RESULTS

In the three races, the temperature (15.2°C, 15.8°C, and 16.4°C), humidity (27%, 28%), and wind velocity (9.5, 10.2, 8.8 km/h) were similar. All subjects showed significant increases in VO_2 max ($p<.05$), Hb ($p<.01$), and Hct ($p<.01$), as well as a significant ($P<.01$) decrease in 1,500 m track race time.

Figure 2 shows that Hcts were increased more than 4% by the RBC infusions. The comparisons between baseline Hct and Hct after reinfusion and between placebo and reinfusion were highly significant. In group 2, the Hct increase from baseline caused by the reinfusion persisted after the placebo. Figure 3 shows a corresponding increase in Hb after reinfusion (baseline mean 15.1±1.05 mg/dl; RBC infusion mean 16.2± 1.22 mg/dl). Maximal aerobic power (VO_2 max) at baseline was 62.5±5.4 ml/kg/min and after RBC infusion increased to 68.0± 5.6 ml/kg/min (figure 4). Figure 5 shows a decrease in 1,500 m track race time from a baseline of 259.5±10.0 s to a post RBC reinfusion of 255.0 ± 8.5 s. There were no differences for P_{50}, 2,3-DPG or La. Mean P_{5O} at baseline was 25.6±3.8 mm Hg. After RBC infusion, it was 24.5± 3.3 mm Hg. Mean 2,3-DPG level was 2.10 ±0.26 umol/ml at baseline and 2.56 ± 0.55 umol/ml after infusion. Mean La level was 7.60 ± 3.37 mmol/ml at baseline and 7.36 ± 3.85 mmol/ml after infusion.

STATISTICAL ANALYSIS

We were primarily interested in running time (RT) and hematocrit (Hct) as dependent variables, but wanted to check for very large effects on the other 5 measures as well. Further, our interest in differences among infusion conditions centered on the Saline (Sal) vs. Own Blood (OB) comparison (since that most convincingly corrects for any placebo effects) and on the difference between the effects of the own-blood infusion and the average performance under baseline (BL) and saline conditions (since we anticipated that the saline infusion would have no important effect on physiological response or on resultant performance). We did not, however, want to ignore any large effects that might show up in terms of the 4 other subset contrasts among the 3 infusion conditions (BL vs. OB, BL vs. Sal, BL & OB vs. Sal, BL vs. OB & Sal).

The analysis thus consisted of computing a total of 84 Fs for contrast (F_{contr}s), each based on 1 & 2 df: 42 contrasts testing one of 6 aspects of differences among the infusion conditions with respect to one of the 7 d.v.s., and another 42 contrasts testing the interaction between each of the 42 infusion-condition contrasts and order. In order to control for the inflation of Type I error rate that conducting 84 F-tests entails, Bonferroni adjustment [12] was applied to the individual, a priori alphas, with higher alphas being assigned to the contrasts and dependent measures of greatest interest to us. In particular, a total familywise alpha of .10 was assigned to the 42 main-effect contrasts, with .04 of this alpha being assigned to the 12 Fs involving RT and Hct and the remaining .02 assigned to the 30 Fs involving Hb, change in La, 2,3-DPG, P_{50}, and VO_2 max. Further, .035 of the familywise alpha of .10 was assigned to the 14 contrasts involving the Sal vs. OB comparison or the BL, Sal vs. OB comparison, with the remaining .03 being assigned to the 28 contrasts involving the other 4 kinds of comparisons conducted. Table 3 gives the individual alphas employed for each of the 42 main-effect contrasts. Exactly the same allocation of alpha was employed for the 42 interaction F_{contr}s.

Table 4 gives the F-ratio (with 1 and 2 df) for each of the 84 comparisons we carried out. Not surprisingly, given the large number of comparisons and the extremely low sample size, only 5 contrasts were statistically significant by the Bonferroni-adjusted critical value that assigned a total familywise alpha of .10 to the 42 main-effect contrasts and another .10 to the 42 tests of interactions with order.

1. Mean running time after the own-blood infusion (4:15.0) was significantly faster than the average of the baseline and post-saline-infusion running times (4:18.9), $F(1,2) = 961.00$.

2. The magnitude of this difference, however, interacted significantly with order: When the own-blood infusion was the last procedure, the two subjects' mean running time went from a baseline of 4:21.5 to a post-saline-infusion time of 4:22.5 and then dropped to 4:16.5 after the own-blood infusion. However, when the own-blood infusion preceded the saline infusion, mean running time went from a baseline of

FIGURE 2

Relationship between Hematocrit and Infusions. Hematocrit Increase Occurred After Infusion of Red Blood Cells and was Prolonged for 7 Days between the 1.5 km Race after Reinfusion and the 1.5 km Race after Placebo in Group 2

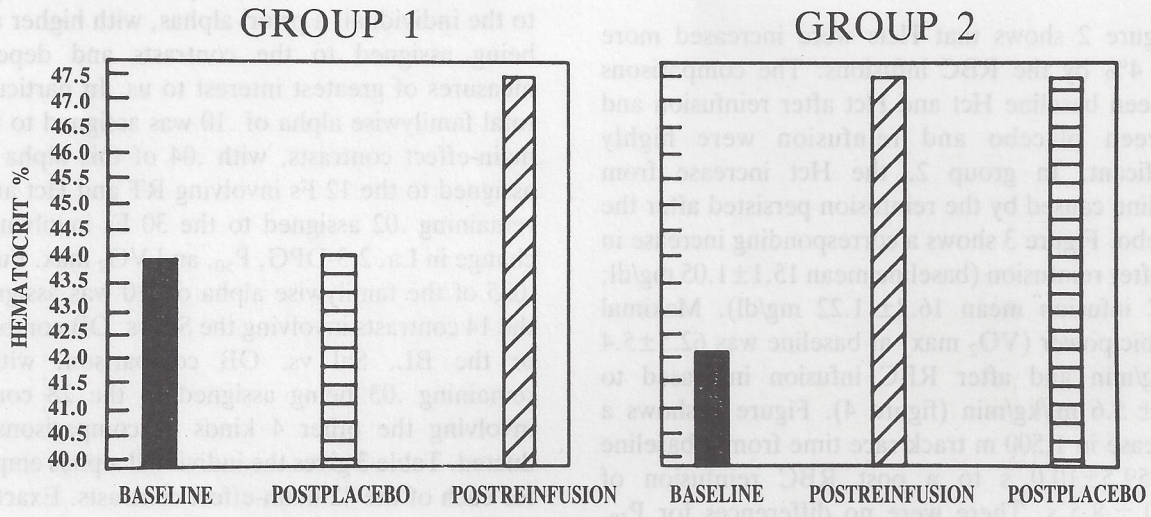

FIGURE 3

Relationship between Hemoglobin and Infusions. Hemoglobin Increase Occurred after Infusion or Red Blood Cells and was Sustained for 7 Days between the 1.5 km Race after Reinfusion and the 1.5 km Race after Placebo in Group 2

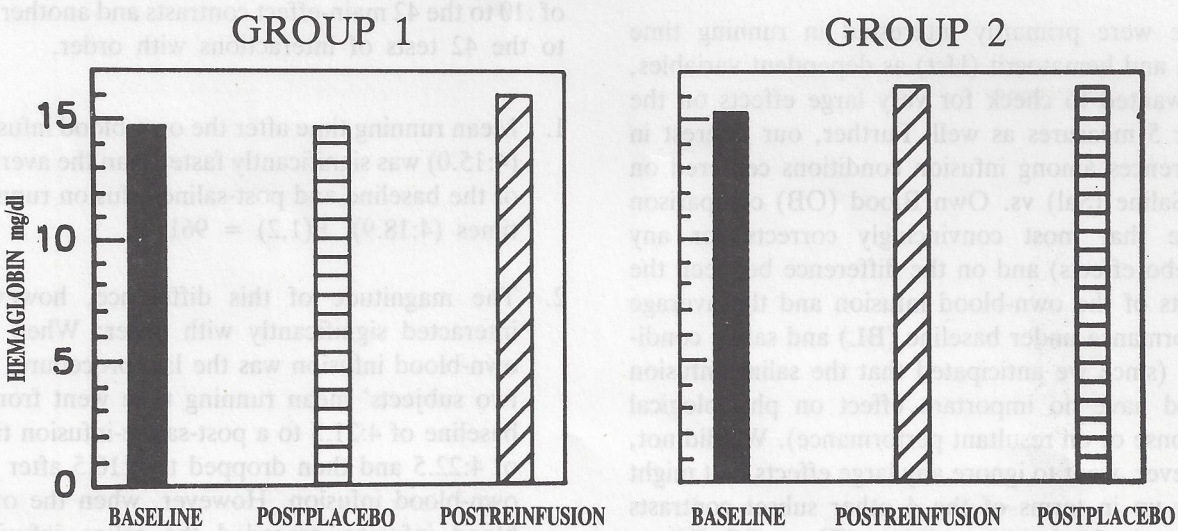

FIGURE 4

Relationship between Maximal Oxygen Uptake and Infusions in Milliliters of Oxygen Per Kilogram of Body-weight per Minute (ml/kg/min).

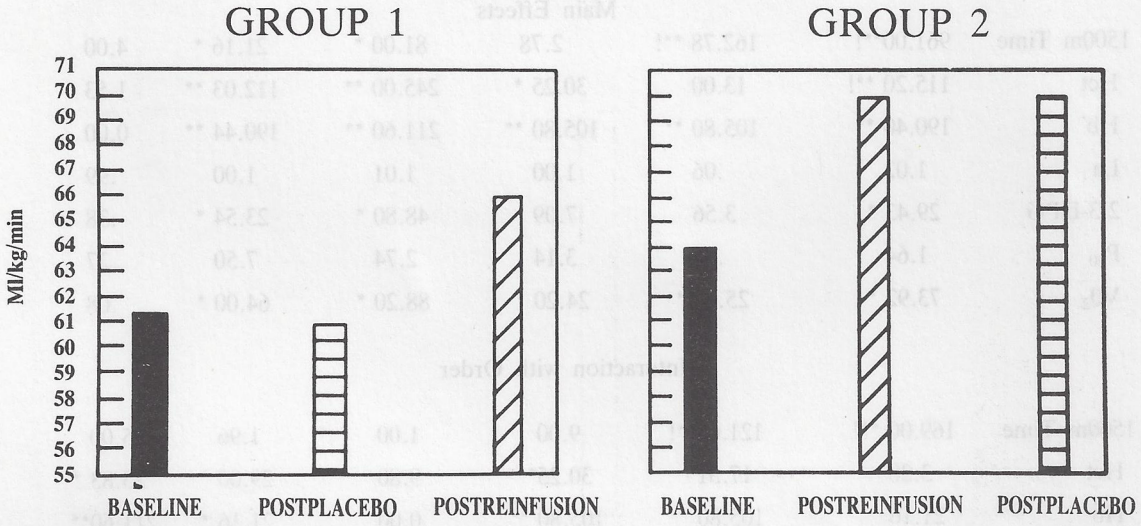

FIGURE 5

Relationship between Time to Run 1.5 km Race and Reinfusion or Placebo. In Group 1, Time Decreased after Blood Reinfusion but not after Placebo. In Group 2, Time Decreased after Blood Reinfusion and Improved Time was Sustained for 13 Days from Reinfusion of Red Blood Cells to the 1.5 km Race after Placebo Infusion

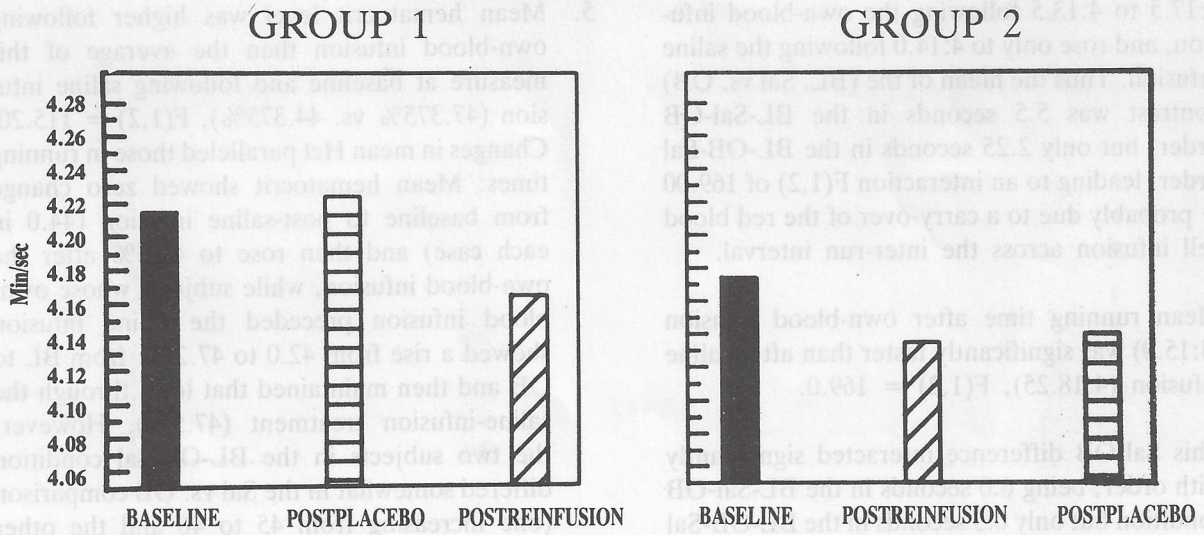

TABLE 4

F-ratios[a] for Infusion Contrasts

Dependent Variable	*BL, Sal vs. OB*	*Sal vs. OB*	*BL vs. Sal*	*BL vs. OB*	*BL vs. Sal, OB*	*Sal vs. BL, OB*
			Main Effects			
1500m Time	961.00**!	162.78 **!	2.78	81.00 *	21.16 *	4.00
Hct	115.20 **!	13.00	30.25 *	245.00 **	112.03 **	1.53
Hb	190.40 **	105.80 **	105.80 **	211.60 **	190.44 **	0.00
La	1.02	.06	1.00	1.01	1.00	.99
2,3-DPG	29.43 *	3.56	7.09	48.80 *	23.54 *	.38
P_{50}	1.64	.96	3.14	2.74	7.50	.27
$V0_2$	73.92 *	25.00 *	24.20 *	88.20 *	64.00 *	.08
			Interaction with Order			
1500m Time	169.00 **!	121.00**!	9.00	1.00	1.96	25.00
Hct	3.20	17.31	30.25*	9.80	29.00 *	25.83 *
Hb	21.16 *	105.80 **	105.80 **	0.00	21.16 *	211.60**
La	.96	1.31	1.00	.98	.99	1.03
2,3-DPG	21.88 *	10.58	.19	14.26	1.70	3.32
P_{50}	.27	.20	.05	.37	.76	.11
VO_2	3.77	25.00 **	33.80 *	1.80	16.00	40.69 *

[a] All Fs with 1,2 df.

*,**p < .05, .01 by a priori test.

! Statistically significant by Bonferroni-adjustment procedure.

4:17.5 to 4:13.5 following the own-blood infusion, and rose only to 4:14.0 following the saline infusion. Thus the mean of the (BL, Sal vs. OB) contrast was 5.5 seconds in the BL-Sal-OB order, but only 2.25 seconds in the BL-OB-Sal order, leading to an interaction F(1,2) of 169.00 – probably due to a carry-over of the red blood cell infusion across the inter-run interval.

3. Mean running time after own-blood infusion (4:15.0) was significantly faster than after saline infusion (4:18.25), F(1,2) = 169.0.

4. This Sal-OB difference interacted significantly with order, being 6.0 seconds in the BL-Sal-OB condition but only 0.5 seconds in the BL-OB-Sal Order. (See point (2) above for the relevant means).

5. Mean hematocrit level was higher following own-blood infusion than the average of this measure at baseline and following saline infusion (47.375% vs. 44.375%), F(1,2) = 115.20. Changes in mean Hct paralleled those in running times: Mean hematocrit showed zero change from baseline to post-saline infusion (44.0 in each case) and then rose to 47.5% after the own-blood infusion, while subjects whose own-blood infusion preceded the saline infusion showed a rise from 42.0 to 47.25% from BL to OB and then maintained that level through the saline-infusion treatment (47.5%). However, the two subjects in the BL-OB-Sal condition differed somewhat in the Sal vs. OB comparison (one increasing from 45 to 46 and the other decreasing from 49.5 to 49), which was sufficient inconsistency to prevent the BL, Sal vs. OB and