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Spurious Pulse Oximeter Desaturation with Methylene Blue Injection

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Pulse oximetry allows reliable and noninvasive monitoring of arterial oxygenation. Arterial oxygen saturations of 65–100% are accurately recorded.[1] However, several clinical conditions interfere with the accuracy of the oximeter. These include peripheral vasoconstriction caused by vasopressors, peripheral vascular disease, hypothermia, hypotension, dyshemoglobinemias,[2] as well as the placement of a sphygmomanometer cuff on the ipsilateral extremity and the application of high-intensity heat lamps.[3] We report a case of iv administration of methylene blue dye causing a pulse oximeter to give a spurious reading of hemoglobin desaturation.

REPORT OF A CASE

A 64-yr-old man was scheduled for cystoscopy, transurethral resection of the prostate gland, and right testicular mass excision. The past medical history was unremarkable. Past surgical history included a left nephrectomy under spinal anesthesia without complications. The patient had no known drug allergies, took no medications, and did not smoke tobacco.

Physical examination revealed an arterial blood pressure of 130/70 mmHg, a heart rate of 60 beats/min, height 176 cm, and weight 91 kg. The airway and teeth were normal. Examination of the heart and lungs was unremarkable. All laboratory data, including hemoglobin concentration, serum electrolytes, chest radiogram, and electrocardiogram, were normal. The physical status was ASA Class I.

The patient received intraoperative monitoring that included electrocardiogram, oral temperature, end-tidal carbon dioxide tension, right brachial indirect blood pressure, and left index finger pulse oximetry. After breathing oxygen, general anesthesia was induced with sufentanyl 20 μg and thiopental 250 mg iv. After adequate airway control had been verified, succinylcholine 120 mg was given iv to facilitate oro-tracheal intubation. Anesthesia was maintained with 1.0% enflurane, in a 50% nitrous oxide/50% oxygen mixture. Neuromuscular blockade was maintained with intermittent doses of atracurium and monitored with a peripheral nerve stimulator applied to the left ulnar nerve. Ventilation was controlled.

Throughout the procedure the pulse oximeter indicated a hemoglobin oxygen saturation of 99%. On completion of surgery, methylene blue 100 mg was administered iv to check ureteral urine flow. Within 30 s the oxygen saturation alarm sounded and the monitor indicated a hemoglobin oxygen saturation of 65% with a satisfactory pulse search signal. All other clinical and monitoring signs were stable, bilateral breath sounds were good over both lung fields, and the patient was not cyanotic. The oxygen saturation rose to 97% over the next 5 m. Twenty minutes later, a second bolus of methylene blue was administered iv with identical results. After the anesthetic had been discontinued, the neuromuscular blockade reversed with neostigmine, and glycopyrolate and the trachea extubated, recovery from anesthesia and surgery was uneventful.

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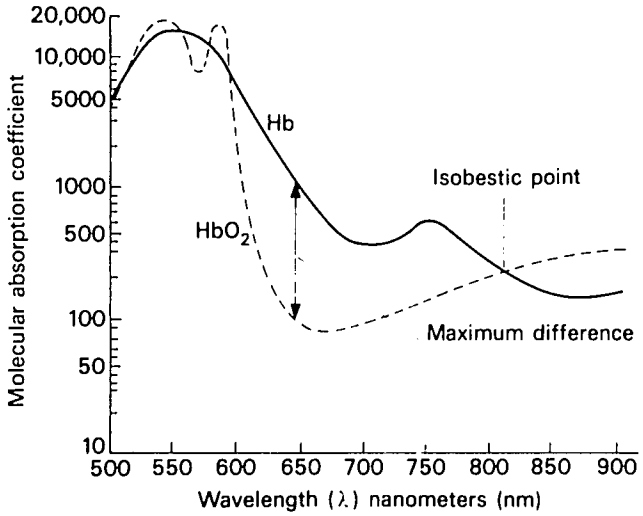

FIG. 1. Absorption spectrum of reduced (Hb) and oxygenated hemoglobin (Hb_{O_2}). (See text for explanation.)

DISCUSSION

The principle of pulse oximetry rests on a combination of spectrophotometric analysis and plethysmography.

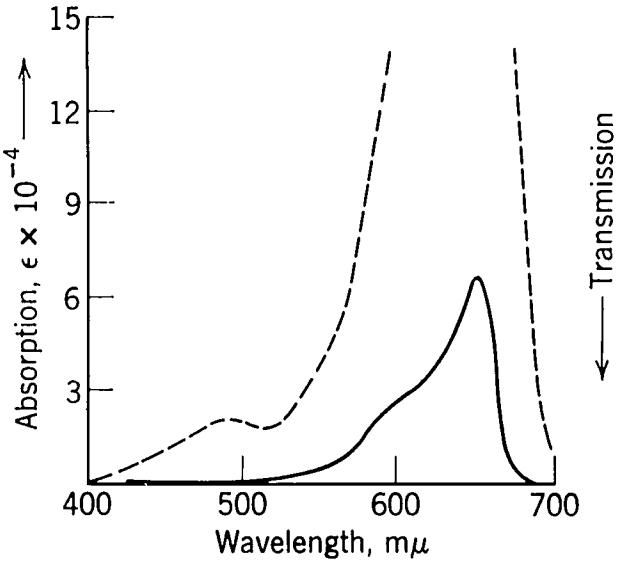

FIG. 2. Absorption curve of methylene blue dye solution, reflecting maximal absorption at 668 nm. at both concentrated (*dashed line*) and dilute (*solid line*) solutions.

Light transmitted through tissue varies with each pulse of blood from the heart and is proportional to the hemoglobin concentration of the blood. This is expressed in Beer's Law,[4] which states that the quantity of light absorbed equals the product of the absorption coefficient of hemoglobin, the concentration of hemoglobin, and the thickness of tissue the light traverses. In our instrument (Nellcor® Pulse Oximeter), the finger attachment contains two light-emitting diodes (LEDs) and a photodetector diode that receives the light that is transmitted through the finger. The light emission of the LEDs is at the wavelengths of 660 nm and 925 nm. The 660 nm wavelength approaches the maximal difference in light absorption by oxyhemoglobin and reduced hemoglobin (fig. 1).[5] The 925 nm wavelength corresponds to a plateau on the curve where the absorption changes minimally with varying wavelengths and functionally mimics the isobestic point; *i.e.*, the wavelength where the absorption coefficients of reduced and oxyhemoglobin are equal (approximately 810 nm). The percentage of oxyhemoglobin is proportional to the ratio of light absorption at 660 nm and at the reference point of 925 nm.

Methylene blue has a spectral absorption peak of 668 nm (fig. 2).[6] It therefore absorbed most of the 660 nm light emission. The oximeter interpreted this absorption as the presence of reduced hemoglobin and a fall in arterial oxygen saturation. The return to normal readings of oxygen saturation is a reflection of the dilution of the dye and its rapid renal clearance. Should any doubt exist, an arterial blood sample should be obtained to confirm Pa_{O_2} and hemoglobin saturation.

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