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Assessment of an International Breaststroke Swimmer Using the 7 × 200-m Step Test

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Thompson and Cooper[1] observed that improvements in the swimming speed at 2-m*M* and 6-m*M* lactate concentration coincided with improvements in competitive breaststroke performances, whereas Pyne et al[2] concluded that changes in swimming speed at lactate threshold were not directly associated with competition performances in a mixed-stroke group of 12 elite swimmers. This case study presents data from eleven (7 × 200 m) step tests over a 3-year period for a world-class 200-m male breaststroke swimmer. Personal-best race times were reduced by 9.5 seconds over this period. For this individual, step-test data provided valuable information with regard to the swimmer's readiness for performance, health and training status, and nutritional habits.

Method

A male breaststroke swimmer (world ranked among the top 10) undertook 11 (7 × 200 m) step tests over a 3-year period (see Table 1). Before each test, a standardized 1000-m warm-up was completed. All tests were completed in a 25-m pool, except for step test 10 (in a 50-m pool). Data were fitted with a third-order polynomial to provide a blood lactate–swimming speed curve.[3] The speeds at various fixed blood lactate concentrations were determined from the appropriate *y*-intercept on the blood lactate–speed curve. Stroke-rate measurements were made based on timing the fifth to the seventh stroke (Base 3 function, Timestar, Germany) in each 25-m lap. The swimmer counted the number of strokes per repetition.

Results and Practical Applications

Figure 1 demonstrates how the speed at various fixed blood lactate values fluctuated on each of the step tests over a period of 3 years. A limitation of this case study is that the frequency of testing varied because of time and competitive programming constraints. However, in most instances, step tests were undertaken after a needs analysis that identified when the tests would be of most benefit to the coach and

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Table 1 Protocol for 7 × 200-m Step Test[4]

Step	Seconds slower than personal-best time	Blood lactate*† and glucose* sampling	Timing of heart rate‡ and RPE§ measurement
1	25	<45 s postexercise	<5 s postexercise
2	21	<45 s postexercise	<5 s postexercise
3	17	<45 s postexercise	<5 s postexercise
4	13	<45 s postexercise	<5 s postexercise
5	9	<45 s postexercise	<5 s postexercise
6	5	<45 s postexercise	<5 s postexercise
7	1	<45 s postexercise, then at 3, 5, 7, 9, 11, 13, 15 min	<5 s postexercise

*Earlobe capillary blood (5-μL) samples measured for lactate concentration with a lactate ProLT-1710 lactate analyzer (Arkray, Japan) and for glucose concentration with a β-glucose 201 Photometer (Haemocue Ltd, England).

†Blood sampling continued until the lactate concentration fell by 2 m*M* or more over 2 consecutive samplings, that is, over 4 minutes.

‡Heart rate measured with a Polar Sports tester (Polar Electro Oy, Kempele, Finland).

§Borg G, Ottson D, eds. *The Perception of Exertion in Physical Work.* London, UK: Macmillan; 1986. Rating scale of 6 to 20.

swimmer with regard to the swimmer's training status, health status, and readiness for performance.

Improvements in the speed at fixed blood lactate concentrations during step tests were generally followed by improvements in 200-m competitive performances. Indeed, a ranking of fastest to slowest speeds at 6 m*M* and 8 m*M* was the same rank order as the fastest to slowest 200-m race speeds, when measured within 2 to 3 weeks of competition. The swimmer's lifetime personal best was achieved a few weeks after step test 6, where a speed at a lactate concentration of 2 m*M* was observed for the first time and the highest speeds at the various lactate values (except for the speed at a lactate concentration of 8 m*M*) were measured along with the smallest differential in these speeds of all the step tests. These findings suggest that swimming economy, lactate removal, and aerobic energy metabolism were at their most developed for low- to moderate-speed swimming when the swimmer was competing at his best. No relationship was observed between absolute peak lactate values on step tests and race times ($P > .05$), although peak lactate values of 13 to 16.5 m*M* were generally observed after the final repetition of step tests and were similar to concentrations measured after races.

Routine testing can provide an insight into how training and health status affect swimming capability. For example, step tests 5 and 9 confirmed a loss of fitness after a recent history of poor training and competitive performances because of an infection and a series of soft-tissue injuries, respectively. Step test 7 was undertaken to evaluate the swimmer after an episode of overreaching. From the results, it was interpreted that the swimmer's aerobic fitness was relatively poor, necessitating an increased utilization of anaerobic glycolysis to meet energy demands or a greater

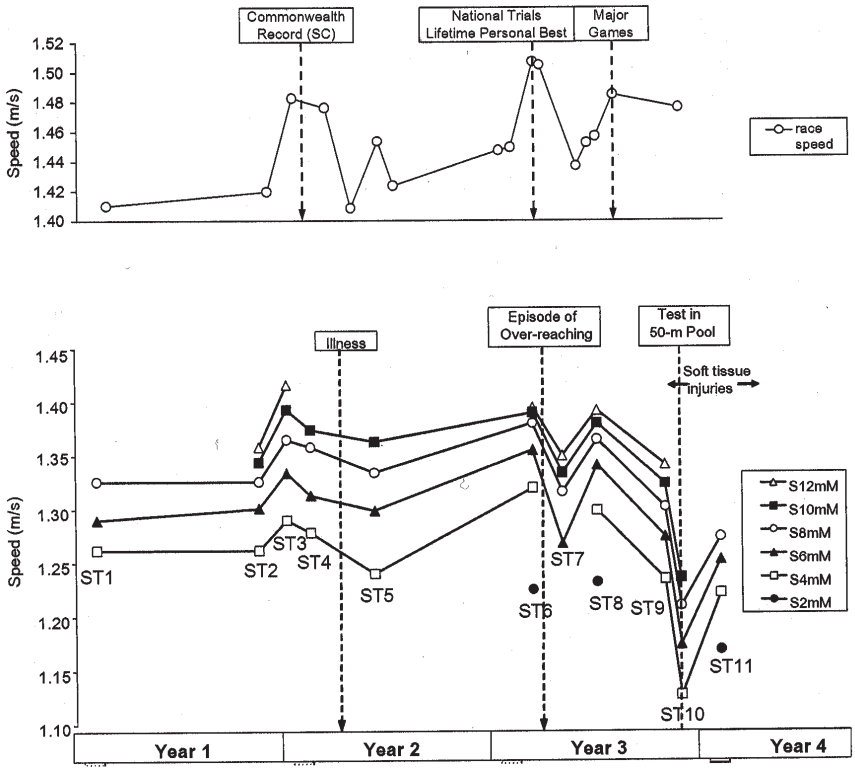

Figure 1 — The upper panel describes the competition speeds for 16 races over a 3-year period. The lower panel describes the changes in swimming speeds at reference blood lactate values from 11 (7×200 m) step tests completed over the same period of time. The label S12mM indicates swimming speed eliciting a blood lactate concentration of 12 m*M*; S10mM, swimming speed eliciting a blood lactate concentration of 10 m*M*; and so on. The label ST1 indicates step test 1; ST2, step test 2; and so on. Step test 10 was undertaken as part of a national program of testing in a 50-m pool and has been included purely to demonstrate how different the response is compared to a 25-m pool. For example, despite identical peak lactates (13.2 m*M*) on both step test 9 and step test 10 (4 weeks later), the final repetition speeds were 1.39 m/s and 1.34 m/s, respectively.

recruitment of fast-twitch fibers, even at low speeds. Elevated stroke rates and counts (compared with previous tests; data not shown) and relatively high heart-rate and lactate values for a given speed are indicative of a decline in swimming efficiency and economy. Increases in training load were carefully managed until step test 8, at which point improvements in fixed blood lactate concentrations suggested that the swimmer was again able to train at full capacity.

Although the volume of winter training was disrupted by injury, step test 11 demonstrated lower speeds at fixed blood lactate concentrations than expected. Despite a maximal effort at the end of the test (peak heart rate 191 beats/min, RPE 20), the final repetition speed and peak blood lactate value (7.2 m*M*, approxi-

mately 50% of normal) were uncharacteristically low. In addition, blood glucose concentration before the test (3.7 m*M*, normally 3.9 to 4.7 m*M*) and after it (5.3 m*M*, normally 6.2 to 8.3 m*M*) were lower than expected for this swimmer. From these results, the recent training history, and a food diary it was concluded that glycogen depletion was probably a contributing factor, and this led to a nutritional intervention (modification of timing and type of foods consumed).

References

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