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Pulse oximetry in people with darker skin tones

Current devices may overestimate oxygen saturation measurement

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Pulse oximetry is one of the most widely used medical technologies worldwide, yet it performs less accurately for people with darker skin.[1] This inequity requires urgent action. In a linked study, Martin and colleagues[2] provide strong prospective evidence that pulse oximeters overestimate oxygen saturation in people with darker skin tones (doi:10.1136/bmj-2025-085535).

Evidence of this bias has accumulated for decades—first noted in 1990 and rediscovered during the covid-19 pandemic.[3 4] These earlier studies were retrospective and relied on routinely collected data, leaving room for scepticism about measurement quality, timing, and whether race or skin tone explained the observed differences.

The prospective cohort study by Martin and colleagues[2] addresses these questions. This study of skin tone and pulse oximeter accuracy evaluated five pulse oximeters used in the National Health Service (NHS) England COVID Oximetry @home scheme.[5] The investigators paired simultaneous pulse oximeter readings with arterial blood gas measurements across 24 intensive care units and measured skin tone objectively using spectrophotometry. They found that oxygen saturation measurements were falsely raised in patients with darker skin tones, which could result in missed hypoxaemia. Clinicians and policy makers should now confront the implications of these findings and identify strategies to mitigate harm.

Pulse oximeters are foundational to clinical assessment from the home to the intensive care unit, informing triage, decisions to prescribe oxygen therapy, and treatment thresholds. During the covid-19 pandemic, for instance, patients with darker skin were often sicker when arriving at hospital or intensive care.[6 7] Because eligibility for dexamethasone in covid-19 treatment depended on the presence of hypoxaemia, falsely raised readings effectively increased the treatment threshold,[8] potentially restricting access to a treatment that reduces mortality by almost 20%.[9]

The implications extend far beyond covid-19. Pulse oximeters guide millions of decisions each day—from home monitoring to emergency response to anaesthesia. Inaccuracies may delay treatment across a wide range of conditions, including cardiorespiratory emergencies, sickle cell crises, and chronic respiratory failure. The problem is even more consequential in lower resource settings globally, where pulse oximetry often remains the only means to assess oxygen saturation. This study raises two questions: how did this happen, and what must change now?

How did this happen? The root cause is not clinician error but a failure of device design and regulation.[10] Early pulse oximeter studies were flawed, relying on small groups of healthy volunteers, predominantly with light skin. Regulatory standards failed to require diversity in testing or transparent reporting by skin tone. Early evidence—reported by Jubran and Tobin in 1990—was a warning that went unheeded.[3] Our collective blind faith in pulse oximeters, combined with lax oversight, allowed this inequity to persist for more than three decades.

What do we do now? Addressing the pulse oximeter problem requires three integrated steps: technological innovation, cautious interpretation, and stronger surveillance.

Firstly, innovation must accelerate. Despite manufacturers having a clear commercial and ethical incentive to design accurate devices across the full spectrum of skin tones, progress is slow. New medical technology will need to replace older equipment, which may be costly and could limit universal adoption.

Secondly, medical education and clinical practice must adapt. Even when better devices become available, millions of existing pulse oximeters will remain in use worldwide. Clinicians must recognise the limitations of current devices and interpret readings for patients with darker skin with care and caution. Despite widespread discussion, this message has not reached all frontline settings.[11 12]

Thirdly, surveillance and transparency are essential after devices reach the market. Martin and colleagues studied device accuracy in critically ill patients—a pragmatic choice given the incidence of hypoxaemia and the availability of arterial blood gases. However, their findings likely underestimate the real world implications, where device quality and user experience vary widely. Regulators should mandate real world testing of pulse oximeters, especially in community and home settings, and make those data publicly available. The United States Food and Drug Administration has proposed new guidance requiring diversity in validation cohorts and reporting by skin tone.[13] Regulators should go further by mandating monitoring after devices reach the market to ensure the ongoing reliability of vital medical equipment that is frequently used.

Martin and colleagues showed that pulse oximeters perform differently depending on skin tone, and the potential clinical implications are clear. Regulation must now catch up with science: inclusive validation, transparent data, and continuous oversight should become non-negotiable standards for medical devices.

Clinicians, meanwhile, should interpret oxygen saturation within the clinical context, integrating patient symptoms, clinical trajectory, and awareness of device limitations. The goal is not to abandon pulse oximetry but to understand its limits and make it equitable, ensuring that the technology designed to measure oxygen does not itself perpetuate inequalities in those who receive it.

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