

Oxygen Reserve Index: Utility as an Early Warning for Desaturation in High-Risk Surgical Patients

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Background: Perioperative pulse oximetry hemoglobin saturation (SpO₂) measurement is associated with fewer desaturation and hypoxia episodes. However, the sigmoidal nature of oxygen-hemoglobin dissociation limits the accuracy of estimation of the partial pressure of oxygen (PaO₂) >80 mm Hg and correspondingly limits the ability to identify when PaO₂ >80 mm Hg but falling. We hypothesized that a proxy measurement for oxygen saturation (Oxygen Reserve Index [ORI]) derived from multiwavelength pulse oximetry may allow additional warning time before critical desaturation or hypoxia. To test our hypothesis, we used a Masimo multiwavelength pulse oximeter to compare ORI and SpO₂ warning times during apnea in high-risk surgical patients undergoing cardiac surgery.

Methods: This institutional review board-approved prospective study ([NCT03021473](#)) enrolled American Society of Anesthesiologists physical status III or IV patients scheduled for elective surgery with planned preinduction arterial catheter placement. In addition to standard monitors, an ORI sensor was placed and patients were monitored with a pulse oximeter displaying the ORI, a nondimensional parameter that ranges from 0 to 1. Patients were then preoxygenated until ORI plateaued. Following induction of anesthesia, mask ventilation with 100% oxygen was performed until neuromuscular blockade was established. Endotracheal intubation was accomplished using videolaryngoscopy to confirm placement. The endotracheal tube was not connected to the breathing circuit, and patients were allowed to be apneic. Ventilation was resumed when SpO₂ reached 94%. We defined ORI warning time as the time from when the ORI alarm registered (based on the absolute value and the rate of change) until the SpO₂ decreased to 94%. We defined the SpO₂ warning time as the time for SpO₂ to decrease from 97% to 94%. The added warning time provided by ORI was defined as the difference between ORI warning time and SpO₂ warning time.

Results: Forty subjects were enrolled. Complete data for analysis were available from 37 patients. The ORI alarm registered before SpO₂ decreasing to 97% in all patients. Median (interquartile range [IQR]) ORI warning time was 80.4 seconds (59.7-105.9 seconds). Median (IQR) SpO₂ warning time was 29.0 seconds (20.5-41.0 seconds). The added warning time provided by ORI was 48.4 seconds (95% confidence interval [CI], 40.4-62.0 seconds; $P < .0001$).

Conclusions: In adult high-risk surgical patients, ORI provided clinically relevant added warning time of impending desaturation compared to SpO₂. This additional time may allow modification of airway management, earlier calls for help, or assistance from other providers. The potential patient safety impact of such monitoring requires further study.