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Lactate threshold and endurance performance, taken from:

Papadopoulos et al (2006). Relationship Between Running Velocity of 2 Distances and Various Lactate Parameters. International Journal of Sports Physiology and Performance. 1:270-283.

The lactate threshold is a commonly used term within the world of endurance sports and is often used to predict performance or prescribe training intensities. Lactate threshold is often described as the highest intensity at which an athlete can sustain exercise for a prolonged period but this term is very general and fails to specify exactly how long is a 'prolonged period'. It also fails to identify differences between sports and assumes that lactate levels will be the same for all activities and individuals.

What is blood lactate?

Lactate is produced as a consequence of lactic acid generation during exercise and leaves the muscles to enter the blood stream (measured as mmol). There appears to be an exercise intensity above which the body produces lactate at a faster rate than it can be removed (lactate threshold) and continuous exercise above this intensity would create a rapid upward spiral in blood lactate causing the athlete to slow or even stop. Sports scientists have proposed several different blood lactate levels as the 'lactate threshold' to include:

- The point at which lactate departed from baseline
- 1 mmol above resting baseline
- 2.2 mmol blood lactate
- 2.5 mmol blood lactate
- 4.0 mmol blood lactate

In addition to the above figures, lactate threshold has also been calculated by plotting blood lactate on a graph and examining the curve or introducing best fit lines.

The initial concern is that not all of the lactate thresholds can be correct all of the time. To set '4 mmol of blood lactate' as actual lactate threshold is simple, but does not take into account individual differences, exercise duration and choice of activity.

Papadopoulos et al (2006) constructed their research to examine all of the above theoretical lactate threshold and discover which one would be best to predict 10k and half marathon running performance.

Results

The results showed the point at which lactate departed from baseline was blood lactate level most closely associated with half marathon performance.

To be more precise, the athletes ran the half marathon with blood lactate levels of somewhere between resting and 2 mmol. During 10k running, the speed which corresponded to the lactate threshold of 2.2 was most closely associated to race pace.
These findings indicate that a single lactate threshold cannot be applied for both events, they also indicate that the speed associated with the marker of 4 mmol cannot be used for 10k running (showed least statistical significance) and in theory, athletes would not be capable of sustaining the speed associated to 4 mmol of blood lactate for prolonged periods of time.

The researchers discovered that the most accurate way to predict half marathon and 10k performance was to plot the points on a graph and examine the curve or plot best fit lines. This proved more reliable that relying upon a specific blood lactate measurement.

Discussion

The results question whether a single lactate threshold can be applied to both 10k and half marathon running, they also indicated that the pace associated with 4 mmol (commonly used as lactate threshold) would not be sustainable by runners during either event. In contrast, studies have shown blood lactate levels in excess of 4.0 mmol during cycle time trials of 60 minutes in length, suggesting that responses differ greatly between sporting activities.

One of the most interesting facts to be drawn from the results was the relationship between testing and performance. Lactate tests are carried out by gradually increasing the treadmill speed or cycle power output at regular intervals, taking lactate or heart rate samples at the end of each time interval and then comparing the results. During the maximal test carried out by subjects the lactate level most closely associated with 10k race speed was 2.2 mmol, yet during the actual self paced 10k time trial, blood lactate rose continuously, reaching almost 6 mmol by the end of the test. These results question whether the maximal testing protocol gives an accurate prediction of race conditions.
It is easy to presume that by cycling or running at a constant intensity, lactate levels and heart rate will also stay constant but this may not be the case. Consider the following scenario:

Bob completes a maximal cycle test which involves increasing the power output (watts) by 20 watts every 60 seconds until he reaches exhaustion. Mid way through the test he completes 60 seconds at 220 watts and records a heart rate of 146 and a blood lactate level of 3.2 mmol.

Do we now make the presumption that Bob can cycle at 220 watts continuously and his heart rate and blood lactate will stay constant at these levels? It is already recognised that heart rate drifts even when cycling at a constant intensity (cardiac drift), it's appears that blood lactate may well do the same, continuously rising even though a constant pace is maintained. What we actually recorded was a 'snap shot' of information within a maximal test which may not be the best way to predict heart rate and lactate levels during sustained race conditions.

Conclusion

To conclude, the following should be taken into account:

- Different threshold may occur for different sports such as cycling and running.
- Different threshold may occur for each race distance such as 10K & half marathon or 10 miles & 25 miles cycle time trial.
- Different thresholds may occur for each individual dependent upon individual physiology.
- Care needs to be taken when using maximal testing to predict or guide race performance, especially when measuring physical parameters such as HR and lactate.

If only everything was so simple!

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