THE USE OF LACTATE THRESHOLD IN TRAINING

By Richard W. Field

Richard Field discusses the concept of pulse rates to determine workout intensities and outlines how the controversial Conconi test can be used to guide and to monitor training processes. The methods described herein give the coach and athlete reasonably accurate and functional methods for monitoring and guiding the athlete to new heights of athletic performance. Reprinted with the permission of Modern Athlete and Coach.

The monitoring of an athlete's pulse during training is not a new concept, it is however a technique that is often overlooked or misunderstood. The most important energy source for intense exercise are carbohydrates. With lower exercise intensities the burning of fat as a fuel source becomes more important. With well-planned training there will be an increase in the utilization of fat as a fuel source which tends to act as a carbohydrate sparing mechanism. This will aid in improving the performance capacity (Brooks & Fahey, 1990). Improvement in this parameter is an obvious plus to athletes in many sports, yet few coaches have an understanding of exercise physiology that will enable them to develop workout schedules to improve this critical area.

To design a program which will improve athletic function relative to energy source usage, the coach must first understand the relationship of the pulse rate and physical exercise and the concept of lactate threshold. Pulse rates can be used as a measure of the intensity of physical exercise because there is a linear correlation between pulse rates and the workout intensity. When a coach knows the athlete's pulse rate percentage relative to his/her maximum pulse rate, valuable information can be obtained as to the energy sources being utilized and the effort expended during a workout.

THE CONCEPTS

Critical to the relationship of the pulse rate and the workout intensity is the fact that pulse rates and intensities are not parallel at higher workout intensities. There is a point during intense exercise where intensity continues to climb, but the pulse rate begins to lag behind. This is the pulse rate deflection point which corresponds to the lactate threshold. This deflection indicates the point at which the athlete shifts from a predominantly aerobic (with oxygen) energy supply to an increasing reliance on anaerobic (without oxygen) energy systems (Brooks & Fahey, 1990).

The deflection point is highly individual and, as mentioned before, is subject to changes relative to the athlete's training status. The lactate threshold can be found at this deflection point. It indicates that this is the highest intensity, or pulse rate, at which aerobic fuel sources are primarily used. Beyond this pulse rate or intensity level, lactate levels will rise dramatically as the anaerobic energy systems begin contributing significantly greater portions of the fuel needed to continue exercise (Brooks & Fahey, 1990). Lactate is a by-product (waste product) which occurs during the oxidation of glucose with insufficient oxygen. Understanding these concepts will not only allow the athlete to train more efficiently (preventing workouts of excessive intensity and allowing the athlete to work aerobically for increasing workloads), but will increase one's competitive potential as well (by increasing the percentage of the maximum oxygen uptake on VO_2 max at which the athlete can perform for a longer time period).
In addition, there are several disadvantages to the athlete relative to high lactate levels which include the following:

- High lactate concentrations cause an acidosis in and around muscle cells.
- High lactate values disrupt coordination.
- High lactate values increase the risk of injury.
- High lactate values disrupt the creatine phosphate energy system.
- High lactate values slow down the oxidation of fat (Janssen, 1989).

A final advantage of knowing the deflection point is that it allows the coach to optimize endurance training which could result in improved performance concurrent with reduced training load.

THE CONCONI METHOD

How then is the deflection point found and what are its practical uses for the coach and athlete? An Italian sports researcher, named Francesco Conconi, developed a noninvasive (without taking blood samples) method to measure lactate levels. Conconi developed both a running and bicycling test to establish the lactate threshold from his research with well trained athletes. According to Conconi these tests have a correlation coefficient of .99th invasive laboratory tests for measuring he deflection point (Janssen, 1989).

In the running test for lactate threshold measurement the athlete starts with a warm-up of 15 to 20 minutes. The test will be conducted on a 400m track with stations 1 and 2 set up at both start and finish of a normal 200m run. Both heart rates and pulse rates will be measured and recorded at each of these stations. Pulse rate recording is facilitated if the athlete is wearing a heart rate monitor, however in the absence of this device standard measurement techniques of the carotid or radial pulse for fifteen second intervals will suffice.

The athletes begin by running the first 200m in 70 seconds if untrained, or 60 seconds if trained. Every successive 200m is run 2 to 3 seconds faster, with those at the end of the test being 1 to 2 seconds faster. The athlete pauses at the end of each 200m segment only long enough for the recording of pulse and time data and then accelerates into the next 200m section. The test goes on until the athlete cannot accelerate any more. It is necessary to insure a thorough warm down of the athletes following the test.

The 200m times are then converted to a pace in kilometres per hour by using the formula: 720/time. Once this conversion has been accomplished the results should be plotted on a graph. The vertical or Y axis is for the pulse rate and the horizontal or X axis is for the pace in kilometers per hour. It will be helpful to know that the deflection point is often at, or near, a pulse rate of 210 minus age. This point corresponds with the lactate threshold and will now yield specific pulse rates or a running pace corresponding to this threshold (Janssen 1989). Using 165 beats per minute as an example, Janssen gives the following intensities with suggested durations of training runs:

100% — 165 bpm — 6 to 12 min
97% — 160 bpm — 20 to 30 min
90% — 150 bpm — 30 min
80% — 140 bpm — 50 to 90 min
75% — 135 bpm — 90 to 120 min

(Percentages indicate percent of pulse rate at the deflection point).

To conduct the bicycle ergo meter test the following is needed:

- A bicycle ergo meter with a RPM meter and a meter for the number of watts (measure of the workload) performed.

- An individual to record pulse rates and adjust the workloads.

After a 10-minute warm-up the test may begin. Untrained athletes (or the unfit) start at a workload of 150 watts and trained athletes start at 200 watts. Pulse rates are measured every minute of exercise. Pedaling frequency must be kept at a constant level. The recommended frequencies are either 70 or 80 rpm's (it is not allowable to go between the two frequencies).

The workload is increased by 10 to 20 watts every minute and continues until the athlete can no longer keep up the set rpm speed or failure due to exhaustion. The data is then plotted with the pulse rates on the Y axis and the workload in watts on the X axis. This particular version of the Conconi test is easy to administer to several athletes at once (assuming bikes and data recorders are available) and does not invalidate the test results if the athlete has no previous knowledge of the pace in the running test (a critical factor in the gathering of valid data in the running test). Either test is an excellent tool to measure changes in the state of the athlete's conditioning level. When the endurance capacity has improved, the curve will move to the right and the deflection point will equate with a higher pulse rate (Janssen, 1989).

The test can be repeated monthly, but it must be repeated under similar conditions. In order to establish reliability the following rules should be adhered to:

- Test under the same conditions at the same time of day.
- Allow no heavy meals for 5 hours prior to the test.
- Do not drink alcohol for 24 hours prior to the test.
- Make sure the athlete gets a good night's sleep prior to the test.
- Do not allow coffee, tea, or coca cola in the hour prior to the test.
- Do not train or do hard physical work on the day of the test, or the day before the test.
- The testing area should have a constant temperature and air humidity.
- Do not test athletes when they are ill or feverish.
- Make sure that an adequate warm-up is performed prior to each test. (Janssen, 1989).

IN SUMMARY

In summary, the practical benefits of using these tests are varied. Not only does knowledge of the deflection point allow the coach and athlete to plan better workouts, it also allows to optimize competitive performance. With this knowledge the athlete can avoid workouts which are either too long or too intense (or both), by knowing the deflection point and monitoring heart rates during practice.

In addition, the repeated use of the pace which corresponds to the deflection point will allow the athlete to compete at this pace until such time as he/she needs to increase the pace and recruit anaerobic energy sources. This will allow the athlete to race and train more efficiently. By using the heart rate and percentage method of training (example given within this text) the coach can give the athlete a specific heart rate to follow, a rate that corresponds with a given intensity level relative to the deflection point. Not only can workouts which are inappropriate for the individual or the specific phase of training be avoided, but injury risk, overall fatigue, and recovery times can all be substantially reduced. Finally, the methods described herein (used in conjunction with A.M. pulse rate monitoring) give the coach and athlete reasonably accurate and functional methods for monitoring and guiding the athlete to new heights of athletic performance.