PROPEL: PRomoting Optimal Physical Exercise for Life*
Submaximal Graded Exercise Assessment
Guidelines

*PROPEL: PRomoting Optimal Physical Exercise for Life, Toronto Rehabilitation Institute–UHN, University of Toronto 2005, Revised 16 June 2018

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I. Foreword

Users of this assessment, for those with stroke, should review the Aerobic Exercise Recommendations to Optimize Best Practices in Care after Stroke (AEROBICS) prior to proceeding.
http://strokebestpractices.ca/wp-content/uploads/2013/07/AEROBICS-FINAL-July-2013.pdf

AEROBICS Best Practice Recommendation 1.5.
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.
Level of Evidence: C (Expert opinion)

Excerpt from AEROBICS Recommendation 1.5 Rationale:
Exercise testing assists in the diagnosis of asymptomatic and symptomatic coronary artery disease, evaluation of cardiorespiratory fitness, and assessment of 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 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 [ACSM 2010]. 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" [Gordon et al, 2004]. However, care must be taken to ensure that low-intensity exercise is not prescribed simply to circumvent the need for an exercise stress test.

- MacKay-Lyons, M, Macko R, Eng J, et al. Aerobic Exercise Recommendations to Optimize Best Practices in Care after Stroke (AEROBICS) http://strokebestpractices.ca/wp-content/uploads/2013/07/AEROBICS-FINAL-July-2013.pdf
- American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription. 8th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2010
- Gordon NF, Gulanick M, Costa F, et al. Physical activity and exercise recommendations for stroke survivors. An American Heart Association Scientific Statement from the Council on Clinical Cardiology, Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention; the Council on Cardiovascular Nursing; the Council on Nutrition, Physical Activity, and Metabolism; and the Stroke Council. *Circulation* 2004;109:2031-41

II. Disclaimer

The PROPEL Submaximal Graded Exercise Assessment guidelines are currently used within the Brain and Spinal Cord Rehabilitation program of Toronto Rehabilitation Institute – University Health Network (UHN). The information within the guidelines has been developed by clinical experience and consensus of local experts, best practices and research. Choices reflected in these guidelines do not preclude the possibility of other approaches or practices also being valid and relevant. Clinicians must also consider their own clinical judgment, patient preferences, and contextual factors such as resource availability in their decision-making processes about implementation of these assessment guidelines. Moreover, healthcare professionals must at all times respect the legal and normative regulations of the regulatory bodies, in particular with regards to scopes of practice and restricted/protected activities, as these may differ provincially. Toronto Rehabilitation Institute-UHN or any of the developers of this exercise test, contributors, and supporting partners shall not be liable for any damages, claims, liabilities, costs, or obligations arising from the use or misuse of this material, including loss or damage arising from any claims made by a third party

III. Submaximal Graded Exercise Assessment Guidelines

Overview

The protocol consists of two to four 3-minute stages at increasing work rates, appropriate for the client. (A 3-minute stage should allow the heart rate (HR) and rate of perceived exertion (RPE) to rise and then level off. It is possible that for some unfit clients, the HR & RPE may continue to rise without increasing the workload. When the HR exceeds 110, a steady state must be reached before workload is increased.)

STOP EXERCISE TEST (and proceed to cool-down) when *any* of following thresholds are met:

- HR reaches/exceeds outer limits of test (see calculations within Appendix 1), OR
- RPE reaches 5/10 ('heavy' or 'strong') of Borg category-ratio scale OR
- Cadence cannot be maintained e.g. decrease >10 spm after 1 warning

STOP ADDITIONAL INDICATIONS TO STOP TEST:

- Patient requests to stop and/or physical manifestations of severe fatigue
- Signs of poor perfusion (e.g. light headedness, confusion, ataxia, pallor, cyanosis, cold clammy skin, etc)
- Drop in systolic BP by 10 mm Hg or a failure to rise with an increase in exercise intensity
- Excessive rise in BP* (Absolute: 210 mmHg systolic or 105 mmHg diastolic; if diabetic then 100 mmHg diastolic but see also below*)
- Failure of HR to increase or drop in HR with increased exercise intensity
- Patient requests to stop and/or physical manifestations of severe fatigue
- Signs of poor perfusion e.g. light headedness, confusion, ataxia, pallor, cyanosis, cold clammy skin, etc
- Onset of angina-like symptoms
- Abnormal or severe shortness of breath
- Failure of test equipment

*Usual clinical practice would be to use more conservative BP cut-off values than outlined above. Moreover conservative BP cut-off values (e.g. 160/90 or 140/90) could be recommended for some diagnoses (including but not limited to individuals with hemorrhagic stroke or hemorrhagic transformations, carotid or vertebral stenosis, dissections, +/- stents, carotid endarterectomies).

STOP DO NOT PROCEED WITH TEST, consult with physician, if:

- resting HR is outside 60-100 bpm;
- BP >160/100 or greater than patient-specific cut-off values**
- blood glucose levels are <5.6 or >13.9 mmol/l

Resting BP	Action
SBP<140 DBP <90 SBP 140-160 DBP 90 -100 SBP 160-180 DBP 100 -110 SBP>180 DBP>110	*OK to exercise* *Maybe OK to exercise but monitor closely*** *Do not exercise, check first with physician* *Do not exercise. Alert physician immediately*
** More conservative BP restrictions may be warranted for some patients/diagnoses e.g. haemorrhagic stroke, carotid or vertebral dissections +/- stent procedures, diabetes with risk factors. Consult physician.	

CAUTION: If a patient has an abnormal resting ECG, significant cardiovascular disease or multiple risk factors then an ECG-monitored exercise test (submaximal or full cardiopulmonary exercise stress test) may be warranted.

Administration of submaximal graded exercise test

1. Outline rationale, risks and benefits, protocol and test endpoints of *submaximal* exercise assessment and obtain informed consent from patient as per usual practice. Explain that the client should work at a comfortable level throughout the test with regards to both intensity & duration, and also that the test can be stopped at any time.
2. Describe use of Borg RPE (0-10) scale to the client.
   Explain that *"While exercising, we want you to rate your perception of exertion or overall effort. This feeling should reflect how heavy or strenuous the exercise feels to you. Do not concern yourself with any one factor, such as leg effort or breathing, but combine all sensations and feelings of physical stress, effort, and fatigue for a total feeling of exertion. Try not to over- or under-estimate your feeling of exertion; be as honest and accurate as possible. We will use this rating scale; it ranges from 1 to 10, where 1 means no exertion or " nothing at all" and 10 means that the exercise if "very very heavy" or your "maximal exertion or effort." Throughout the exercise, I will ask you to choose the number from this scale that best describes your level of exertion."* Review RPE descriptors with patient. Ask patient to provide you with resting value to ensure understanding.
3. Adjust seat position. There should be a slight bend in the knee at maximal leg extension. Legs only are used on the recumbent stepper.
4. Obtain resting values after patient has sat quietly for a few minutes. Complete chart for heart rate outer limits of the test (see Appendix 1) and for resting values. (See also 'Do not Proceed with Test' guidelines above). It is recommended that a HR monitor be used to allow for continuous monitoring. If required, HR monitor values can be verified by chest auscultation.
5. Warm up for 2 minutes at very low resistance (level 0) in order to acquaint the client with the recumbent stepper (or cycle ergometer) and explain that the aim is to have the client keep at a steady step rate or cadence for the duration of the entire test. The client should select a very comfortable rate which could be maintained even as resistance is increased (e.g. 60-100 spm with stepper OR 50-60 rpms for cycle ergometer). Record the warm-up readings.
6. Workload is set according to the patient's leg strength and fitness level. As an example, if using a recumbent stepper, the workload at Stage 1 could be between level 1 or 2 and could be increased by 1 or 2 levels at each successive stage. As an example, if using a cycle ergometer, the workload at Stage 1 could be between 15-40 watts and could be increased by 15-20 watts at each successive stage.
7. Take the RPE and heart rate twice at each stage, (near the end of the 2nd and 3rd minutes of each stage e.g. at 1:45 and 2:45 for the first stage). If the heart rate is greater than 110 bpm, a steady-state heart rate (i.e. two readings of heart rates within 6 bpm) should be reached before the work load is increased. If not steady, maintain that work load for an additional minute or as long as necessary.
8. Blood pressure is measured in the latter portion of each stage (e.g. over the course of the 3rd minute of each stage). Client appearance, symptoms and overall response to exercise are monitored continuously.

9. Stop the test and proceed to cool-down when HR outer limits of test are reached (see Appendix 1) OR RPE outer limits of test are reached OR if cadence cannot be maintained. Stop the test if patient symptoms or response to exercise would indicate you should terminate the test (see above 'Additional indications to stop…').
10. Cool-down/recovery period consists of continued stepping/pedalling at a negligible work rate as per the warm-up. Observations patient RPE and patient physiologic responses, e.g. heart rate and blood pressure, should be measured every 2 minutes until HR and BP stabilize at lower values, but not necessarily until they reach pre-exercise levels.
11. Complete on back of form reason for discontinuing the test.

Appendix 1. Determining HR outer limits of test

Toronto Rehabilitation Institute – UHN submaximal aerobic capacity test has historically used Option 1 method (percentage of age-predicted maximal heart rate i.e. HRmax(pred)) for determining heart rate (HR) outer limits of test. Within this method, the planned threshold for intensity is: 70% HRmax(pred), or; 60% HRmax(pred) for patients who are on beta blockers, or are diabetic with multiple risk factors, or patients for whom therapists feel lower intensity is warranted.

AEROBICS guidelines suggest use of Option 2 method (heart rate reserve i.e. HRR), recommending that the planned exercise intensity should not exceed 45% of HRR.

We therefore currently use both methods and compare. Clinical judgment is warranted as to whether you use the more conservative cut-off, consider the average, or range of values between the two methods. However, do not exceed 45% HRR thresholds as per AEROBICs recommendations.

(NOTE: test is discontinued *prior* to achieving the HR outer limits if: RPE of 5 is reached; cadence cannot be maintained, or; any other patient symptoms or response to exercise would suggest that the test should be stopped)

OPTION 1 (use 60-70% of age predicted max HR):

1. **Determine age-predicted maximal HR:**
   - HRmax(pred)= (206.9 - (0.67XAge)=_____bpm
2. **Determine HR Outer Limits as percentage of HRmax(pred) :**
   - ☐ **70%** HRmax(pred) _____bpm **OR**
   - ☐ **60%** HRmax(pred) _____bpm (if on beta blockers or diabetic with multiple risk factors or patients for whom therapists feel lower intensity is warranted)

OPTION 2 (use 45% Heart Rate Reserve):

1a. **Determine age-predicted maximal HR:**
   - HRmax(pred)= 206.9 - (0.67XAge)=_____bpm OR

1b. **Determine age-predicted maximal HR adjusted for those on Beta Blockers:**
   - HRmax(pred) *w* Beta Blocker = 164 - (0.7XAge)_____bpm
2. **Determine Heart Rate Reserve (HRR):**
   - **HRR** = HRmax(pred) – HRrest = _____bpm
3. **Determine HR Outer Limits using 45% of HRR:**
   - HRrest**+(.45 of HRR**) = _____bpm

(see next page for case examples)

Case Example A: 73 year old male with stroke, *not on Beta Blockers*, with resting HR of 71.

OPTION 1 (using 60-70% of age predicted max HR):

1. **Determine age-predicted maximal HR:**
   - **HRmax(pred)=** 206.9 - (0.67XAge)=_____bpm
   - **HRmax(pred) =** 206.9 - (0.67X 73) = 206.9 - 49= 158 bpm
2. **Determine HR Outer Limits as percentage of HRmax(pred) :**
   - ☐ **70%** HRmax(pred) = 110 bpm

OPTION 2 (use 45% Heart Rate Reserve):

1a. **Determine age-predicted maximal HR:**
   - HRmax(pred)= 206.9 - (0.67XAge)=_____bpm
   - HRmax(pred) = 206.9 - (0.67X 73) = 206.9 - 49= 158 bpm
2. **Determine Heart Rate Reserve (HRR):**
   - **HRR** = HRmax(pred) – HRrest = _____bpm
   - **HRR =** 158 – 71 **=** 87 bpm
3. **Determine HR Outer Limits using 45% of HRR:**
   - HRrest**+(.45 of HRR**) = _____bpm
   - 71+39 = 110 bpm

➢ HR Outer Limits for Case Example A could be either Option 1 or Option 2. In this case example, they are both the same; therefore, the HR outer limits for Case Example A would be 110 bpm.

Case Example B: 73 year old male with stroke, *on Beta Blockers*, with resting HR of 71.

OPTION 1 (using 60-70% of age predicted max HR):

3. **Determine age-predicted maximal HR:**
   - HRmax(pred)= 206.9 - (0.67XAge=_____bpm
   - HRmax(pred) **=** 206.9 - (0.67X 73) = 206.9 - 49= 158 bpm
4. **Determine HR Outer Limits as percentage of HRmax(pred) :**
   - ☐ **60%** HRmax(pred) = 95 bpm

OPTION 2 (use 45% Heart Rate Reserve):

1a. **Determine age-predicted maximal HR:**
   - HRmax(pred) *w* Beta Blocker = 164 - (0.7XAge)_____bpm
   - HRmax(pred) *w* Beta Blocker = 164 - (0.7X73) = 113 bpm
2. **Determine Heart Rate Reserve (HRR):**
   - **HRR** = HRmax(pred) – HRrest = _____bpm
   - **HRR =** 113 – 71 **=** 42 bpm
3. **Determine HR Outer Limits using 45% of HRR:**
   - HRrest**+(.45 of HRR**) = _____bpm
   - 71+19 = 90 bpm

➢ HR Outer Limits for Case Example B could be either Option 1 (i.e. 95 bpm) or Option 2 (i.e. 90 bpm). In this case example, Option 2 HR Outer Limits may be chosen so as not to exceed the 45% HRR threshold; therefore, the HR outer limits for Case Example B would be 90 bpm.