



Purpose

To determine if pulse oximetry is equally accurate in black and white patients undergoing general anesthesia.

Introduction

Pulse Oximeters (PO) are widely used by health care providers to obtain an indirect measure of arterial blood oxygen saturation (SaO₂) to make real-time, critical clinical decisions. Current Scientific evidence demonstrates PO overestimate SaO₂ in black patients leading to delayed diagnosis and treatment.¹ While most of these studies were conducted in critical care environments like the Emergency Department and Intensive Care Unit, there are no existing studies examining only surgical patients undergoing general anesthesia. Surgical patients under general anesthesia have unique considerations; including, changes in cardiovascular system and peripheral vascular tone, hyperoxia, and motionless state. It remains uncertain whether PO will overestimate SaO₂ in black patients undergoing surgery as well. Accuracy of PO remains critical in patients undergoing anesthesia. The American Society of Anesthesiologists (ASA) adopted pulse oximetry as a standard for basic anesthetic monitoring since 1990.²

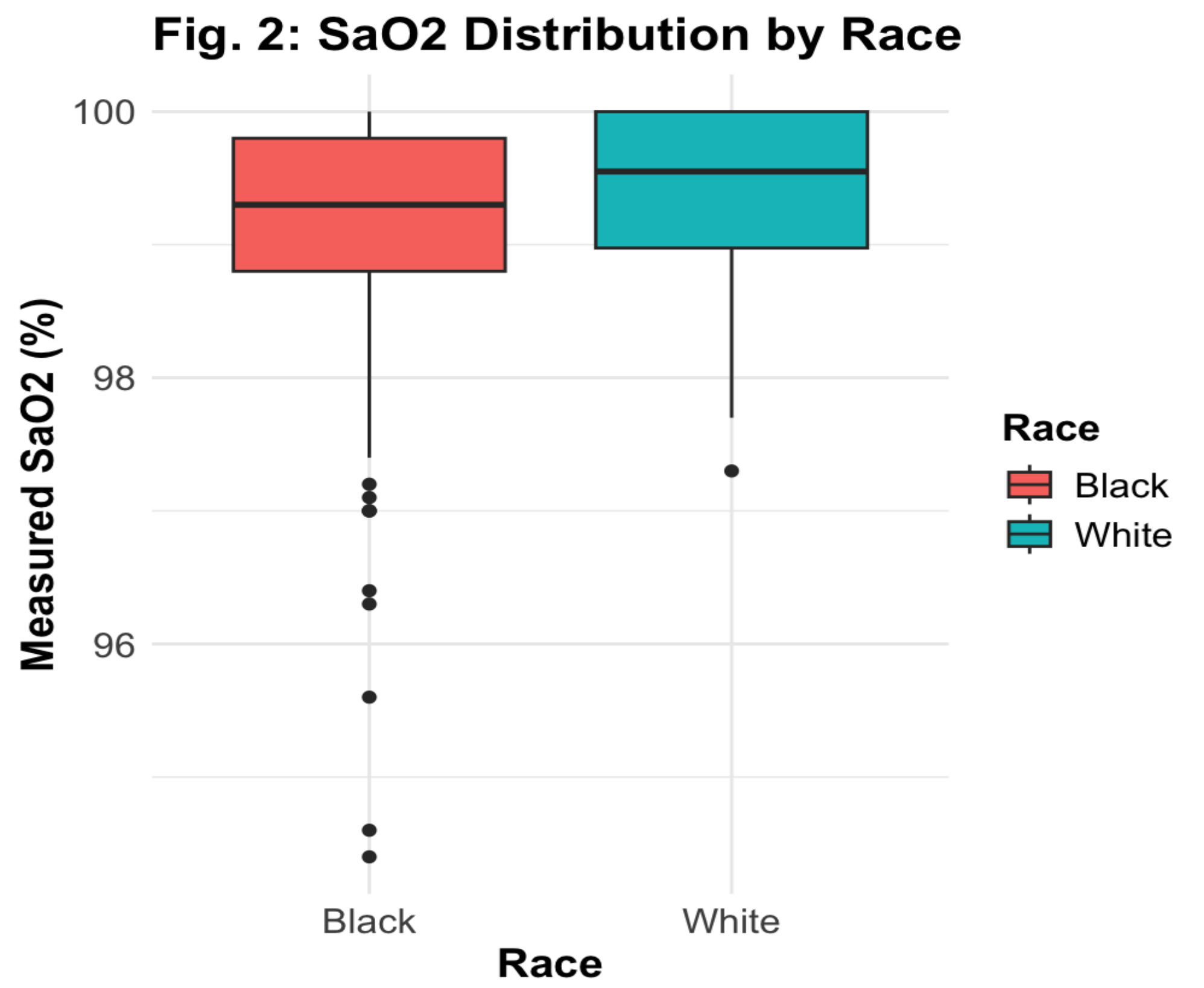
Methods

We conducted a retrospective cohort study on Black and White patients ≥18 years who underwent general anesthesia for cardiac surgery and solid organ transplant surgery at three metropolitan medical centers from 7/01/2018 to 06/30/2023. Convenience sampling was used to obtain self-reported race (i.e. Black/White), (functional SaO₂, SpO₂) data pairs, carboxyhemoglobin (COHb), methemoglobin (MetHb) and type of surgery on the first 344 patients with an arterial blood gas (abg) drawn during the first stable SpO₂ plateau under general anesthesia. We defined stable plateau as an unchanging SpO₂ value for 5 minutes prior to and after an abg draw. The study was adequately powered to inspect significant mean SpO₂ error differences between the two cohorts. To determine significant differences between the cohorts, we did a Welch Two Sample T-test for mean SpO₂ error (i.e. SpO₂-SaO₂), COHb, MetHb, and a Brown-Forsythe test to compare the SaO₂ ranges.

Mean SpO₂ error in Black and White Cohort: Welch Two Sample T-test demonstrated a positive mean SpO₂ error of 0.739 in Blacks and 0.142 in Whites. This difference was statistically significant [95% CI: 0.224-0.970], (p=0.002).



SaO₂ ranges for Black and White Cohort: Brown-Forsythe Test did not demonstrate a significant difference between the SaO₂ ranges for Black patients and White patients (p=0.129). We noted a higher prevalence of lower SaO₂ values in the Black patients compared to Whites patients.



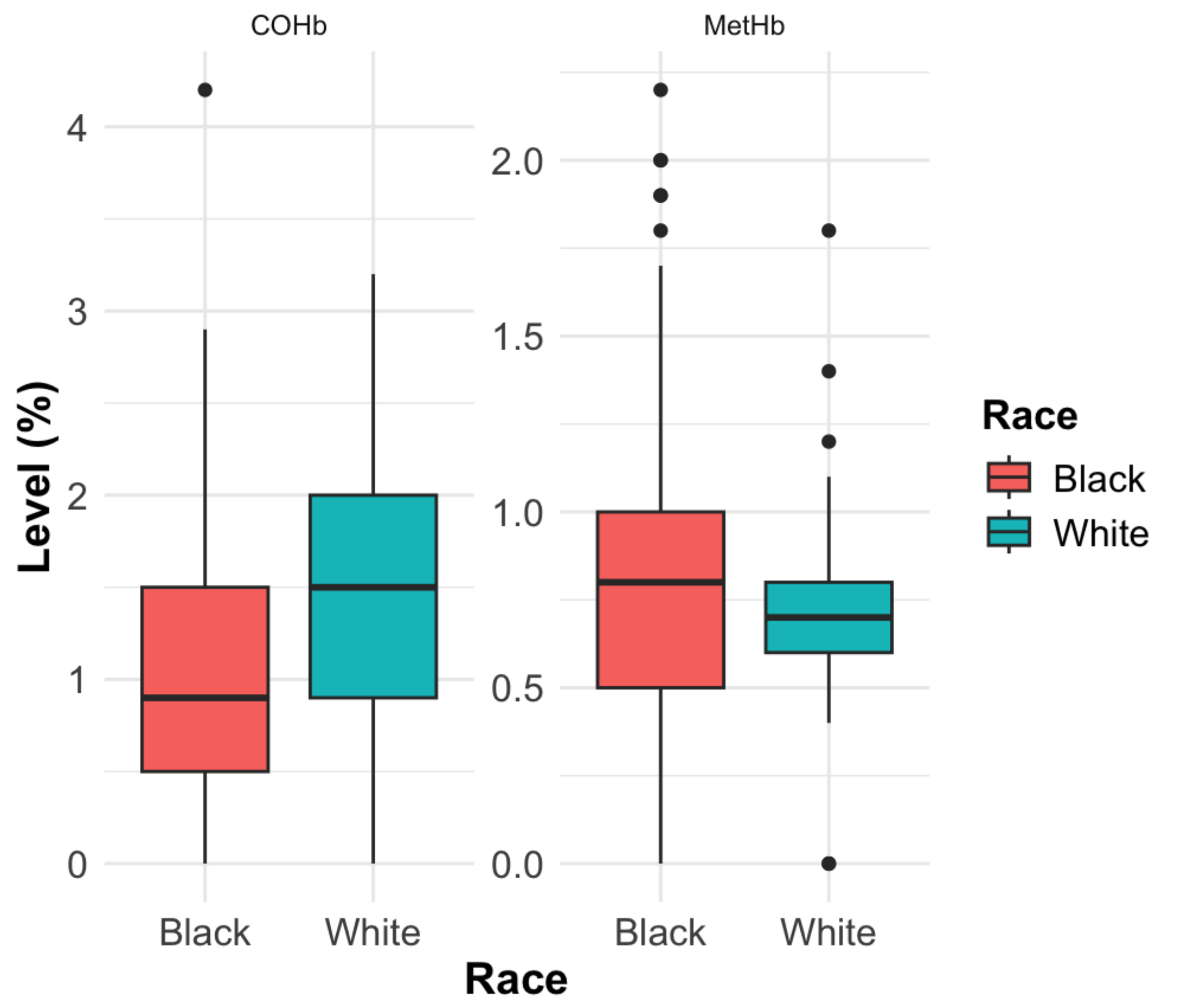
Discussion

In similar SaO₂ ranges, Black cohort demonstrated more positive mean SpO₂ error than White cohort. The difference in this error between the two cohorts was small (.597) but significant, overestimating SaO₂ in Black patients. Though it is not clinically significant (<1%), given typical PO performance, it is uncertain whether these differences may reach clinical significance at lower SaO₂ ranges. Since COHb and MetHb may contribute to SpO₂ error, we limited our data to <3% and <2%, respectively. There was no difference in mean MetHb between the two cohorts. Interestingly, we noted significantly higher COHb in the White cohort with implications for larger true mean SpO₂ error differences between cohorts. We did not collect PO sensor type, tobacco use or patient acuity.

Results

COHb and MetHb in Black and White Cohort: Though MetHb levels were similar, COHb was significantly higher (p=0.003) in White patients compared to Black patients.

Fig. 3: COHb and MetHb by Race



Conclusions

PO overestimates SaO₂ significantly in Black patients but not in White patients undergoing General Anesthesia. At high SaO₂ ranges, this difference is not clinically significant (<1%).

References

1. Fawzy A, Wu TD, Wang K, Robinson ML, Farha J, Bradke A, Golden SH, Xu Y, Garibaldi BT. Racial and Ethnic Discrepancy in Pulse Oximetry and Delayed Identification of Treatment Eligibility Among Patients With COVID-19. JAMA Intern Med. 2022 Jul 1;182(7):730-738. doi: 10.1001/jamainternmed.2022.1906. Erratum in: JAMA Intern Med. 2022 Oct 1;182(10):1108. doi: 10.1001/jamainternmed.2022.3817. PMID: 35639368; PMCID: PMC9257583.
2. Jubran A. Pulse oximetry. Crit Care. 2015 Jul 16;19(1):272. [PMC free article] [PubMed] [Reference list]
3. Cabanas AM, Fuentes-Guajardo M, Latorre K, León D, Martín-Escudero P. Skin Pigmentation Influence on Pulse Oximetry Accuracy: A Systematic Review and Bibliometric Analysis. Sensors (Basel). 2022 Apr 29;22(9):3402. doi: 10.3390/s22093402. PMID: 35591092; PMCID: PMC9102088.