A TEST TO CONFIRM MAXIMAL OXYGEN UPTAKE IN CHRONIC HEART FAILURE PATIENTS WITHOUT THE NEED FOR SECONDARY CRITERIA


Cardiopulmonary exercise testing for peak oxygen uptake (VO2peak) is widely used to evaluate severity, pathophysiology and prognosis in patients with chronic heart failure (CHF). A VO2peak ≥14 (or 12 with β-blocker) ml/kg/min is associated with increased mortality and is a key criterion for cardiac transplant listing. A symptom-limited exercise test, however, may elicit a VO2peak lower than the physiological limit (VO2max); the latter commonly “confirmed” using the secondary criterion of respiratory exchange ratio (RER) >1.05. RER, however, is sensitive to the test format. We, therefore, determined if a ramp-incremental (RI) step-exercise (SE) (or RISE) test could determine VO2max in CHF patients without using RER, by satisfying the criterion that two different work rates are terminated at the same VO2peak. Twenty-one male CHF patients (NYHA class I: n=5, II: n=16, and III: n=1) initially performed a modified Bruce treadmill test. Patients then completed a symptom-limited RISE95 cycle ergometer test in the format: RI (4–18 W/min; ~10 min); 5-min recovery (10 W); SE (95% of peak RI work rate). Thirteen of these patients also performed RISE95 tests using slow (RI 3–8 W/min; ~15 min) and fast (RI 10–30 W/min; ~6 min) ramp rates. VO2 and RER were measured breath-by-breath by a mass spectrometer and turbine (MSX, NSpire, UK). Peak VO2 and RER were compared within-subjects, between RI and SE, by unpaired t test of differences. VO2max was similar (p=0.06; 10.8±3.2 vs 10.6±3.7 ml/kg/min) in the fast ramp and slower in the slow ramp (p<0.05). There was no effect of ramp rate on the VO2peak (p=0.09). There was a greater kinetic index in the fast ramp (1.24±0.09) compared to the slow ramp (1.12±0.06). The single-visit RISE95 test incorporating incremental- and step-exercise phases, each to the volitional limit, was well tolerated by CHF patients: The SE phase was contraindicated in only 3 of the 47 tests. The RISE95 detected VO2max in 14 of 21 patients with a sensitivity of ~30% (ie, similar to healthy subjects), and without the need for secondary criteria or incidence of false-positive. In contrast, the end-exercise RER was sensitive to both modality and ramp rate and provided a false-positive for VO2max attainment in every incidence. Therefore, the RISE95 protocol provides a robust measure of VO2max in CHF patients, to within an individually-defined CI without dependence on secondary criteria.