Oxygen Reserve Index: Utility as Early Warning For Desaturation in Morbidly Obese Patients

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Introduction: Expansion of infrared transmission pulse oximetry technology to include multiple wavelengths (7+) provides additional information that has been shown to correlate with moderately hyperoxic arterial oxygen concentrations.[1] This information is characterized as the Oxygen Reserve Index (ORI), a unit-less scale between 0 and 1, that correlates with P_aO_2 values between 100 and 200mmHg. ORI has been shown to provide a clinically useful advanced warning of arterial hemoglobin desaturation in pediatric[2] and critically ill patients.[3] Obese patients are an additional high risk group presenting with increasing frequency for both elective and emergent surgical procedures. Airway management in these patients presents problems associated with both physical and physiological changes of obesity. Pre-oxygenation is more difficult and unpredictable[4], maintenance of a patent airway can be more difficult[5] and obese patients desaturate more rapidly during periods of apnea[6]. As a consequence, arterial oxygen desaturation is more common and more severe in this patient population[7]. This protocol was designed to determine the amount of early warning of impending arterial hemoglobin desaturation provided by ORI in obese patients.

Methods: Written, informed consent was obtained from patients with a BMI>30,<40 m/kg^2 who were scheduled for an elective surgical procedure requiring general anesthesia and endotracheal intubation. Following the placement of standard monitors plus an additional sensor capable of measuring ORI, baseline values were recorded. Patients were then pre-oxygenated with 100% oxygen. When ORI plateaued, general anesthesia was induced with a combination of amnestics, narcotics, intravenous induction agents and muscle relaxants. Endotracheal intubation was accomplished under direct visualization using a GlideScope. When the arterial hemoglobin saturation reached 94% ventilation was initiated with 100% oxygen. Both ORI and arterial hemoglobin saturation were recorded continuously by an automated data capture system.

Results: 40 patients provided written, informed consent. In four patients the ORI sensor failed initial calibration. For the remaining 36 patients there were 19 females and 17 males with an average age of 59±14 years and average BMI of 34±3 (range 30 to 39). The time from the initiation of endotracheal intubation (onset of apnea) to the activation of the ORI alarm, triggered by the value and the rate of change, averaged 4.1±1.3 minutes (range 1.0 to 6.8). The average time to the decrease in arterial hemoglobin saturation to 98% was 4.8±1.5 minutes (range 1.5 to 7.7). The average increase in warning time provided by the ORI (time between ORI alarm start and 98%) was 42±49 seconds (range 5 to 255 seconds). Elimination of two outliers (>2SD) changed the average increase in warning time provided by the ORI to 33±23 seconds (range 5 to 107 seconds).

Conclusion: This study demonstrates the ability of ORI to provide advanced warning of arterial desaturation as an adjunct to SpO_2 in this high risk patient population. This additional warning time can potentially translate to improved patient safety by allowing earlier calls for help, assistance from a more experienced person, or modification of airway management. For this analysis we defined the advance warning to end at 98% SpO_2, with a defined trigger for intervention of 94% SpO_2. In clinical situations where 98% SpO_2 might not be considered to be critical, using a lower SpO2 as the alarm level would increase the advance warning provided by ORI. Further analysis of the correlations of ORI and P_aO_2, the use of ORI as a guide to pre-oxygenation, and its utilization in either ideal body weight or the super morbidly obese patients are areas for future study.