Co2BACKGROUND

Supplemental oxygen is currently used by some elite-level swimming federations to assist in recovery from competition based on the assumption that its use enhances subsequent performances by improving recovery time via an increased availability of oxygen in the blood.

Normal atmospheric oxygen content availability (20.93%) at sea level demonstrates blood oxygen saturation levels of 96-98%. A very small percentage of oxygenated blood passing through unventilated alveoli decreases the saturation of hemoglobin from 100%.

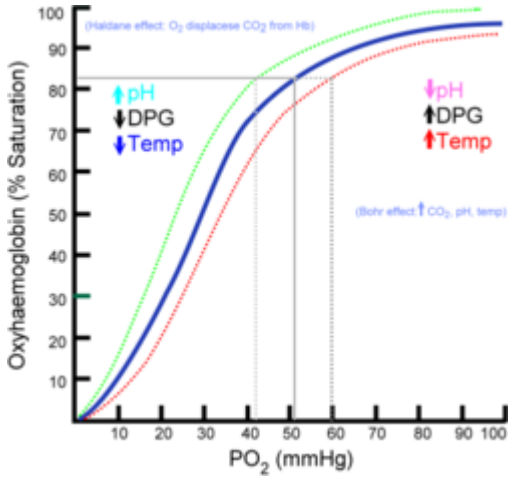
Average Male

Arterial O_2 content = 0_2 physically dissolved + O_2 in combination with hemoglobin

C_{ao2} = .3 ml O_2 * dl^{-1} blood + (1.34 ml O_2*g^{-1} Hb)(15 g Hb*dl^{-1} blood)

= 20.4 ml O_2 * dl^{-1} blood

In addition to the partial pressure of O_2, increased CO_2, temperature, pH, and concentration of 2,3 DPG can affect the combination of O_2 with hemoglobin. For the purpose of this investigation only increased CO_2 and pH are discussed.



The decrease in blood pH can partially be attributed to the increased lactic acid produced from lactate accumulation during performance. The subsequent involvement of the bicarbonate buffer system allows for a rise in nonmetabolic CO_2 produced from the following reactions meant to mitigate the acidic properties of lactic acid.

HLA----$H^+ + LA^-$

$H^+ + HCO_3^-$----H_2CO_3

$H_2CO_3^-$---$H_2O + CO_2$

The increased pressure from higher levels of CO_2 and H^+ can loosen O_2 binding to hemoglobin. But in equal fashion oxygen can also act to displace CO_2 and H^+ from hemoglobin when given a greater pressure gradient than its counterpart.

While exercise has a minimal effect on the combination of O_2 with hemoglobin at the lungs, active tissues where PO_2 is less than 40 mmHg binding can be reduced 10-15% with the difference represented in the additional O_2 support for metabolic requirements.

At this point a controlled investigation into the efficacy of supplemental oxygen's impact on an elite swimmer's recovery from a single performance bout is at best incomplete. This investigation's purpose is an attempt to distinguish any difference between a pre-existing recovery protocol, derived from capillary

blood lactate draws, and based primarily in active recovery as a means of lactate oxidation versus a proposed protocol of passive recovery augmented by supplemental oxygen.

A 100-L Douglas Bag was chosen based upon prior research into O_2 consumption.

METHODS

Subjects

12 national caliber swimmers are to be recruited for this investigation. The group is to be further broken down into six male and six female competitors. Informed consent will be obtained.

Equipment

A single bout of the 100 meter freestyle is to be performed in an Olympic size pool (50m).

A 100-L Douglas Bag, containing either 20.93% O_2 or 100% O_2, is to be connected, via tubing, to a nonrebreathing valve at the inspiratory end. The corresponding valve is then attached to a mask intended to be placed over the participant's mouth and nose to create a seal between device and face.

Blood lactate will be taken at the ear lobe. Before being pricked with a lancet, the area will be prepped using alcohol pads. The resultant capillary blood droplet will be placed into a lactate strip and analyzed by a Lactate Pro. Gauze pads will be used to remove any excess blood at the ear lobe. For protection of participants and administrators alike, all test administrators will wear latex gloves as a precaution. Disposal of used lancets will be into a Sharps-A-Gator and all remaining strips, gauze, and alcohol prep pads will be placed in a biohazard bag.

Capillary blood gas measurements will be taken using a pulse oximeter.

Heart Rate is to be monitored after performance using a polar model.

Weight in kilograms will be recorded.

Protocol

Participants will perform one trial assigned to either the control (20.93%) or experimental (100%) group. A second trial is to follow with participants now assigned to the group in which they did not previously partake. Participants will be unaware of their assignment in either trial.

Prior to performance, the swimmers will participate in their individually established warm-up procedure.

Time of performance, along with race tempos, and split times will be recorded to compare to personal bests.

Immediately upon completion, the swimmer will be given either concentration of oxygen via the previously established method. The heart rate equipment will be placed on the athlete before one minute of recovery has expired and remain on for the duration of the protocol. At three minutes post performance an initial pulse oximeter reading and blood lactate draw will be made. Two subsequent pulse oximeter readings and blood lactate draws will be made be at ten minute intervals (13 and 23 minutes post performance). Throughout the protocol, the athlete will continue to breathe from the 100-L Douglas Bag until its contents are emptied. At which point, the Douglas Bag will then be discarded and the participant will be asked to breathe room air, if necessary, for the remainder of the investigation.

Addendum

If so desired a second 100-L Douglas Bag can be attached to the expiratory end of the nonrebreathing valve to collect gases (O_2, CO_2, N_2) for the first 20 seconds after completion of performance to allow for back extrapolation of peak VO_2 from performance. Procedure can then be repeated every 40 seconds from completion of performance until 160 seconds have elapsed. The resultant data will be used in a Haldane equation to obtain VO_2 at the specific points and back extrapolated from the first reading to provide a peak VO_2 for the performance. Data will then be plotted to find EPOC and the control results can than be compared to experimental results to observe any significant changes. Protocol can be done for one (future research implications) or for the entire population.