ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Effect of nail polish colour on pulse oximetry reading.

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Manuscript Info

Manuscript History:

Received: 15 June 2015
Final Accepted: 29 July 2015
Published Online: August 2015

Key words:

"nail polish colour", "pulse oximetry"

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Abstract

Pulse oximetry is a rapid, non invasive and simple method of determining blood oxygen saturation of patients in Emergency Department before any critical intervention. Over the years the accuracy of pulse oximeter reading in patients with nail polish applied on their fingers have been questioned through many studies.

Objective: Our study was done to determine whether different coloured nail polishes significantly affect measurement of oxygen saturation.

Material and methods: 100 healthy females with ages between 20 & 35 years and with no known disease were included into the study. All the participants were applied nail polishes of nine different colours (orange, red, purple, yellow, white, blue, green, beige, black) to nine different fingers just before the study and one finger was left empty as control. Arterial blood gas analysis was also done on each individual to see the accuracy of pulse oximeter. The nail polishes of same brand were used for the study and all the readings were taken in day light and constant room temperature. Oxygen saturation measurements were done using two different pulse oximetry devices (device I, II) from the control and different colour nail polished fingers.

Results: No significant difference between measurement for both with and without nail polish of all colours was noted except red for which the said error difference is even very small; less than 0.5 at 5% level of significance.

Conclusion: The results suggest that nail polishes do not significantly affect pulse oximetry reading from patient management point of view.

INTRODUCTION

Pulse oximetry (SpO2) is an easy, non invasive method of monitoring the oxygenation of a patient's haemoglobin which is necessary to take quick decisions regarding interventions whenever a patient's oxygenation is found unstable. Since its discovery by Takuo Aoyagi in 1972 **[1],** pulse oximetry has become a standard monitoring technique that is extensively used in the Emergency Department. Though thought to be accurate, it should be kept in mind that factors like extreme anaemia, vasoconstriction, hypotension and hypoperfusion, hyperbilirubinaemia, carboxyhaemoglobinaemia and methemoglobinemia, and motion **[2,3,4,]** can affect the SpO2 values obtained by pulse oximetry. Nail polish has also been reported to interfere with pulse oximetry in several previous studies **[4, 6, - 13]** and even the WHO 2011 guidelines **[5]** recommend removing nail varnish from one finger before pulse oximetry. Previous studies on the effect of nail polish colours on pulse oximetry are limited and the results of these few prospective clinical studies are variable and inconclusive leading to ongoing controversy. Removing the nail polish with a remover before taking the reading is the common practice followed worldwide. This is not only hazardous and time consuming in an emergency situation, but also carries risk of causing allergic skin reactions and brittle nails.

Theoretically, however, nail polish should not influence pulse oximetry because it absorbs pulsatile light of haemoglobin to determine oxygen saturation which has no relation to different colours **[2].**

Adequate scientific evidence to prove or disprove that nail polish interferes with pulse oximetry readings are lacking **[6, 7].** Our study aims to see whether nail polish colours alter oximetry readings significantly to cause change of patient management.

Materials and Methods:

We did a prospective observational study on one hundred healthy female volunteers between 20 & 35 years age in the Department of Emergency Medicine at Peerless Hospital, Kolkata between April 2012 to March 2013. Nail polishes of nine different colours of the same brand were applied in 2 coats in the fingers of these volunteers with one finger left without nail polish as a control before taking the readings by the participants. After taking all precautions to rule out factors that can adversely affect the accuracy of pulse oximeters, like transducer movement, peripheral vasoconstriction, a nonpulsating vascular bed, hypotension, anaemia or hypothermia, readings with two separate pulse oximeters (model OxiMax N-560; NELLCOR) with a clip-type sensor were used to take readings for each colour and compared with the control finger.

Health screening of the volunteers was done prior to the study by obtaining proper history and physical examination along with relevant routine tests as deemed necessary by the physician. Also, prior to the data collection for the actual study, SpO2 of all the fingers of each of the volunteers were checked without nail polishes to make sure that there was no difference in SpO2 readings. All pulse oximeter readings were taken during daytime between 10 am and 11 am and at constant room temperature.

Arterial blood gas analysis was done in all participants just after the readings to not only rule out instrumental error but also provided standard value for comparing the two instruments being used for the research.

All the data were noted down in a specified data collection form. Written consent was taken from the participants in vernacular language regarding both invasive & non invasive procedures before commencement of the study procedure. 'Ethical Committee' approval was obtained for the study.

Results:

Participant characteristics:

We screened 121 female volunteers after explaining them about the study and taking written informed consent. Of these 121 volunteers 100 were selected for the study after being declared fit and free from disease by an experienced Emergency Physician who did a detailed clinical examination and routine tests on them. The demographics of the volunteers and the distribution of SaO2 of the volunteers are given below in Table I and II.

Volunteer demographics (n =100)		
Age (years)	**20 – 25**	**32**
	25 – 30	**46**
	30 – 35	**22**
Smoker	**No**	**100**
	Yes	**0**
Nail abnormalities	**None**	**100**
	Nail bites	**0**
	Medical disorders	**0**
Haemoglobin (Gm/dl)	**<12**	**0**
	12 – 15	**100**
	>15	**0**

Table I: Demographics of the volunteers

Sl. No.	Parameter	SaO2
1	Mean	98.75
2	Std. Dev.	0.97
3	Minimum	96.0
4	1st Quartile	98.00
5	Median	99.00

6	3rd Quartile	99.70
7	Maximum	100.0
8	Inter Quartile Range (IQR)	1.70
9	95% Confidence Interval for Mean (LCL)	98.56
10	95% Confidence Interval for Mean (UCL)	98.94

Table II: Distribution of SaO2 of 100 Volunteers under Study

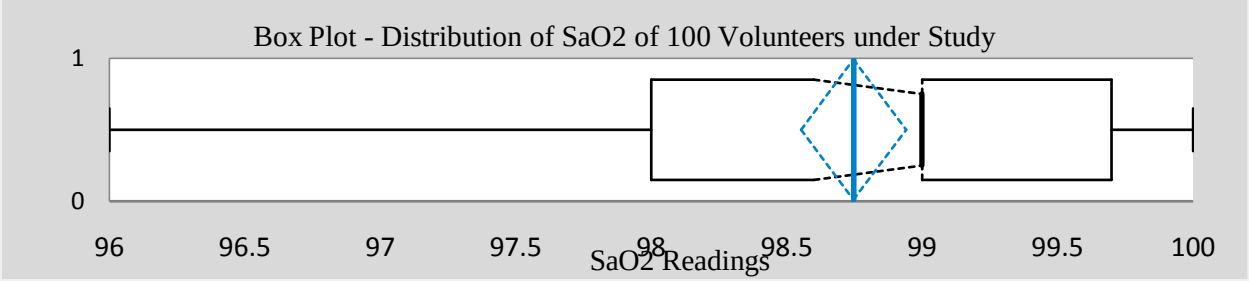

Figure I: Box Plot - Distribution of SaO2 of 100 Volunteers under Study

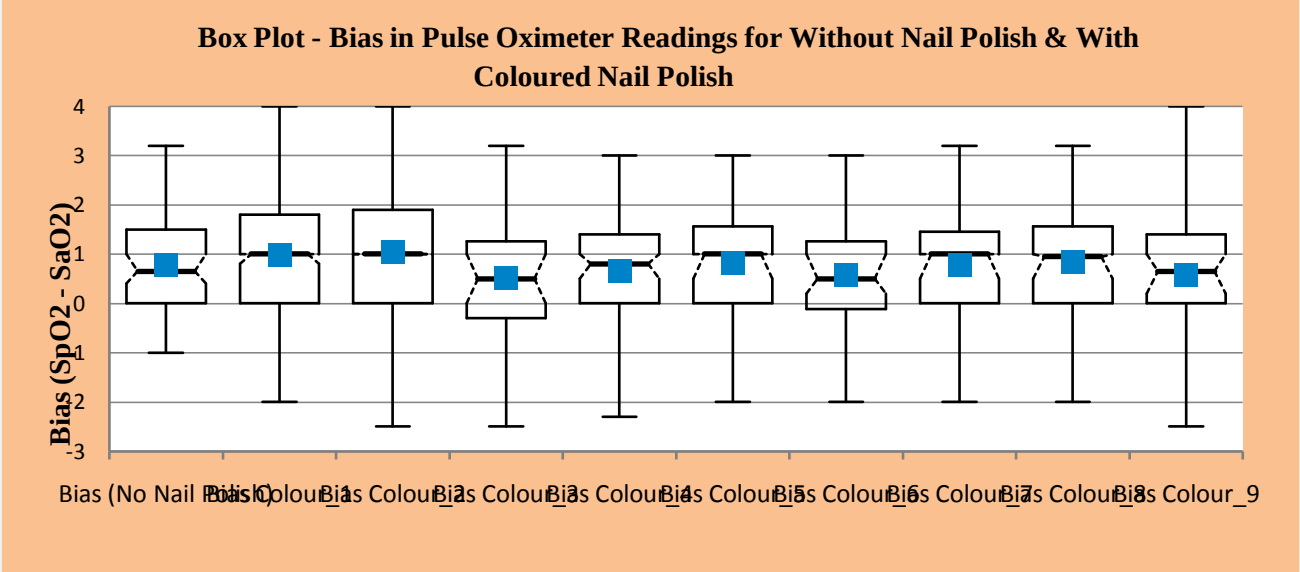

Figure II: Box Plot -Bias in Pulse Oximeter Readings for Without Nail Polish & With Coloured Nail Polish

Analysis of the effect of nail polish on pulse oximetry reading:

The analysis of the effect of nail polish on pulse oximetry reading was done with the help of box plot diagram and paired Z-test. The results found no significant statistical difference between two measurement errors SpO2-SaO2 (arterial oxygen saturation) for with and without nail polish of all colours except Red (for which the said error difference is even very small, say less than 0.5) at 5% level of significance. However, even with the red nail polish, the actual values of pulse oximetry remained within the range of acceptability (from 96% to 99%) and thus clinically insignificant from patient management point of view.

Sl. No.	Nail Polish	Error Difference : Absolute Error in Colored Nail Polish – Absolute Error in Control (No Nail Polish)	Alt Hypo	**Z- test (for large sample)**		
				Z-statistic value	p value (one sided test)	**Remarks**
1	Red Nail Polish Colour_1	Δ = Error (Red Nail polish) – Error (Control)	Δ > 0	2.35	0.0094	**Reject Null Hypo at 5% level of Significance**

			Δ > 0.5	-7.78	1	**Do Not Reject Null Hypo at 5% level of Significance**
2	Blue Nail Polish Colour_2	Δ = Error (Blue Nail polish) – Error (Control)	Δ > 0	-3.01	0.9987	**Do Not Reject Null Hypo at 5% level of Significance**
3	Purple Nail Polish Colour_3	Δ = Error (Purple Nail polish) – Error (Control)	Δ > 0	-0.51	0.695	**Do Not Reject Null Hypo at 5% level of Significance**
4	Yellow Nail Polish Colour_4	Δ = Error (Yellow Nail polish) – Error (Control)	Δ > 0	-0.62	0.7324	**Do Not Reject Null Hypo at 5% level of Significance**
5	Green Nail Polish Colour_5	Δ = Error (Green Nail polish) – Error (Control)	Δ > 0	-2.14	0.9838	**Do Not Reject Null Hypo at 5% level of Significance**
6	White Nail Polish Colour_6	Δ = Error (White Nail polish) – Error (Control)	Δ > 0	-0.89	0.8133	**Do Not Reject Null Hypo at 5% level of Significance**
7	Black Nail Polish Colour_7	Δ = Error (Black Nail polish) – Error (Control)	Δ > 0	-0.98	0.8365	**Do Not Reject Null Hypo at 5% level of Significance**
8	Orange Nail Polish Colour_8	Δ = Error (Orange Nail polish) – Error (Control)	Δ > 0	-0.89	0.8133	**Do Not Reject Null Hypo at 5% level of Significance**
9	Beige Nail Polish Colour_9	Δ = Error (Beige Nail polish) – Error (Control)	Δ > 0	-1.33	0.9082	**Do Not Reject Null Hypo at 5% level of Significance**

Table III: Testing of Hypothesis

Discussion:

The results obtained from our study reveals that nail polish colours does not alter pulse oximetry readings to a statistically significant extent except for red.(p – value: 0.094). Though this difference obtained after red nail polish is statistically significant, in clinical practice the mean readings with red nail polish altered SpO2 by less than 0.5% which is clinically insignificant (Table IV).Therefore this difference in reading does not affect the clinical decision making from patient management point of view.

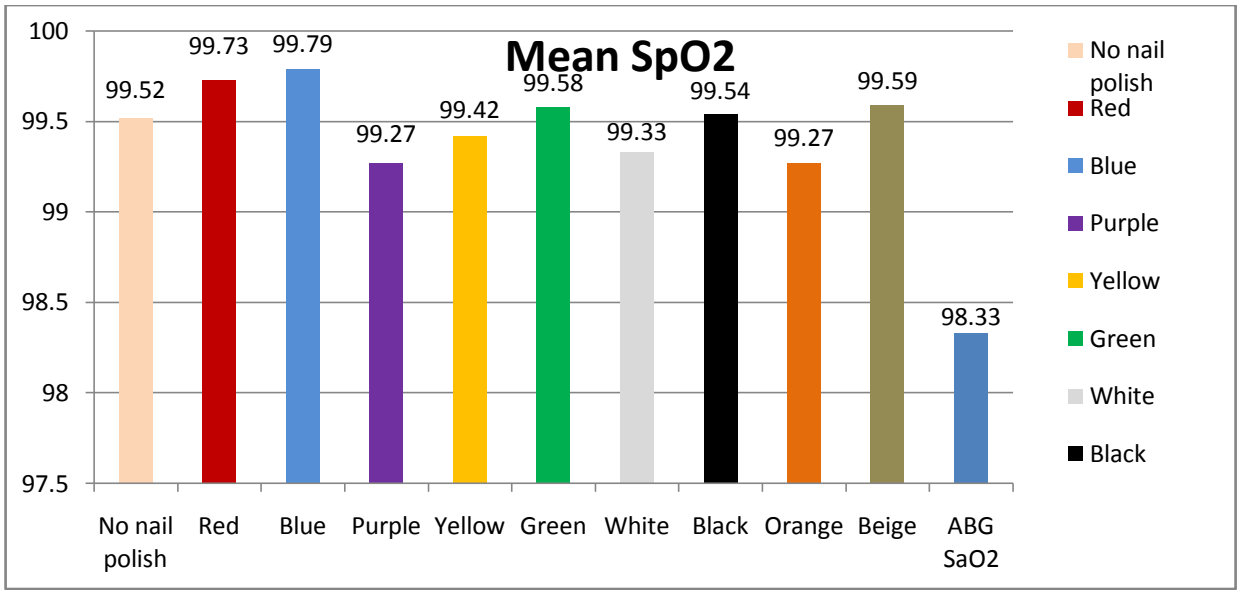

Table IV: Mean readings of SpO2 with different nail polishes

Looking at the current literature, we found that very few studies have been done to investigate the effect of nail polish on SpO2 readings **[6, 7].** In one study, Kataria and Lampkin **[8]** reported that nail polish did not interfere with pulse oximetry. The above study only evaluated 15 volunteers and the colour of nail polish used was not reported. A contradictory result was obtained by Wahr et al., **[4]** who concluded nail polish of various colours can affect pulse oximetry readings. Another study by Coté et al **[7]** on 14 volunteers found that black, dark brown, blue and green nail polish produced a significant drop in SpO2 readings. However, they did not specify profile of the subjects or possible pathologic conditions. Contrasting results were reported by Brand et al **[9]** when they analyzed 12 healthy volunteers and found that the blue, green and lemon green colours caused no statistically significant differences in pulse oximetry readings.

Other previous studies involving spectrophotometric data **[9, 10, 11,]** described some consistency in the spectrophotometric data obtained, but there is a lot of differences and discrepancies in SpO2 data which could be attributed to the specific light-absorption characteristics of the various nail polish preparations and colours.

Our results closely match with one of the largest studies done in Brazil **[2]** on 61 volunteers. The study, like ours, concluded that red colour presented significant statistical difference interference in SpO2 readings, but clinical values remained within the range of acceptability (from 96% to 99%) **[2].**

To summarize, the different colours of nail polishes used in our study, namely red, blue, purple, yellow, green, white, black, beige, orange, did not significantly interfere with the pulse oximetry readings that would alter the clinical management of patients. The results obtained from our study can thus be generalized and applied in day to day practices for the emergency patients where one cannot afford to waste time on maneuvers like removal of nail polishes before interpreting results. There were some limitations in our study. Our study was done on healthy female volunteers who were not hypoxic and did not represent a patient population. The results of our study are applicable for only the nine nail polish colours that we used.

So, we conclude that red, blue, purple, yellow, black, beige, white, orange and green coloured nail polishes do not alter pulse oximetry reading to a clinical significant level and their removal before pulse oximetry reading in clinical settings is not recommended.

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