

## Original Article

# The Effect of Nail Polish on Pulseoximeter's Measurements in Healthy Individuals

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### Abstract

**Background:** Pulse oximetry is considered as the most valuable non-invasive method for continuous oxygen saturation (SpO<sub>2</sub>) monitoring in patients with hypoxemia risk.

**Aim:** The aim of this study to determine whether nail polish affected peripheral capillary hemoglobin oxygen saturation measurements in healthy individuals

**Methodology:** This is a semi-experimental study.. This research was conducted with the 80 female who 18 age and above and not having any health problem, not having any communication problem, non-smoker, agreed to participate in study at a Nursing Department from January 2015 to June 2015 were included. The right hand of the participants was selected as the hand to receive nail polish for the experiment, while the left hand was used as a control without nail polish. A portable pulse oximeter was used for oxygen saturation measurement.

**Results;** There was statistical significant difference between SpO<sub>2</sub> measurements performed on the right and left thumbs ( color pearl, p=.000). Similarly, statistically significant differences were found between measurements of right and left hand index finger( color red, p=.000), middle finger( color blue, p=.000), ring finger (color brown, p=.000) and small finger (color green, p=.000).

**Conclusion:** As a result, all the nail polish colors caused a reduction in the measurement of SpO<sub>2</sub>.Nurses may be recommended to remove nail polish of the patients before measuring oxygen saturation on the finger

**Key Words:** Nail polish, oximetry, monitoring, nursing

### Introduction

Pulse oximetry was first developed by Takuo Aoyagi in mid-1970s. Continuous oxygen saturation monitoring using pulse oximetry is a standard practice used in operating rooms, post-anesthesia care units, emergency services, intensive care units and in homes (Sharma et al, 2015; Hakverdioglu,2007; Guiliano2005). .Pulse oximetry is considered as the most valuable non-invasive method for continuous oxygen saturation (SpO<sub>2</sub>) monitoring in patients with hypoxemia risk. It is generally used to detect hypoxemia, reduce the frequency of blood gas

analysis, and titrate the oxygen amount given to the patient (Hakemi,2005). The oxygenation status, which is as important as patient's vital signs, should be continuously monitored and recorded by the nurse. Assessments related to the patient's oxygen saturation also guide the medical treatment of the patient. Fingernail, toe, ear, nose and forehead regions are used to assess oxygen saturation of the patient in intensive care units. The use of pulse oximetry during patient follow-up is highly important for establishing and intervening in hypoxic conditions, in particular, in the early period, evaluating the treatment response during patient follow-up and

increasing patient safety (Hinkelbein,2007 ;Sun,2003). The use of pulse oximetry may be limited by certain circumstances such as anemia, paints, nail polish, motion artifact, skin pigmentation, low perfusion levels, probe design, oximeter types, vasoactive drugs, and arterial acid-base status (Coşkun,2008; Casey,2001). Since pulse oximetry probes are most commonly applied over the fingernails, it has been a concern that nail polish impedes light transmission. There are studies investigating the impact of nail polish on pulse oximetry (Yomato,2008; Rodden,2007). There are studies that show that nail polish does not affect SpO<sub>2</sub> measurements (Hinkelbein,2007; Rodden,2007;Brand,2002; Chan,2003). There are studies in the literature that green, brown, black and blue nail polish reduce oxygen saturation by 3-5%

(Hinkelbein,2007,Rodden,2007;Branson,2004;Al shehri,2000). Monitoring the oxygenation status, which is as important as vital signs, is important for the medical treatment of the patient and nursing care. The nurse is responsible for ensuring that the measurements of the patient's oxygenation status are properly made, sharing the results with other team members, and administering an adequate amount of oxygen to the patient so that it will meet the oxygen needs of the patient. Since a limited number of studies on this topic are identified in the literature, the present study was designed to evaluate the effect of different nail polish colors on pulse oximetry measurements.

The aim of the study was to determine whether nail polish affected peripheral capillary hemoglobin oxygen saturation SpO<sub>2</sub> measurements in healthy subjects.

### Methods

This study was designed as quasi-experimental research. The 80 female who 18 age and above and not having any health problem, not having any communication problem, non-smoker, agreed to participate in study at a Nursing Department from January 2015 to June 2015 were included. There were 524 female students in the Nursing Department ( 1. class 155, 2. Class 142, 3.Class 155, 4.Class 72). It was aimed to reach 15% of each class in this study ( 1. class 24, 2. Class 22, 3.Class 24, 4.Class 10). Exclusion criteria were: a difference in measured values of SpO<sub>2</sub> greater than  $\pm 2\%$  between the

fingers, history of pulmonary disease, and hematologic and metabolic disorders.

### Instruments

Data collection was completed in the nursing laboratory between January 2015 and June 2015. The data were collected using personal information form which included age, class, pulse rate of each participant, and SpO<sub>2</sub> measurements for each finger. The fingers of the right hand were used as experimental and selected as the hand to receive the nail polish colors. The fingers of the left hand were used as controls and selected as the hand to not receive the nail polish colors. After each participant is rested for 10 minutes, firstly SpO<sub>2</sub> was measured. Each fingernail of the right hand received the colored nail polish in the following sequence: the little finger received green; ring finger, brown; middle finger, blue; index finger red and thumb, pearl.

Nail polish was applied 2 coats each fingernail of the right hand. We waited for the drying of the nail polish and then we measured of SpO<sub>2</sub>. For measurement of SpO<sub>2</sub>, a portable pulse oximeter was used (model OxiMax N-560; NELLCOR) with a finger sensor that included an alligator clip.

The equipment calibration was performed before testing. The time of pulse oximetry measurement was 30 seconds for each finger, and this time started from the moment the reading was stabilized with the device.

### Data analysis

The data were evaluated using SPSS 16.0. The data were evaluated mean, standard deviation and minimum and maximum values for the fingers of the right and left hands. The t test were applied to examine the difference between the mean score of SpO<sub>2</sub> measurements. Significance in all statistical analyses was defined as  $p < 0.05$ .

### Ethical Considerations

A university-affiliated institutional review board approved the study. We explained the aim and the process of the study to the participants and guaranteed the confidentiality of their personal data. Participation in and withdrawal from the study were voluntary. All the participants signed an informed consent before taking part in the study

## Results

Averageage of female students was  $21 \pm 00$ . Table 1 shows the descriptive measurements of oxygen saturation (%) and the analysis of difference between the mean score of SpO<sub>2</sub> measurements by finger of the right hand (with nail polish), and the left hand (without nail polish). Table 1 shows that the measured values of the left hand fingers (without nail polish) are higher than those of the right hand fingers (with nail polish). There was statistical significant difference between SpO<sub>2</sub> measurements performed on the right and left thumbs (color

pearl,  $p=0.000$ ). Similarly, statistically significant differences were found between measurements of right and left hand index finger( color red,  $p=0.000$ ), middle finger( color blue,  $p=0.000$ ), ring finger (color brown,  $p=0.000$ ) and small finger (color green,  $p=0.000$ ). The highest measurement average between the right hand fingers was on the index finger ( $98.55 \pm 2.36$ ), and the highest average between the left hand fingers was little( $99.12 \pm 1.29$ ). The highest oxygen saturation level measured on fingers was  $98.55 \pm 2.36$  with red nail polish and the lowest was with blue ( $97.87 \pm 3.05$ ).

**Table 1. Comparisons of SPO<sub>2</sub> values from fingers of both hands with and without nail polish**

| Finger color | Thumb Pearl                    |       | Index Red                        |       | Middle Blue                      |       | Ring Brown                       |       | Little Green                     |       |
|--------------|--------------------------------|-------|----------------------------------|-------|----------------------------------|-------|----------------------------------|-------|----------------------------------|-------|
|              | Right                          | Left  | Right                            | Left  | Right                            | Left  | Right                            | Left  | Right                            | Left  |
| Mean         | 98.23                          | 98.51 | 98.55                            | 98.88 | 97.87                            | 98.98 | 98.17                            | 99.04 | 98.15                            | 99.12 |
| SD           | 2.44                           | 1.42  | 2.36                             | 1.20  | 3.05                             | 1.37  | 2.42                             | 1.58  | 2.33                             | 1.29  |
| Maximum      | 100                            | 100   | 100                              | 100   | 100                              | 100   | 100                              | 100   | 100                              | 100   |
| Minimum      | 84                             | 95    | 82                               | 95    | 78                               | 93    | 84                               | 89    | 83                               | 93    |
| Analysis     | t:625.518<br>df:17<br>p <0.001 |       | t:669.830<br>df: 171<br>p <0.001 |       | t:538.441<br>df: 171<br>p <0.001 |       | t:622.881<br>df: 171<br>p <0.001 |       | t:676.377<br>df: 171<br>p <0.001 |       |

## Discussion and conclusion

The effect of nail polish on pulse oximetry SpO<sub>2</sub> measurements has been discussing for long time. There are studies in the literature that involve different findings on this subject (Sharma et al, 2015; Rodden,2007; Branson,2004;Jakpor,2011;Kataria 1986). In our study, the difference between oxygen saturation values on fingers with no polish and with green, brown, blue, red, and pearl colored polish was statistically significant ( $p < 0.05$ ). Some studies have found that red nail polish affects pulse oximetry SpO<sub>2</sub> values. Rodden et al (2007) found red nail polish to cause considerable change in pulse oximeter values. However, this change is less than 1% compared to actual SpO<sub>2</sub> value and thus it is not clinically significant.

Some studies have found that nail polish decreases pulse oximeter SpO<sub>2</sub> values, whereas others have found no effects from nail polish. Previous studies have reported conflicting results (Hinkelbein,2007; Chan,2003;Jakpor,2011). Chan et al (2003) stated that black, blue, and green nail polishes considerably decrease oxygen saturation by 3-6%, whereas blue nail polish decreases oxygen saturation from 97% to 87%. Hinkelbein et al (2007) worked with 50 critically ill patients using nine different nail polish colors, where all colors showed a different level of impairment on the readings of pulse oximetry. There was also a statistically significant difference between the measurement of SpO<sub>2</sub> between coffee color. Results of the study showed that most significant interference was for

black, purple, and dark blue nail polishes. A study in which ten different colors were analyzed in 12 non-smoking volunteers, concluded that the colors blue, green and lime green, caused no statistically significant difference in pulse oximetry contradicting the results of previous studies (Brand,2002). Diccini et al (2011) found the nails colored plum, chocolate and coffee with milk, showed no significant differences in SpO<sub>2</sub> while the colors red and coffee showed statistically significant differences in SpO<sub>2</sub>, but without clinical importance. Artificial acrylic finger nails have been reported not to interfere with pulse oximetry, although there are no clinical studies to support that. The study by Hakverdioglu et al (2007) indicated that nine colors affected pulse readings, but the values were too small to be clinically significant. Results of Jakpor's (2011) study revealed that most of the artificial nails and nail polish (white, red, blue, pink, and wine) did not interfere with the measurement of oxygen saturation by pulse oximetry and most colors had a little or no significant effect.

The green, brown, blue, red, and pearl colored polish was statistically significant differences in the reading of SpO<sub>2</sub>. We have concluded that different nail polish colors cause a clinically significant change in pulseoximeter values in healthy subjects, but more work is needed. In the future, an extended study can be conducted with larger groups of ill subjects to compare pulse oximeter values using different nail polish colors and artificial nails.

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