart rate at each stage. Submaximal exercise tests also include step tests and walking tests. Field tests consist of individuals or groups walking a predefined distance in a certain amount of time or a certain distance in a predefined time (e.g., 6MWT).$^{16}$ Limitations of such tests include the influence of motivation and functional ability on accuracy of the results and infrequent monitoring of heart rate and blood pressure.$^{16}$ In post-stroke exercise trials, the only submaximal test used other than cycle ergometry was the 6MWT.$^{101,102}$ One advantage of the 6MWT is that the participant tends to walk at a constant pace near their critical power; thus VO$_2$ is in a steady-state condition for most of the test. Further, predictive equations permit assessment of the distance covered relative to normative values.$^{103}$ However, within the stroke population, Eng and colleagues$^{101}$ found weak correlations between distance walked and VO$_2$peak, as well as between heart rate at the end of the 6MWT and VO$_2$peak. Tang et al.$^{102}$ reported similar results, leading them to conclude that, because the distance walked depends greatly on the ambulation status of the patient post-stroke, the 6MWT alone is not an adequate measure of aerobic fitness.

**Pharmacological stress tests** are reliable for detecting coronary artery disease in patients post-stroke, but they are expensive to conduct as initial screens for exercise training and may be inadequate to define the cardiovascular response to physical exertion.$^{104,105}$ Dobutamine stress echocardiography, a non-exercise-dependent stress modality, has been used to screen patients post-stroke for cardiac risks prior to participation in strengthening and physical conditioning.$^{17}$ Rokey and colleagues$^{106}$ reported that 58% of 50 patients after TIA or mild stroke subjected to treadmill testing with Thallium-201 scintigraphy and exercise radionuclide ventriculography had evidence of significant coronary artery disease, half of whom were without prior known history of cardiac disease. Using bicycle exercise Thallium-201 myocardial scintigraphy, Di Pasquale$^{107}$ found asymptomatic coronary artery disease in 6% in control subjects and 28% of 83 patients post TIA or mild stroke who lacked symptoms or ECG signs of coronary artery disease. In patients with known coronary artery disease, Piepoli and colleagues$^{108}$ recommend conducting a symptom-limited exercise stress test to assess exercise capacity and ischemia threshold before commencing regular physical activity.
<table>
<thead>
<tr>
<th><strong>Test</strong></th>
<th><strong>Description</strong></th>
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<tbody>
<tr>
<td>Semi-recumbent cycle ergometry</td>
<td><em>General description:</em> Symptom-limited maximal semi-recumbent cycle ergometry exercise test&lt;br&gt;<strong>Stroke population studied:</strong> Mean of 17.6 days post-stroke&lt;sup&gt;102&lt;/sup&gt;&lt;br&gt;<strong>Protocol:</strong> Ramp protocol included a 2-minute warm up at 10-Watts at a target cadence of 50 revolutions/min,&lt;sup&gt;108&lt;/sup&gt; followed by progressive 5-Watt increases in work rate every minute&lt;br&gt;<strong>Test-retest reliability:</strong> ICC = 0.50 for VO&lt;sub&gt;2&lt;/sub&gt;peak and 0.74 for peak heart rate&lt;br&gt;<strong>Validity:</strong> 9% of participants reached a peak heart rate within 10 beats per minute of the age-predicted maximal heart rate</td>
</tr>
<tr>
<td>Modified total-body reclining cycle ergometer</td>
<td><em>General description:</em> Symptom-limited maximal total-body recumbent stepper exercise test (mTBRS-XT)&lt;br&gt;<strong>Stroke population studied:</strong> Mean of 40 months post-stroke&lt;sup&gt;109&lt;/sup&gt;&lt;br&gt;<strong>Protocol:</strong> 2-minute stages at a stepping cadence of 80 steps/min, with an initial resistance of 25-Watts, which was increased at each stage until test termination&lt;br&gt;<strong>Test-retest reliability:</strong> ICC&lt;sub&gt;3,1&lt;/sub&gt; = 0.94 for VO&lt;sub&gt;2&lt;/sub&gt;peak, 0.93 for peak heart rate&lt;br&gt;<strong>Validity:</strong> Correlation between mTBRS-XT and cycle ergometry for VO&lt;sub&gt;2&lt;/sub&gt;peak, r = 0.91; peak heart rate, r = 0.89</td>
</tr>
<tr>
<td>Combined upper and lower limb ergometer</td>
<td><em>General description:</em> Symptom-limited maximal test using combined upper-and-lower limb ergometer&lt;br&gt;<strong>Stroke population studied:</strong> Mean of 7.3 weeks post-stroke&lt;sup&gt;110&lt;/sup&gt;&lt;br&gt;<strong>Protocol:</strong> 3-minute stages at a cycling cadence of 30-40 rpm with resistance increased at each stage until test termination (resistance applied was not reported)&lt;br&gt;<strong>Test-retest reliability:</strong> Not reported&lt;br&gt;<strong>Validity:</strong> 75%±11% of age-predicted maximal heart rate achieved using this protocol</td>
</tr>
<tr>
<td>Body-weight supported treadmill test</td>
<td><em>General description:</em> Symptom-limited maximal treadmill test&lt;br&gt;<strong>Stroke population studied:</strong> Mean of 26 days post-stroke&lt;sup&gt;56&lt;/sup&gt;&lt;br&gt;<strong>Protocol:</strong> 15% of body weight is supported during the test. 2-minute stages beginning with walking at self-selected speed and 0% treadmill grade for 2 minute, followed by a 2.5% increase in grade every 2 minute until an incline of 10% is reached and, thereafter, a .05m/s increase in speed every 2 minute, until test termination&lt;br&gt;<strong>Test-retest reliability:</strong> ICC&lt;sub&gt;3,1&lt;/sub&gt; = 0.94 for VO&lt;sub&gt;2&lt;/sub&gt;peak and ICC&lt;sub&gt;3,1&lt;/sub&gt; = 0.93 for peak heart rate&lt;br&gt;<strong>Validity:</strong> 86.4%±11% of age-predicted maximal heart rate achieved using this protocol</td>
</tr>
</tbody>
</table>

ICC = intraclass correlation coefficient
| Box 1.6b Modes of submaximal exercise testing used in exercise studies of patients post-stroke |
|---------------------------------|------------------------------------------------------------------------------------------|
| **Cycle ergometer test**        | *General description:* Submaximal cycle ergometer test                                   |
|                                 | *Health condition studied:* Mean of 3.5 years post-stroke                                 |
|                                 | *Protocol:* Submaximal VO\(_2\) measure was extracted as the VO\(_2\) corresponding to heart rate at 85% of age-predicted maximum |
|                                 | *Test-retest reliability:* ICC\(_{2,1}\) for VO\(_2\) = 0.93                            |
|                                 | *Validity:* Correlation between VO\(_2\) and VO\(_{2}\)peak, \(R = 0.80\)               |
| **Treadmill test**              | *General description:* Submaximal treadmill test                                          |
|                                 | *Health condition studied:* Mean of 3.5 years post-stroke                                 |
|                                 | *Protocol:* A 6-minute walk beginning at a comfortable, pre-selected speed (~60% of the self-selected over ground speed), bringing the subject to a plateau of ~85% of age-predicted heart rate maximum value of the maximal cycle ergometer test within the first 2 minutes. During the first minute, treadmill speed was increased 3 times (0.5km/hour every 20 seconds). In the second minute, speed remained constant while the ramp was elevated 3 times (2% grade every 20s). The speed and ramp were then held constant for the last 4 minutes. |
|                                 | *Test-retest reliability:* ICC\(_{2,1}\) for VO\(_2\) = 0.75                            |
|                                 | *Validity:* Correlation between VO\(_2\) and VO\(_{2}\)peak, \(R = 0.71\)                |
| **6-Minute Walk Test (6MWT)**   | *General description:* Submaximal walking test                                           |
|                                 | *Health condition studied:* Mean of 3.5 years post-stroke                                 |
|                                 | *Protocol:* Walking at self-selected speed for 6 minute, inclusive of rest intervals      |
|                                 | *Test-retest reliability:* ICC\(_{2,1}\) (for VO\(_2\)) = 0.96; ICC\(_{2,1}\) (for distance covered) = 0.99, ICC\(_{2,1}\) (for distance covered within a 7-day interval) = 0.99,ICC\(_{2,1}\) (for distance covered with a 7-day interval) = 0.99,ICC\(_{2,1}\) (for distance covered with a 7-day interval) = 0.99 |
|                                 | *Validity:* Correlation between 6MWT VO\(_2\) and VO\(_{2}\)peak, \(R = -0.66\); between 6MWT distance and VO\(_{2}\)peak, \(R = -0.37\); between heart rate at end of 6MWT and VO\(_{2}\)peak, \(R = -0.18\) |
|                                 | *Special notes:* Wu and colleagues\(^{112}\) suggested that in the rehabilitation setting a single 6MWT may be adequate, provided that modest learning effects are considered when interpreting the results. |

ICC = intraclass correlation coefficient; \(R\) = correlation coefficient
**Best Practice Recommendation 1.7**

*What should be monitored during a screening exercise stress test?*

Heart rate and electrical activity of the heart should be continuously monitored using electrocardiography during exercise stress testing. Blood pressure monitoring and rating of perceived exertion should be done intermittently throughout the test, often at each stage of an incremental exercise protocol. Monitoring should continue after termination of the test until baseline values are approximated.

**LOE: A** (The exercise stress testing protocols used in RCTs on aerobic exercise post-stroke involved monitoring of heart rate, blood pressure and RPE, consistent with standard practice.)

**Strength of Recommendation:** Strong  
**Agreement among panelists:** 100%

**Rationale**

Careful monitoring of the individual’s response to exercise testing is essential to ensure safety of the test, to determine when termination of the test is indicated, and to collect reliable and valid information to make clinical decisions about the planned interventions.

**System Implications**

Access to monitoring equipment (e.g., ECG, sphygmomanometer).

**Performance Measures**

Percentage of records with documentation of a plan for appropriate medical follow-up for individuals post-stroke with positive exercise tests.

**Measurement Notes**

Documentation of exercise testing outcomes with ECG printout or exercise testing flow sheet, with values recorded at each stage.

**Summary of the Evidence**

Regardless of the exercise testing protocol selected, monitoring of blood pressure, heart rate, ECG activity, and rating of perceived exertion should be done before, during, and after the exercise test. These data are used to identify test termination endpoints, determine baseline cardiovascular fitness levels, and identify supervision requirements for or contraindications to exercise training. Absolute and relative indications for terminating an exercise test are outlined in Box 1.5.

*Blood pressure measurements* can aid in determining termination endpoints and serve as a safety precaution during the exercise test. For example, a decrease in SBP or no increase in SBP during incremental exercise testing may indicate clinically significant myocardial ischemia, left ventricular dysfunction, or chronotropic insufficiency. During exercise, DBP should either remain relatively constant or decrease. The ACSM advises that BP should be measured in both a supine position and in an exercise posture before the exercise test. During the actual test, BP should be recorded during the last 45 seconds of each stage (interval protocol) or the last 45 seconds of each 2-minute period (ramp protocols) as well as immediately after the exercise test and then every 2 minutes thereafter until the readings approximate resting levels.

*Heart rate monitoring* can also be used to assess the level of voluntary effort during exercise testing and to determine when to terminate the test, particularly if the testing protocol includes a targeted percentage of predicted maximal heart rate (see Box 1.5).
Because many patients post-stroke are at risk for or have cardiovascular disease, the ACSM recommends *12-lead ECG monitoring* to ensure there are no acute changes or complications.\textsuperscript{75,114} The ACSM\textsuperscript{16} advises that ECG recordings should be taken before the exercise test with the patient in a supine position as well as an exercise posture. During testing, ECG should be recorded during the last 15 seconds of each stage (interval protocol) or the last 15 seconds of each 2-minute period (ramp protocols). ECG should also be recorded immediately after the exercise test, during the last 15 seconds of the first minute post-exercise and then every 2 minutes thereafter until the readings approximate resting levels. The ASCM\textsuperscript{16} cautions that people with AF are often taking digoxin, beta-blockers, or other anti-arrhythmic agents and have left bundle branch block and left ventricular hypertrophy, making ST-segment changes during exercise difficult to interpret.

*Rating of perceived exertion* (RPE) should be used to monitor the subjective effort expended during an exercise test.\textsuperscript{115}

### Box 1.7 Indications for terminating an exercise test\textsuperscript{16}

<table>
<thead>
<tr>
<th>Absolute Indications</th>
<th>Relative Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspicion of a myocardial infarction or acute myocardial infarction</td>
<td>Any chest pain that is increasing</td>
</tr>
<tr>
<td>Onset of moderate-to-severe angina</td>
<td>Physical or verbal manifestations of shortness of breath or severe fatigue</td>
</tr>
<tr>
<td>Drop in SBP below standing resting pressure or drop in SBP with increasing workload accompanied by signs or symptoms</td>
<td>Wheezing</td>
</tr>
<tr>
<td>Signs of poor perfusion, including pallor (pale appearance to the skin), cyanosis, or cold and clammy skin</td>
<td>Leg cramps or intermittent claudication (grade 3 on a 4-point scale)</td>
</tr>
<tr>
<td>Severe or unusual shortness of breath</td>
<td>Hypertensive response (SBP &gt;260 mm Hg; DBP&gt;115 mm Hg)</td>
</tr>
<tr>
<td>Central nervous system symptoms (e.g., ataxia, vertigo, visual or gait problems, confusion)</td>
<td>Pronounced ECG changes from baseline &gt;2 mm of horizontal or down sloping ST-segment depression, or &gt;2 mm of ST-segment elevation (except in aortic valve replacement)</td>
</tr>
<tr>
<td>Serious arrhythmias (e.g., second / third degree atrioventricular block, atrial fibrillation with fast ventricular response, increasing premature ventricular contractions, or sustained ventricular tachycardia)</td>
<td>Exercise-induced bundle branch block that cannot be distinguished from ventricular tachycardia</td>
</tr>
<tr>
<td>Technical inability to monitor the ECG</td>
<td>Less serious arrhythmias (abnormal heart rhythms) such as supraventricular tachycardia</td>
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<tr>
<td>Request by patient to stop</td>
<td></td>
</tr>
</tbody>
</table>
### SECTION 2. PRESCRIPTION OF AEROBIC EXERCISE INTERVENTIONS AFTER STROKE OR TIA

<table>
<thead>
<tr>
<th><strong>Best Practice Recommendation 2.1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How does aerobic training fit into the overall management of patients after stroke or TIA?</strong></td>
</tr>
<tr>
<td>Aerobic training should be incorporated into a comprehensive, inter-professional program of stroke rehabilitation, vascular risk reduction, and secondary stroke prevention. Aerobic training should be implemented as part of an overall exercise program that may also include, but is not limited to, muscle strengthening and task-oriented training of motor control, balance, gait, and functional use of the upper extremity. Physical activity designed to maintain cardiovascular fitness is an important aspect of community reintegration after stroke.</td>
</tr>
</tbody>
</table>

| **LOE:** C (Expert opinion. Although there is relatively strong evidence to support the efficacy of aerobic training to improve exercise capacity and function post-stroke, trials investigating the effectiveness of incorporating aerobic exercise into a comprehensive inter-professional framework are lacking.) |

| **Strength of Recommendation:** Strong | **Agreement among panelists:** 80% |

<table>
<thead>
<tr>
<th><strong>Rationale</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimization of recovery after stroke or TIA usually requires a comprehensive plan of complex interventions involving a number of health care providers. Aerobic training should be regarded as a core component of stroke care. However, rather than perceiving aerobic exercise as an isolated intervention, it is preferable to incorporate training into an overall program of physical activity. In some cases, the metabolic demands of standard rehabilitation activities (e.g., progressive task-oriented exercises and mobility training) may be of sufficient intensity to elicit an aerobic training effect. However, often exercise above and beyond the incidental physical activity accumulated in the course of structured formal rehabilitation or daily living is required. Thus, it is imperative that the intensity of exercise be monitored (see Recommendation 2.9) to ensure that an adequate intensity has actually been achieved.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th><strong>System Implications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Coordination of a comprehensive stroke management program that includes aerobic exercise interventions and is delivered by an inter-professional team.</td>
</tr>
<tr>
<td>• Provision of adequate time, personnel, and communication strategies to ensure that all aspects of stroke management, including aerobic exercise interventions, are implemented as required.</td>
</tr>
<tr>
<td>• Provision of equipment and facilities for aerobic exercise across the continuum of stroke care.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Performance Measures</strong></th>
</tr>
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<tbody>
<tr>
<td>• Percentage of documented intervention plans that include aerobic exercise as a component of a comprehensive plan.</td>
</tr>
<tr>
<td>• Exercise plan should document nature of proposed exercise, duration, intensity, plan for progression, goals, outcome measures, and periodic reassessment.</td>
</tr>
<tr>
<td>• Proportion of individuals who participate in aerobic exercise interventions during the course of recovery from stroke or TIA.</td>
</tr>
<tr>
<td>• Proportion of people post-stroke who continue to engage in physical activity after completion of formal rehabilitation.</td>
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</tbody>
</table>

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<thead>
<tr>
<th><strong>Measurement Notes</strong></th>
</tr>
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<tbody>
<tr>
<td>Performance measurement could include targeted data collection through audits of rehabilitation records and community program records.</td>
</tr>
</tbody>
</table>
Summary of the Evidence

There is evidence to suggest that patients post-stroke have not been challenged enough in standard rehabilitation to induce the metabolic stress needed to enhance their cardiovascular fitness.\textsuperscript{116,117} In a longitudinal study of stroke rehabilitation, investigators documented that the mean time per physiotherapy session spent in a given target heart rate zone was less than three minutes and per occupational therapy session was negligible.\textsuperscript{116} Moreover, monitoring of heart rate and blood pressure during therapy sessions was rarely observed.\textsuperscript{116}

A few training studies involving people post-stroke studied the combination of aerobic and strengthening exercise interventions.\textsuperscript{17,19,24,25} Strength training protocols were conducted at home\textsuperscript{18,24} or in the community\textsuperscript{19,25,118} using Theraband,\textsuperscript{17,18,24} body weight,\textsuperscript{17} free weights,\textsuperscript{17,25} and uncoupled resistive training machines,\textsuperscript{118} and training was conducted individually\textsuperscript{18,24} or in groups.\textsuperscript{19,25,119} Teixeira-Salmela and colleagues\textsuperscript{17} reported that the combination of physical conditioning and muscle strengthening improved training outcomes for patients in the chronic post-stroke period. However, Pang and Eng\textsuperscript{29} concluded that further investigation is needed to determine whether aerobic exercise plus strengthening exercise is more beneficial than aerobic exercise alone in improving aerobic capacity after stroke.
Best Practice Recommendation 2.2

Where should aerobic exercise interventions be conducted?

Aerobic exercise programs can be administered in a variety of barrier-free and accessible settings: hospital, outpatient clinics, community, and home. Training of high-risk individuals must be done in a setting with immediate access to external defibrillation and emergency medical response. For lower-risk individuals, supervised home-based aerobic exercise programs may be a safe and effective option.

LOE: C (Expert opinion - RCTs have demonstrated the efficacy of aerobic training post-stoke in a variety of settings, but the relative effectiveness of different settings has not been investigated.)

| Strength of Recommendation: Strong | Agreement among panelists: 80% |

Rationale

Determining the most appropriate and effective setting for aerobic exercise interventions post-stroke depends on many factors. In a set of clinical practice guidelines, Duncan and colleagues (LOE: B) recommended that the setting for overall stroke rehabilitation (i.e., not specific to aerobic training interventions) should be easily and safely accessible and based on medical status, functional status, social support, and access to care. The researchers also stated that a home setting might be restricted to higher-functioning patients due to the lack of available necessary equipment, including emergency medical equipment. The guidelines concluded that, regardless of the setting, the patient should be managed by a coordinated, experienced, and organized rehabilitation team.

System Implications

- Access to aerobic training interventions across that the continuum of care (from inpatient rehabilitation to home and community) to ensure that the correct intervention is available to the appropriate people in the proper setting.
- Barrier-free space for exercising with adequate temperature control and wheelchair access, if required, to facilitate access and ensure safety.
- Access to drinking water, a source of glucose (e.g., juice), and first aid equipment.
- Adverse event protocol for patients at high risk of further vascular events or falls.
- Availability of an automatic external defibrillator and emergency medical response for patients at high risk of further vascular events.

Performance Measures

Proportion of patients who have access to aerobic training interventions across the continuum of care (i.e., hospital, outpatient rehabilitation centers, home, and community).

Summary of the Evidence

The majority of post-stroke aerobic exercise training studies have been conducted in hospital settings, or in rehabilitation centers. The remaining were conducted in community settings or home environments. No adverse events attributable to the setting have been reported.
Best Practice Recommendation 2.3

Who should design and supervise the aerobic exercise intervention?

An aerobic exercise program for a person post-stroke should be designed by appropriately qualified health care professionals, such as physical therapists or cardiac rehabilitation specialists. The level of supervision is determined by the health care professional based on the individual participant’s health condition. High-risk individuals require constant supervision whereas low-risk individuals with demonstrated ability to exercise safely and effectively may require only intermittent supervision. Supervision may be provided by a qualified health care professional or an exercise instructor who has been trained by the health care professional. Progression of the exercise program should be monitored by the health professional.

LOE: C (Expert opinion - the recommendation is consistent with cardiac rehabilitation practices, but the relative effectiveness of involving different health care professionals in the design, monitoring, and supervision of post-stroke aerobic exercise programs has not been studied.)

Strength of Recommendation: Strong  
Agreement among panelists: 90%

Rationale

According to the ACSM Guidelines for Exercise Testing and Prescription, well-trained exercise/clinical professionals should supervise exercise programs for all individuals who are at high risk for cardiovascular disease or have a chronic disease or health condition. The Canadian Guidelines for Cardiac Rehabilitation and Cardiovascular Disease Prevention recommend that all health professionals involved in cardiac rehabilitation (in which aerobic exercise interventions are a principal component) should have emergency response capability (i.e., Basic Cardiac Life Support or higher). Rimmer et al. expressed concern that use of untrained personnel in community-based gyms may limit rehabilitation outcomes of stroke survivors because of safety concerns and the potential for compromising the quality of the program. Similarly, community-based stroke survivors were apprehensive about a perceived lack of safety associated with their fitness instructors’ low levels of knowledge about stroke and limited monitoring of participants while exercising. Nevertheless, Johansson underlined the importance of creating an environment that encourages stroke survivors to continue rehabilitation exercises and activities following completion of conventional rehabilitation. Exercise class instructors who were trained and supervised by health care professionals successfully conducted low-intensity exercise programs in community settings for older adults post-stroke.

Patients discharged to home should continue their program of aerobic exercise established during formal rehabilitation, with a level of supervision determined by the health professional.

System Implications

- Credentialing of health care providers supervising individuals post-stroke or TIA during aerobic exercise across the continuum of care to ensure acquisition of relevant knowledge (e.g., pathology and presenting signs and symptoms of stroke, stages/time course of stroke recovery, basic cardiovascular and exercise physiology/pathophysiology, common co-morbidities, vascular risk factor reduction) and skills (e.g., cardiovascular assessment, motivational/behavioral change techniques, exercise prescription and progression, emergency response procedures).

Performance Measures

Proportion of personnel involved in designing and supervising aerobic exercise programs who have the appropriate training and credentials.

Measurement Notes

Credential check of personnel supervising aerobic exercise programs.
Summary of the Evidence

Rimmer et al.\textsuperscript{122} noted a lack of research regarding the appropriate personnel to supervise aerobic training post-stroke. In the majority of training studies of people post-stroke, physical therapists supervised the exercise programs.\textsuperscript{17-20,22,24-26,30} Other personnel included occupational therapists,\textsuperscript{18} exercise physiologists,\textsuperscript{17,20} kinesiologists,\textsuperscript{25} nurses,\textsuperscript{30} gym instructors,\textsuperscript{19,60} student interns,\textsuperscript{20} research staff,\textsuperscript{21} and “assistants.”\textsuperscript{23} In the study by Stuart and colleagues,\textsuperscript{19} the gym instructors employed to conduct the exercise classes were trained by physical therapists and were selected based on their experience and ability to motivate the participants. As a safety measure and to ensure exercise protocols were being executed correctly, the physical therapists visited the facility at random times throughout the program.\textsuperscript{19}

A qualitative study exploring the perceptions of exercise among stroke survivors reported that most people in the focus group felt that exercise classes should be instructed by "professionals" with an understanding of the challenges and capabilities of people post-stroke in order to ensure safety and comfort, present necessary exercise information, and provide external motivation to exercise.\textsuperscript{124} Wiles et al.\textsuperscript{60} explored the views of physical therapists, patients, and fitness instructors on the appropriateness and acceptability of exercise programs conducted by fitness instructors in community gyms to which patients post-stroke were referred by physical therapists. The physical therapists expressed concern about safety due to the fitness instructors' lack of knowledge and experience in working with stroke populations.\textsuperscript{60} The authors identified a need for closer interaction with physical therapists and fitness instructors to ensure that the exercise programs are safe and meet the abilities and multi-faceted needs of stroke survivors.\textsuperscript{60}
**Best Practice Recommendation 2.4**

**What format (individual, group) should be used for aerobic training after stroke or TIA?**

Aerobic exercise interventions can be conducted in either an individual (one-on-one) or group format, with the ratio of participant to supervising personnel determined by the severity of the participant's neurological and cardiac status as well as the planned exercise intensity and mode of training.

**LOE: B** (Several RCTs have demonstrated effective application of aerobic exercise interventions after stroke using either an individual or group format. However, the LOE was downgraded due to a lack of stroke trials that directly compared individual and group formats.)

**Strength of Recommendation:** Strong  
**Agreement among panelists:** 90%

**Rationale**

Aerobic exercise for individuals who have had a minor stroke or TIA may be initiated using a group format. Individualized exercise programs may be indicated early in the recovery process for people with moderate to severe stroke to ensure safety and effectiveness by adapting the program according to the individual's presentation and by close monitoring of the individual's response to exercise. When the person is capable of more independent participation without the need for one-on-one monitoring, a group format (which is more cost effective) should be considered. Engagement in exercise may be facilitated by the social support that a group format offers.

**System Implications**

- Inpatient and outpatient rehabilitation settings adequately staffed to provide individualized aerobic exercise interventions.
- Community-based settings adequately staffed to provide group aerobic exercise interventions.
- Maximum number of participants in a class may be defined by building and fire code regulations.

**Performance Measures**

Ratio of participants to health professionals delivering the aerobic training sessions for individuals or groups of individuals with varying cardiopulmonary and neurologic deficit profiles.

**Measurement Notes**

Data gathering in regard to patient to personnel ratios requires an operations/administration audit.

**Summary of the Evidence**

Direct comparison of the effectiveness of aerobic training with individuals or groups of individuals post-stroke has not been done. The majority of the post-stroke aerobic exercise programs reviewed were performed individually by the participants. A qualitative study by Wiles described an individualized exercise program designed specifically for people post-stroke exercising in a public gym setting. The researchers observed limited interaction among participants because the exercise programs were so individualized.

All of the training studies that used a group format involved people in the chronic stages of post-stroke recovery. Two studies specified the group size: 9-13 participants per group in the trial by Stuart et al. and seven in the water-based study by Chu et al. A few studies specified the ratio of participants to instructors in the aerobic exercise programs. In the study by Wiles et al., the ratio of participants to fitness instructors during the gym sessions was 1:10. In the water-based trial, three instructors were required for every seven participants for the first week and only one instructor for the following seven weeks of the program. A 1:5 ratio of staff to participants was used in a recent trial of an adapted cardiac rehabilitation program for people with chronic stroke.
**Best Practice Recommendation 2.5**

**What mode of exercise should be used for aerobic training after stroke or TIA?**

A variety of exercise modes can be used to induce an aerobic training effect. Task-specific exercise that activates large muscle masses is recommended.

**LOE: B** (Several RCTs have demonstrated effective application of various modes of aerobic exercise interventions after stroke. However, the LOE was downgraded due to lack of stroke trials that directly compared different modes.)

<table>
<thead>
<tr>
<th>Strength of Recommendation: Strong</th>
<th>Agreement among panelists: 90%</th>
</tr>
</thead>
</table>

**Rationale**

Because of the variability in stroke severity, selecting an appropriate training modality can be challenging. Ivey and colleagues\(^{126}\) suggested that the mode of training be based on post-stroke impairments, fitness levels, stroke severity, time since stroke, and exercise prescription protocols. Selection of exercise mode is also influenced by the presence of arthritis, obesity, seizure history, or dementia. The ACSM\(^{75}\) suggests the use of upper- and lower-body ergometers, cycle ergometers, treadmills, arm ergometers, and seated steppers as training modalities for aerobic conditioning post-stroke. Water-based training may be indicated for people post-stroke who are morbidly obese or have severe arthritic conditions. Given the task specificity of motor learning and motor skill reacquisition, the exercise modality should be aligned with the participant’s functional goals, if feasible (e.g., treadmill training, with or without body-weight support, would be an appropriate modality if improved ambulatory status was a principal goal).

**System Implications**

Access across the continuum of care to exercise equipment, certified for patient use, for the safe and effective delivery of aerobic exercise interventions for individuals at various levels of functional mobility and motor control.

**Performance Measures**

- Adequate supply of certified aerobic exercise equipment.
- Percentage of participants who received appropriate exercise modalities.
- Equipment maintenance schedules with checklists and documentation of calibration and repairs.

**Measurement Notes**

Equipment inventory should be part of the audit process.

**Summary of the Evidence**

Although the relative effectiveness of aerobic exercise modalities has not been directly investigated in the stroke population,\(^{122}\) modes commonly used with non-disabled people have been proven to be capable of eliciting a training effect in people post-stroke. The majority of exercise studies reviewed used either treadmill training\(^{13,22,23,28,32,33,41,43}\) or cycle ergometry.\(^{17,18,20-22,24,26,36,42,45,61}\) Other studies employed stair machines,\(^{22}\) steppers,\(^{17,20,25}\) walking circuits,\(^{19,25}\) and water-based exercises.\(^{27}\)

**Treadmill training**

Gordon and colleagues\(^{79}\) reported three advantages of treadmill training for stroke survivors: (i) involvement of locomotor training that can be applied to daily tasks such as walking; (ii) adjustment of exercise intensity by increasing or decreasing the treadmill grade without altering treadmill speed, (iii) inclusion of exercise participants with varying levels of ambulatory function by incorporating body weight support devices. A disadvantage of treadmill training is that constant supervision is often
required. Preliminary evidence supports the effectiveness of body weight-support treadmill training post-stroke.\textsuperscript{23,32,41} Demonstrated benefits of treadmill training for the people in the chronic post-stroke period include improved physiologic fitness reserve by increasing VO\textsubscript{2}peak and decreasing energy expenditure,\textsuperscript{28,41,43} increased peak ambulatory workload capacity,\textsuperscript{28,41,43} enhanced functional mobility,\textsuperscript{41,43} improved glucose tolerance,\textsuperscript{13} and reduced insulin resistance.\textsuperscript{13}

\textit{Cycle ergometry}

As with body-weight supported treadmill walking, cycle ergometry can be used by a wide range of patients because it accommodates non-ambulatory stroke survivors.\textsuperscript{21} Cycle ergometry provides trunk stability and support for those with poor postural control, making it advantageous for patients in the early stages of recovery after stroke.\textsuperscript{21,61} Post-stroke training studies using cycle ergometry have demonstrated improved aerobic capacity\textsuperscript{21,26} and functional mobility.\textsuperscript{21,24,56,45} Cycle ergometry has been reported to be a safe modality for people less than three months post-stroke.\textsuperscript{21}
**Best Practice Recommendation 2.6**

**Over what period of time should the aerobic training sessions be conducted?**

A minimum of 8 weeks of aerobic exercise is recommended to achieve a clinically meaningful training effect. However, physical activity should be sustained indefinitely to ensure maintenance of health benefits.

**LOE:** B (Several RCTs have demonstrated effective application of aerobic exercise interventions after stroke of >8 weeks duration. However, the LOE was downgraded due to lack of stroke trials that directly compared different program durations.)

**Strength of Recommendation:** Strong

**Agreement among panelists:** 100%

**Rationale**

The minimum length of time to make the long-term physiological and behavioral adaptations to exercise for improved cardiorespiratory fitness varies from person to person. In general, a period of eight weeks of aerobic exercise is considered the minimum time needed for these adaptive responses to occur. However, it has long been recognized that benefits of training decline significantly without ongoing participation in physical activity. Consequently, a fundamental objective of a structured exercise program is to elicit changes in participants' attitudes and behaviors regarding habitual physical activity. The ultimate goal is to engage patients in long-term physical activity as part of their daily lives.

**System Implications**

Access to aerobic exercise programs of at least eight weeks in duration.

**Performance Measures**

Percentage of participants who completed an aerobic exercise program of adequate duration.

**Measurement Notes**

Data gathering regarding duration of aerobic exercise sessions requires a chart review or consistent use of reliable workload measurement tools.

**Summary of the Evidence**

Although the most effective duration of formal aerobic training programs for patients post-stroke remains to be determined, the available literature suggests a minimum of eight weeks is required. A wide range of program durations was found in the training studies reviewed: 2 weeks, 8 weeks, 10 weeks, 12 weeks, and 6 months. In an overview of exercise studies, Ivey et al. noted that program durations ranging from eight weeks to six months were sufficient to improve cardiorespiratory fitness and function in stroke survivors. Further, because a plateau in VO2peak gains was not achieved over a 6-month period and fitness gains were evenly distributed over the initial and final three month periods, the authors postulated that program durations longer than six months may produce even more benefits.

Data are lacking regarding the sustainability of exercise benefits after stroke. However, based on literature from sport medicine, the exercise-mediated cardiopulmonary and metabolic gains are lost after 4 to 6 weeks of detraining. Thus, sustained engagement in regular aerobic exercise or physical activity is needed to maintain long-term health benefits.
**Best Practice Recommendation 2.7**

**How frequently should aerobic exercise interventions be conducted after stroke or TIA?**

Although physical activity should be done “most days of the week” for general health, structured aerobic exercise should be conducted a minimum of 3 days/week. On the other days of the week, participants are encouraged to engage in lighter forms of physical activity.

**LOE:** B (Several RCTs have demonstrated effective application of post-stroke aerobic exercise interventions conducted ≥3 days/week, which is consistent with the evidence from other adult populations. However, the LOE was downgraded due to lack of stroke trials that directly compared different frequencies of exercise sessions.)

**Strength of Recommendation:** Strong  
**Agreement among panelists:** 90%

**Rationale**

Although recommendations vary, participation in aerobic exercise most days of the week is advised to maintain or improve cardiorespiratory fitness. The ACSM endorsed engaging individuals post-stroke in aerobic exercise 3-5 days/week, whereas Gordon and colleagues recommended 3-7 days/week. In a meta-analysis of nine post-stroke training studies, Pang et al. reported that the frequencies of exercise sessions were consistent with the ACSM recommendations of 3-5 days/week. Evidence is emerging of the benefits of supplementing an exercise program with non-structured physical activity on non-exercise days. Thus, for optimal gains in cardiorespiratory fitness, lighter physical activity, such as brisk walking, should be encouraged on days when the person is not participating in structured aerobic exercise sessions. Benefits derived from aerobic training are dose dependent, with dose determined by the interaction of frequency, duration, and intensity (Box 2.7). It is the total volume of exercise that is important for attaining and maintaining cardiorespiratory fitness; various combinations of frequency, duration, and intensity of aerobic exercise may be used in stroke rehabilitation to achieve the same endpoint.

**System Implications**

Access to aerobic exercise interventions at least three times per week.

**Performance Measures**

Percentage of participants who completed an aerobic exercise program of adequate frequency.

**Measurement Notes**

Data gathering regarding frequency of aerobic exercise sessions requires a performance audit, a chart review, or consistent use of reliable workload measurement tools.

**Summary of the Evidence**

Optimal frequency of aerobic training to improve health and function has not been determined specifically for the stroke population. In the post-stroke exercise studies reviewed, 3 days/week was the most commonly used frequency, with frequencies in other studies ranging from 2 days/week to 6 days/week.
### Box 2.7 Interaction of frequency, duration, and intensity of aerobic exercise sessions

Frequency of aerobic training sessions cannot be determined without taking into account session and intensity — the total **volume** of exercise is important. The interaction of intensity, duration, and frequency is illustrated in this diagram.

1. **A.** Basic model, with equal frequency, intensity, and duration of exercise;
2. **B.** Protocol using greater intensity, with shorter duration and less frequency of exercise;
3. **C.** Protocol with greater duration and less frequency and intensity;
4. **D.** Protocol with greater frequency, shorter duration, and less intensity.
## Best Practice Recommendation 2.8

**How long should each aerobic exercise session be?**

Aerobic exercise sessions of >20 minutes are recommended, depending on exercise frequency and intensity. In addition, warm-up and cool-down periods of 3-5 minutes are advised. A gradual progression in the duration may be required, starting with bouts of 5 minutes or less, alternating intervals of rest or lower-intensity exercise, as needed.

**LOE: B** (Several RCTs have demonstrated effective application of aerobic exercise sessions of >20 minutes for the stroke population, in keeping with exercise guidelines for other adult populations. However, the LOE was downgraded due to lack of stroke trials that directly compared different durations of exercise sessions.)

<table>
<thead>
<tr>
<th>Strength of Recommendation: Strong</th>
<th>Agreement among panelists: 80%</th>
</tr>
</thead>
</table>

**Rationale**

It is generally accepted that most individuals can achieve their fitness goals by exercising >20 minutes, excluding warm up and cool down; thus 26-30 minutes is required (i.e., 3-5 minutes of warm up and 3-5 minutes of cool down). For very deconditioned individuals, exercise may be delivered in “bouts” of five minutes or less, with rest periods or lower-intensity activity between bouts.

**System Implications**

Access to aerobic exercise sessions of ≥20 minutes in duration.

**Performance Measures**

Percentage of participants who completed an aerobic exercise program of adequate duration.

**Measurement Notes**

Data gathering regarding duration of aerobic exercise sessions requires a performance audit, chart review or consistent use of reliable workload measurement tools.

**Summary of the Evidence**

As with exercise frequency, evidence on duration of aerobic exercise sessions specifically for the stroke population is lacking.122 For cardiac populations, the ACSM16 recommends discontinuous bouts of mobilization of 3-5 minutes for inpatient cardiac rehabilitation and 20-60 minutes of continuous or intermittent aerobic activity per session for outpatient programs. Interval training — high-intensity exercise interspersed with light-intensity recovery periods — is increasingly being used as an alternative to traditional continuous aerobic training, but its use among the stroke population has not been investigated. The Cochrane Review by Saunders et al.131 reported that exercise durations greater than 20 minutes were sufficient to achieve benefits for stroke survivors. The ACSM75 recommends 20 to 60 minute sessions or bouts of 10 minutes for patients post-stroke, and Gordon and colleagues79 advocate for session durations of 30 minutes. Short bouts of aerobic exercise may be better tolerated by stroke survivors who are severely deconditioned or have substantial motor impairments.43

In the post-stroke training studies reviewed, duration of aerobic training sessions ranged from 10-20 minutes, 30 minutes, 40 minutes, and 60 minutes.22,25,27 Studies have also progressed the session duration over time to achieve a total time of 15-60 minutes of aerobic exercise by the end of the intervention period.18,20,23,43,45,68 In a training study by Macko et al.,43 the initial session duration involved 2-3 minutes of treadmill walking for those participants unable to walk continuously for long periods of time, progressing by five minutes every other week to achieve a total of 45 minutes by the third month of training.
### Best Practice Recommendation 2.9

**What intensity of aerobic exercise should be used?**

Intensity of aerobic exercise must be determined on an individual basis, depending on response to the exercise stress test, health status (neurologic status, cardiac, and other co-morbidities), and planned exercise frequency and duration. Frequent heart rate monitoring and periodic blood pressure monitoring are recommended for safety and assurance that exercise is being performed at the planned intensity. Surrogate markers of intensity, such as rating of perceived exertion (RPE), should be used, particularly when the linear relationship between cardiopulmonary exertion and heart rate is compromised by medication or autonomic dysregulation.

**Low-intensity exercise:** <45% of HRR or RPE_0-10_ of <4 or RPE_4-20_ of <10

**Moderate-intensity exercise:** 45-60% of HRR or RPE_0-10_ of 4-5 or RPE_6-20_ of 11-13

**High-intensity exercise:** >60% of HRR or RPE_0-10_ of 6 or RPE_6-20_ of >14

Exercise intensity should be progressed as tolerated by the participant.

**LOE:** B (Several RCTs have demonstrated safe and effective application of aerobic exercise interventions using intensities consistent with those recommended above. However, the LOE was downgraded due to lack of stroke trials that directly compared different intensities of exercise sessions.)

| Strength of Recommendation: Strong | Agreement among panelists: 80% |

**Rationale**

Intensity of exercise is of foremost concern in exercise prescription because it dictates the level of metabolic stress to which a participant is exposed, safeguards against adverse responses to inappropriately stressful exercise, and is the most critical factor in ensuring an adequate dosage to elicit a training effect. In general, higher intensities elicit greater improvements in cardiopulmonary fitness and insulin sensitivity and greater reductions in vascular risk factors. However, the safety and feasibility of attaining a particular training zone needs to be taken into account when determining an appropriate exercise intensity for an individual post-stroke. In addition, the interactions of intensity with frequency and duration of aerobic training are important to consider. As with any exercise intervention, gradual progression of intensity is a fundamental component of a safe and effective program.

**System Implications**

- Education of health professionals involved in aerobic exercise interventions for individuals post-stroke regarding prescription of exercise intensity.
- Access to equipment to monitor heart rate and blood pressure during aerobic exercise (heart rate monitors, sphygmomanometers).

**Performance Measures**

- Percentage of individuals involved in aerobic exercise that have exercise intensity appropriately established, monitored, and progressed.
- Frequency of adverse events.

**Measurement Notes**

- Data gathering regarding intensity of aerobic exercise sessions requires a performance audit or chart review.
Summary of the Evidence

The most effective and safest intensity of aerobic exercise for stroke survivors has not been established. For cardiac populations, the ACSM recommends intensities of (i) 40% to 80% of HRR, (ii) RPE of 11-15 or RPE of 4-6, or (iii) heart rate below the determined ischemic threshold for the participant. However, a meta-analysis concluded that, for very unfit individuals, intensities as low as 30% of HRR can induce a cardiovascular training effect.

Heart rate is typically used to establish and monitor training intensities. Care must be taken to establish an accurate resting pulse by measuring heart rate following a minimum of five minutes of quiet sitting (i.e., no movement or talking). β-blocker medication depresses the heart’s response to exercise, posing challenges when prescribing exercise intensity based on predicted rather than measured heart rate-dependent parameters. Also, because of the chronically irregular ventricular rate in the presence of atrial fibrillation, age-predicted maximal heart rates are not valid for people with this arrhythmia.

RPE is a recognized proxy measure of exercise intensity. However, given the substantial interindividual variability in psycho-physiological relations, the target RPE should be set for each individual and for each specific training mode. Pictorial versions of RPE are usual for people with aphasia (Box 2.9a). Other proxy measures are available but have not been validated in the stroke population. The Talk Test indicates that the patient should be able to talk while exercising, but if the patient can sing, the intensity should be increased, and if they cannot talk, the intensity should be decreased. Foster and colleagues confirmed that the exercise intensity at the ventilatory threshold coincided with the last intensity at which a subject could comfortably speak. Relationships among RPE, Talk Test, and physiological measures of intensity are outlined in Box 2.9a. It is important to note that these relationships are based primarily on data from studies involving non-disabled individuals; validation of the relationships in special populations, including stroke, has not been done.

A recently introduced proxy measure is the Count Talk Test, which measures how high a person at rest can count aloud without taking a second breath, starting with "one, one-thousand; two, one thousand…" The percentage of the resting count during exercise has been found to be strongly correlated with percentage of HRR, VO2 reserve, and RPE. A Count Talk Test result of 50% was found to be strongly correlated with percentage of HRR corresponding to moderate-intensity exercise.

The intensity of an aerobic training program depends on baseline fitness level, neurologic and cardiac status, presence of co-morbidities, and goals of the program. Various recommendations have been made regarding the appropriate intensity for people post-stroke. Sacco et al. recommended "moderate training intensities," whereas Gordon et al. recommended intensities of 40-70% of VO2peak or HRR, 50-80% of maximal HR, or an RPE of 11-14. Intensities in the range of 50-80% of the maximal HR have been found to improve aerobic capacity when combined with appropriate frequency and duration.

Several post-stroke training studies used exercise intensities consistent with the ACSM-recommended levels. Teixeira-Salmela et al. trained individuals in the chronic post-stroke period for 10 weeks using graded walking plus stepping or cycling at a target HR of 70% of the maximal HR attained from the baseline exercise test. The 6-month treadmill training protocol used by Macko et al. and Ivey et al. consisted of gradually progressing exercise intensity from an initial level of 40-50% of HRR for 10-20 minutes to a target aerobic intensity of 60-70% of HRR for 40 minutes. In a 14-week exercise trial by Rimmer and colleagues, a “moderate-intensity, shorter-duration” group initiated their 30-minute sessions at 40% of HRR and progressed the intensity by 10% every 4 weeks, whereas a “low-intensity, longer-duration” group maintained an intensity of <50% of HRR and increased exercise time from 30-45 to 60 minutes in 4-week increments. Dose-dependent effects on blood pressure and total cholesterol were noted, with better results attained in the moderate intensity, shorter duration group than in the low intensity, longer duration group. Other investigators used more arbitrary indicators of exercise intensity, including cycle ergometer work rate, patient preference, exercise duration, supervising therapist’s determination, and peak power output from maximal exercise test.
**Box 2.9a Pictorial versions of RPE**

<table>
<thead>
<tr>
<th>OMNI-Walk/Run RPE scale</th>
<th>OMNI-Cycle RPE scale</th>
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<tbody>
<tr>
<td><img src="image" alt="Pictorial versions of RPE" /></td>
<td><img src="image" alt="Pictorial versions of RPE" /></td>
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</table>

**Box 2.9b Approximate relationships among indicators of exercise intensity based on data from studies involving non-disabled individuals. Adapted from 16.**

<table>
<thead>
<tr>
<th>Exercise Intensity</th>
<th>Clinical Indicators of Exercise Intensity</th>
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<tbody>
<tr>
<td><strong>Description</strong></td>
<td><strong>%HRR</strong></td>
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<tr>
<td>Very Light</td>
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<td>Light</td>
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### Best Practice Recommendation 2.10

**What clinical outcome measures should be used to monitor the effect of aerobic exercise interventions?**

Outcomes that reflect patient-oriented goals of aerobic exercise interventions should be measured periodically to monitor change over time, progress the intervention, or transition to other interventions or physical activities. Measures to consider include assessments of cardiovascular health (e.g., blood pressure, blood lipids, fasting plasma glucose, waist circumference, medication adherence, tobacco use), cardiovascular endurance/functional capacity (e.g., 6-Minute Walk Test, Shuttle Walk Test, heart rate at a fixed submaximal workload, daily step counts) and other health domains (e.g., mobility, goal attainment, emotional wellbeing, quality of sleep, and quality of life).

**LOE:** B (Several post-stroke exercise trials have demonstrated effective application of a broad range of outcome measures. However, the LOE was downgraded because the optimal set of outcome measures has not been ascertained.)

**Strength of Recommendation:** Strong    **Agreement among panelists:** 90%

**Rationale**

Given that the potential benefits of aerobic exercise interventions are numerous (see Box 1.1), outcome assessment should be aligned with anticipated outcomes. The most likely benefits are usually those most closely associated with the intervention provided; in the case of aerobic interventions, these benefits include improved exercise capacity, fatigue levels, and vascular risk profile. Possible benefits more remotely associated with the intervention include improved mobility, cognition, emotional wellbeing, sleep quality, and quality of life.

**System Implications**

- Education/training of health professionals regarding appropriate outcome assessment procedures and documentation.
- Access to equipment for assessment and documentation.

**Performance Measures**

- Percentage of standardized stroke rehabilitation assessments that incorporate outcome assessment related to aerobic exercise interventions.
- Percentage of individuals engaged in aerobic exercise after stroke or TIA for whom outcome assessment related to aerobic exercise interventions has been administered.

**Measurement Notes**

Data gathering regarding outcome assessments requires a chart review.

**Summary of the Evidence**

Evidence related to submaximal tests of cardiovascular endurance is discussed under Recommendation 1.5. A recent meta-analysis concluded that accelerometers yield valid and reliable data regarding the physical activity of patients post-stroke.137
### Best Practice Recommendation 2.11

**What are strategies to overcome barriers to participant engagement in aerobic training after stroke or TIA?**

A participant-focused approach, endorsed by all relevant health care providers, should be used to encourage sustained involvement in aerobic exercise interventions. A planned and gradual transition from participation in a structured clinical program of aerobic exercise to less structured, more self-directed engagement in physical activity at home or in the community may facilitate the lifestyle changes needed for long-term commitment. Multiple strategies to deal with specific barriers related to health care providers, the environment, and participants are recommended.

<table>
<thead>
<tr>
<th>LOE: B (Evidence is emerging from recent RCTs of strategies to engage people post-stroke in aerobic exercise.)</th>
</tr>
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</table>

**Strength of Recommendation: Strong**  
**Agreement among panelists: 100%**

**Rationale**

Evidence supporting the benefits of aerobic exercise post-stroke on cardiovascular and functional health is increasing, and, at the same time, interventions to facilitate achievement of these benefits are emerging. On the other hand, preliminary evidence suggests that these benefits are not sustained in the long term because participants either stop participating in such programs or decrease their level of engagement.

Evidence-informed strategies, such as Motivational Interviewing, that are consistent with theories of behavioral change (e.g., Transtheoretical Model, Social Cognitive Theory, Theory of Reasoned Action, Theory of Planned Behavior, Health Belief Model, Protection Motivation Theory, Self-Determination Theory) may serve as useful frameworks for development of new approaches to aerobic exercise interventions that facilitate long-term engagement. Ultimately, the exercise program must be tailored to the level of impairment and social and environmental situation of the stroke survivor.

**System Implications**

- Education of health professionals regarding theories of behavioral change and motivational strategies.
- Support for transportation, well-maintained facilities, and equipment.

**Performance Measures**

Percentage of individuals who sustain participation in prescribed aerobic exercise interventions.

**Measurement Notes**

Data gathering regarding participant engagement via follow-up surveys.

**Summary of the Evidence**

Qualitative studies examining participation of stroke survivors in exercise programs have identified **self-efficacy** (i.e., belief that one has control over change in a particular behaviour such as exercising) as an important psychological factor predicting engagement. Investigations involving people with various disabilities assessed interventions such as counseling and information, behavioral techniques, social support and education, and motivational counseling through videotapes. However, the extent to which these interventions are applicable to the stroke population is not known. Morris and Williams noted that many individual characteristics (e.g., age, gender, level of disability), social and cultural factors (e.g., social norms), and environmental features (e.g., access to facilities, travel) influence the level of engagement in exercise and physical activity in populations of mixed disabilities. This variability confounds identification of effective participation strategies, particularly with reference to the unique features of the stroke population.
Numerous psychological, cognitive, and emotional factors known to influence engagement in physical activity (e.g., self-efficacy, attitude, competence, intention, knowledge of health and exercise benefits, motivation, readiness to change, and the value of exercise benefits) have been explored in non-stroke populations. According to Bandura's social cognitive theory, core determinants of behaviour change include self-efficacy, knowledge of lifestyle habits, outcome expectations (expected benefits versus costs of performing a particular behaviour), goal setting and strategies for goal attainment, and perceived facilitators and barriers to goal attainment.

One study involving people post-stroke reported self-efficacy as an important psychological factor predicting participants' engagement in physical activity. Garner and Page exposed community-based chronic stroke survivors to a theoretically-based intervention using the Transtheoretical Model, which consists of five stages of change (i.e., pre-contemplation, contemplation, preparation, action, and maintenance), with change mediated in each stage by self-efficacy, decisional balance, and processes of change. Gillham and Endacott used a stroke-specific score based on the Transtheoretical Model to assess readiness to change behaviors in a secondary stroke prevention program. The program consisted of conventional rehabilitation plus additional advice, motivational interviewing, and telephone support. Participants showed improved exercise frequency and increased consumption of fruits and vegetables compared to the control group, who received conventional rehabilitation. Readiness to change behavior did not reach statistical significance, although more patients in the intervention group progressed from the contemplation to action stage of change.

Jurkiewicz and colleagues (LOE=4) found that the level of adherence to aerobic training after stroke was inversely correlated with the age of the participant. After termination of involvement in a formal exercise group, adherence with training declined, due, in part, to lack of motivation, fatigue, and musculoskeletal issues. An American survey of 83 people who were more than six months post-stroke identified cost of the exercise program as the most commonly perceived barrier to exercise (LOE=4). Other frequently cited barriers included lack of awareness of a fitness center, lack of transportation to a fitness center, lack of knowledge of how to exercise, and lack of knowledge of where to exercise.
| Box 2.11 Barriers to participant engagement in aerobic training after stroke or TIA |
|--------------------------------|---------------------------------|---------------------------------|
| **Category** | **Specific Barriers** | **Strategies to Overcome Barriers** |
| Health providers | Lack of belief in role/benefits of exercise | • Continuing professional education  
| | Lack of knowledge of theories of behavioral change and motivational strategies | • Professional education  
| | Lack of qualified and enthusiastic health professional staff | • Professional/continuing professional education  
| | | • Support of health care administrators  |
| Environment | Inadequate administrator support | • Education of health care decision makers  |
| | Lack of availability of exercise testing | • Share resources with cardiac rehabilitation personnel  |
| | Lack of continuity of programs across the continuum of care | • Communication among providers at each transition in the health care continuum  
| | | • Government policies to support for community-based physical activity programs  |
| | Lack of social support for participant to attend | • Buddy system  
| | | • Education of families and caregivers  
| | | • Regular and convenient scheduling of program  |
| | Lack of employer support for participant to attend | • Education of employers  
| | | • Encouragement of flex time and exercise facilities at workplace  
| | | • Government incentives for employers  |
| | Lack of availability of nearby facilities (i.e., within a 30-minute radius) | • Polyvascular management (e.g., combining stroke and cardiac rehabilitation)  
| | | • Use of existing community and clinical facilities  |
| | Lack of funding for programs | • Government policies to provide funding to cover facility/program fees (particularly low-income families)  
| | | • Development of low-cost options such as community-based walking programs  |
| | Lack of transportation | • Government policies for accessible transportation  
| | | • Car pooling  
| | | • Volunteer drivers  |
| Participants | Reduced self-efficacy (i.e., external locus of control, feeling of a lack of autonomy) | • Telephone reminders regarding exercising  
| | | • Buddy or mentor system  
| | | • Patient-oriented goal setting  |
| | Lack of readiness to participate | • Assessment of state of readiness  
| | | • Program tailored to different stages of readiness  |
| | Lack of belief in role/benefits of exercise (e.g., sedentary premorbid lifestyle, cultural beliefs) | • Patient education  
| | | • Self-monitoring of exercise progress (e.g., health passports, exercise logs, step counters)  
| | | • Monitoring and discussion of beneficial effects of exercise (e.g., reduced blood pressure, decreased blood glucose, reduced fatigability)  |
| | Inability to communicate (expressive aphasia) | • Provision of aphasia-friendly educational material  |
| | Depression and anxiety | • Screening for depression and anxiety  
| | | • Referral system  |
| | Fear of exercise (e.g., falling, second stroke) | • Education, choice of exercise modes  |
| | Excessive fatigue | • Gradual progression of exercise intensity  |
| | Lack of enjoyment of exercise | • Group programs with emphasis on socialization  
| | | • Variety in program to reduce boredom  
| | | • Use of age-appropriate music  
| | | • Hydration and refreshments during and after exercising  
| | | • Incorporation of physical activity into daily routine (e.g., walking, stair climbing, active leisure, recreation)  |
REFERENCES


86. Swain DP, Leutholtz BC. Heart rate reserve is equivalent to %VO2Reserve, not to %VO2max. Medicine and science in sports and exercise 1997;29:410-4.


Appendix: Parmed-X

**PARmed-X PHYSICAL ACTIVITY READINESS MEDICAL EXAMINATION**

The PARmed-X is a physical activity-specific checklist to be used by a physician with patients who have had positive responses to the Physical Activity Readiness Questionnaire (PAR-Q). In addition, the Conveyance/Referral Form in the PARmed-X can be used to convey clearance for physical activity participation, or to make a referral to a medically-supervised exercise program.

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. The PAR-Q by itself provides adequate screening for the majority of people. However, some individuals may require a medical evaluation and specific advice (exercise prescription) due to one or more positive responses to the PAR-Q.

Following the participant’s evaluation by a physician, a physical activity plan should be devised in consultation with a physical activity professional (CSEP-Certified Personal Trainer™ or CSEP-Certified Exercise Physiologist™). To assist in this, the following instructions are provided:

**PAGE 1:**
- Sections A, B, C, and D should be completed by the participant BEFORE the examination by the physician. The bottom section is to be completed by the examining physician.

**PAGES 2 & 3:**
- A checklist of medical conditions requiring special consideration and management.

**PAGE 4:**
- Physical Activity & Lifestyle Advice for people who do not require specific instructions or prescribed exercise.
- Physical Activity Readiness Conveyance/Referral Form - an optional tear-off tab for the physician to convey clearance for physical activity participation, or to make a referral to a medically-supervised exercise program.

<table>
<thead>
<tr>
<th>This section to be completed by the participant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
</tr>
<tr>
<td>PERSONAL INFORMATION:</td>
</tr>
<tr>
<td>NAME</td>
</tr>
<tr>
<td>ADDRESS</td>
</tr>
<tr>
<td>TELEPHONE</td>
</tr>
<tr>
<td>BIRTHDATE</td>
</tr>
<tr>
<td>GENDER</td>
</tr>
<tr>
<td>MEDICAL No.</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

| **C**  | **D**  |
| RISK FACTORS FOR CARDIOVASCULAR DISEASE: | PHYSICAL ACTIVITY INTENTIONS: |
| Check all that apply | What physical activity do you intend to do? |
| □ Less than 30 minutes of moderate physical activity most days of the week. | |
| □ Currently smoker (tobacco smoking 1 or more times per week). | |
| □ High blood pressure reported by physician after repeated measurements. | |
| □ High cholesterol level reported by physician. | |
| □ Excessive accumulation of fat around waist. | |
| □ Family history of heart disease. | |

**Please note:** Many of these risk factors are modifiable. Please refer to page 4 and discuss with your physician.

<table>
<thead>
<tr>
<th>This section to be completed by the examining physician</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Exam:</strong></td>
</tr>
<tr>
<td>HT</td>
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</tr>
</tbody>
</table>

| Conditions limiting physical activity: |
| Cardiovascular | Respiratory | Other |
| Musculoskeletal | Abdominal |

| Tests required: |
| ECG | Exercise Test | X-Ray |
| Blood | Urinalysis | Other |

**Physical Activity Readiness Conveyance/Referral:**
Based upon a current review of health status, I recommend:
- □ No physical activity
- □ Only a medically-supervised exercise program until further medical clearance
- □ Progressive physical activity:
  - with avoidance of: |
  - with inclusion of: |
- □ under the supervision of a CSEP-Certified Exercise Physiologist™
- □ Unrestricted physical activity—start slowly and build up gradually

Further Information:
- □ To be forwarded
- □ Available on request

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Supported by: Canadian Society for Exercise Physiology
Following is a checklist of medical conditions for which a degree of precaution and/or special advice should be considered for those who answered "YES" to one or more questions on the PAR-Q, and people over the age of 69. Conditions are grouped by system. Three categories of precautions are provided. Comments under Advice are general, since details and alternatives require clinical judgement in each individual instance.

<table>
<thead>
<tr>
<th>Absolute Contraindications</th>
<th>Relative Contraindications</th>
<th>Special Prescriptive Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent restriction or temporary restriction until condition is treated stable, and/or past acute phase</td>
<td>Highly variable. Value of exercise testing and/or program may exceed risk. Activity may be restricted. Desirable to maximize control of condition. Direct or indirect medical supervision of exercise program may be desirable</td>
<td>Individualized prescriptive advice generally appropriate: • limitations imposed; and/or • special exercises prescribed. May require medical monitoring and/or initial supervision in exercise program.</td>
</tr>
</tbody>
</table>

**Cardiovascular**
- aortic aneurysm (dissecting)
- aortic stenosis (severe)
- congestive heart failure
- crescendo angina
- myocardial infarction (acute)
- myocarditis (active or recent)
- pulmonary or systemic embolism—acute
- proarrhythmias
- ventricular tachycardia and other dangerous dysrhythmias (e.g., multifocal ventricular activity)

**Infections**
- acute infectious disease (regardless of etiology)
- subacute/chronic/recurrent infectious diseases, (e.g., malaria, others)

**Metabolic**
- uncontrolled metabolic disorders (diabetes mellitus, thyrotoxicosis, myxedema)
- renal, hepatic & other metabolic insufficiency

**Pregnancy**
- complicated pregnancy (e.g., toxemia, twin pregnancy, incompetent cervix, etc.)
- advanced pregnancy (late 3rd trimester)

**ADVICE**
- clinical exercise test may be warranted in selected cases, for specific determination of functional capacity and limitations and precautions (if any).
- dose progression of exercise to levels based on test performance and individual tolerance.
- consider individual need for initial conditioning program and/or medical supervision (indirect or direct).
- intermittent claudication
- hypertension: systolic 160-180; diastolic 100+ progressive exercise; care with medications (serum electrolytes; post-exercise syncope; etc.)

**References**

The PAR-Q and PARmed-X were developed by the British Columbia Ministry of Health. They have been revised by an Expert Advisory Committee of the Canadian Society for Exercise Physiology chaired by Dr. N. Gledhill (2002).

No changes permitted. You are encouraged to photocopy the PARmed-X, but only if you use the entire form.

Disponible en français sous le titre «Évaluation médicale de l'aptitude à l'activité physique (X-AAP)»

Continued on page 3...
<table>
<thead>
<tr>
<th>Conditions</th>
<th>ADVICE</th>
</tr>
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</table>
| Lung      | 1. chronic pulmonary disorders - special attention and breathing exercises  
           | 2. obstructive lung disease - breath control during endurance exercises to tolerance  
           | 3. asthma - avoid public exercise to avoid extreme cold conditions, warm up adequately, utilize appropriate medication  
| Musculoskeletal | 1. low back conditions (pathological, functional) - avoid or minimize exercise that precipitates or exacerbates e.g., forced extreme flexion, extension, and violent twisting; correct posture, proper back exercises  
|          | 2. arthritis—acute (infective, rheumatoid) - joint flares, treatment plus judicious blend of rest, stretching, and gentle movement  
|          | 3. arthritis—osteoarthritis and above - progression of active exercise therapy  
|          | 4. arthritis—chronic (osteoarthritis and above) - maintenance of mobility and strength; non-weight-bearing exercises to minimize joint trauma (e.g., cycling, aquatic activity, etc.)  
|          | 5. hernia - minimize straining and isometrics; strengthen abdominal muscles  
|          | 6. osteoporosis/low bone density - avoid exercise with high risk for fracture such as push-ups, curl-ups, vertical jump and trunk forward flexion; engage in low-impact weight-bearing activities and resistance training  
| CNS      | 1. convulsive disorder not completely controlled by medication - minimize or avoid exercise in hazardous environments and/or exercising alone (e.g., swimming, mountain climbing, etc.)  
|          | 2. recent concussion - thorough examination if history of two concussions; review for discontinuation of contact sport if three concussions, depending on duration of unconsciousness, retrograde amnesia, persistent headaches, and other objective evidence of central nervous system damage  
| Blood    | 1. anemia—severe (< 10 g/dL) - control preferred; exercise as tolerated  
|          | 2. electrolyte disturbances - moderate program  
| Medications | 1. anginal - antihypertensive  
|          | 2. antihypertensive - angiotensin-converting enzyme inhibitors  
|          | 3. beta-blockers - digitalis preparations  
|          | 4. diuretics - ganglionic blockers  
| Other    | 1. post-exercise syncope - moderate program  
|          | 2. heat intolerance - prescribe cool-down with light activities; avoid exercise in extreme heat  
|          | 3. temporary minor illness - postpone until recovered  
|          | 4. cancer - if potential metastases, test by cycle aromatase; consider non-weight-bearing exercises; exercise at lower end of prescriptive range (40-65% of heart rate reserve); depending on condition and recent treatment (radiation, chemotherapy, mastectomy, and lymphocyte counts; odd dynamic lifting exercise to strengthen muscles, using machines rather than weights.)  

*Refer to special publications for elaboration as required*
PARmed-X PHYSICAL ACTIVITY READINESS MEDICAL EXAMINATION

Physical activity improves health.

Every little bit counts, but more is even better——everyone can do it!

Get active any way — build physical activity into your daily life.
- at home
- at school
- at work
- at play
- on the way
- that’s active living!

Choosing a variety of activities from these three groups:

- Endurance
  - 4 days a week
  - Moderate activity
  - for your age, fitness, and medical history

- Flexibility
  - Always maintain a well-balanced program

- Strength
  - Incorporate 2 days a week

Regular exercise increases bone density and improves function.

The benefits of regular activity are well documented.

For a copy of the Guide to Active Living 1 800 334 9799 or www.parmed-x.com

Aerobics Best Practice Recommendations

Get Active Your Way, Every Day—For Life!

Aerobics best practices include a minimum of physical activity every day to improve function or maintain your health. As you progress to moderate activities, you can add to 30 minutes, 5 days a week. Adding your exercise is gradual, at least 10 minutes each. Start slowly and build up.

Time needed depends on effort

You Can Do It — Getting started is easier than you think.

Physical activity doesn’t have to be very hard. Mild physical activities are your daily routine.

- walk where you can — get off the bus, walk on the main instead of the element.
- read, or doing something fun.
- take your dog for a walk.
- do some general cleaning.
- do some general cleaning.
- do some general cleaning.

Tips for accomplishing your daily routine.
- Plan out meals and activities in advance.
- Don’t plan on doing too much.
- Start and build up pace and intensity.
- Schedule a time for your exercise.
- Make it a part of your daily routine.

Benefits of regular activity:
- Increases bone density and improves function.
- Increases muscle strength and endurance.
- Increases stamina and endurance.
- Reduces risk of heart disease.
- Reduces risk of diabetes.
- Reduces risk of stroke.
- Reduces risk of cancer.
- Improves mental health.
- Improves overall well-being.

Health risks of inactivity:
- Increases risk of heart disease.
- Increases risk of diabetes.
- Increases risk of stroke.
- Increases risk of cancer.
- Increases risk of obesity.
- Increases risk of depression.
- Increases risk of anxiety.

PARmed-X Physical Activity Readiness Conveyance/Referral Form

Based upon a current review of the health status of _______________ I recommend:

- No physical activity
- Only a medically-supervised exercise program until further medical clearance
- Progressive physical activity
  - with avoidance of:
  - with inclusion of:
  - under the supervision of a CSEP-Certified Exercise Physiologist™
- Unrestricted physical activity — start slowly and build up gradually

______________________________________
M.D.

__________
(date)

Further Information:
- Attached
- To be forwarded
- Available or request

Physician/clinic stamp:

NOTE: This physical activity clearance is valid for a maximum of six months from the date it is completed and becomes invalid if your medical condition becomes worse.

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