

CHANGES IN ARTERIAL, MIXED VENOUS AND INTRAERYTHROCYTIC ION CONCENTRATIONS DURING PROLONGED EXERCISE

Background

Prolonged equine exercise can cause hypochloraemic alkalosis and hypokalaemia secondary to the loss of hypertonic sweat. Movement of ions in and out of erythrocytes during exercise can help regulate acid-base balance and changes in plasma ion concentrations. However, the extent to which this happens during prolonged equine exercise has not been reported.

Aim

To measure changes in arterial and mixed venous blood gases, major ion concentrations, and intraerythrocytic (iRBC) concentrations of these ions in horses undergoing prolonged submaximal exercise.

Methods

Six conditioned horses were trotted at ~30% VO_2max on a treadmill for 105 minutes. Arterial and mixed venous blood samples were collected every 15mins, and pre- and post-exercise. Blood gases and plasma (pl) concentrations of sodium, potassium and chloride were measured and their iRBC concentrations calculated. Data were analyzed using a one-way repeated measures ANOVA ($p < 0.05$).

Results

$P_a\text{CO}_2$ decreased in all horses. With the exception of $\text{iRBC}[\text{K}^+]_a$, there were no changes in iRBC ion concentrations during exercise, although $\text{pl}[\text{Cl}^-]_v$ decreased and $[\text{HCO}_3^-]_v$ increased. Due to the exhalation of CO_2 and chloride shifting, $[\text{HCO}_3^-]_a < [\text{HCO}_3^-]_v$, $\text{pl}[\text{Cl}^-]_a > \text{pl}[\text{Cl}^-]_v$ and $\text{iRBC}[\text{Cl}^-]_a < \text{iRBC}[\text{Cl}^-]_v$. $\text{pl}[\text{K}^+]_a$ and $\text{pl}[\text{K}^+]_v$ both increased with the onset of exercise, then decreased, and horses were hypokalaemic post-exercise. However, there was no arteriovenous difference in $\text{pl}[\text{K}^+]$. $\text{iRBC}[\text{K}^+]_a$ decreased but was $> \text{iRBC}[\text{K}^+]_v$. Conversely, $\text{iRBC}[\text{Na}^+]_a < \text{iRBC}[\text{Na}^+]_v$. $\text{pl}[\text{Na}^+]_a$ and $\text{pl}[\text{Na}^+]_v$ only increased post-exercise.

Conclusion

Significant arteriovenous differences in iRBC and plasma concentrations of chloride, potassium and sodium reflect the role that movement of ions across erythrocyte cell membranes play in regulating acid-base balance and plasma concentrations of these ions. Expiration of CO_2 has a major influence on this ion flux. Finally, exercise-induced changes in plasma concentrations of these ions are not necessarily associated with corresponding changes in iRBC concentration of the same ion.