Principle energy systems involved in 1500m racing- Consideration for race tactics

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Middle-distance runners are probably some of the most dynamic and uniquely adapted athletes in the entire world, as they can handle an unbelievable range of metabolic stresses, distances and intensities in their training and racing. This is why most middle distance runners can run some of the best times in the world in everything from the 800m to the 10,000m events and elite athletes, such as a Peter Snell, could do marathon type training and yet still run under 47-seconds for the 400m. This unbelievable range in racing is accomplished through a yearly plan to maximize and optimize the humans' three unique evolutionarily developed metabolic human energy systems. This allows for optimal race performance, and arguably the race that stresses these energy systems the most is the mile, or the metric mile of 1500m.

It is well established among exercise physiologists that among nearly all sporting events the mile, or 1500m, produces the *highest* levels of blood and muscle lactate ever recorded in the human, which is a direct consequence of the utilization of the anaerobic energy system. Yet, these races still have an overall aerobic energy contribution of about 75 to 85% (depending who you talk to, see below), and the creatine-phosphate (CP) system is also vital in race tactics and the final finishing drive to the tape.

It should stressed that traditionally it was thought that in the 1500m the relative energy contribution was 75% aerobic, 22% anaerobic and a 2-3 % of the energy coming from the creatine-phosphate system. But recent evidence has strongly suggested an even greater energy contribution from aerobic sources during middle distance running. In fact, Spencer and Gastin (Med.Sci.Sport Exerc., 2001), of the Australian Institute of Sport re-evaluated the energy contributions during middle distance running in highly trained and elite athletes and found that the relative contribution of the aerobic energy system during track running is considerable and greater than originally thought. They found that during 800m and 1500m races, aerobic energy provides 66 and 84% respectively. Therefore, coaches should possibly reassess some of their training intensities and time spent training the different energy systems, as this would suggests that aerobic development and aerobic power are even *more* important than once thought (but this could be another whole article and not the emphasis here). Nevertheless, all three of these systems have to be considered, not only when trying to optimize overall speed and performance, but also when considering race tactics and final winning percentage.

Making senior-type athletes more aware of these energy systems and their physiological functions, limitations and potential is vital to race tactics and something probably not nearly addressed enough in our sporting community by coaches and thus will be the general scope of this article. As background, each energy system has some pros and cons. The CP systems strength is that it can provide energy very quickly and can be replenished very quickly as well, but unfortunately is very limited in terms of absolute overall energy provision to the athlete and the amount that can be stored. The anaerobic system can also continue to provide energy quickly, and at a high level of intensity, which is necessary in middle-distance events. However, its drawback is its primary by-product, the adverse lactate, which decreases muscle enzyme function and ultimately muscle contractile processes. Finally, the major contributor of energy in the 1500m is the aerobic system which can provide lots of energy for long periods of time, and it doesn't have many adverse by-products, but unfortunately cannot exclusively meet the energy demands of the 1500m, in-terms of intensity.

Before a race effort, it is vital, in terms of the body's metabolic machinery, to do a thorough warm-up to optimize the utilization and overall per cent contribution of the aerobic system during the early portions of the 1500m race. By increasing an athlete's relative utilization of the aerobic system, and limiting the early use of the anaerobic system, they will produce less of the adverse lactate. It has been definitively shown in research that a good warm-up before a tough effort will decrease the overall amount of lactate production by allowing more of the energy to be produced aerobically instead of anaerobically.

In a middle distance event when an athlete comes to the starting line, the energy system used to get that athlete up to race speed in the first 40-50m, after the gun has been fired, is primarily the CP system regardless if the race is the 100m dash or the 1500m. It has also been shown in exercise physiology research that, as a rule of thumb, regardless of how hard you get off the line in the first 40-50m, the athlete will produce approximately the same amount of lactate, which is relatively low, since the anaerobic system hasn't had time to fully activate yet. Therefore, tactically, a good recommendation to make to the athlete is to get off the line, in the first 40-50m, as hard as he or she can, before settling in. By getting off the line as fast as an athlete can, they will both set themselves up with a good strong fast early rhythm, but also by getting near to the front of the pack or cut-in, such as in a 1-turn stagger in an 800m race, they will be better able to "choose" their position in the early portions of the race. A coach and athlete *does* need to be weary of extending the initial 40-50m acceleration off the line for too long, as after this initial section of racing, and once the anaerobic system has more time to activate fully, a large bolus and surge of lactate could quickly temper the runners early aggressive pace. Thus urging the athlete to get into his or her race pace after the first 40-50m is also vital so as to not unnecessarily load the muscles with lactate. Of course the best way is to mimic race starts, with timing different 50m sections, in practice so the athlete is "hardwired" to optimize their start come race time.

One of the positive points of the CP system is its ability to regenerate very quickly to once again provide a sudden burst of energy, as long as there is 'extra' ATP available to regenerate the creatine-phosphate. In other words, the CP system can only regenerate when the body is not under metabolic and physical stress that can be found during the *last half* of 1500m races. Knowing the physiological limitations of the CP system during the early portions of the race, can once again, provide insight into the best tactical racing plan for the first half of the 1500m. Like described before, getting off the line quick will indeed use up some of the CP systems limited reserves, but as long as the athlete runs within his or her abilities and fitness level, and as smooth, even paced and consistent as possible through the first 800m, the CP system will at least partially regenerate and be ready to use for that final vital kick for home over the last 60-80m of the race.

Urging athletes to be confident in their abilities, even when not near the front of the pack for the entire race is important. Urge the 1500m runner to put him or herself in the desired tactical position with 300-500m to go and *not* to worry about early position through the first 1000m of the race. So many inexperienced athletes make sudden bursts and sudden moves to put themselves in the lead *several* times during the first 1000m of the race, only to be boxed in once again- to making another big move to the front- to be boxed in again- to making another burst to the front. Making sudden bursts uses up the limited CP reserves and allows for no regeneration, especially in the last half of the race when lactate levels are increasing. Then this athlete will most certainly be out-kicked in the last 50-60m, regardless of the athletes overall leg speed. Instead, having the athlete run even and consistent will put them in the same position overall anyway and then making a slow and easy surge to the front at the desired time of the race will spare the CP reserves for that final burst at the end of the race, when they really need it.

Again knowing these CP reserves and an athletes specific high-end anaerobic speed threshold, comes in handy when coming up with a race plan, and specifically, *when* to kick and

make your final burst in a 1500m race. Some coaches get these ideas, or notions, that *every* athlete should kick 300m out or 200m out, or doing a "3-step" kick 150m out or whatever. But every single athlete is not the same, or the same each season, or within a season or within a certain pace of a specific race, and thus, using these cookie-cutter approaches as to *when* to kick is tactically and, most certainly, physiologically unsound. For example, if an athlete has done a lot of long anaerobic top speed type training coming into an event, and thus can handle high levels of lactate and not break down, they might be able to sustain a long ferocious kick of over 400m if the early pace of the race was slow. Conversely, if an athlete has done lots of aerobic power and base training coming into an event, they may want to really push the pace early in the race, since they know their high-end kick may only be able to last over the last 150-200m.

Hearing coaches and fans say that an athlete hasn't done enough speed work, when they are out-kicked in anything greater the last 150m of a 1500m race, shows that they are very naïve and physiologically uneducated. Pure leg speed only comes down to the last 50-60m of the race, when you fully, and finally, activate the CP system for that last burst to the tape. An athlete who is dropped anywhere from 150m out from the finish, is most generally because of a lack of aerobic base development, but more importantly, anaerobic speed endurance development in their training. Nearly all athletes could win a 1500m race if they could start the race fresh at 200m to go, when all the other athlete have already covered 1300m of racing. Therefore, most athletes' basic leg speed is fine (at a certain level of competition), but they lack the aerobic conditioning to handle the early pace of the race to feel fresh enough with 200m to go to win.

When considering all of these physiological phenomena associated with the three unique energy systems and applying them to race tactics, knowing an athletes strengths and limitations coming into a race, and assessing them together candidly, will allow the coach to go over every single race plan and scenario to optimize the athletes' potential for the win.