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Kenneth E. Johnson

University of Massachusetts Medical School

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A comparison of exercise-induced hematocrit (Hct) changes between non-invasive infrared sensors (NIRS) and venous blood draws

Babs Soller, PhD; Jacqueline Wu, MD; Michelle Landry; Keith Fragoza, MS4
University of Massachusetts Medical School, Worcester, MA

Background: Near Infrared spectroscopy (NIRS) uses the principle of light absorbance by hemoglobin, coupled with complex mathematical algorithms, to obtain a relative value of the blood’s hematocrit (Hct), a reflection of its oxygen carrying capacity. Because of the rapid, non-invasive nature of NIRS, it could be very useful in a variety of clinical settings for determining patients’ homological status and immediate response to treatment (e.g. during shock and trauma).

Objectives: To compare the Hct values calculated using the NIRS sensor with those obtained from venous blood samples, the ultimate goal being to develop an NIRS system that accurately and continuously determines a patient’s hematocrit.

Methods: Healthy volunteer subjects (n=5) were challenged with a one-handed grip exercise test, with the NIRS sensor secured to the subjects’ forearm. Subjects underwent four separate exercise sessions, each of five minutes duration and separated by thirty minute intervals. NIRS readings were taken immediately before each session (baseline values). They were then taken every minute during the exercise period, and subsequently averaged (exercise values). Venous blood samples were also taken from the same arm at each of these time points. Each blood sample was drawn into three microcapillary tubes, centrifuged, and measured on a capillary tube reader scaled for hematocrit.

Results: For the NIRS data, the Hct values consistently decreased with exercise amongst all five patients. On average, the NIRS values decreased by 0.004 points of the readout (P<0.001) between baseline and exercise. For the venous blood data, the Hct values consistently increased amongst the patients, increasing by an average of 2.1 points (P<0.001).

Conclusion: Based on this set of values, there was a lack of consistency between Hct values obtained by NIRS and those taken from venous blood samples, as they trended in opposite directions. Though this was a small sample size, these differences were statistically significant and were seen consistently amongst all subjects. Further subject trials must be conducted, as well as continued work on the mathematical algorithms, to determine if a direct correlation in Hct values determined by these two techniques can be consistently recorded.