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The values shown on optical technology-based patient monitors must be cautiously interpreted: intravenous dye-induced errors

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Intravenous dyes such as indocyanine green (ICG), indigo carmine, and methylene blue are commonly used during various surgical procedures. The intraoperative administration of intravenous dyes can result in misreadings of the actual values measured by optical technology-based patient monitors (i.e., cerebral oximeters and pulse oximeters) because they interfere with the amount of the specific infrared or red wavelength detected by each device. Therefore, clinicians would benefit from a narrow review of the effects of intravenously administered dyes on regional cerebral tissue oxygen saturation and percutaneous oxygen saturation readings.

The pulse oximeter was developed based on the fact that oxygenated and reduced hemoglobin have different rates of absorption of red and infrared light (Lambert-Beer law). Oxyhemoglobin absorbs more infrared light (990 nm), whereas deoxyhemoglobin absorbs more red light (660 nm). The device detects the difference in the extent of absorption of two wavelengths of light (660 and 925 nm) in arterial blood. The value is automatically calculated as an absorption ratio (extent of light detected at 660 nm/extent of light detected at 925 nm) and is represented as the arterial oxygen saturation (SaO_2). Similar to pulse oximetry, cerebral near-infrared spectrometry measures the absorption ratio of two different wavelengths of near-infrared light (730 and 805 nm) in venous, capillary, and arterial blood and represents the value as the regional cerebral tissue oxygen saturation ($SctO_2$).

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In clinical practice, intraoperative ICG is commonly used during neurosurgery to confirm the patency of the anastomosed vessels after middle cerebral artery-superficial temporal artery bypass surgery or carotid endarterectomy and the completeness of the secured aneurysm after cerebral aneurysmal clipping. The peak absorption wavelength of ICG is 805 nm [1]. A clinical study published in this issue of the *Korean Journal of Anesthesiology* demonstrates that the intravenous injection of ICG can produce false increases in $SctO_2$ readings in a dose-dependent fashion [2]. This finding can be partly explained by an increase in the absorption ratio of two different wavelengths of light: 730 and 805 nm. In other words, ICG absorbs light with a wavelength of 805 nm, falsely decreasing the amount of 805 nm light detected by the cerebral oximeter; this light is displaced as an increased $SctO_2$ reading. Another recent study showed that intravenous ICG administration caused a false decrease in SaO_2 readings [2,3]. ICG acts similarly to deoxyhemoglobin in arterial blood; this falsely decreases the absorption ratio of red and infrared wavelengths detected by the pulse oximeter, resulting in a decreased SaO_2 reading.

Indigo carmine is commonly used during urologic surgical procedures to identify the ureteral orifices in the bladder. Indigo carmine is a blue dye with peak absorption at around 620 nm [1]. Therefore, intravenous indigo carmine administration, like ICG injection, causes a false decrease in SaO_2 readings by decreasing the amount of red light (660 nm) detected by the pulse oximeter. In contrast to ICG, however, indigo carmine administration results in a false reduction in $SctO_2$ readings by decreasing the amount of light with a wavelength of 730 nm detected by the cerebral oximeter [4]. Methylene blue, which is used to treat vasoplegic syndrome in clinical practice [5,6], has an absorption peak at 668 nm and shows a dose-dependent effect on plasma light absorbance, resulting in falsely low values on pulse oxim-

eters and cerebral oximeters [7,8].

In conclusion, clinicians should be aware that the intraoperative administration of various dyes can cause misreadings of the actual values measured by optical technology-based patient monitors, including cerebral oximeters and pulse oximeters, by interfering with the amount of the specific infrared or red wavelength detected by each device.

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