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EFFECT OF DIFFERENT COLORS OF NAIL POLISH ON PULSE OXIMETER'S READINGS IN VENTILATED PATIENTS

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Abstract - *This paper presents the effect of different colors of nail polish on pulse oximetry readings in ventilated patients. Pulse oximetry is primarily used in hospitals for care of patients in different departments like Hospital wards, Emergency room, Intensive care units and Operation Theater. Other than hospital pulse oximetry is also used in home care. Since in daily life there is frequent use of nail polish so while using a fingertip type of pulse there may be any effect due to nail polish in this paper we are going to analyze those effects. In this paper we had used 9 colors of nail polish on ventilated patients. The colors are Metallic, Pink, Green, Yellow, Black, White, Purple, Blue and red color of different shade number of Elle 18 brand of nail polish. Every nail polish of each color has particular shade number. Every color has applied to finger of each volunteer participating. A total of 30 ventilated patients volunteer participated.*

Key Words: *Nail polish, Pulse Oximeter, SpO_2, Ventilated Patients, Pulse Oximetry*

1.INTRODUCTION

Pulse oximetry is a device used to measure the value of SpO_2. There are different type of pulse oximeter available in market namely Fingertip type, Hand hold type and Table top type. Mostly fingertip type of pulse oximeter is used since it is small in size, easy to carry, easy to handle and having low cost. Due to being inexpensive and many advantages like non-invasive device pulse oximeters became a most accepted device in clinical and non-clinical for measurement of oxygen saturation of blood.

Study so far proven that only red nail polish did not yield statistically significant reading result. Conclude that different nail polish color cause a clinically significant change in pulse oximeter reading of healthy volunteers.[1]. Fingernail polish does not cause a clinically significant change in pulse oximeter readings in healthy people. [2]. Nail polish does not alter pulse oximeter readings in mechanically ventilated patients to a clinically relevant extent. [3]. The mean error of measurement for all colors was within the manufacturer's specified range of $\pm$ 2%.

In this study I had considered healthy volunteers, patients including ventilated and non-ventilated patients both male and females of different age groups. We had used FINGERTIP TYPE OF PULSE OXIMETER of Nidek medical India Company and 9 nail polish of Elle 18 brand.

2. Methods

The sample group of this study comprised of 30 ventilated patients. Volunteers are both male and female ventilated patient. Patient's sample has taken from patients of medical college hospital Jhansi. All the pulse oximeter readings were taken when participant was in rest and at room temperature.
In first phase of this study, reading of all ten fingers was taken without nail polish to determine finger to finger deviation in value pulse oximeter. Then in second phase of this study pulse oximeter reading without and with nail polish was taken for all 9 color namely metallic, pink, yellow, green, blue, purple, black and white and red color of Elle 18 brand nail polish. All nail polish was of same brand and same shade number of color was used all volunteers for same color.
In the process of second phase of study following steps were followed. In first step finger were cleaned by using cotton and thinner then after keeping it until it become dry we find SpO_2 using pulse oximeter and then one coat of nail color was applied. When it dry out then again reading of SpO_2 was taken. This process was applied for all nine colors.

3. Working principle of Pulse oximeter

Pulse oximeter uses two type of working principles that are transmittance method and reflectance method as described below [4].

3.1. Transmittance Method:

In this method, light is transmitted through tissue using the LED and is detected on the other end using a photo-detector. It is more suited to the areas of body that lend themselves better to light transmittance through them, e.g. fingers or ear lobe. This configuration cannot be

used in other areas of body when there are obstacles such as bones or muscles [4].

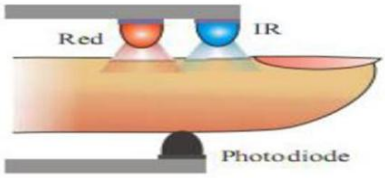

Fig -1: Transmittance Method

3.2. Reflectance Method:

In reflectance pulse oximetry it uses a photo detector on the same side as the LED to detect the light reflected by the tissue. This method is more useful where the vasculature is available close to the surface of skin e.g. forehead, wrist, forearm.

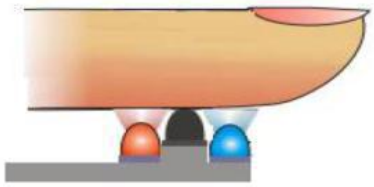

Fig. 2 Reflectance Method

Based on all these review, there are two methods are chosen to calculate heart rate and blood oxygen saturation level. [4].

3.3. Calculation of blood oxygen saturation level:

The principle of pulse oximetry is based on the red and infrared light absorption characteristics of oxygenated and deoxygenated haemoglobin. Oxygenated haemoglobin absorbs more infrared light and allows more red lights to pass through whereas deoxygenated haemoglobin absorbs more red light and allows more infrared light to pass through. Red light is in the 600-750 nm wavelength light band whereas infrared light is in the 850-1000 nm wavelength light band. The absorption relationship is shown in following figure. Blood for the Red and Infrared Wavelengths because the flow of blood is pulsatile in nature, the transmitted light changes with time.

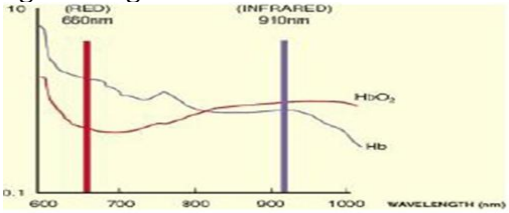

Fig.3 Absorption Relationship of Oxygen Levels In the Blood for the Red and Infrared Wavelengths [4]

A normal finger has light absorbed from bloodless tissue, venous blood, and arterial blood. The volume of arterial blood changes with pulse, so the absorption of light also changes.

According to Handbook of Biomedical Instrumentation by R.S. Khandpur [5], techniques of measuring heart rate are:

3.4. Average Calculation:

An average rate is calculated by counting the number of pulses in given time. This method does not show changes in time between beats and thus does not represent the true picture of heart's response to exercise, stress and environment

3.5. Heart rate calculation:

In this project is based on the beat to beat heart rate calculation process. In this process, number of pulses for a given period T is calculated and converted to bpm by multiplying with 60/T, that gives the instantaneous heart rate in bpm. So this can be expressed as[7]:

$$\text{Heart rate (bpm)} = \frac{\text{Number of pulse for given time (T)} \times 60}{T} \qquad \textbf{(1)}$$

3.6. Beat To Beat Calculation:

This is done by measuring the time (T) in seconds, between two consecutive pulses, and converting the time into beats/min, using the formula beat/min = 60/T.

4. Statistical analysis

The peripheral oxygen saturation (SpO2) is defined as ratio of oxygenated hemoglobin (HbO_2) to total hemoglobin (sum of oxygenated (HbO_2) and deoxygenated (Hb))[6]. It is oxygen carrying ability of hemoglobin. SpO_2 is usually used as reference functional oxygen saturation determined by pulse oximeter. Now the basic formula to calculate oxygen saturation level can be stated as:

$$SpO_2 = \frac{HbO2}{Hb+HbO2} \qquad (2)$$

The SpO_2 for each finger before and after polish was determined using pulse oximeter then it tabulated for each color separately for healthy volunteer and patients. For comparison and visual analysis histogram representation was used. Significant difference was determined for suggesting clinically acceptance of particular of nail polish.

5. Results

A total of 30 volunteer were participated and all were ventilated patients. Fig.4: Average values of oxygen saturation measured on right and left hand finger nail with no polish of all volunteers who were ventilated patients. This shows that there is no significant deviation in pulse oximeter reading for different finger of both hands.

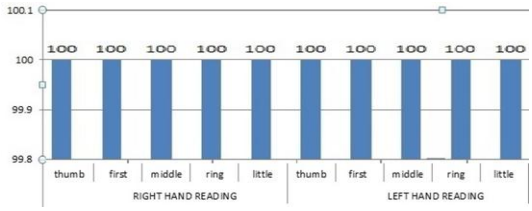

Fig.4: Average values of oxygen saturation measured on right and left hand finger nail with no polish.

In further Fig.5 shows histogram representation of SpO_2 of ventilated patients which contain average value without nail polish and with nail polish of all 30 ventilated patients. This shows that there is no significant deviation in pulse oximeter reading, all values remained 100 before and after applying nail polish.

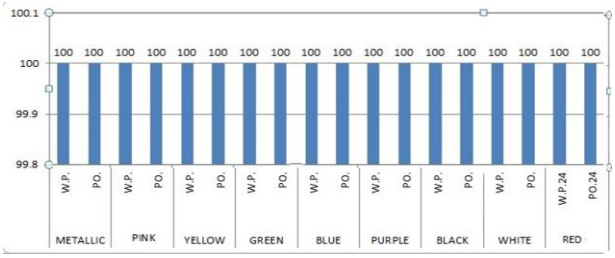

Fig.5: Average values of oxygen saturation measured for ventilated patients.

6. Conclusion

We conclude that Patient who are critical and ventilated was found to have SpO_2 value 100 and no effect of nail polish of any colour is detected. It remains same.

7. Clinical suggestion

Since our study shows no change in pulse oximeter readings for all colours so it is advisable that If patient is ventilated then it is found that pulse oximeter reading remains at 100 and not effected by any colour of nail polish.

7. Acknowledgement

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