



Guest Editorial

Increasing awareness of the racial bias of pulse oximetry measurements in populations with darker skin

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Vital sign monitoring of physiological measurements is the foundation on which clinical care is based. Measures of heart rate, blood pressure, respiratory rate, and temperature are used to assess disease severity, monitor for deterioration, guide therapy, and allocate medical resources globally. In the typical patient journey through a health-care system, vital sign monitoring may occur in the community, at hospital admission, and throughout the hospital stay. Over recent decades pulse oximetry has joined these measurements and has been termed the “fifth vital sign.”^[1]

Given vital sign monitoring is the bedrock of care, clinicians may assume it is precise and validated. This is not the case. Real-world data suggest that pulse oximetry accuracy decreases below 90% blood oxygen saturation^[2] and that this measurement error is greater in patients from ethnic minorities with darker skin tones.^[3-5] This effect size and direction has the potential to mislead clinicians. For example, in individuals recorded as being of Black or Asian origin, the oxygen saturation derived from pulse oximetry provides a value that is approximately 4–5% higher than the true oxygen saturation provided by arterial blood gas samples.^[6] Importantly, this error occurs when true oxygen saturations are 85–89%, the range in which many important clinical decisions are made. The inaccuracy related to skin tone is thought to be from the effect of melanin on the light signals that differentiate between oxygenated and deoxygenated hemoglobin.^[7]

The central role of pulse oximetry in the assessment and delivery of medical care to respiratory patients makes this differential measurement error in patients with darker skin coloration a major concern. During the COVID-19 pandemic, this may have delayed hospital admission, delayed the initiation of oxygen, and delayed the prescription of drugs that reduce mortality.^[8] Pulse oximetry inaccuracy is likely to have contributed to the fact that patients with darker skin tones were sicker at the time of transfer to intensive care^[9] and had higher mortality rates than patients with white skin.^[10] These concerns extend beyond COVID-19 infection, as administration of supplementary oxygen to any acutely unwell patients is generally guided by pulse oximetry. Pulse oximetry error in patients with darker skin coloration also has the potential to delay assessment and initiation of long-term oxygen for a chronic respiratory disease which is used to palliate symptoms and decrease mortality rates.^[11]

Given that the United Nations estimates 1.3 billion people live in Africa, and 4.7 billion people in Asia, the potential deleterious effect of pulse oximetry inaccuracy on clinical outcomes

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in populations with darker skin coloration is extremely concerning. This is exacerbated by the reliance of clinicians on pulse oximetry in countries where the gold standard measurements of arterial blood gases are not a realistic option for the majority of clinicians and patients, due to the need for analyzers, reagents, and reliable electricity sources. In Ethiopia for example, access to arterial blood gas analysis assays is not routinely available in government hospitals, while in private hospitals, shortages of equipment and reagents are a recurrent problem.

The use of pulse oximetry is being re-evaluated in light of the rapidly evolving evidence base. The longer term solution is affordable pulse oximeters that reliably provide measurements of blood oxygen saturation regardless of skin color. However, this may not happen for many years, and the existing stock of pulse oximeters will continue to be used. Thus, the short-term solution must be to increase awareness of the intrinsic bias of pulse oximetry in populations with dark skin coloration.

Sadly, despite concerns about the accuracy of oxygen saturation measurements being in the academic literature for decades,^[12] this knowledge has not crossed over into front-line clinical care. To address this, we have created a simple five-minute education cartoon based on data from the USA and from our patients which can be viewed at: <https://www.youtube.com/watch?v=CeWaHk3MOyM>. This animation can be easily modified to local contexts by changing the speakers, background or languages and thus has potential to reach wide audiences across Africa and beyond. We invite any individuals interested in doing this, with the capacity to disseminate it within their country, to contact us via our email above.

In conclusion, health-care professionals should be cautious when using currently available pulse oximetry devices to measure oxygen saturation in individuals with dark skin coloration and mindful of the potential for these devices to provide measurements that are higher than reality in these patients.

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