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Letter to the Editor

HYPERBARIC OXYGENATION AND AEROBIC PERFORMANCE

Dear Editor-in-Chief

The continuing desire to improve performance, particularly at the national and international levels, has led to the use of ergogenic aids. Ergogenic aids are defined as "a procedure or agent that provides the athlete with a competitive edge beyond that obtained via normal training methods". Random drug testing has been implemented in an effort to minimize an athlete's ability to gain an unfair advantage. However, other means of improving performance have been tried. Blood doping has been used to enhance endurance performance by improving oxygen delivery to working muscles. As oxygen is carried in combination with the hemoglobin, it seems logical that increasing the number of red blood cells (RBC's) in the body would increase the oxygen carrying capacity to the tissues and result in improved performance. The first experiments of removing and then reinfusing blood showed a significant improvement in performance time on the treadmill (Ekblom et al., 1972). This process is now known as blood doping.

Of course, this practice is not without risk. The addition of RBC's results in an increase in hematocrit causing blood viscosity to rise exponentially (McGuire and Spivak, 1993). The slowed blood flow resulting from the increased hematocrit is believed to increase the risks of thromboembolic events. Increased viscosity also increases vascular resistance requiring an increased force of cardiac contraction to circulate the blood.

More recently, erythropoietin (EPO) has been used to stimulate RBC production. However, it is less predictable than RBC infusion and the amount of RBC production cannot be predicted. This places the athlete at greater risk for complications from increased blood viscosity. There has been speculation that EPO administration may have contributed to several deaths of European cyclists (Woodland, 1991). Blood doping and the use of EPO have both been banned by the International and the United States Olympic Committees.

The goal of delivering increased amounts of oxygen to the tissues may be accomplished in another manner that, while temporary, carries minimal risk. Hyperbaric oxygenation involves providing a person with 100% inspired oxygen while in an environment where the pressure is greater than that at sea level (760 mmHg; 14.7 pounds per square inch-psi; or one atmosphere absolute-ATA). At a pressure of 2.4 ATA (45 feet of sea water) and breathing 100% oxygen there is an increase in the arterial partial pressure of oxygen (P_aO_2) from 100 mmHg to over 2000 mmHg. The increased pressure causes the oxygen to dissolve in the plasma leaving the hemoglobin carrying capacity of the RBC unaltered. Under normal conditions, almost all oxygen is transported by hemoglobin and very little is dissolved in the plasma. This sets up a very large gradient at the tissue level that can raise the tissue oxygen levels to over 300 mmHg (Lambertson et al., 1953). It has been speculated that these high levels of oxygen can remain in the tissues for two to four hours (Bannister et al., 1970).

It would seem logical then that such an elevation of blood and tissue oxygen tensions could provide a competitive advantage to athletes competing in aerobic events. In order to test this hypothesis we had experienced runners predict their times for a 5 km course and exposed them to hyperbaric oxygenation. Following exposure, they ran the course and compared actual with predicted times. Nine volunteers were solicited from the Fort Worth Runners Club and were between the ages of 18 and 65 years with sufficient running experience to be able to predict their time on a local 5 km course with which they were familiar. They reported to the Hyperbaric Medicine Facility where they received ninety minutes of 100% oxygen in three thirty minute periods interspersed with two ten minute breaks for air and liquids. They were pressurized in a multiplace hyperbaric chamber to 2.2 ATA. All volunteers underwent the exposure without incident.

Upon completion of the hyperbaric oxygenation, the runners were immediately transported to the 5 km course. The interval between completion of the exposure and the beginning of running was 30 minutes. Upon arrival at the course, runners were given an opportunity to modify their predictions when they personally experienced the weather conditions. Each runner was provided with a stop watch, started the course when they felt ready, and kept their own times. On crossing the finish line a researcher verified and recorded their times. Four runners had actual times longer than their predicted, four bested their predicted, and one runner ran the predicted time. The average predicted time was 12,860 seconds and the average actual time was 12,904 seconds. A two tailed Student's t test, assuming equal variances, provided a value of 0.98 (no significant difference).

While the hypothesis seems sound, this small test could not substantiate it. Some runners in this study predicted a time anticipating a performance boost rather than their customary time. However, the literature on this topic is also mixed (Webster et al., 1998; Cabric et al., 1991). It would also be interesting to measure serum lactate levels at several time intervals which have been shown to be affected by exercise under hyperbaric conditions (Weglicki et al., 1966). It should also be remembered that statistical validity does not always coincide with validity in competition when the difference between gold medals and nothing can be tenths of a second.

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