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Dynamic Errors in Pulse Oximetry Preclude Use of Correction Factor

To the Editors:

We commend Dr. Jamali and colleagues for their thorough review of almost 4 decades of research in "Racial Disparity in Oxygen Saturation Measurements by Pulse Oximetry: Evidence and Implications" (1). In this article, the authors raise the possibility of implementing a skin-tone correction factor to compensate for the overestimation of arterial oxygen saturation (Sa_{O_2}) by pulse oximeters (Sp_{O_2}) among individuals with darker skin. We wish to highlight more recent data that suggest this strategy would not rectify the error but rather cement the inequity imposed by current technology and worsen disparities by disproportionately harming patients of color. Instead, a systematic solution that enhances oxygen monitoring device technology is urgently needed.

Studies have repeatedly demonstrated that, on average, pulse oximeters overestimate oxygen saturation for patients who are Black, Hispanic or Latinx, and Asian. However, recent data show extensive variability in pulse oximeter accuracy within the same person over time, which disproportionately occurs in patients who are Black. In a multicenter retrospective cohort study investigating repeated paired Sp_{O_2}–Sa_{O_2} measurements, Chesley and colleagues found that three-quarters of Black patient encounters and two-thirds of White patient encounters had a within-subject measurement error greater than four percentage points (2). More concerning, three-quarters of patients had bidirectional errors over time, such that pulse oximeters both under- and overestimated oxygen saturation for the same subject at different time points. Similarly, Valbuena and colleagues demonstrated variability that was worse for Black general medical and surgical patients in the Veterans Health Administration (3).

The authors showed that good agreement between pulse oximeter Sp_{O_2} and arterial blood gas Sa_{O_2} on a first measurement pair in a day was reassuring only for White but not Black patients. For example, despite a small Sp_{O_2}–Sa_{O_2} difference of less than 0.1% on the first reading, 12.9% of Black patients with Sp_{O_2} of 92% on the subsequent reading had occult hypoxemia ($Sa_{O_2} < 88\%$) compared with only 2.7% of White patients.

Race-based correction factors in medicine have historically used reasoning that relies on beliefs of inherent biologic differences between races. Some race-based correction factors, such as those applied to X-ray radiation (4), have rightfully been abandoned; in contrast, others persist despite a lack of scientific justification and growing contradictory evidence (5). Although Jamali and colleagues suggest using skin tone rather than race for the proposed correction factor, the aforementioned studies underscore that current devices are not only less accurate among Black patients but also less precise, producing estimates of arterial saturation that are both biased and variable, such that any attempt to apply a correction factor without reengineering the fundamental technological shortcomings of the pulse oximeter would continue to promote erroneous clinical interpretations.

The combination of directional inconsistency, differential inaccuracy, and poor precision of pulse oximeters exhibited in these studies demonstrates that differences in melanin absorption in patients with a darker skin tone cannot be single-handedly responsible for racial discrepancies in pulse oximeter accuracy. These additional studies provide strong evidence that a static correction factor on the basis of skin tone is not a reasonable solution for this dynamic problem. Instead, a potential short-term solution is to target a modestly higher oxygen saturation concentration, for instance, 94–98% (2), understanding that this may increase the risks of hyperoxia (6). However, although this strategy may reduce the overall prevalence of occult hypoxemia, racial and ethnic minority patients will likely continue to experience disproportionately higher occult hypoxemia because of faulty oxygen monitoring devices. Therefore, we emphasize that even as clinicians struggle with workarounds, the core task must be effective and evidence-based advocacy to create a purchasers' market for equitable devices and persuade regulatory agencies to report data on real-world device performance, requiring medical devices to function similarly in all people regardless of race, ethnicity, or skin tone. ■

Author disclosures are available with the text of this letter at www.atsjournals.org.

Ashraf Fawzy, M.D., M.P.H.*
Johns Hopkins University
Baltimore, Maryland

Valeria S. M. Valbuena, M.D., M.Sc.
University of Michigan
Ann Arbor, Michigan

and

Veterans Affairs Center for Clinical Management Research
Ann Arbor, Michigan

Christopher F. Chesley, M.D., M.S.C.E.
Hospital of the University of Pennsylvania
Philadelphia, Pennsylvania

and

University of Pennsylvania
Philadelphia, Pennsylvania

Tianshi David Wu, M.D., M.H.S.
Baylor College of Medicine
Houston, Texas

and

Michael E. DeBakey Veteran's Affairs Medical Center
Houston, Texas

Theodore J. Iwashyna, M.D., Ph.D.
Johns Hopkins University
Baltimore, Maryland

University of Michigan
Ann Arbor, Michigan

and

Veterans Affairs Center for Clinical Management Research
Ann Arbor, Michigan

ORCID ID: 0000-0001-7921-1879 (C.F.C.).

*Corresponding author (e-mail: afawzy1@jhmi.edu).

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