W' recovery during intermittent exercise: current limitations and future challenges of predictive models

The application of the traditional critical power (CP) model to intermittent exercise has generated a lot of interest from both academia and cycling practice. One of the main reasons for its popularity lays in the fact that intermittent exercise strongly relates to many real-life sports situations in which high-intensity efforts (i.e., above CP) are alternated with low-intensity recovery intervals (i.e., below CP). Applying the CP model to this type of exercise offers a mathematical and physiological framework to estimate the depletion and the recovery of the so-called W': a fixed amount of energy that can be spent during exercise above CP and can be recovered during exercise below CP. In 2012, Skiba et al. developed an equation to predict the balance in W' (W'_{BAL}) at any time during intermittent exercise. In this model, W' recovery is assumed to occur in an exponential fashion with the speed of the recovery being dependent on the recovery power output. Although the introduction of the W'_{BAL} model was a big step forward towards the individual modelling of W' recovery kinetics, the results from several studies we have conducted in our own laboratory have shown the need to further improve these mathematical models and to gain a better understanding of their physiological underpinnings. First, we have demonstrated that the recovery of W' following exhaustive cycling exercise exhibits a two-phase exponential time course that is dependent on the exercise modalities of both the fatigue-inducing work bout and the subsequent recovery interval. Second, we have shown that the quantification of the recovery time constant, as it is incorporated in the current W'_{BAL} model, does not sufficiently account for changes in recovery power output in relation to the intensity domains. At last, we have demonstrated that individual differences in aerobic fitness have a significant impact on the W' recovery. To some degree, this influence may explain the large variability in W' recovery between individuals. Based on the above results, and based on the fact that we observed low predictive capabilities of the W'_{BAL} model, we recommend that future predictive models for W' recovery carefully account for these influencing factors.