Ventilatory Threshold Prediction by Spectral Analysis of Heart Rate Variability in Incremental Maximal Tests

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Ventilatory thresholds (VT1 and VT2) are useful in many fields of medicine and sports. Nevertheless, their measurement is cumbersome and needs trained personnel. This work proposes an alternative method to predict VT1, VT2 and maximum loads in incremental maximal tests based on heart rate variability (HRV) analysis of the RR time series obtained while performing the test. Twelve competitive male cyclists (34.1 +/- 5.7 years old) executed an incremental exhaustive test (25W/min) in the upright position on an electronically braked cycle ergometer. HRV data were collected with a Polar RS800 and the gas measurement was performed with a Cosmed Quark PFT-Ergo gas analyzer. An expert doctor annotated VT1 and VT2 loads from the gas measurements. After artifact correction, the power spectrum of the RR time series was estimated in a sliding window and central frequency (CF) and bandwidth that contains half the total power (BW) were computed. These indices dont need a band definition and are useful for analysis during exercise because the physiological changes associated with physical effort cause a radical modification of the power spectrum. An automatic algorithm recognized the loads at where CF and BW experiment a significant change. These loads were used as inputs in linear regression models to predict VT1, VT2 and maximum loads. The standard errors of the estimates were 24.3 W for the maximum load, 23.6 W for VT2 and 22.6 W for VT1 so the errors of the predictions are comparable to the resolution of the load (25 W). Moreover, the abrupt changes in BW and CF happened always in advance of the first ventilatory threshold so this methodology can be applied in real time and the test can be stopped once the abrupt changes in CF and BW are detected.