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## Exercise Testing and Prescription

### Assessing Functional Capacity in Practical Settings: The Value of Submaximal Cycle Ergometer, Step and Shuttle Walking Tests in Cardiovascular Prevention and Rehabilitation Programmes

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#### Rationale for Exercise Testing

In relation to cardiovascular disease (CVD), the role of exercise testing has mainly focused on it being part of diagnosing coronary heart disease (CHD). However, with a diagnostic average sensitivity and specificity of less than 70%, and with a variety of emerging non-invasive, more sensitive and specific arterial imaging techniques plus increased referral rates straight to angiography, its not surprising the National Institute for Clinical Excellence (NICE)<sup>1</sup> in the

UK has now removed exercise treadmill testing as part of CHD diagnosis. It is however hoped that the value of the other four roles of exercise testing are not over-shadowed by such a recommendation. These other roles of exercise testing include: prognosis prediction, risk stratification, programme outcome measures, exercise prescription, and physical activity guidance.

*“The question continually needs to be asked of clinicians that for the purposes of prognosis, risk stratification, programme outcome measures, and exercise prescription/physical activity guidance, what are the actual advantages (clinically and practically) for maximal exercise testing compared to submaximal exercise testing?”*

This article aims to explore the value of more practical means of assessing functional capacity, especially knowing that the opportunity for full maximal testing is likely to decline in the future and is increasingly not available in many settings (community programmes and home programmes). This certainly does not mean that we should be lowering the quality and standards for health and exercise professionals carrying out the testing – if anything we should be training more people to be highly knowledgeable and experienced in exercise testing, independent of the mode or testing protocol used. Practical tests can include treadmill and shuttle walking, cycle ergometry, and step tests.

#### History of Tests

Historically the use of submaximal exercise tests has been to estimate maximal oxygen uptake ( $VO_{2max}$ ). This dates back, at least, to the 1940s with the Harvard step test for estimating fitness in large swathes of army

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# From the Editor

## Lea Carlyle, MA

This issue of the CICRP covers a variety of topics related to exercise and exercise testing. Within the articles you'll read about the history of the graded exercise test (GXT), current practice in the use of the GXT, psychological factors affecting exercise adherence, as well as recommendations for adventure seeking cardiac patients. We are fortunate to have perspectives on these topics from the United Kingdom and Australia in keeping with our international theme.

An increase in the number of referrals and admissions to cardiac rehabilitation (CR) has prompted programs to look at factors affecting their wait times. One of these factors has been the GXT. Some programs test all patients entering CR while others use an algorithm to determine who needs a GXT. Some programs, however, do not have access to a GXT at all and use other means of assessing functional capacity. Our Feature articles, by Dr. James Stone and Dr. John Buckley and Jenni Jones, as well as our Program Profile, by Jennifer Harris and colleagues, will discuss these issues in detail and provide food for thought on the past, present and future of exercise testing.

Cardiac patients entering CR can be complex. They not only present with their heart condition, but often times depression and anxiety which can affect adherence to health behaviour changes. Dr. Peter Prior and colleagues provide an excellent clinical example how depression can present serious self-management challenges and how the CR exercise professional can help cardiac patients with depression.

The References and Reviews have been submitted by our most recent addition to our editorial team, Danielle Rolfe. She includes a review on the impact of anxiety disorders on the assessment of myocardial ischemia and exercise stress test performance, treadmill versus arm ergometry, and interval training for patients with coronary artery disease.

We are trying a new format for our Case Study this

issue. We have put together a scenario and had two different programs submit their responses with their recommendations. The scenario includes a patient with an implanted cardioverter defibrillator who would like to return to high intensity and adventure activities. Paula Candlish from the Heart Failure Service in Australia and Christine Foisy and Sue Fisher from the Northern Alberta Cardiac Rehabilitation Program in Edmonton have provided their insight. Together, the two programs provide a comprehensive response to this Case Study.

The Program Profile is a submission by Jennifer Harris and Marja-Leena Keast. They describe the University of Ottawa Heart Institute's program experience of not stress testing all patients that come into their program and how a triage tool is used to ensure specific patient needs are met and that a systematic approach to stress testing is applied.

In the national Office News, Marilyn Thomas includes details of the upcoming CACR Annual Meeting and Symposium in Vancouver. We hope that many of you will be able to attend and celebrate the 20th Anniversary of CACR with us!

I would like to take this opportunity to thank all the authors for contributing their articles and to those authors that continually contribute to the CICRP. We would not be able to do this without you and we appreciate the time you take to write for us.

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recruits.<sup>2</sup> In the 1950s Astrand and Rhymining designed predictive nomograms for cycle ergometry and box stepping.<sup>3</sup> In the 1970s McGavin<sup>4</sup> adapted Cooper's 12 minute run test<sup>5</sup> into a 12 minute walk test for pulmonary disease patients, which was later shown by Butland et al.<sup>6</sup> to be just as valid if performed over six minutes; the birth of the 6-minute walk test (6MWT). In 1985 Guyatt et al.<sup>7</sup> validated the 6MWT for use with heart failure patients. Another key highlight of this study by Guyatt et al., was the reporting of the effects of practice and encouragement on walking performance; thus showing the importance of standardizing instructions, practice and verbal encouragement. In 1992 Singh et al.<sup>8</sup> developed the Incremental Shuttle Walk Test (ISWT) for pulmonary patients, which was externally paced by incremental beeps and aimed to eliminate problems of self-pacing found in the 6MWT. The ISWT was derived from the incremental shuttle run tests designed for athletes by Leger and Lambert<sup>9</sup> and Brewer et al.<sup>10</sup> The American College of Sports Medicine (ACSM)<sup>11</sup> and the YMCA have adopted stepping and cycle ergometry in addition to treadmill tests as exercise modes to estimate  $\text{VO}_2\text{max}$  from submaximal work-rates. These predictions are based on the three key assumptions developed by Astrand and Rhymining<sup>3</sup> from the 1950s:

1.  $\text{VO}_2$  (metabolic equivalents; METs) can be estimated from any given work-rate (cycle power in Watts, walking speed and gradient, or stepping height and stepping rate)
2. Maximal heart rate (HRmax) can be estimated from an individual's age
3. HRmax and  $\text{VO}_2\text{max}$  are coinciding markers and that a given %HRmax or heart rate reserve (HRR) can thus represent a given % $\text{VO}_2\text{max}$  (e.g., 65% HRmax or 50% HRR = 50% $\text{VO}_2\text{max}$ )

In acknowledging these three assumptions  $\text{VO}_2\text{max}$  can be predicted from a given submaximal work-rate but the intensity of the test has to reach a moderate-to-vigorous level.<sup>12</sup> The above principles were an underpinning feature of tests popularized in the 1980s and 1990s including the Canadian Standardized (Step) Test of Fitness<sup>13</sup>, the Chester Step test<sup>14</sup> and the ISWT.<sup>8</sup> The error of such predictions can however range up to 15%<sup>8,12</sup> but as will follow in this article, there is more value to the information from these tests than just the heart rate (HR) or performance-based estimations of  $\text{VO}_2\text{max}$ .

### Prognosis and Risk Stratification

In the studies published by such groups as Blair et al.<sup>15</sup> and Myers et al.<sup>16</sup> where large samples of people have been fitness tested and then followed-up in the longer term for CVD morbidity and mortality (for those with and without diagnosed CVD) they have been able to define specific risk categories related to

levels of aerobic fitness.

1. Poor or low fitness; high risk:  $\text{VO}_2\text{max} < 21$  ml/kg/min (<6 METs)
2. Poor to average fitness; moderate risk:  $\text{VO}_2\text{max}$  21 to 29 ml/kg/min (6 to 8 METs)
3. Average to good fitness; low risk:  $\text{VO}_2\text{max}$  30 to 40 ml/kg/min (8.5 to 11 METs)

Interestingly the ACSM<sup>11</sup> categories of risk stratifying for "an event on exertion" for someone with established CHD provide very similar delineations to the three categories above for estimating risk of CVD morbidity and mortality. The person with a maximal capacity >7 METs is considered low risk and anyone < 6 METs high risk.

With the estimated MET values for walking speed, stepping and cycle ergometry having good validity<sup>11</sup>, then practical functional capacity tests using these modes of activity will be able to at least categorize patients into one of the three levels of risk noted above. To illustrate this, here are some case examples using MET values derived from the ACSM equations during submaximal testing<sup>11</sup>:

**Case 1:** A patient obviously struggles to complete 300 m of a 6MWT, this equates to an average intensity of 2.5 to 3.0 METs; it is clear that this person would not have the fitness to attain 6 METs and can thus be stratified into the high risk category.

**Case 2:** An 80 kg patient performs a cycle ergometer test. At 90 Watts he is still clearly finding the work comfortable and gives a rating of perceived exertion (RPE) on Borg's scale of 11 (light). This level (90 Watts) is estimated to be 4.7 METs. It is clear that this person could continue being tested to a higher stage and at 90 Watts he is not using more than 60% of his maximal capacity (or he would be starting to feel the strain) and thus his maximum capacity is going to be greater than 7 METs, which puts him into the low risk category. If a Chester step test were used, the equivalent level to 90 Watts of cycling would be Stage 2 (20 steps per minute) using an 8 inch step.

In both these scenarios we have avoided the errors of trying to estimate maximal capacity using an age-estimated (and possibly beta-block affected) HRmax, which is the typical feature of the Astrand cycle test, the Chester Step test, or the Canadian Step test of fitness. This does not however mean that measures of HR (beta blocked or not) are not valuable during testing, as you will see in the next section. HRs provide a useful guide in determining whether a change in performance is more likely to be due to a physiological change or due to familiarization, practice and/or confidence. From an exercise prescription

perspective, the HR response at a given MET value during the exercise test can subsequently be used to inform the patient if he/she is working to a safe and effective MET level.

## Outcome Measures; Reporting a True Fitness Change or a Practice Effect?

In any test of fitness, improvements in performance can be influenced either by an improvement in fitness and/or familiarization, confidence, and practice. Especially with walking tests (6MWT and ISWT) there is the natural goal and motivation to go further on a follow-up test. The follow-up test is performed after weeks of exercise where patients have more confidence in their ability, which can easily translate into performing or attaining a higher level or longer distance or time. This is less of a problem for step or cycle tests, which typically have end-points dictated by a target HR (e.g., 75-80% HRmax) or RPE (14-15: hard). Here is where HR and, if used correctly, RPE become of great value. In our study presented at the 2010 CACR Conference in Montreal<sup>17</sup> two factors should be noted to show that an improvement from baseline is not simply an effect of error or practice/familiarization/confidence. The nature of the sensitivity of submaximal walking tests means an improvement of 10% must occur plus a reduction in HR (and RPE) for any given walking speed. The latter can be determined by using a heart-rate-walking-speed index that calculates a ratio of dividing the HR by the walking speed (in meters per minute). On follow-up this index value should be lower as demonstrated by the following case scenario:

Case – Following an 8 week rehabilitation programme, a patient increases his 6MWT distance from 240m to 320m, which shows a 33% improvement. His baseline average HR response was 112 bpm and follow-up HR response was 125 bpm. It is obvious he did push himself harder in the follow-up test as his HR was higher by 13 bpm compared to baseline. So has he truly improved his fitness or did he just push a little harder on the second test now that he is more confident with exercise?

If we compare the heart-rate-walking-speed index at baseline ( $112/240 = .47$ ) to the follow-up test ( $125/320 = .39$ ) it is now clear that for any given walking speed his HR was actually lower. In practical terms this 0.08 decrease in the index means the HR is lower by 8 beats for every 100m walked or for every kilometer walked he saves 80 heart beats; quite a nice little bit of feedback that can be encouraging to the patient. This decrease in the index represents the true physiological improvement of 16% (the “honest”

outcome measure) that should be reported and not the 33% performance improvement, much of which will have been influenced by practice and motivation as highlighted by factors reported by Guyatt et al.<sup>7</sup>

## Exercise Prescription and Physical Activity Guidance

With the results from a functional exercise assessment, the practitioner can reduce the amount of “guess work” in initiating the patients’ exercise programmes. The results also allow the clinician to be more specific on giving advice to the patient about what activities in daily life or leisure activities they can perform or pursue, respectively. Why is this necessary when all one has to do is give a patient a HR monitor and a target range in which to work or target intensity based on RPE? Both HR (based on age estimation) and RPE have inherent errors that need to be acknowledged and factored in when using. The exercise test allows the clinician to see how the patient is actually coping at a given age-estimated %HRmax (or HRR) and/or an RPE. The exercise test allows one to evaluate the patient’s ability to: follow instructions, show an understanding of pacing and intensity, comprehend RPE, perform simple motor tasks of cadence or stepping rate, and manage simple activities in light of comorbidities (e.g., balance, joint or muscle dysfunction, or respiratory conditions) as demonstrated in the following case.

Case – An 80 kg patient performs an incremental Chester step test. At stage 3 (stepping rate of 25 steps per min., step height 8 inches), which equates to 5.5 METs, the patient seems in control of the movement and can keep up with the metronome beat. There is a noticeable increased breathing rate but controlled, and he can talk but has some effort sensations in his muscles and gives an RPE of 12 to 13 (up to somewhat hard). He is beta-blocked with a HR of 105. The guidance we can now give can include activities that require up to 5.5 METs of intensity. He will be able to cope with cutting the lawn on the flat with a power mower, but it won’t be too easy as this intensity does challenge him, thus he needs to make sure he does some light gardening activities before and after cutting the lawn to provide a warm-up and cool down. He can play golf but needs to be careful that if the course has hills he uses a trolley for his clubs and is careful about pacing himself. He can swim using breast-stroke; front-crawl with a MET value up to 9 METs is not advisable. During an exercise class, it will be known that at a HR of 105 and RPE of 13 he will be working at 5.5 METs so he can expect to set the treadmill speed at 6 to 6.5 kph, an exercise

bike to 90 Watts and a Concept II rowing ergometer to a pace of 3:00 mins per 500m.<sup>11, 18, 19</sup>

In knowing these values determined from an initial assessment of functional capacity provides a more objective starting point for the patient's exercise programme and activity plan at home. Finer adjustments on subsequent visits or meetings with the patient can be made as confidence, skill and fitness progress. Not having these reference points to start with means that much guess work and trial and error is going to be required to set the appropriate intensity and with the risk of over-exertion. The importance of getting the intensity right is also not just a physiological matter. By getting the intensity wrong (e.g., too high) means the patient may not be able to achieve the required duration and he/she then feels a sense of failure, which in actual fact was a result of poor guidance from the practitioner and not the patient's belief of a lack of fitness. The wrong exercise intensity has also been strongly associated with client mood, confidence, and enjoyment, all qualities that predict longer-term adherence<sup>18</sup> and thus the importance to have a system, which takes a scientific approach to getting the exercise intensity just right!

## Test Selection and Summary

The 6MWT, ISWT, cycle and step tests can easily be provided (cost and practicality) by a cardiac rehabilitation team and the choice of test will be dependent on space, patient fitness, mobility, and co-morbidities. For low capacity patients the 6MWT and the ISWT seem ideal, although with the correct cycle ergometer a very low starting work-rate can be easily set. If an individual can easily complete a 6MWT (covers >500m without stopping) you should have used one of the other tests. In many cases, submaximal tests of functional capacity from a perspective of prognosis, risk stratification, outcome measures, and physical activity guidance/prescription, can be as valuable as maximal treadmill stress tests. The caution however is for those patients who continue to have symptoms or presence of ischemic changes on moderate to vigorous levels of exertion who do require ECG monitoring.

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*“The wrong exercise intensity has also been strongly associated with client mood, confidence, and enjoyment, all qualities that predict longer-term adherence<sup>18</sup> and thus the importance to have a system, which takes a scientific approach to getting the exercise intensity just right!”*

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# Muscle over Mood: Depression and Exercise in Cardiac Rehabilitation

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In this article we draw upon research and clinical experience to explore how cardiac rehabilitation (CR) exercise professionals can help heart patients with depression. We focus on depression, acknowledging this may be complicated by anxiety.

**Meet Pfictional Phil**, a 57 year-old contractor who began CR two months after a myocardial infarction (MI) and stent insertion. Phil's exercise attendance has been sporadic. He seems tense, irritable, and withdrawn. Despite normal blood sugar, well-managed blood pressure, and functional capacity of 7.5 METs on his non-ischemic stress test, he feels tired, having trouble finishing exercise sessions. Intake psychometric screening produced elevated depression and anxiety scores. Phil is self-critical concerning his health and lifestyle. His wife reported Phil had seemed down and disorganized for a year, worsening since the MI; he had taken an antidepressant years ago. The kinesiologist, identifying adherence concerns, has referred Phil to the team's clinical psychologist. After assessment, including neurocognitive screening, the psychologist has diagnosed major depressive and generalized anxiety disorders.

## Background

Depression, affecting approximately 20% of cardiovascular patients,<sup>1</sup> is often comorbid with anxiety.<sup>2</sup> Depression is associated with increased risks of incident<sup>3</sup> and recurrent<sup>4</sup> coronary artery disease, and like anxiety, can assume a chronic course.<sup>5</sup> Efficacious treatments include psychological therapies, medications, or combined approaches.<sup>6</sup> Interestingly, exercise may effectively treat depression,<sup>7</sup> although evidence is inconsistent.<sup>8</sup>

## Dimensions of Depression

Widely understood to be an emotional disturbance, depression involves sustained low mood and/or loss of enjoyment. Other symptoms include sleep, appetite, weight and energy disturbances;<sup>5</sup> negative thinking about one's self, situation and future;<sup>9</sup> to which anxiety may contribute ruminative, catastrophic tendencies;<sup>10</sup> and impaired motivation. Which of these can you identify in Phil?

Less appreciated is that depression is a disorder of self-regulation, involving impairments of attention and executive functions,<sup>11</sup> mediated in part by frontal cortex, and crucial to planning and organization of goal-directed behaviour.<sup>12</sup> Importantly, self-management<sup>13</sup> relies upon self-regulatory functions. Clinical experience suggests depressed patients often

perceive loss of capacity to direct their own behaviour and lives.

Cardiovascular patients must draw upon self-regulation, to formulate and sustain attention to goals; organize behaviour to attain goals and overcome barriers; attend to progress, feedback, symptoms, and medications; and to maintain motivation. Consequently, disordered self-regulation in depression may have important implications for self-management of chronic illness. One outcome may be "non-compliance".

The kinesiologist valiantly tries again to educate and motivate Phil. He looks irritated and distressed, feeling overwhelmed by so many new tasks facing him as a heart patient, which he likens to climbing Mt. Everest. Phil knows exercise is important, but just feels like going home to bed. He cannot imagine completing the program. Frustrated, the kinesiologist thinks "why can't Phil just work with me, for his own good??"

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*Consequently, disordered self-regulation in depression may have important implications for self-management of chronic illness. One outcome may be "non-compliance".*

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Phil's mood and thinking are negative. But can you spot clues to his impairments of attention, executive functions and behavioural self-regulation? Typical of many depressed patients in clinical practice, when asked to consider one particular course of action (exercise persistence), he automatically thinks of many tasks. In his low energy state, he then reacts to this perceived "Mt. Everest", feeling overwhelmed. He has trouble defining and selecting a specific goal, maintaining his attention to that while filtering out competing demands, harnessing motivation, and organizing strategies to cope with barriers. Phil's "executive muscles" have been weakened by depression, just as skeletal or cardiac muscle is weakened by injury and deconditioning. What can we do?

## Strategies

The kinesiologist and psychologist can collaborate. Psychological intervention can help Phil to remain engaged in exercise; while exercise programming can help his depression and facilitate psychological treatment. Interdisciplinary CR offers "virtuous circles"!

First, something has already been done right.

Despite her frustration, the kinesiologist has correctly discerned that Phil's "non-adherence" might be related to psychological factors, and has referred him.

Second, let us briefly consider what not to do. Our kinesiologist's frustration is understandable: she is trying to help someone who appears to be thwarting his own treatment. But Phil is not deliberately complicating things. In fact he may be very self-critical about non-compliance. Negative judgements, from health professionals, often perceived as authority figures, could reinforce his self-criticism, shame and demoralization at his self-perceived "weakness". If his depression worsens, his capacity to self-regulate could deteriorate further, making adherence yet more difficult, in a "vicious circle". Depression already puts him at risk to quit CR,<sup>14</sup> which would bode ill for his medical and psychological health.

Third, the kinesiologist can assist Phil with behavioural self-regulation, including a) attention to one goal at a time; b) pursuing realistic, graduated exercise goals; c) registering psychological benefits of exercise and goal attainment. In effect, the kinesiologist can serve as a kind of "frontal lobe assistive device" for depressed patients with attentional and self-regulatory challenges. Let's look at each of these points.

a) Attention. Phil's thinking may be busy, especially if he is anxious; but easily diverted by multiple, competing concerns. The goal of a walk, for example, may lead to thoughts about taking out the garbage, cutting the lawn, and washing the car, all of which becomes overwhelming; so he has a nap. Phil may benefit from gentle, respectful but repeated coaching to focus on one activity at a time; to avoid considering successive goals and activities until the first is completed; and to push through despite low energy and motivation.

b) Realistic goals. What defines a "realistic goal" in psychological terms? A practical approach is through the concept of perceived self-efficacy; defined as beliefs in one's own capabilities to organize and execute courses of action to achieve specific goals.<sup>15</sup> Self-efficacy is a key concept in self-regulation and self-management,<sup>13</sup> and is fundamentally patient-centred. Often misunderstood, self-efficacy is not a trait; but is always anchored to a specific goal. It is easily measured by asking questions such as: "Phil, all things considered, like your exercise accomplishments last week, and stressors you face, on a scale of 0-100%, how genuinely confident are you that you can take one 15-minute walk this week?" Behavioural specificity and timeframe are important. It is helpful to assist a patient to distinguish confidence to attain a goal, from potentially confounding concepts including prediction, commitment, intention, wishful thinking, or moral imperative. The key verb is "can"; not "will", "promise", "plan", "want", or "should". A deceptively simple concept, self-efficacy integrates

a wide range of information affecting motivation, such as emotional state, stressors, barriers, or task difficulty. High self-efficacy predicts goal attainment. Assessed as discussed above, a rating of at least 70% confidence defines a realistic goal.<sup>15</sup> Self-efficacy is derived from several sources, the most powerful of which is "enactive mastery": first-person experiences of accomplishment.<sup>15</sup> In other words, self-efficacy increases most strongly to successful goal attainment; or decreases most strongly to failures. Realistic, progressive goal-setting to maximize success is crucial. If Phil's confidence rating is less than 70%, then the kinesiologist should help him to scale down the goal; or problem-solve about barriers. The final rating should be at least 70%. Self-efficacy tends to be reduced in depressed heart patients,<sup>16</sup> so their goals compared to others' may be less ambitious.

A continuing process of realistic, progressive goal-setting, one step at a time, respectfully guided by the kinesiologist, may increase the likelihood of enactive mastery; vs. defeat in tackling ill-defined, multiple or unrealistic goals. Patients experiencing enactive mastery may be more likely to maintain engagement with exercise, which in turn may confer antidepressant benefits.

c) Registering psychological benefits. Mental health professionals use "activation" to mobilize depressed patients with decreased initiative and energy. Patients who sleep in, nap, or avoid even minor tasks or pleasurable activities, are encouraged to counteract these tendencies. This can be counter-intuitive: a depressed individual might assume rest is needed to restore energy. But passivity tends to worsen depression. Graduated, focused, self-initiated, goal-directed activity, and structure, including the sleep-wake cycle, can be effective "behavioural antidepressants".

Clinical experience shows that depressed patients can often report improvements in mood, energy and motivation, after, compared to before goal attainment. Perhaps due to attentional impairments however, they often seem to need guided enquiry to identify these benefits. Explicit, repeated recognition of these benefits by a patient may be important in developing self-managed activation. Such recognition may clarify the rationale and value of activation experientially.

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*"A continuing process of realistic, progressive goal-setting, one step at a time, respectfully guided by the kinesiologist, may increase the likelihood of enactive mastery; vs. defeat in tackling ill-defined, multiple or unrealistic goals."*

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Similarly, exercise professionals can guide depressed patients to register changes in mood, energy and motivation. For example: “Phil, reflecting back to when you were only thinking about your walk, compared to after you finished it, what did you notice about your mood? energy? motivation?” While we should avoid leading questions or implicit demands, Phil may identify minor improvements in one or more of these dimensions. Linking this explicitly to his own activity (Phil himself may not!) can help him to grasp experientially the benefits of exercise and goal attainment. Note: clinical experience suggests these improvements are unlikely to involve mild euphoria or an “exercise high”; but rather, a sense of accomplishment and self-direction.

## Summary

Depression presents serious self-management challenges. Strategies for exercise professionals include:

1. Referral to, and ongoing collaboration with a mental health professional;
2. Avoidance of blame for non-adherence;
3. Focus on self-regulatory challenges.

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## Exercise Stress Testing in Cardiac Rehabilitation: Fit as a Fiddle or Fiddling with Fitness?

James A. Stone, MD, PhD, FRCPC, FAACVPR, FACC and Ross Arena, PhD, FAACVPR

There was a time when virtually everyone in a cardiac rehabilitation (CR) program had angina. Indeed, some of us can remember when patients without angina were unlikely to be admitted into CR programs. Back in the day, the overriding goal of CR was to improve the angina threshold of patients with coronary artery disease (CAD), when the presence of exertion-induced myocardial ischemia was inferred by the onset of angina. Although significant myocardial ischemia was usually present long before the onset

of angina, using the angina threshold, as a surrogate for the myocardial ischemic burden, was a reasonable estimation of a patient’s ischemic potential. Under these circumstances, the clinical utility of exercise treadmill testing was extremely high. By objectively documenting at what level of perceived exertion, heart rate (HR), systemic blood pressure, and functional capacity patients experienced the onset of angina, exercise prescriptions could be derived that would significantly increase a patient’s functional

capacity and elevate their angina threshold, without obligating them to consistently exercising above their ischemic threshold.

In the last few decades, the numbers of individuals entering CR programs with refractory angina has dramatically declined. Although the presence of refractory angina remains a significant problem for a minority of patients with CAD, we have seen a paradigm shift in how CR programs treat persons with angina. In contemporary CR programs, it is the expectation that virtually every patient is free of angina. Indeed, so complete is the use of myocardial revascularization in most patients with CAD, that when patients within CR programs do experience angina, they are usually referred back for urgent reassessment by their treating cardiologist or are sent directly to hospital emergency departments for further evaluation. Thus, in only a few short decades, we have moved from a situation where almost every patient within CR had angina to a situation where virtually no patient in CR is now allowed to have angina. Under these circumstances, it is relatively easy to understand why some CR practitioners, given the fact that angina is now so rarely observed, feel that objective assessment of a patient's functional capacity, ischemic threshold, angina classification, and, where appropriate, maximal oxygen uptake capacity, is no longer required. However, the belief that no symptoms equals no problems, not only fails to appreciate the overwhelming weight of scientific evidence regarding the variable and sometimes unpredictable relationship between angina, coronary atherosclerosis and myocardial ischemia, but it also propagates the widely believed, yet absolutely incorrect, patient care mantra that no symptoms equals no problems.

There is overwhelming evidence to indicate aerobic capacity is one of the strongest prognostic markers in apparently healthy individuals as well as those at risk for or with confirmed CAD. Thus, quantification of aerobic capacity, and improvements resulting from CR, is highly valuable irrespective of other patient characteristics.<sup>1</sup> And arguably, the principle reason why patients in CR now tend to be mostly angina-free and experience a relatively low incidence of acute exercise-related cardiac events, is precisely because the routine use of a graded, symptom limited exercise stress test (GXT) prior to beginning a CR program, has excluded all the high risk and potentially high risk patients. Thus, the very safety issues used to argue against routine GXT testing in CR are, paradoxically, a direct result of GXT testing itself.

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Patients with documented CAD are at significantly

greater risk for recurrent adverse acute cardiac events compared to persons in whom coronary atherosclerosis has yet to be diagnosed.<sup>2</sup> The fact that in contemporary CR programs many of these patients may be asymptomatic does not necessarily mean that they are not at risk. Rather, their lack of symptoms is a direct reflection of both almost ubiquitous invasive myocardial revascularization and the evidence-based, treatment target driven medical therapy of these patients compared to the usual care of 10 or 20 years ago. For patients with documented CAD, the appropriate contemporary patient care philosophy is one that embraces and actively promotes proactive, symptom independent vascular vigilance.<sup>3</sup> In order to significantly delay mortality and to reduce the incidence of recurrent acute cardiac events in patients with known CAD, it is critically important to maximize patients' cardiometabolic fitness through a program of vascular vigilance. This means consistently and regularly questioning patients with respect to their current Canadian Cardiovascular Society Angina Classification, their current New York Heart Association Dyspnea Classification, as a surrogate for the determination of potential heart failure (HF), obtaining an objective assessment of functional capacity, and consistently and regularly monitoring their metabolic profile with respect to serum lipid levels and blood sugars. Those individuals with the best metabolic profiles have the best outcomes.<sup>4</sup> And as mentioned previously, CR patients with the highest levels of aerobic capacity also have the best outcomes.<sup>2,5,6</sup>

In light of all of this scientific evidence, most learned societies with an interest in CR and exercise stress testing, who have published and endorsed evidence-based recommendations regarding CR, have determined that a GXT is an essential component of vascular vigilance in patients with documented CAD and should be considered standard care in this patient population.<sup>2,7-11</sup> Importantly, none of these organizations has endorsed a policy that does not require a GXT as a critical component of the initial and on-going evaluations of CR patients. The 2009 CACR guidelines for CR clearly and specifically state, “A directly supervised GXT is recommended as part of the initial cardiac rehabilitation assessment prior to the initiation of therapy”, as a requisite clinical practice recommendation for CR programs.<sup>12</sup>

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*“In light of all of this scientific evidence, most learned societies with an interest in CR and exercise stress testing, who have published and endorsed evidence-based recommendations regarding CR, have determined that a GXT is an essential component of vascular vigilance in patients with documented CAD and should be considered standard care in this patient population.<sup>2,7-11</sup>”*

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A GXT is recommended in order to develop an individualized, safe, and effective exercise prescription based on estimated metabolic equivalents (METs), measured peak oxygen uptake, peak HR, resting and exercise systemic blood pressures, exercise related symptoms, symptomatic or asymptomatic ECG changes, and/or the presence or absence of clinically important and prognostically significant dysrhythmias.<sup>2</sup> However, within the clinical context of CR, it is important to understand that there is a difference between a diagnostic exercise test and one performed to assess the prognosis of CR patients. A diagnostic GXT is often one of the initial steps in determining whether presenting signs or symptoms (e.g., chest pain or dyspnea) are cardiac in origin. However, at entry into CR, the overwhelming majority patients already have documented CAD. Thus, in this clinical situation, a graded, preferably symptom limited, GXT is administered primarily as a prognostic test that objectively quantifies exercise capacity, chronotropic and blood pressure responses to exercise, the presence and severity of dysrhythmias, and thus prognosis. In addition, this objective assessment of functional capacity can also identify symptoms of angina or HF and document the presence or absence of EKG abnormalities suggesting potential underlying myocardial ischemia. Furthermore, within the context of CR, a GXT also allows for patients to be effectively stratified with respect to their risk of exercise associated adverse cardiac events and facilitates the prescription of an accurate, and therefore clinically efficacious, exercise training prescription. Not only is a GXT useful in objectively determining functional capacity, but it is an essential tool in objectively determining how well CR patients are maintaining their functional capacity as a direct reflection of their on-going exercise commitment.<sup>11</sup>

Despite these recommendations, there has been an increasing trend in some geographical regions for patients being referred to and entering CR programs to do so without a GXT. Some of the arguments promulgated in defence of this unscientific strategy include shorter hospital stays, more aggressive revascularization interventions, increased sophistication of diagnostic procedures, extreme deconditioning, orthopaedic limitations, left ventricular dysfunction that is limited by dyspnea, knowledge of the coronary anatomy, recent and successful coronary revascularization, and uncomplicated myocardial infarctions.<sup>2,14</sup> However, it is important to understand that the rationale put forth for patients not undergoing a GXT prior to CR is in no way equivalent to the scientific strength of the rationale supporting a routine GXT prior.<sup>14</sup> In short, there is no strong scientific evidence to support abandoning the routine use of GXTs in CR as an objective, standardized and repeatable assessment

of a patients initial aerobic fitness and as a mean of determining their cardio fitness improvements realized through CR.

Is it reasonable to consider alternatives when CR programs have absolutely no access to any exercise stress testing facilities? The obvious answer is yes. Clinical practice guidelines are, after all, guidelines. The 2009 Canadian Association of CR guidelines provide a clear alternative to exercise testing for patients and programs that do not have access to these services.<sup>2</sup> However, it is important to stress that although an alternative approach is presented, this approach is neither recommended nor endorsed. It is provided for information purposes only as an attempt to facilitate the provision of CR services to those patients who might otherwise be denied.

In summary, an objective, symptom limited GXT is, and must remain, a critical component in the safe and effective risk stratification of patients entering CR programs. To argue otherwise, is to ignore a massive volume of scientific evidence and to compromise not only patient safety but also the potential benefits patients may derive from exercise training with CR programs.

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## References & Reviews

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### The Impact of Anxiety Disorders on Assessment of Myocardial Ischemia and Exercise Stress Test Performance

*Pelletier R et al. J Cardiopulm Rehabil Prev 2011;31:60-66*

The authors of this paper have previously demonstrated that patients with coronary artery disease (CAD) and major depressive disorder (MDD) exhibit poor exercise stress test (EST) performance by achieving lower exercise parameters (% age-predicted maximal heart rate [%PMHR], exercise duration, metabolic equivalents [METs]) than patients without MDD. These differences may reduce the sensitivity of electrocardiographic (ECG) ESTs compared to single photon emission computed tomography (SPECT) ESTs for the assessment of myocardial ischemia in this population. Since MDD and anxiety disorders (AD) are common among cardiac patients, and may affect EST performance, this study examined the impact of AD on exercise test performance, and the sensitivity of ECG compared to SPECT measures of myocardial ischemia in patients undergoing exercise stress testing.

Patients referred for SPECT exercise stress testing (Bruce treadmill protocol) with simultaneous ECG measurement were invited to participate in the study (n=2271, 33% female, 48% with history of CAD). Following the test, the research team administered a brief structured psychiatric interview to assess for anxiety and mood disorders, and collected relevant sociodemographic information and medical history. Twenty-one percent of subjects (n=471) had an AD, and these subjects were younger, more likely to be female, educated, a current smoker, (p<.05) and to have MDD (p<.001), than patients without an AD (n=1800). Subjects with an AD were also less likely to have a history of CAD and previous bypass surgery

than patients without AD (p<.05). After controlling for age, sex, baseline blood pressure (BP), anti-ischemic medication, history of CAD, and %PMHR, patients with AD exhibited significantly lower peak exercise systolic BP (p=.03) and rate pressure product than patients without an AD (p=.008). However, when MDD was controlled for, these differences were no longer significant. No effect of AD on exercise performance (%PMHR, exercise duration, METs) was found. Rates of ECG-positive tests for ischemia were significantly lower among patients with AD (40%) than among patients without AD (46%), but this difference was not observed on SPECT assessments of ischemia (i.e., false-negative diagnoses of ischemia were observed when ECG was compared with SPECT, using SPECT as the gold-standard). After controlling for MDD, the difference in the rates of ECG-positive tests between subjects with and without an AD became non-significant, as did the difference in the rates of false-negative ECG diagnoses of ischemia.

The authors of this study are commended for initiating the task of understanding how psychological status can impact clinical exercise testing and the assessment of myocardial ischemia. Further research is necessary to better understand the mechanisms responsible for the observed effects of AD on exercise stress testing, as it is unknown whether this difference is attributable to a heightened sensitivity to physiological arousal, autonomic dysregulation, fear of physical symptoms indicative of a cardiac event, or differences in subjective assessment of fatigue among patients with AD compared to patients without AD. Nonetheless, this research has significant clinical implications for those responsible for the referral, conduct and interpretation of clinical exercise testing. Given the prevalence of AD and MDD among cardiac patients, physicians should consider including

information on patients' psychological status when referring for diagnostic ESTs. Routine mood and anxiety disorder screening should also be considered as part of exercise stress testing protocols.

## Comparison Study of Treadmill Versus Arm Ergometry

*Schrieke IC et al. Clin Physiol Funct Imaging 2011;31:326-331*

The Bruce protocol is an incremental treadmill exercise test used to measure  $\text{VO}_{2\text{peak}}$  and evaluate cardiovascular function. While this protocol is commonly used to facilitate exercise prescription in a cardiac rehabilitation (CR) setting, large increments of intensity between the stages of this test may limit its suitability for some populations. For example, it has been reported that the large increments of the test may lead to a lower sensitivity for detecting cardiovascular disease (CVD) and less reliable outcomes for the evaluation of the effects of exercise therapy. In addition, the initial stage of the protocol can be too demanding for patients who are obese, have hip or knee injuries, lower extremity disabilities, or CVD. Since arm crank ergometry provides physiological data similar to treadmill testing, it may be a useful alternative for exercise testing individuals with such conditions or impairments.

Using a sample of 30 subjects (16 men and 14 women) who were young ( $31.0 \pm 11.3$  years) and free of any significant health conditions ( $\text{BMI} = 26.1 \pm 4.0$ ), this study assessed the differences in physiological responses in arm crank ergometry and treadmill ergometry (Bruce protocol) to determine a regression equation to estimate treadmill  $\text{VO}_{2\text{peak}}$  based on arm crank  $\text{VO}_{2\text{peak}}$ . Following a familiarization session, each subject performed the Bruce treadmill and arm crank test on two separate days, in random order. The Bruce protocol was used for treadmill testing. For the arm crank test, men started at a workload of 50W and women at 30W. In both protocols, a crank rate of 75rpm was used and workload increased by 10W every two minutes. Fatigue was determined by the subjects' inability to maintain the crank rate 5rpm below 75rpm, or when the subject reached volitional exhaustion.

Comparison of the exercise tests demonstrated that the arm crank  $\text{VO}_{2\text{peak}}$  was 58% and 57% of the treadmill  $\text{VO}_{2\text{peak}}$ , for men and women, respectively. Based on these tests, they developed the following linear regression model to estimate treadmill  $\text{VO}_{2\text{peak}}$  ( $\text{TVO}_{2\text{peak}}$ ) based on arm crank  $\text{VO}_{2\text{peak}}$  ( $\text{AVO}_{2\text{peak}}$ ):  $\text{TVO}_{2\text{peak}} = 0.852 + 0.8 * \text{AVO}_{2\text{peak}} + 0.019 * \text{weight} + 2.025 * \text{gender} - 0.038 * \text{GW}$ . Gender is coded '0' for men and '1' for women, ( $r^2=0.832$ ,  $\text{SEE}=0.471$ ).

The authors of this study are the first to report differences in arm crank ergometry compared to the Bruce treadmill test and their findings can be used to interpret the results of arm crank ergometry and predict treadmill  $\text{TVO}_{2\text{peak}}$  for populations with lower body limitations and/or limited capacity to complete Bruce protocol treadmill testing. They also provide sex-based analyses of their findings, reporting the differences in testing between male and female subjects. Keeping in mind that the subjects in this study were generally young, healthy and active (and therefore the predictive capacity of the model may be less accurate in more sedentary and older populations), this study provides a model that may be useful for exercise prescription in CR settings with patients who are unable to complete Bruce protocol treadmill testing.

## Interval Training for Patients with Coronary Artery Disease: a Systematic Review

*Cornish AK et al. Eur J Appl Physiol 2011;111:579-589*

The American College of Sports Medicine provides guidelines for exercise testing and prescription in the cardiac population and indicates supervised, large-muscle group continuous exercise (such as walking or cycling) performed at 40-85% of heart rate reserve. While the health and fitness benefits of such moderate-intensity continuous training (MCT) for patients with coronary artery disease (CAD) have been well established, a number of recent studies have also demonstrated the safety and effectiveness of interval training for this population. Interval training (IT) involves alternating moderate-intensity workloads with brief intervals (2-5 minutes) of high-intensity workloads ( $\geq 75\% \text{VO}_{2\text{max/peak}}$ , or  $\text{RPE} > 15$ ) during an exercise session.

The authors of this paper conducted a systematic review of the literature involving IT in patients with CAD and provide a summary of the safety and physiological benefits of IT in this population. This review included seven peer-reviewed studies ( $n=213$ , 180 men and 33 women), of which five were randomized controlled trials (RCTs). Given the small sample size of the review and the fact that comorbidities of subjects were not presented in six of the seven studies, the authors note the limited capacity to generalize their findings to the larger cardiac patient population. The interventions described varied with respect to duration of the intervention, session duration, specific training modalities and intensity ranges. All trials prescribed aerobic and anaerobic exercise training modalities (typically involving treadmill or bicycle ergometers), with one trial including resistance training. Since only three of the five RCTs compared IT to MCT, and

each involved less than 30 subjects, the effectiveness of IT compared to MCT remains unknown. While the authors conclude that IT prescribed in isolation or in combination with resistance training can induce significant and clinically important physiological adaptations in cardiac patients, the methodological

limitations of all studies suggest the need for additional RCTs. Although no trial reviewed reported adverse cardiac symptoms or complications due to exercise training, more research in this area is required before implementing this new exercise prescription in a cardiac rehabilitation setting.

## Case Study

Lea Carlyle, MA; Northern Alberta Cardiac Rehabilitation Program, Edmonton, AB

Mr. X is a 49 year old male who was referred to cardiac rehabilitation (CR) after having an implanted cardioverter defibrillator (ICD) installed in 2010. His upper heart rate (HR) limit of the ICD was set at 185 bpm. On his most recent stress test he achieved 15:00 minutes (17.5 metabolic equivalents (METs) on the Bruce protocol. His past medical history includes a bicuspid aortic valve which was replaced with mechanical prosthesis and a dilated ascending aorta replaced using Bentall procedure, hypertension, and herniated C1, C2, S1, S2. He exercises daily by walking, swimming, running, or x-country skiing as well as doing push ups and sit ups. Work-related activities include digging, carrying equipment, and walking with back packs.

This individual would like to participate in scuba diving, alpine skiing, 8-10 hour hikes in the jungle, mountain climbing, and hunting and would like to know how hard he can push himself. What would your recommendations be in regards to returning to these types of activities?

**Christine Foisy, BScOT and Sue Fisher, RN**

*Northern Alberta Cardiac Rehabilitation Program, Edmonton, AB*

There are a few things that need to be considered when guiding this individual in his desire to return to these leisure and work-related activities. These include the intensity of the activities, environmental factors, and the safety.

The actual workload of each activity needs to be evaluated and the individual needs to be able to gauge how hard he is working. For example, cross-country skiing can range from 6.8 – 15 METs<sup>1</sup> depending on the intensity so he needs to know that a certain pace will keep him in a safe HR zone for that activity. Based on his stress test results, he is physically able to handle a higher level of work and for day-to-day activities the recommendation would be 45% of his maximum METs on the stress test (7.7 METs) with a peak of 70% (11.9 METs) for short periods of time.<sup>2</sup>

Environmental factors such as ambient temperature, humidity, and altitude need to be taken into account as they can affect the cardiovascular response to an activity.<sup>3,4</sup> For example, exercising in hot, humid weather may increase his HR beyond a safe target HR zone.<sup>5</sup> Poor thermoregulation due to

medication needs to be considered as well.

Some recommendations to keep him safe while participating in these activities should include: carrying a lighter load while hiking; slowing the pace; talking, whistling, singing while hiking to ensure appropriate rate of perceived exertion; monitoring HR; keeping hydrated; exercising earlier in the day; and walking/hiking in a circular path rather than out and back so he is closer to safety. It would also be advantageous for him to carry information about his device (e.g., pacing parameters, ICD therapy zones, manufacturer's name); medical history; medication list including extra prescriptions; cell phone; and emergency contact numbers. This information should be carried in a waterproof container if he is doing water activities such as rafting.

Some other things for this individual to think about though would be the safety of the activity if his device delivers a shock while mountain climbing or scuba diving; his heart's reaction if he has a close encounter with wildlife (e.g., a bear); ensuring those with him know what to do if his device discharges; and how the potential risk associated with participating in these activities can impact his family.

Although these types of activities may be at the extreme end for a cardiac patient, our program is seeing younger individuals who would like to return to higher intensity activities such as hockey or marathon training. We need to be able to provide these individuals with appropriate guidelines so they can participate in these activities in a safe manner if they choose to do so. Counselling in regards to their "new normal" is also important.

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### **Paula Candlish; RN, NP, BN, MN**

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Younger patients in particular have concern about anxiety or fear to resume lifestyle adjustment after ICD implant<sup>1</sup>. However, for this gentleman it appears the opposite. It has been shown that optimism and positive health expectations do improve quality of life, so it would not be wise to stop him from trying to achieve his goals<sup>2</sup>. I think the first thing to be done is a thorough assessment as there is a lot of detail omitted in the information given. What is his threshold setting for ventricular pacing and device activation? Setting the HR at 185 bpm is quite high, and as this man is athletic, his HR would be on the low side and this would be of concern in relation to hemodynamics and rhythm disturbance. An assessment would gauge his physical and psychological condition. It would enable the clinician to collect a full and comprehensive history, and include current medications.

Some activities, such as mountain biking, skiing, snorkeling, scuba diving, parachuting, and boating have to be undertaken with caution and after authorization from his treating physician because they increase the risk of injury (for the patient or for others) in case of sudden incapacity<sup>3</sup>. Moreover, activities such as rowing or repetitive upper-body exercises could endanger the integrity of the implant. On the basis of what has been provided in this case study, I would recommend the following:

**Scuba diving:** If he has never dived previously and has not been certified, he will not receive certification from a Dive Instructor. This is due to the fact that he is excluded by his hypertension, his back injury, and his heart surgery that has left him with a mechanical prosthesis that will require him to be on life long anticoagulation (i.e., Warfarin)<sup>4</sup>. If he did not have the history noted it would be dependant on his device manufacturer which would recommend he can only dive to 2 ATA (9 meters or 30 feet). However, Boston Scientific has graded their device to 5 ATA (40 meters or 130 feet). He must always have a buddy who is fully cognizant of his condition and willing to take on the responsibility of caring for him if his device activates underwater. He should **never** dive alone.

**Alpine skiing:** He would be limited to skiing with a buddy. Also, a fall could damage the implant. There are also the haemorrhagic side effects of his anticoagulant to consider.

**Hunting:** If the device is on the same side as his dominant hand, there is no possibility of being able to shoulder a gun. The impact from the rifle butt would damage the device and may cause extensive bruising. Again, he would always need to be with someone who can support him if he has an activation of the device.

**Hiking 8-10 hours in the jungle:** With distance and isolation being very important factors, I would advise against it. The changes in temperature and conditions would also affect his hypertension and long walks carrying a pack would cause an aggravation to his back injuries.

He appears to be fit and will no doubt manage some quite high intensity exercise; however, he will be limited by his device, hypertension, and back injuries. So for this gentleman, it would be unrealistic for him to continue his extreme activities in isolated areas (what happens in the event of a shock?). Therefore, he will require some counseling (psychologist input), as to what really is achievable, adjusting to lifestyle restrictions, motivation at setting some realistic goals and addressing any anxiety/depressive symptoms related to living with a potentially life-threatening condition and potential experience of aversive treatment. But, at the end of the day, like most of our patients, he can be given all the advice under the sun - whether he chooses to heed the advice or not is another issue, one that time, knowledge, support, and life experience can resolve.

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# University of Ottawa Heart Institute's Program Experience: An Algorithm-based Approach to Screening for Exercise Testing

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## Background

The standard of practice for cardiac rehabilitation (CR) programs is graded exercise testing (GXT) for the purpose of risk stratification and exercise prescription. This practice began during the early days of CR, when it was considered highly unorthodox to exercise cardiac patients. Every precaution was taken to ensure safety, as well as to convince practitioners that exercise after a cardiac event was not only safe, but beneficial. These initial recommendations were not evidence-based, as they were new concepts. CR has since evolved, requiring us to look more critically at our current practices, as well as to develop new

protocols that can be evaluated to inform evidence-based practice.

Prior to 2005, all CR patients at the University of Ottawa Heart Institute Prevention and Rehabilitation Center (HIPRC) program were referred for GXT. At that time, the program performed a review to determine how to increase access and decrease wait times for CR. It became apparent that GXT was a barrier for patients to access CR, so as a result GXT was eliminated as a mandatory pre-CR test. Instead, a triage tool, or algorithm, was developed to ensure that specific patient needs were met, and that a systematic approach to stress testing was applied (see Figure 1).

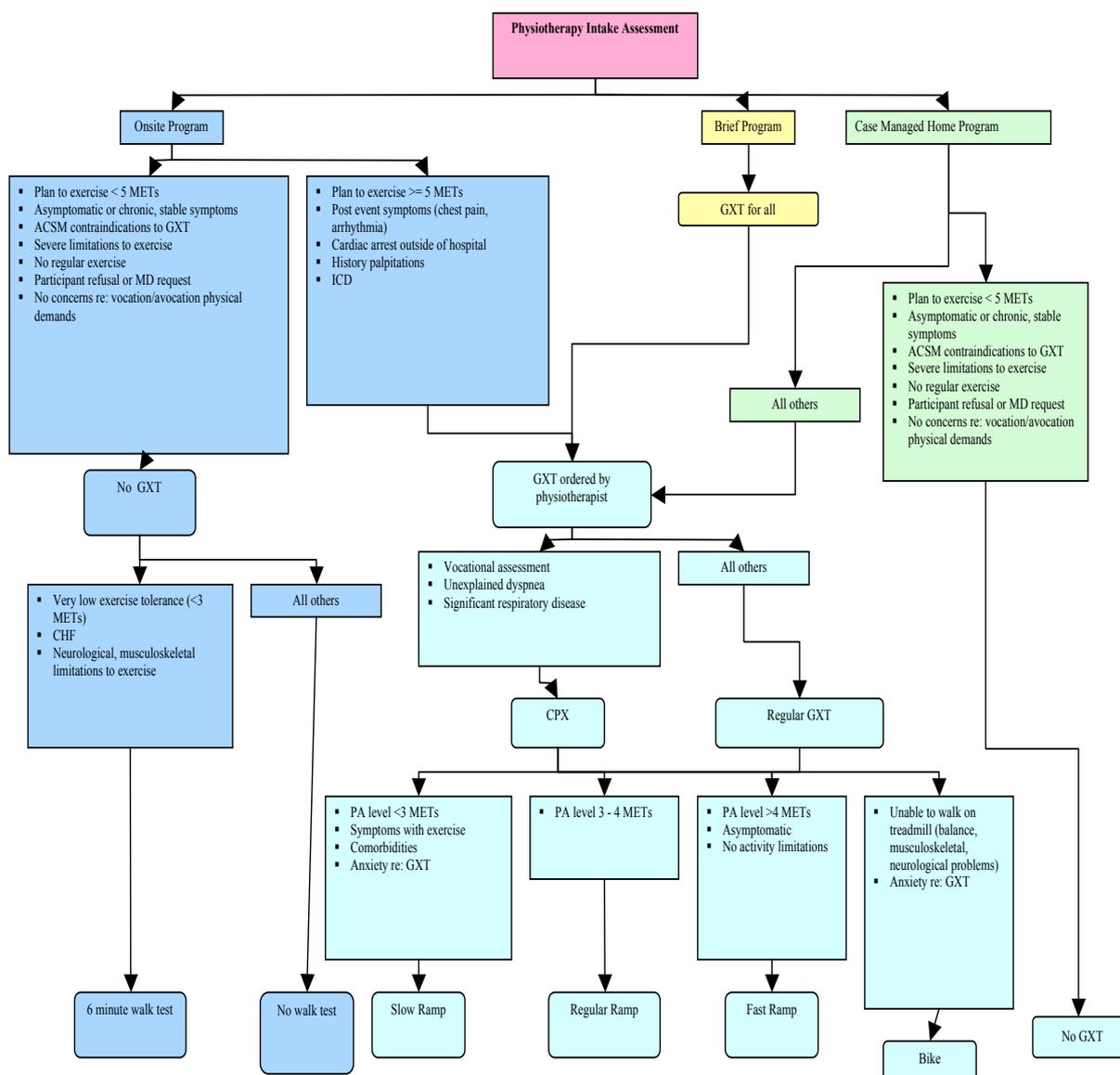


Figure 1. Algorithm used at HIPRC for decision to stress test at entry to CR.

## Current Practice

Current Canadian Association of Cardiac Rehabilitation guidelines state that all patients entering CR programs “must undergo an initial assessment, and should undergo symptom-limited exercise testing to objectively determine their exercise capacity and screen for signs and symptoms of myocardial ischemia.” (p.342)<sup>1</sup> At HIPRC all patients are assessed upon entry to CR. The initial physiotherapy assessment includes medical and exercise history, musculoskeletal, neurological and cardiac symptoms, planned activities and goals. This assessment is combined with the algorithm to determine the need for stress testing. Patients attending the onsite program with close staff supervision are considered for GXT only if they plan to engage in vigorous physical activities; have ongoing cardiac symptoms; have had a cardiac arrest outside of hospital; have a history of palpitations; or have an internal cardiac defibrillator. Case-managed home program patients who have a close follow-up with a mentor have GXT according to the onsite program guidelines. Brief program patients, who do not attend the supervised onsite exercise or have regular contact with a mentor, all undergo a GXT to ensure optimal exercise prescription and exercise safety. All low-intensity onsite patients are triaged to a six minute walk test (6MWT). Once patients are enrolled in their exercise program, a GXT can be ordered at any time by either the attending MD or the physiotherapist. In both the algorithm method, as well as after intake, the decision to administer a stress test is a clinical one, and is based on the patient’s history, presentation, goals and exercise capacity.

### Functional capacity assessment using the Six Minute Walk Test (6MWT)

An alternative method of exercise capacity assessment used in many clinical populations is the 6MWT. The 6MWT objectively assesses exercise capacity and is ideally suited for many CR patients, particularly patients with congestive heart failure (CHF). HIPRC incorporated the 6MWT as a means of functional capacity assessment in 2006. The appropriateness for the 6MWT is determined at the time of CR intake assessment. Patients with very low past physical activity levels, CHF patients and patients with neurological or musculoskeletal limitations are most likely to complete the 6MWT. The results of 6MWT are used to detect any cardiac signs and symptoms, to determine initial exercise intensity and for outcome measures.

### Alternative Exercise Prescription Methods

In addition to 6MWT, HIPRC uses other methods to prescribe exercise in the absence of a GXT. Resting heart rate (RHR) plus 20-30 beats has been described in the literature and evaluated for safety and efficacy.<sup>2</sup>

This method works well for patients who intend to exercise at a moderate level and can effectively monitor their pulse. Encouraging them to increase their exercise intensity to at least 20 beats over RHR, in order to increase their aerobic output, combined with staying below 30 beats over RHR, allows them to feel confident that they are exercising at a safe level. One of the core components of CR is to provide patients with self-management tools to be able to self-tailor health enhancing activities such as exercise.<sup>1</sup> Using the Rating of Perceived Exertion (RPE) method is another valuable exercise prescription method, as well as an effective self-management tool for patients as it encourages patients to listen to their body’s exercise response. The American College of Sports Medicine (ACSM) lists RPE as an exercise prescription method for patients with cardiac conditions.<sup>3</sup> Studies have shown that encouraging patients to exercise at an RPE between 11-13 is both safe and optimal.<sup>4</sup> At HIPRC, the modified RPE scale using ratings from 0-10 is used for simplicity. Patients are encouraged to exercise at a level between 3 (moderate) and 5 (difficult) on this scale.

### Impact of the New Stress-Testing Protocol on Current Practice

A review of our experience in applying the algorithm was undertaken from January to June 2011, during which 820 patients were enrolled in CR. Of these patients, 32% underwent a GXT at intake. Of those having a GXT, 52% entered the onsite program and 48% entered the home program. Among patients who had a GXT at intake, 87% were men. Prior to the introduction of this new approach the average wait time before enrolment in CR was 12 weeks; it is now less than three weeks. We did not track medical incidents as part of our review, however, our Quality of Care committee confirms that there has been no increase in the number or severity of incidents since the implementation of the new GXT protocol.

### Conclusion

HIPRC has seen substantial growth in the last five years. The volume of patients accessing CR and community exercise programs has tripled, from 1121 patients in 2005/2006 to 4006 patients in 2010/2011. Furthermore, our patients are presenting with increasing co-morbidities which make standard stress testing more difficult and less relevant. The current use of the algorithm has allowed outreach to a greater number of eligible patients in our region. Further research is needed, however, to assess both the effectiveness and safety of exercise prescription without stress testing.

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