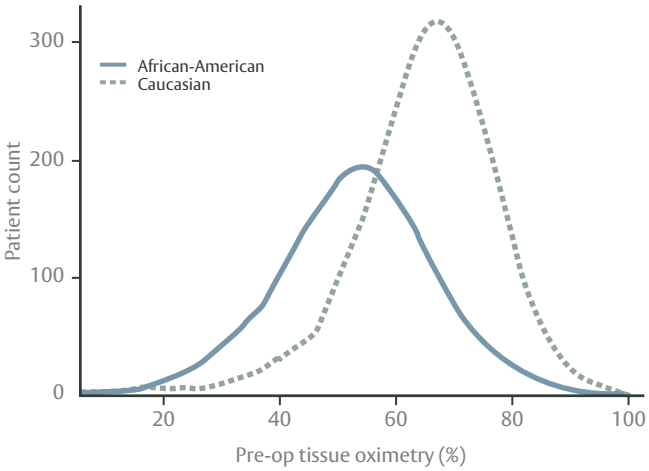
ForeSight tissue oximetry system: Understanding the role of melanin in tissue oximetry

Tissue oximetry uses light waves to penetrate the skin and evaluate oxygen saturation. Higher levels of melanin can make oxygenation readings seem lower than they are, which could lead to unnecessary interventions and increased risk for the patient and/or increased cost of care (Figure 1).[1,2,3] ForeSight tissue oximetry system has been designed to account for the skin pigmentation variance in individuals by interrogating the tissue with five different wavelengths of near-infrared spectroscopy (NIRS) utilizing a proprietary algorithm to estimate and compensate for the effect of melanin in the measurement.[4]

Figure 1. Preoperative tissue oximetry, Sun et. al.



Melanin and its complexity in oximetry

Near infrared spectroscopy (NIRS) has been utilized in medicine for decades, always with the goal of providing clinicians with more information about their patients while remaining noninvasive. Many early limitations (light absorption or scattering) of the technology have been largely overcome. However, one limitation that has not been widely addressed is the issue of melanin interference. The absorption curve of NIR light for melanin is similar to deoxygenated hemoglobin at certain wavelengths, providing potential for melanin to confound tissue oximetry readings if the system does not account for it.[5] This potentially erroneous reading could lead to unnecessary interventions in procedures,[1,3] which can increase the risk for the patient.

Five different wavelengths of NIRS with ForeSight tissue oximetry system

To ensure accurate readings on patients of different skin types, ForeSight system was designed with a unique 5th wavelength to accommodate for the melanin present in the skin. Incorporating five different wavelengths of NIR light analyzes the tissue at the points where oxygenated and deoxygenated hemoglobin are more greatly distinguished.[5] Utilizing the absorption curves of oxygenated and deoxygenated-hemoglobin and other chromophores such as melanin enables ForeSight system to provide reliable and consistent readings regardless of the color of the patient's skin.[5]

There are other biologic substances that mirror the absorption characteristics of oxy- and deoxyhemoglobin. Chromophores present in some patients with high bilirubin or newborn patients who still have meconium in their stools are two examples.[6,7] Because the ForeSight system and its algorithm are designed to compensate for the effects of these substances, it can perform in such patients or conditions.[7,8]

ForeSight system test for the melanin effect

Stannard et. al, noted in a previous study that darker skin pigmentation appears to cause underestimation of regional oxygen saturation for certain cerebral oximetry devices. This underestimation of regional oxygen saturation presents a risk of triggering unindicated interventions and may limit its utility for predicting adverse outcomes. The authors retrospectively evaluated ForeSight cerebral oximetry measurements during

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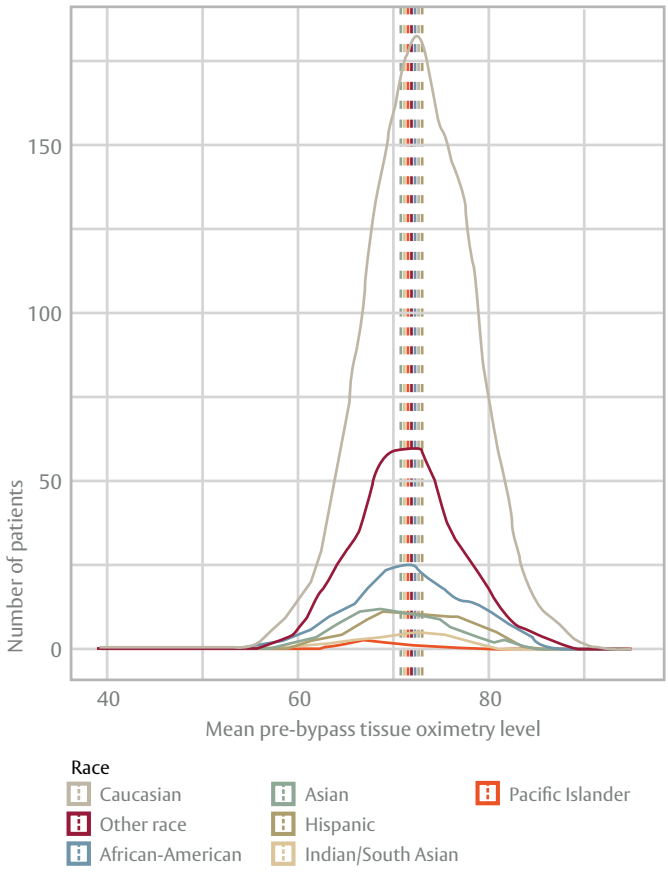
cardiac surgery with self-reported race and quantified the impact of race on the reading. There were 4267 patients studied and included a self-reported race cohort of Caucasian, African American, Asian, Hispanic, Indian/South Asian, and Pacific Islander patients. After adjusting for perioperative variables, differences in readings less than 2% were observed between racial groups (Figure 2).[4]

Conclusion

Melanin can make oxygenation readings seem lower than they are, which could lead to unnecessary interventions, and potentially increased risk for the patient and/or increased cost of care.[1] It is for these reasons that melanin is an important consideration in tissue oximetry technologies.

Figure 2. ForeSight sensor readings by race, Stannard et. al.



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