Leaders

β Adrenergic blocking drugs and the Borg rating scale of perceived exertion

In 1963 as a medical student "guinea pig" I took part in a pharmacological experiment and was given the first experimental ICI β adrenergic blocker pronethalol (a non-cardiac selective β blocker, subsequently withdrawn for causing sarcoma in beagles and replaced by propranolol). The experiment was aborted when I had a syncopal episode despite being recumbent. During the insertion of a central venous line my normal middle distance athlete's resting heart rate of 42-48 beats/min plunged momentarily to nothing and then after a head down tilt and a large dose of atropine rose to 30 beats/min, where it stayed for an hour or so. This was the first ever demonstration of the dangers of giving bradycardic individuals a β adrenergic blocking drug, highlighted by the strong unopposed vagal stimulus of some venospasm from the venous catheter.

Six hours later I went for my customary training run, a five mile road circuit. I found that I was running slowly (about 80% of normal pace) despite considerable effort and that I could not raise my heart rate above 110 beats/minute. My legs even at that pace felt very heavy and when I reached the end of the run I felt light headed and hypoglycaemic, but ate some cake and immediately felt better.

This episode led to studies on the metabolic as opposed to the cardiac effects of β blockers and exercise.¹ We studied the release and increased serum concentrations of non-esterified fatty acids during exercise. This release is prevented by β adrenergic blockade, thereby reducing the ratio of fat to carbohydrate burnt by muscles during prolonged aerobic exertion (normally about 50/50) and increasing the risk of exercise induced hypoglycaemia, which even with β blockers is rare.

My hypoglycaemic episode was precipitated by the combination of circumstances, the β blocker, the fact that I had been fasting all day, having had nothing to eat before the experiment, missing lunch through being nursed flat because of my severe bradycardia, and then the prolonged exercise at quite a high intensity.

This historical anecdote puts into perspective the cardiac and metabolic effects of β blockers during exercise.

It also shows the difficulty of assessing the rating of perceived exertion when using β blockers, which prevent the normal acceleration of heart rate with exercise, and reduce cardiac contractility, limiting maximum exercise cardiac output. Additionally, depending on their degree of cardiac selectivity, β blockers have an effect on β adrenergic receptors in many other tissues, including liver, muscle, and the bronchi.

The very subjective sensations associated with physical effort can obviously be modified not only by the degree of β blockade, which must vary throughout the day, but also by the dose and cardioselectivity of the agent used.

Borg pioneered the rating of perceived exertion (RPE). He found that young men could learn to roughly estimate their

Table 1 Borg linear 6-20 scale of perceived exertion

6	
7	Very very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very very hard
20	

exercising heart rate when performing aerobic exercise if they were given a vertical scale of effort from "very very light" to "very very hard". His original 21 point scale was replaced by the current popular 15 point scale in 1970,² in which the heart rates are shown without the final zero to give a scale from 6 to 20 with descriptions of RPE (table 1).

This scale is widely used for exercise prescription in health and fitness clubs, gymnasias, and, above all, in cardiac rehabilitation classes where exercise levels are titrated against monitored heart rate and patients are encouraged to exercise sufficiently hard to benefit but not so hard that they are at risk. Once taught by feedback of heart rates or estimation of percentage of maximum aerobic exertion with reference to oxygen uptake, RPE levels can be prescribed with reasonable approximation to heart rate prescription.

RPE, once learnt, is therefore invaluable for controlling severity of exertion where heart rate monitors are not readily available or their use would be difficult.

The linear RPE scale has now been updated with a non-linear 0-10 scale that is also used for pain, but the original Borg 6-20 scale because of its parallel to heart rate is more widely used.

The papers by Eston and Thompson (p 114) and by Head *et al* (p 120) illustrate that even 34 years after my initial experience of the cardiac and metabolic effects of β adrenergic blockade during exercise, there is still considerable interest and original work to be done on this group of drugs, which are still widely used for angina, hypertension, and the control of cardiac arrhythmias.

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1 Muir GG, Chamberlain DA, Tunstall Pedoe DS. Effects of sympathetic blockade on non-esterified fatty acids and carbohydrate metabolism at rest and during exercise. *Lancet* 1964;ii:930-3.

2 Borg G. Perceived exertion as an indicator of somatic stress. *Scand J Rehabil Med* 1970;2:3:92-8.