THE USE OF LACTATE CURVE IN THE TRAINING OF MIDDLE-DISTANCE RUNNERS

Marcel **NEMEC**

Faculty of Sports, University of Prešov in Prešov, Slovakia

Key words:
- anaerobic threshold,
- middle distance,
- running,
- training,
- performance capacity.

Abstract:
At present lactate curve is used to determine the state and changes in the training level in middle and long distance runners. The purpose of the research was to determine the anaerobic threshold using the lactate curve and to verify laboratory-based data by means of a running test. The collected data were used to modify training load, which induced positive adaptational changes in running performance capacity.

INTRODUCTION

Qualitative changes in the performance of middle-distance runners (800m, 1,500m, 1 mile, 3,000m and 3,000m steeplechase) are induced by altering the ratio of exercise intensity and volume that are determining in terms of performance enhancement [4]. Achieving high performance level in middle-distance running events depends on the efficiency and economy of particular systems providing energy supply during performance itself [7]. With respect to bioenergetic contribution in middle-distance running, the determining factors are aerobic power, anaerobic lactacid power and anaerobic alactacid capacity [5]. The intensification of aerobic training requires sufficient preparation targeted at the development of aerobic capacity. Without sufficiently developed aerobic capacity athletes will be unable to sustain high-quality “performance-oriented” training load, which would induce performance gains [6].

The basic parameter of anaerobic endurance is the level of maximal excess post-exercise oxygen consumption and the ability to tolerate high levels of blood lactate during middle-distance running events [11]. Anaerobic threshold (AT) refers to maximal exercise intensity at which during prolonged exercise dynamic balance is maintained between lactate production in the working muscles and its removal by the cardiac muscle and the less working muscles [10]. In trained runners, the mobilization of the dynamic balance of lactate level starts at 70 % of relative exercise intensity [14]. Bunc [3] defines AT as the deflection point of the curve which is indicative of the relation between lactate level and exercise intensity. Bielik [1] consider AT one of the most important parameters with regard to the prediction of endurance performance. Pupiš, Broďáni [12] regard the AT to be a physiological parameter that determines the maximal limit for endurance development. One of the options of determining the actual functional capacity of an athlete is to assess the relation between the course of lactate concentration and incremental exercise indicated by the so-called lactate curve [3].

Using the course of the lactate curve enables to determine the effectiveness of prior exercise bouts and also to determine the most effective training intensity for the development of aerobic and anaerobic fitness of runners [13].

THE AIM OF THE WORK

The purpose of the research was to determine the anaerobic threshold using the lactate curve and to verify laboratory-based data by means of a running test. The collected data were used to modify training load, which induced positive adaptative changes in running performance capacity.

THE MATERIAL AND THE METHODOLOGY

The lactate curve of runner M.B. (Table 1) was obtained using field-based incremental running test performed on a 300-meter synthetic athletic track.

Table 1. Basic data about the middle-distance runner

Name	Date of birth	Body height	Body mass	Running events - specialization	Personal bests in 2011
M.B.	1984	180	65	800m 1500m	800m 2:00.16 1500m 4:25.32 5000m 15:52.63

The test consisted of running incremental running lengths followed by sampling of capillary blood. The runner ran for a total of 10 minutes and underwent blood sampling during the 2-minute rest period. The runner was asked to run the lengths at a set 1km pace that was based on the pace in the 5km race in the personal best time of 15:52.63 minutes. The purpose of the test was to induce the state of maximal exercise, which determines the maximal lactate production.

The baseline testing adhered to the following procedures:

1st length – aerobic zone: 50-60% intensity of running
2nd length – below anaerobic threshold: 70% intensity of running,
3rd length – at anaerobic threshold: 80% intensity of running,
4th length – above anaerobic threshold: 90% intensity of running,
5th length – maximal effort: 100% intensity of running.

The re-testing consisted of 5 running lengths. The running intensity at AT was determined using the interpretation of the lactate curve. The running lengths were interspersed with a rest period during which the capillary blood was taken. The blood sample was collected within 1 minute after completion of the running length. According to the heart rate data and post-exercise blood lactate level, a lactate curve of the runner was determined. Blood sampling was performed using the Accusport device. The blood lactate level was measured using the lactate analyzer Biosen 5130, which allows for the collection of constant sample volume of capillary blood of 20 µl and measurement error of less than 3% at 12 mmol/l. Heart rate was recorded using heart rate monitor Polar S 610i with 5-second monitoring intervals.

RESULTS

The purpose of the experimental study was to determine AT using the data based on the course of the lactate curve with subsequent retesting to verify the adaptive changes in the energy systems of runner's organism. As seen in baseline testing (Table 2) consisted of running lengths incrementally in order to induce the state of maximal lactate production.

Table 2. Results of the baseline testing of the runner M. B. (4/20/2011)

M.B.	100	150	300	Pace per km	Time	Number of laps	Running speed km/h
1.	00:26.5	00:39.7	01:19.4	04:24.7	05:17.6	4	13.60
2.	00:23.8	00:35.8	01:11.5	03:58.4	05:21.8	4.5	15.10
3.	00:21.7	00:32.5	01:05.1	03:36.9	04:52.8	4.5	16.60
4.	00:19.9	00:29.8	00:59.7	03:18.9	04:58.4	5	18.10
5.	00:18.4	00:27.6	00:55.1	03:03.7	05:03.1	5.5	19.60

Runner M.B. ran 4 lengths, but was unable to run the fifth length (Table 3). The failure to finish the testing may be attributed to high exercise intensity in the aerobic zone as demonstrated by the values of average and maximal heart rates during the running lengths 3 and 4. The results of the baseline testing include relevant data for the determination of the lactate curve, which was used to set the AT value of the runner M.B.

Table 3. Results of the re-testing of the runner M. B.

Running length	Lactate mmol/l	HR Av	HR MAX	Time	Km per hour	Pace per 1 km	Pace per 100m
1.	1.4	155	159	5:24.0	13.33	4:30.0	00:27.0
2.	2.0	178	181	5:28.0	14.82	4:03.0	00:24.3
3.	3.5	189	193	4:53.0	16.59	3:37.0	00:21.7
4.	7.4	201	204	4:59.6	18.02	3:19.7	00:20.0
5.	Not completed	-	-	-	-	-	-

The course of the lactate curve of the runner is indicative of the dependence of lactate concentration on exercise intensity as well as the ability to perform the exercise bouts in aerobic and anaerobic training zones, which is shown by the angle between the ascending part of the lactate curve and the horizontal axis of exercise (Figure 1). The angle of the course of the lactate curve in the runner M.B. equals 52°, which shows well-developed anaerobic capacity of the runner.

The heart rate values and blood lactate measured during the baseline testing were used to obtain the course of the lactate curve of the runner. Subsequently, physiological values such as well as the running pace at anaerobic threshold were determined in order to achieve desirable training effects.

Table 4. Values of the runner M.B. based on the course of the lactate curve

Parameters	Value	Unit
Heart rate at AT	190	bpm
Lactate at AT	4.1	mmol/l
Running pace at AT	3:33,02	min/km
Running speed at AT	16.9	km per hour

The control running test performed by the runner at his individual laboratory-based anaerobic threshold was conducted in order to verify the accuracy of the determined pace parameters at AT (Table 5).

Table 5. The results of the control running test of runner M.B. at laboratory-based AT

Running length	Pace per 1 km	HR Av	HR MAX	Time	Lactate
1.	3:33.0	171	184	10:01.4	3.9
2.	3:33.0	167	172	10:01.0	4.2
3.	3:33.0	167	171	10:01.1	4.3
4.	3:33.0	167	173	9:59.7	4.3
5.	3:33.0	166	177	10:01.6	4.9
6.	3:33.0	168	176	10:01,4	5.1

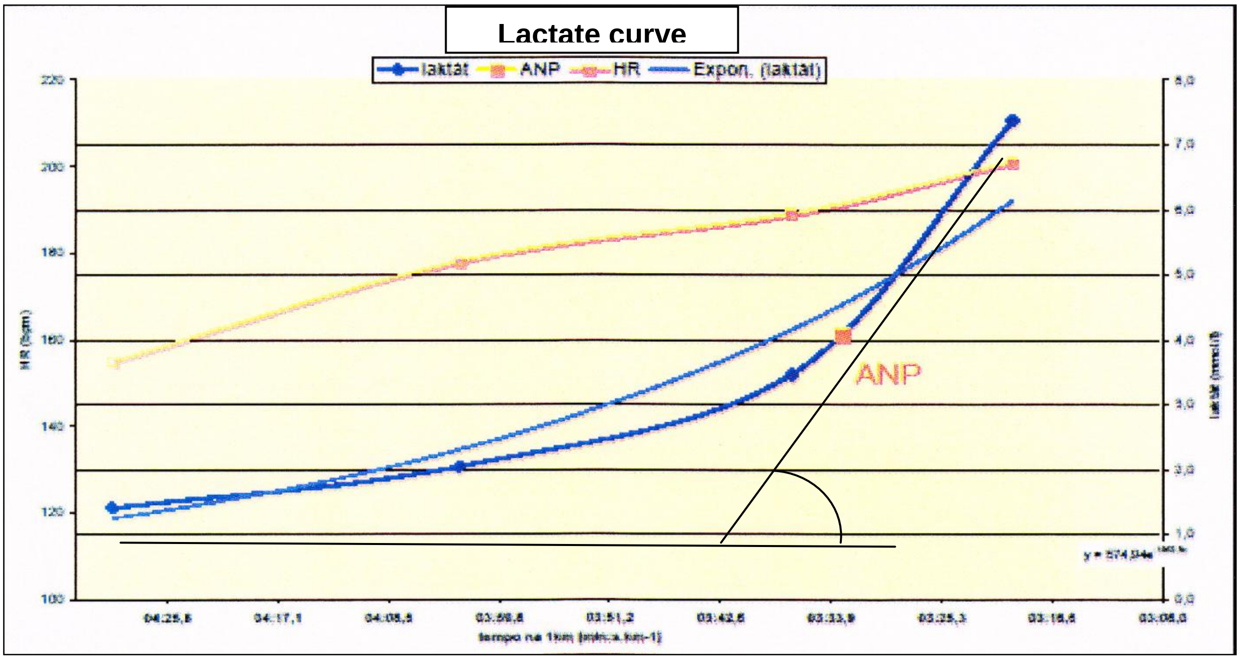

Figure 1. Lactate curve of the runner M. B.

The course and the results of the running test that consisted of running 5 lengths at the level of laboratory-based anaerobic threshold confirmed the ability of the runner to maintaining the pace set at 3:33,0 min/km, which was equivalent to LA 4.1 mmol/l. The recorded values of both average and maximum heart rate were almost equal to the generally accepted norms (Figure 2). Undergoing the running test of the total distance equaling 17.192 meters in 1 hour and 62 seconds at the running pace equivalent to 21.3 seconds per 100 meters demonstrates adequate pacing, which the runner was able to follow. The course and the results of the control running test showed that running pace of 3:33,0 min/km refers to such running intensity which in the runner M.B. positively stimulates the upper zone of aerobic endurance. With regard to study findings, we agree with Soumar, Soulek, Kučera [13], Greene, Pate [8] , Janssen [9] who in order to progressively develop aerobic endurance recommend exercise intensity approximating the AT. It should also be noted that AT is to be understood not as a determined exercise constant, but as a determined exercise zone.

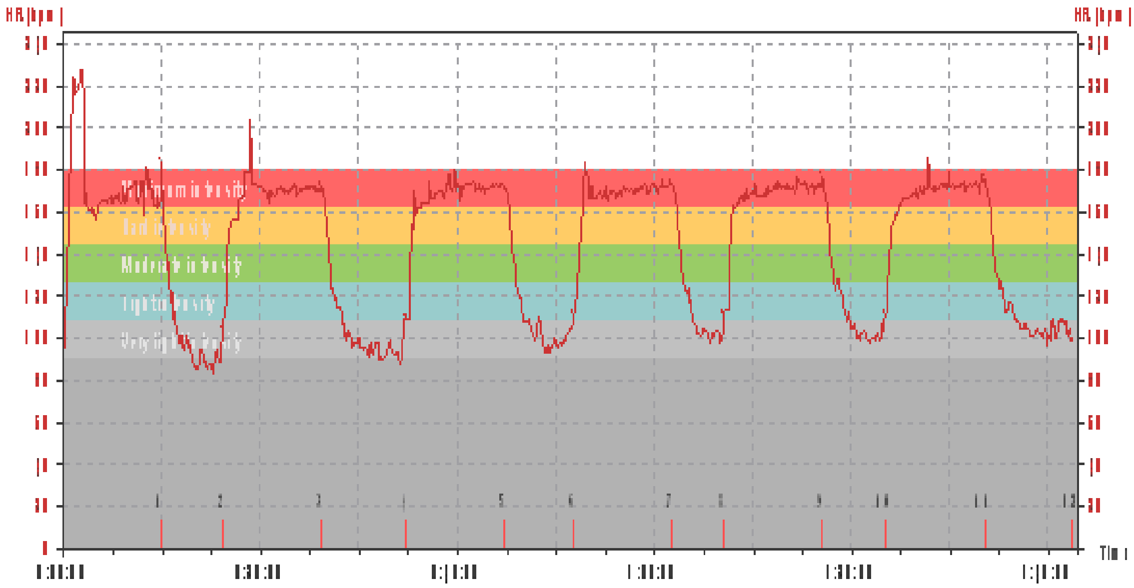

Figure 2. Course of the heart rate during the control running test at the laboratory-based AT of the runner M.B.

CONCLUSIONS

The determination of AT in a middle-distance runner using a lactate curve is one of the effective means for the control of the training process. The research findings have shown that the determination of individual running speed, blood lactate level and heart rate zone at AT is also one of the most beneficial means for the control of the training process. The modification of training load using a lactate curve in the outdoor season 2011 resulted in enhanced performance in the running events of 800m and 1,500 meters. The runner M.B. improved his personal bests in 800m by 1.28 s to 1:58.88 and in 1,500m by 15.8 s to 4:09.52 min.

Significant enhancement of running performance in runner M.B. is evident in 1,500 meters running event. His performance improved as a result of enhanced and more economical functioning of the aerobic metabolism. The performance itself is determined by other functional parameters, the percentage of VO_{2max} utilization and the organism's ability to tolerate blood lactate levels, the energy stores and also enzymatic processes, which in a complex manner underlie the biochemical processes. The study results are applicable as an appropriate means for the control of the training process, the efficiency of which is determined by the exercise testing methods used to assess and control the state of training. We are aware of the fact that the efficiency of training control is determined by accepting the individual specifics of athletes that manifest in the values of parameters measured. Therefore, it is desirable that coaches take into account these specifics when designing training plans in order to prevent undesirable generalization and application of negative training stimuli.

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