Falsely Normal Saturation Reading with the Pulse Oximeter

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Several studies have documented excellent correlation between pulse oximetry and simultaneous direct arterial samples for determining oxygen saturation.¹⁻³ This reliable non-invasive monitor has been known to be helpful in rapid detection of intraoperative and postoperative hypoxemia.⁴⁻⁶ Despite its value, there are several well-known limitations to pulse oximetry.⁷ We wish to report a case in which a pulse oximeter reading of 100% persisted in spite of clinical cyanosis and extubation of the trachea.

REPORT OF A CASE

The patient was a 6-day-old, 2.6-kg boy with congenital heart disease. He was the product of a full-term, uncomplicated pregnancy and delivery, to a 35-year-old, gravida 3, para 1 mother. The Apgar scores were 8 (at 1 min) and 9 (at 5 min). At 6 h of age, the infant was noted to have respiratory distress, and the diagnosis of

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Received from the Department of Anesthesia and Critical Care, The
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Key words: Monitoring; pulse oximetry. Oxygen: hypoxia.
a heart rate that varied between 180–255 bpm. This occurred even though the patient’s foot and attached sensor were covered with a thin brown plastic bag. We have concluded that, when the patient was placed in position for surgery, the oximeter was illuminated directly by the surgical light, resulting in a falsely elevated saturation, despite the presence of obvious cyanosis.

**DISCUSSION**

It was alarming to witness a high oxygen saturation reading in a patient who exhibited obvious clinical cyanosis. The reason for the falsely normal saturation reading has been confirmed to our satisfaction, because we have been able to produce similar artificial readings using the same surgical light and many of the other sensors (Nellcor D-20, N-25, and I-20). This surgical light is present in only one of our ten operating rooms, and we have not elicited this type of interference with any of the other lights.

The Narco-Pilling surgical light that was associated with this problem is a xenon arc lamp. Similar to a strobe light, the arc lamp illuminates with rapidly repeated flashes. These flashes result when 7 kilowatt sparks, a product of several discharging capacitors, excite the xenon gas. The resulting light, although seemingly of constant intensity to the human eye, actually contains sharp-edged irregular modulations.

The Nellcor pulse oximeter measures hemoglobin oxygen saturation spectrophotometrically. Red and infrared light from two light emitting diodes (LEDs) is passed through a vascular bed to a photodetector. Although tissue and non-pulsatile venous blood will absorb most of the LED light, a phasic change in absorption occurs as the blood volume in the light path increases with the arterial pulse. These phasic changes in light absorption will not occur when the pulse is absent or decreased, rendering the oximeter incapable of determining arterial saturation.

Ambient light can interfere with accurate function of the pulse oximeter and, for this reason, the manufacturer suggests shielding of the probe. The oximeter also contains a design feature to minimize ambient light interference. By turning the LEDs on and off rapidly, the photodetector will receive both LED light and any ambient light when the LED is “on,” but only ambient light will be detected when the LED is “off.” Therefore, electronic subtraction of the “off” signal from the “on” signal will allow elimination of interference from an unvarying ambient light source. Nevertheless, a strong ambient light source can overpower the phasic changes that occur with arterial pulsation, resulting in the activation of the no-pulse alarm and low or absent saturation readings.

The unique situation that we experienced with our patient was the presence of a strong source of ambient light that had pulsatile quality. High frequency harmonics are produced when the sharp edged modulations of light from the Narco-Pilling lamp interact with the high frequency turning on and off of the LEDs. This is analogous to a motion picture of a television screen. The combination of the movement of the television electron gun across the picture screen with the changing frame of the film interacts, so that, if one views such a film, it appears as if shadows move across the television screen. In a similar way, in our patient, the net light incident to the photodetector had a pseudo-pulsatile quality to it.

We were aware that ambient sources of light and infrared irradiation might interfere with proper function of the pulse oximeter from a previous report, information provided by the manufacturer and our own experience. A recent review of the limitations and disadvantages of pulse oximetry, however, did not include ambient irradiation as a source of potential problems. The previous report and the common clinical experience with this type of interference has suggested that it will result in blank digital display with flashing of the pulse search alarm or, at worst, falsely low readings. A falsely elevated saturation reading was unexpected.

The incident described is an important example of the pulse oximeter giving a falsely high reading. Although this resulted from a unique combination of circumstances, it is doubtful that such an event is unique to the products mentioned in our report. Adverse effects of hypoxia were avoided in this patient because the cyanosis was directly observed in the undraped infant. The importance of direct patient observation and redundancy of surveillance techniques in the anesthetized patient is again emphasized.

The authors wish to acknowledge the help of Mr. G. Harding of ECR and Mr. D. Goodman of Nellcor in helping to determine the cause of this event.

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