ORIGINAL

The Effects of an Autologous Infusion of 400 ml Red Blood Cells on Selected Haematological Parameters and 1,500 m Race Time in Highly Trained Runners

By Anthony J. Brien *, Richard J. Harris, **
and Toby L. Simon***

ABSTRACT

Blood boosting has proven to be an effective ergogenic aid in endurance events requiring energy from mainly aerobic pathways. However, no studies exist describing its effects on events demanding a substantial energy yield from anaerobic sources. Therefore, we investigated the effect of an infusion of 400 ml of previously frozen red blood cells on 1,500 meters track race time, maximal oxygen uptake, hematocrit, hemoglobin, 2,3-diphosphoglycerate, partial pressure of oxygen at 50% hemoglobin saturation, and lactic acid in 4 highly trained male distance runners. The study utilized a double-blind placebo crossover design. Performance was measured pre-infusion, post-infusion of 100 ml saline, and post-infusion of 400 ml red blood cells. Two subjects had saline first and red blood cells second, while two had red blood cells first and saline second. Data were analyzed with an adjusted F-test. After the red blood cells, hematocrit increased from 43.0± 4.3 to 47.4± 3.3 ($p<.01$); hemoglobin increased from 15.1± 1.05 to 16.2± 1.22 mg/dl ($p < .01$); maximal oxygen uptake increased from 62.5± 5.4 to 68.9± 5.6 ml/kg/min ($p<.05$). Partial pressure of oxygen at 50% hemoglobin saturation, 2,3-diphosphoglycerate, and lactic acid did not change significantly (25.6 to 24.5 mm Hg, 2.1 to 2.5 umol/ml, 7.6 to 7.4 mmol/ml). 1,500 m track race time values decreased from 4.19.5± 10 to 4.15.0 ± 8.5 min/sec ($p<.01$) and represented a major improvement for highly trained runners. Thus, RBC infusion effectively enhanced performance capacity, suggesting an increased blood buffering capability as well as an increased oxygen delivery to the working muscles.

The ergogenic effects of red blood cell infusion on aerobic events has been well documented [1, 2, 3]. However, no studies exist describing the effects of an induced erythrocythemia on competitive events requiring a substantial energy yield from anaerobic sources.

The primary physiological mechanism believed responsible for the increase in aerobic power is an

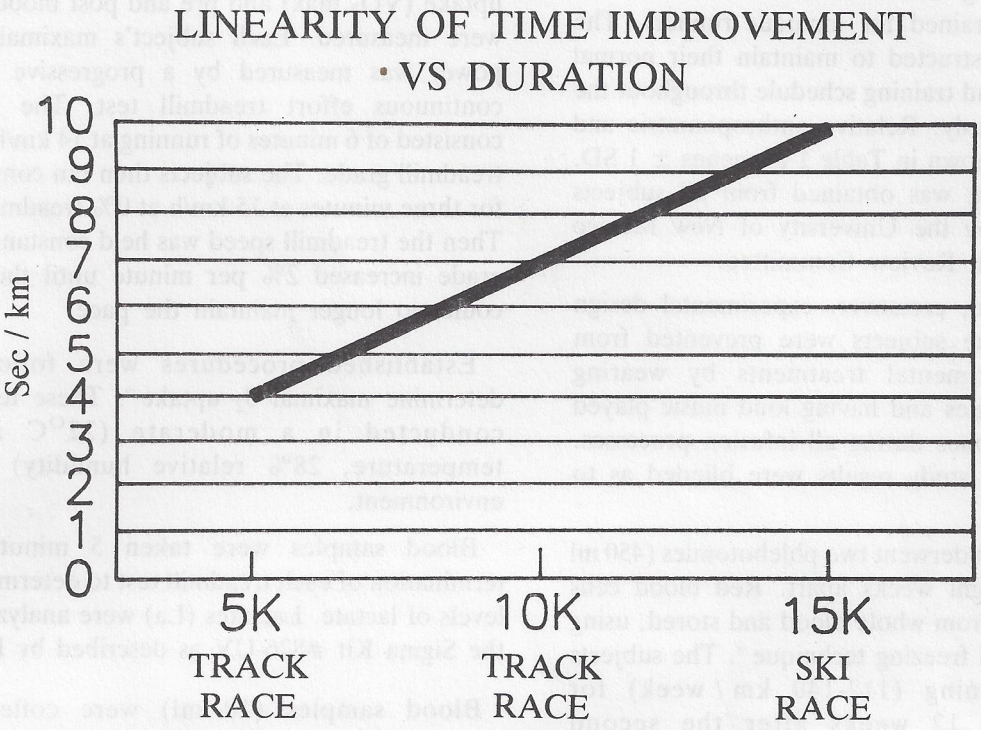
* Exercise Physiology Division
University of New Mexico
Albuquerque, New Mexico
U.S.A.

** Psychology Department
University of New Mexico
Albuquerque, New Mexico
U.S.A.

*** Pathology Department
School of Medicine
University of New Mexico
Albuquerque, New Mexico
U.S.A.

FIGURE 1

Improvement in Seconds (sec) Per Kilometer (km) for Three Different Race Distances After Autologous Reinfusion



elevated arterial oxygen content [5] but other mechanisms such as an increased blood buffering capacity [6] and expanded blood volume [7] may promote improved performance.

Performance data from field studies after erythrocythemia have shown an average improvement of 10 seconds per kilometer (15 km ski race) [2], 7 seconds per kilometer (10 km track race) [1], and 4 seconds per kilometer (5 km track race) [3]. There appears to be a linear decrement in time compared to the duration and aerobicity of the event (Figure 1). This raises the question of whether increased oxygen delivery can be of benefit in events requiring a considerable energy yield from anaerobic sources and if so to what extent? Based on the above data a time decrease of 1-2 seconds might occur for the 1,500 meters track event after induced erythrocythemia.

According to Fox & Mathews [4] the predominant energy systems used in the 1,500 meters track race are supplied by the lactic acid system (55%), the adenosine triphosphate-phosphocreatine system (20%) and the oxygen system (25%).

The 1,500 m race was selected as the performance criterion due to its anaerobic energy component and because of its link to the Olympic distances already accessed elsewhere [1, 3] in field erythrocythemia studies.

This study determined the effects of an infusion of 400 ml of red blood cells (RBC) on well trained, male distance runners in a 1,500 m track race.

METHODS

Four male distance runners were selected to participate in a double-blind study of induced