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PRACTIONER'S CORNER
Regulating exercise intensity when heart-rate based prescription is compromised.

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Abstract
Background: Clinical conditions such as beta-blockade, cardiac conduction defects, use of a cardiac pacemaker, and cardiac transplantation preclude use of heart rate to regulate the intensity of prescribed exercise. *Purpose:* To evaluate the suggestion that Borg's Rating of Perceived Exertion (RPE) may provide a valid alternative, and to weigh possible alternatives. *Methods:* A brief review of factors modifying RPE, and an analysis of RPE data obtained in patients following cardiac transplantation. *Results:* Many factors modify an individual's perceptions of effort, and in consequence simply exercising to a fixed RPE can result in either too low an intensity to induce the required training, or a dangerously high intensity of exercise. *Conclusions:* RPE does not provide a safe method of regulating exercise after cardiac transplantation. A better alternative is to establish the indiviual's oxygen cost of walking, and to prescribe a set walking distance to be covered in a set time, reserving the RPE for a fine-tuning of this prescription. **Health & Fitness Journal of Canada 2015;8(2):29-31.**

Keywords: Borg scale, Cardiac transplantation, Effort perception, Exercise prescription, Walking speed

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Introduction
There are several clinical conditions where an exercise programme may improve prognosis, but the typical heart rate based regulation of exercise intensity is compromised. Examples include the administration of beta-blocking medication, electrical conduction disorders of the heart, the use of pacemakers, and cardiac transplantation. Following cardiac transplantation, the normal autonomic innervation of the heart is lost (Shephard, 1992), and at least for several years any increase of heart rate is dependent upon slow humoral and metabolic responses to effort. On the basis of observations on 15 transplant patients exercising on a treadmill and in a heated pool, a recent article from Brasil (Ciolac et al., 2015) suggested that Borg's 6-20 RPE scale (Borg, 1971) "may be an efficient tool for prescribing and self regulating" exercise intensity. However, the earlier observations of Keteyian et al., (1989) and of Shephard and colleagues (1996) concluded that the RPE was not in itself an adequate tool to regulate exercise intensity after cardiac transplantation. The present brief note examines the limitations of an exercise prescription based solely upon RPE, looks at the magnitude of potential errors, and considers possible alternatives.

1. LIMITATIONS INHERENT IN THE RPE APPROACH
Ratings of perceived exertion are affected by the mode of exercise; for example, a client with weak quadriceps muscles will perceive effort at a given oxygen consumption as more severe when cycling than when walking or running on a treadmill. Ratings at a given oxygen consumption are also increased in

an adverse environment, for example under hot and humid conditions. There are also large inter-individual differences in response at any given fraction of maximal oxygen intake. Such differences are particularly marked in those with clinical disorders, where perceptions may initially be increased by anxiety, but lessen as a client gains confidence in his or her ability to perform the required exercise (Squires, 1990).

2. EMPIRICAL DATA FOLLOWING CARDIAC TRANSPLANTATION

We made an empirical evaluation of the effectiveness of RPE-based prescription a number of years ago (Shephard et al., 1996). Our assessment was based upon a substantial sample of 36 male patients, seen an average of 7 months following orthotopic cardiac transplantation. We made an inter-individual comparison of relative oxygen consumptions when the entire group reported exercising at an RPE of 13 units. On average, the oxygen consumption corresponded to 66% of the individual's directly measured maximal oxygen intake, but the standard deviation was 12%, implying that when an RPE of 13 was reported, at least one person in 40 would reach a dangerously high 90% of their peak oxygen intake, and a further one in 40 would exercise at an ineffectively low 42% of their peak oxygen intake.

A similar type of analysis can be made, using the smaller sample of Ciolac and coworkers (2015). These authors claimed that use of the RPE would keep "most" of their patients within their intended training zone [which they set between the anaerobic threshold (AT) and the respiratory compensation point (RCP)]. However, the actual data show that when exercising at an RPE of 11-13 about a third of the 15 patients fell outside of the intended training zone (4/15, 26% when exercising in heated water, and 5/15, 34% during treadmill walking). The implication for normally distributed data would be that since the oxygen consumption of two thirds of clients fell between AT and RCP, the difference of oxygen consumption between AT and RCP approximated ± 1 SD of the variance associated with an RPE of 11-13. Applying this concept to the GXT data (published in Table 2 of their paper), the oxygen cost when exercising within this training zone would have averaged 16.8 ± 3.4 $mL \cdot kg^{-1} \cdot min^{-1}$. However, one client in 40 would have training at 44% of the average maximal oxygen intake of 22.8 $mL \cdot kg^{-1} \cdot min^{-1}$, and one patient in 40 would have reached or exceeded their maximal aerobic power. Given some rightward skewing in their data, the proportion of patients reaching too high an exercise intensity at a perceived RPE of 11-13 might have been even larger.

Plainly, neither our earlier data nor the recent observations from Brasil allow us to pin great faith in the simple use of RPE as a means of regulating the intensity of exercise following cardiac transplantation.

3. ALTERNATIVE METHODS OF REGULATING EXERCISE INTENSITY

Given that the RPE alone provides a fallible method of regulating exercise intensity in the cardiac transplant patient, what alternatives are available to the exercise professional? The simplest option is to combine the information from the RPE with other indices. Thus Keteyian and colleagues (1989) advocated combining RPE with assessments of dyspnoea and/or muscle fatigue. However, Shephard et al., (1996)

recommended that use of the RPE should be limited to a fine-tuning of exercise prescriptions based primarily upon the distance covered and the speed of fast walking.

The oxygen cost of walking shows a relatively small inter-individual variation, so that if a client is asked to walk a carefully-measured distance of 2.5 km in 30 minutes, the intensity of the required effort is known relatively precisely. Allowance for individual differences in the efficiency of locomotion is possible if the oxygen cost of walking at the intended speed of training is checked at the initial laboratory evaluation.

Arguably, precision in use of the RPE could also be enhanced by making a personal calibration of the relationship between perceptions and energy expenditures at a patient's initial evaluation, although even a personal calibration tends to be compromised by a substantial alteration in perceptions of effort as training proceeds (Squires et al., 1983; Kavanagh et al., 1988; Shephard et al., 1996)).

Conclusion

Contrary to recent assertions, Borg's RPE in itself is not a reliable method of regulating the intensity of exercise in clients who have undergone orthotopic cardiac transplantation. The main basis of regulating exercise should be the walking of a known distance in a specified time. If the oxygen cost of walking is determined during the initial patient assessment, this approach provides a satisfactory method of regulating the intensity of effort. The use of information derived from the RPE should be limited to a fine-tuning of this basic prescription when the client is fatigued or faces adverse climatic conditions.

Author's qualifications

The author's qualifications are as follows: Roy J. Shephard, C.M.; Ph.D., M.B.B.S., M.D. [Lond.], D.P.E., LL.D., D.Sc., FACSM, FFIMS.

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