Impact of Sudden Changes in Oxygenation on the Measurement of Non-Invasive Hemoglobin (Sphgb)

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Background

Hypoxemia secondary to reduced barometric pressure is a complication of ascent to altitude. Current medical operations in support of warfighters often require ascent to 14,000 feet or more in unpressurized aircraft during evacuation of casualties. We evaluated the impact of hypobaric hypoxemia at 14,000 feet and reversal of hypoxia by oxygen administration on the non-invasive measurement of hemoglobin (SpHgb). (Masimo Radical 7, Masimo, Irvine, CA).

Method

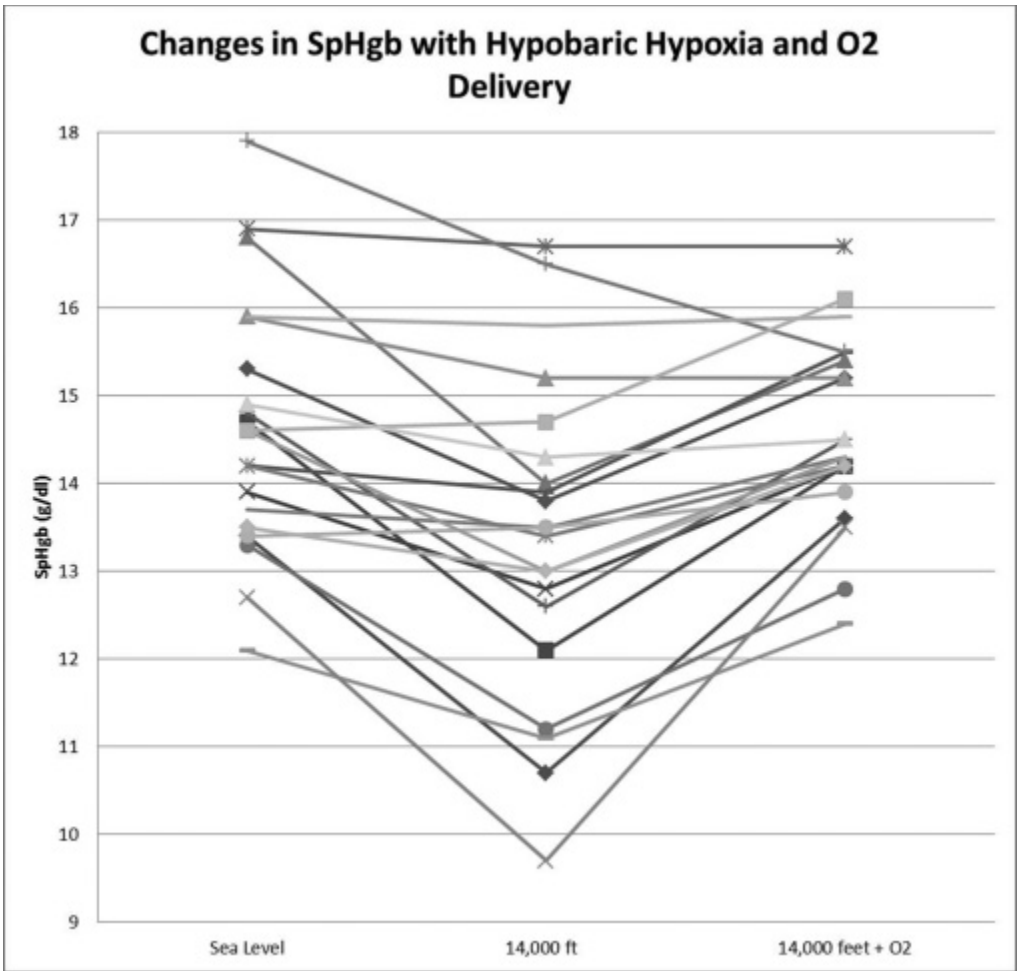
Following informed consent, 20 healthy volunteers were, seated in an altitude chamber, and exposed to a simulated altitude of 14,000 feet (PB 428 mmHg). Subjects breathed room air for 10 minutes to induce hypoxemia (SpO2 goal of 82-84%). After establishment of hypoxia, oxygen was administered via nasal cannula to return SpO2 to sea level values. Measurements of oxygen saturation (SpO2) end-tidal carbon dioxide (EtCO2), respiratory rate (RR) heart rate (HR) (CapnoStream 20, Oridion) SpHgb, and tissue oxygenation (StO2) were continuously recorded (Inspectra STO2, Hutchinson Technology, MN). SpHgb at sea level vs. SpHgb at 14,000 feet and SpHgb at 14,000 feet with and without oxygen were compared using a paired T-test. Study was approved by the University of Cincinnati and Wright Patterson Air Force IRB's.

Results

At sea level with normoxia (SpO2 = 97±1.7%) the mean SpHgb was 14.6±1.4 g/dl, at 14,000 feet (SpO2 = 83±1.1%) mean SpHgb was 13.4±1.8 g/dl, at 14,000 feet with reversal of hypoxemia (SpO2 = 97±2.1%) mean SpHgb was 14.6 ±1.1 g/dl. Figure 1 demonstrates changes for each individual subject. SpHgb and SpO2 changes were statistically significant ($p<0.001$) during the change from normoxia to hypoxia and on return to normoxia.

Conclusion

Sudden changes in SpO2 resulting from hypobaric hypoxia result in a sudden artifactual fall in SpHgb. Reversal of hypoxia results in an increase in SpHgb. These are important findings as sudden hypoxia may appear to be associated with blood loss during monitoring. Changes in SpHgb following large changes in SpO2 should be verified with standard hemoglobin monitoring using a blood sample.


Changes in SpHgb with Hypobaric Hypoxia and O2 Delivery
SpHgb (g/dl)
18
17
16
15
14
13
12
11
10
9
Sea Level
14,000 ft
14,000 feet + O2