

Original Article



Effect of Red Nail Polish on Pulse Oximetry Reading

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Abstract

Background: Pulse oximetry is a beat-to-beat, non-invasive and virtually risk-free method of assessing continuous arterial hemoglobin saturation. It is now a standard for monitoring care in the operating room and the post-anesthesia care unit. It is also widely used in the critical care setting. Numerous factors including dark skin, pigmentation, henna dye, nail polish etc. could lead to inaccuracy or ambiguous information about oxygen saturation. In many cultures, women decorate their fingernails with different colors of nail polish. **Objectives:** The purpose of this study was to determine the effect of red nail polish on the measurement of oxygen saturation. **Materials and Methods:** One hundred young women were recruited for this study and red nail polish was used to color the index finger of the non-dominant hand; the middle finger of the same hand was the control. Blood oxygen saturation was simultaneously measured by two calibrated pulse oximeters with two minutes interval for 30 minutes. **Results:** Red nail polish did not affect pulse oximetry measurement of oxygen saturation. There was no statistically significant difference between the control and the red nail polished fingers. **Conclusion:** Application of red nail polish does not cause statistically significant error in the measurement of oxygen saturation in young healthy individuals.

Key words: Pulse oximetry, Nail polish, Oxygen saturation.

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Introduction

Pulse oximetry is a noninvasive method used to measure heart rate and arterial oxygen saturation (SpO₂).^{1,2} Pulse oximetry techniques have been developed through more than 100 years of technological and experimental advances.³ Pulse oximeters are widely used for patients that require continuous monitoring of oxygen saturation. It is primarily used in hospital wards, emergency rooms, intensive care units, operating rooms, pulmonary out-patient clinics and home care. It is a noninvasive, safe, affordable tool that provides immediate data and does not require specialized personnel. Normal values of SpO₂ at room temperature at a fraction of inspired oxygen of approximately 21% range between 96% and 100%, corresponding to a PaO₂ of 90 to 100 mm Hg. SpO₂ of 91% to 92% is observed when the PaO₂ is approximately 60 mm, with a standard deviation of ±3%.⁴ Substances such as

intravenous dyes, certain colors of nail polish, skin pigmentation, increased serum levels of lipids and bilirubin etc. can cause inaccurate readings. Moreover, inaccurate readings can result from the influence of ambient light, movement, incompatibility with display equipment and lack of equipment calibration. Today, thanks to the noninvasive nature, high reliability and availability of pulse oximeters, SpO₂ is along with other vital signs an essential parameter in the clinical assessment of patients. According to Yamamoto et al. nail polish produced no significant changes in SpO₂ values in healthy subjects with mild hypoxia, both at rest after exercise.⁵ There are also some other studies on effect of SpO₂ on different colors of nail polish.⁶⁻⁸ though there are a numbers of different colors, most women prefer red nail polish. That is why this study, aiming to evaluate the interference of red nail polish on SpO₂ in healthy individuals.

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Materials and Methods

The study was done in January from 2018 to April 2018 at National Institute of ENT, Dhaka. After obtaining the informed consent, it was explained the objectives and the method of the study to the potential participants. One hundred ASA (American Society of Anesthesiologists) class I female patients aged 20 to 45 years undergoing elective surgical procedure requiring general anesthesia were enrolled. The evening before surgery, the patient's nail of left index finger was painted with red nail polish. The criteria for initialization of this study comprises of lack of suffering from anemia, having hemoglobin level within the range 12-15 g/dl, normal body temperature, oxyhemoglobin saturation range 95-100% and other investigations for general anesthesia fitness were within normal range.

Next morning, in the operating room, two similar pulse oximeters were applied to the patients red nail polished index finger and the middle (control) finger simultaneously along with other monitors. Patients were pre-oxygenated with 100% oxygen for 3 minutes following which general anesthesia was induced with inj. fentanyl 1 mcg/kg, inj. propofol 2 mg/kg, and vecuronium 0.1 mg/kg. Patients were intubated and ventilated with oxygen, nitrous oxide and halothane as usual. Both pulse oximeter readings were recorded simultaneously every two minutes for 30 minutes starting from five minutes before induction of anesthesia.

Data was collected and recorded then analyzed statistically. Patients demographic and clinical characteristics were summarized as mean ± standard deviation. To compare oxygen saturation of the nail polished and control fingers, the paired t-test was used. P<0.05 was considered statistically significant.

Results

Demographic data and clinical parameters were recorded (Table-I). To compare oxygen saturation of the nail polished and control fingers, the paired t-test was used. It was shown that the use of red nail polish in comparison with the control did not cause changes statistically in oxygen saturation reading by pulse oximetry (p>0.05) (Table-II).

Table I: Demographic data and clinical parameter.

Parameters	mean ±SD
Age (Years)	41.12±6.89
Body weight (Kg)	61.43±9.28
Base line pulse rate (bpm)	84.3±7.2
Base line mean arterial pressure (mm Hg)	91.67±7.48
Hemoglobin (g/dl)	13.94±.86
Temperature (°C)	36.9± 0.4

Table II: Red nail polished and control finger's oxygen saturation.

Group	Oxygen saturation (mean ±SD)	Number	Pvalue
Nail polished finger	98.8± 0.56	100	p>0.05
Control finger	99.3± 0.42	100	

Discussion

Nail polish has traditionally been considered one of the main factors that can affect the reading of SpO₂ of patients undergoing pulse oximetry. However, this has been questioned by many researchers for decades with little consensus; while some studies concluded that the presence of nail polish decreased SpO₂ values,^{9,10} others found no such differences.¹¹

Subsequent replicated experiments yielded divergent results, in part perhaps because of methodological differences between trials, hindering comparison between them. The low sample size, the non-random method of selection of participants in the studies, the limited number of types and colors of nail polish and specially the various models of pulse oximeters employed represent significant constraints that hinder the external validity of the results obtained.

Technological evaluation on pulse oximeters could reasonably influence the disparity in results, a situation that has been observed in some of the trials in which measurements were performed simultaneously with different pulse oximeters and in which differences between the models were found.^{12,13} According to the study of Diccini et al.¹⁴ they used coffee, brown, chocolate, red and metallic color nail polish on 80 healthy volunteers. SpO₂ values taken in fingers with painted nails were compared with those obtained in unpainted fingers of the opposite hand and they found only brown and red colors caused small reduction in the measurement of SpO₂, but statistically not significant.

A study with blue, green and lime-green color nail polish was used on 12 healthy volunteers at sea level, by Brand et al. found nail polish does not affect the accuracy of pulse oximetry values.¹⁵ Another study done by Hinkelbein et al. on 50 mechanically ventilated critically ill patients using yellow, dark blue, light blue, black, purple, dark green, light green, red and transparent nail polish and analyzed statistically then concluded that nail polish in mechanically ventilated patients produced some change in SpO₂ values, but not clinically or statistically significant.¹⁶

Hakverdioet al. worked on 40 healthy male volunteers using 10 different colors of nail polish and average approximately 1% decrease in SpO₂ value was observed.¹⁷ Shimoya et al. had a study on 42 patients with stable COPD using 4 different colors of nail polish to observe the effect of SpO₂. Their result was light pink and red color nail polish did not affect SpO₂ readings.¹⁸

The study on changes of SpO₂ readings due to different colors of nail polish was published by Sutcu et al. Their result showed mean difference of SpO₂ was less than 2%.¹⁹ Another study done by Rodden et al. using 10 different colors of nail polish, their results were, changes of SpO₂ were not clinically significant.²⁰

In present study, only the red color nail polish was used and this presented no significant interference in SpO₂ readings. One of the limitations of present study is that a number of colors of nail polish are available on the local market but only red color was used.

Conclusion

In the light of this study, it can be concluded that there is small variability in the effects of red nail polish on the reading of the oxygen saturation however; these variations are not clinically or statistically significant.

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