Clinical Pearl: Overestimation of Oxygen Saturation with Pulse Oximetry Compared with Arterial Blood Oxygen Saturation in Infants and Children of Color

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Recently, several studies have examined the accuracy of oxygen saturation compared with arterial oxygen co-oximetry in infants and children of color with white infants and children (1-4). Vesoulis and colleagues compared oxygen saturation with arterial blood gas oxygen values in Black and White preterm infants (124 black, 170 white infants; mean gestational age 25.8 ± 2.1 weeks, mean birth weight 845 ± 265 grams) and demonstrated an overestimation of SpO2 measured by the mean bias of 2.4 greater for Black infants (1). This resulted in greater occult or hidden hypoxemia (SpO2 > 90% when SaO2 < 85% 9.2% vs. 7.7% in Black infants (1). One must remember that the skin color identified as black has considerable variability and may change significantly after birth, especially in premature infants. The range of coloration and increase in pigmentation may lead to results that are incorrectly mapped to lighter skin. The author (MRG) recollects original calibration studies in the 1990s on premature infants where skin color assessment had to be assessed daily because of these changes.

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In addition, studies by Foglia and colleagues and Ruppel et al. at Children's Hospital of Philadelphia of infants and children aged 1-17 years with congenital heart disease in cardiac catheterization also demonstrated moderate overestimation of oxygen saturation of pulse oximetry compared with central arterial oxygen saturation in the cath lab (2,3).

An excellent editorial by Gray, Subramaniam, and Huang summarized the issues and questions regarding hidden hypoxemia in infants and children with darker skin tones (4). We, as clinicians, need to be aware of this phenomenon and that, at this point in time, melanin seems to be the reason for this (1-4). Investigators are very active in their technological work to address "the biases of transmissive oximetry (4)".

Two examples of these new technologies are in development to attempt to address this skin-tone bias: photoacoustic imaging and polarized light oximetry (4). With photoacoustic imaging, sound waves are generated when light is absorbed by a material (4). A corrective equation is applied that accounts for the change in oxygen saturation as a function of skin tone (4). Polarized light oximetry uses polarized light for oximetry because polarization can reduce the light-scattering effects of melanin on oxygen saturation readings, yielding more accurate oxygen saturation readings "across diverse patient populations " (4)". The effects of considering functional versus fractional oximetry and individual differences that may lead to more carboxyhemoglobin or methemoglobin must be considered. Non-invasive Co-oximetry (i.e., Rainbow Technology) may ultimately resolve these concerns.

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I recommend you take some time to review this editorial to understand these new concepts, as I have learned a lot by putting this together for your review.

When I sent this Pearl to Mitchell Goldstein for his thoughtful review, he sent me a letter to the editor from Neonatology Today from Joe Kiani, the Founder, and CEO of Masimo, with Mitchell's response from 2021 (5).

The letter was entitled'Pulse Oximeters are not racist' and described Mr. Kiani (Masi); and his co-inventor Mohammed (Mo) Dian's internal data analysis comparison of oxygen saturation and co-oximetry values in 200 black and 194 caucasian subjects and found a bias of 0.4% (5). The Masimo technology was developed initially in 1989 (5). Joe Kiani's letter and Mitchell Goldstein's response are excellent and provide a historical perspective of this issue for your review(5).

References:

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