HEALTH

ANAEROBIC IMPROVEMENT

With the right training routine, you can actually increase your anaerobic threshold.

By Gary Legwold

As Dag-Otto Lauritzen's expression shows, pushing beyond the anaerobic threshold can be a painful task.

Andy Coggan, Ph.D., wasn't a bad Category I cyclist in his day, winning a few district championships here and there. Now he's on a masters team and is an assistant professor in health, physical education, and recreation at Ohio State University. A few years ago this combination of brains and brawn made it possible for him to be a subject in his own research. The study was on anaerobic threshold, and it proved to be fascinating for those interested in the finer points of cycling training.

Coggan was one of 14 subjects, each with identical aerobic capacities, or maximum oxygen uptakes (VO_2 max). VO_2 max is defined as the largest amount of oxygen one can use per minute in the most strenuous exercise. It is generally considered to be the most representative indicator of cardiorespiratory fitness. Thus, the higher the number, the fitter the person. Cyclists are extremely fit as a group (only cross-country skiers are fitter), with the VO_2 max of a typical elite male cyclist being 70 to 90 milliliters of oxygen per kilogram of body weight per minute.

Each cyclist in Coggan's study was instructed to ride a stationary bike at an intensity of 90 percent of their VO_2 max, just ten percent short of going flat out. "We were told to go 'til we drop," remembers Coggan.

You would think that all 14 racers, each with identical aerobic capacities, would "drop" at about the same time. Not a chance. One subject lasted 12 minutes, while another—Coggan, as things turned out—lasted the longest by going 75 minutes before stopping. Much of the difference, explains Coggan, had to do with anaerobic threshold.

Explaining anaerobic threshold involves explaining how the body produces energy. Aerobic energy is derived from breaking down foods only when oxygen is present and used in the chemical transformations. Anaerobic energy, on the other hand, is created in the absence of oxygen.

The presence or absence of oxygen is an organic chemistry issue and does not mean cyclists use one energy system while they breathe and another when they don't. Instead, cyclists mostly use aerobic metabolism for endurance riding and anaerobic metabolism for short bursts of strenuous activity.

Those short bursts can be quite painful, especially when a rider pushes his anaerobic capacity to its limit of around two minutes. At that point, the muscles begin to give out, partly because of depletion of glycogen (a type of stored sugar that is the primary muscle fuel), and partly as a result of the rapid accumulation in the blood of lactate, a by-product of the breakdown of glucose (another sugar fuel). In aerobic metabolism, lactate is broken down for energy, while in anaerobic metabolism lactate builds up in the blood and causes fatigue. However, lactate is not all bad; after an anaerobic sprint and then a rest, the lactate is used as a fuel in the aerobic energy cycles.

Scientists such as Coggan can measure blood lactate levels during exercise to find the point at which intensity becomes too much for the overworked aerobic metabolic system and the anaerobic button is pushed. That transition point has been called the anaerobic threshold. Coggan says there is a fine-point flap in the sports medicine community (we won't go into it) about the term anaerobic threshold; it's more accurate to call it lactate threshold.

Here's an example of lactate threshold

in cycling. A fit recreational cyclist may be able to ride somewhat easily, and therefore aerobically, for hours at 20 mph. In the lab, scientists measuring blood lactate see nothing to speak of—practically a flat line on a graph. Same at 21 mph, 22, and 23, although they may notice that the cyclist is now puffing a bit. Then, at 24 mph, bingo, the blood lactate level starts climbing. This is the lactate threshold. Go much above this threshold—26 mph, say—and fatigue will close in fast.

Now let's go back to Coggan's study and see how lactate threshold played a part in separating the field among the riders with identical aerobic capacities. The worst performance, from the rider who stopped after just 12 minutes of riding at 90 percent of VO_2 max, had a lactate threshold of 59 percent of his VO_2 max. Coggan, on the other hand, was the winner, with a lactate threshold of 86 percent. Not only did he have more time than the 59-percent subject before being forced to go anaerobic, but Coggan also was only slightly above his lactate threshold when riding at the required 90 percent VO_2 max.

Studies show exercising at or near lactate threshold is manageable for extended periods. But when you go well above the threshold you quickly burn out, as the 59-percent subject did when riding 31 percent above his lactate threshold. As a result, Coggan's blood lactate was six times normal after 75 minutes while the 59-percent subject had 18 times normal lactate after just 12 minutes.

So now you're all excited about determining your lactate threshold, right? Unfortunately, the only way to get the hard number is to plunk down $300 to $500 for lab testing at a university or sports medicine center. But with some patience, a bike computer, and a heart rate monitor or stop watch, you can come up with a pretty good estimate on your own.

On a windless day, find a flat one-mile loop and progressively ride it faster, says Ed Burke, Ph.D., associate professor of biology at the University of Colorado in Colorado Springs. Keep track of your speed and breathing rate. What will happen is "all of a sudden, say at 24 mph, your respiratory rate goes up quickly," says Burke, because blood lactate is building up and then metabolized to produce carbon dioxide. The brain detects a CO_2 buildup and signals for faster breathing. Thus, 24 mph is close to your lactate threshold.

Do this several times on separate days. If you find your lactate threshold to be at 24 mph or thereabouts on a consistent basis, then back up this reading with a heart rate reading. You can do this somewhat crudely by checking your pulse at 24 mph for ten seconds and multiplying by six, or more accurately by checking a heart rate monitor. Regardless, try to get a consistent reading of your heart rate at 24 mph. Then test that number by riding at 25 and 26 mph. If 24 mph is your lactate threshold, your heart rate, which has been increasing gradually, will rise more dramatically at 25 and 26 mph.

If you want to get fancy, you can determine your lactate threshold as a percentage of VO_2 max. On a course that's free of traffic, push your speed up until you reach your maximum effort. That should correlate to your VO_2 max. Check your monitor or take your pulse to get a good idea of your maximum heart rate. If the monitor holds at 200 bpm as you are going all out, you know that your lactate

threshold is about 75 percent of your VO_2 max (assuming that your lactate threshold is 150 bpm). You can also determine your max heart rate by subtracting your age from 220, but it's a crude formula which may deviate by as much as 15 bpm from your actual maximum rate.

Once you determine your lactate threshold, the question becomes: How do you make it higher? The threshold for some people is already high because they "picked their parents well," quips Jennifer Stone, ATC, head athletic trainer at the U.S. Olympic Training Center in Colorado Springs. That is, genetics can affect a host of variables that contribute to a high lactate threshold.

But training is also a part of a high lactate threshold. Aerobic training raises VO_2 max. If you raise your VO_2 max from 40 to 50 milliliters/kilogram/minute and your lactate threshold stays at 75 percent of VO_2 max, you can now ride until your oxygen output is 37.5 ml/kg/min, versus 30 ml/kg/min, before starting to make the anaerobic shift. This means you can go longer before fatiguing.

Finally, you can increase lactate threshold as a percentage of VO_2 max by training at or near lactate threshold. Studies show genetics and aging set a limit on improving VO_2 max. But, says Coggan, once you reach that limit you can still slowly increase lactate threshold for years afterward with regular training. This involves hard one-to-two-minute efforts at the threshold, backing off for a few minutes to recover, and then pushing again, and again, and again. If that sounds monotonous, do it as part of a group ride and it can be fun. Go to the front, ride hard for a minute or two, then peel off and let someone else have at it while you hide in the back to recover for a few minutes. Do this two or three times a week and gradually increase your time at the front.

A recent study published last year in *Medicine and Science in Sports and Exercise* demonstrated the benefits of adding a little speed work into a training program. Researchers in Norway determined the anaerobic capacity, which they defined as the maximal amount of energy available from anaerobic sources, of physically active recreational athletes with a history of jogging two to four times a week at an endurance pace. When the subjects added anaerobic, or sprint, training, which in this study consisted of sets of interval training (hard surges with brief rest in between) three times a week, they found that their anaerobic capacity increased by ten percent after six weeks.

The study demonstrates the importance of specificity and variety in a training program. What it doesn't show is perhaps even more important, however. Speed training feeds endurance by increasing the lactate threshold and letting you ride farther at a given speed than before. Plus, if a sudden surge is required, or if you're required to climb a steep hill, lactate threshold training will help keep your heart rate from spilling over into the dreaded territory of anaerobic metabolism, with its draconian two-minute time limit before exhaustion.

Knowing, or at least knowing about, lactate threshold is knowing about pushing biological limits in training so that when the push is on in a ride you'll be ready. Says Jean-Anne Simoneau, Ph.D., assistant professor of physical education at Laval University in Québec, "Lactate threshold is a training tool that will help you do your best." □