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A cross sectional study of Oxygen Saturation (SpO_2) of Amarnath Yatris at the Amarnath Holy Cave with a pulse oximeter

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ABSTRACT

Many of Hindu devotees undergo an annual pilgrimage to the Amarnath cave. During ascent for Amarnath Yatra in the mountains they experience multiple environmental stressors, but the stress unique to high altitudes is the hypoxia. Oxygen saturation is defined as the fraction of oxygen-saturated hemoglobin relative to total hemoglobin in the blood. The present study was designed with the aim to assess oxygen saturation of Amarnath Yatris at the holy Amarnath cave. A total of 75 subjects of both male and female of different age groups were taken. An informed consent was taken from each subject before the cross sectional study. Peripheral Oxygen Saturation (SpO_2) was measured with pulse oximetry process. There was a significant decrease in Peripheral Oxygen Saturation (SpO_2) in females was more than male Yatris with a mean of 67.7% as compared to 76%. In the study, there was a significant decrease in Peripheral Oxygen Saturation (SpO_2) in all the subjects at the height of the Amarnath cave.

Keywords— *Peripheral Oxygen Saturation (Spo2), Amarnath Yatris, Pulse Oximeter, Hypoxia, High Altitude.*

1. INTRODUCTION

Amarnath cave is a Hindu shrine which is located in Jammu and Kashmir a union territory of India. The height of the holy cave is about 3,888 m (12,756 ft). The shrine is an important part of Hinduism. The cave is surrounded by cold snow rich mountains. The cave itself is covered with snow most of the year except for a short period of time in June to September when it is open for pilgrims. Many of Hindu devotees make an annual pilgrimage to the Amarnath cave. Oxygen saturation is the fraction of oxygen-saturated hemoglobin in comparison to total hemoglobin in the blood. Normal blood oxygen saturation levels ranges from 95% to 100%. If the level is below 90 %, it is considered to be hypoxemia. [1] A pulse oximeter uses red and infrared frequencies to determine the percentage (%) of hemoglobin in the blood that is saturated with oxygen. The percentage is the blood oxygen saturation (SpO_2). SpO_2 means for peripheral capillary oxygen saturation, an estimate of the amount of oxygen in the blood. SpO_2 gives an estimate of arterial oxygen saturation which means the amount of oxygenated hemoglobin in the blood. Amarnath Yatris adapt at high altitudes through a process of acclimatization. The principal means by which acclimatization comes about are:

(a) A great increase in pulmonary ventilation,
(b) Increased numbers of red blood cells,
(c) Increased diffusing capacity of the lungs,
(d) Increased vascularity of the peripheral tissues,
(e) Increased ability of the tissue cells to use oxygen despite low Po_2.Of all these changes, probably the most important is the hyperventilation.

2. MATERIAL AND METHODS

The study was conducted in the department of physiology and Amarnath cave is a Hindu shrine located in Jammu and Kashmir, India in July 2014. The study was approved by the Ethical Committees of the institution, and written informed consent was obtained from all the Amarnath yatris. There were 5 different age group ranging from 15 to 60 yrs for the study. A total of 75 subjects of both male and female of different age groups were taken for this cross sectional study. Darshan figures for Yatra in 2014 were 372909 Amarnath Yatris had darshan at holy cave. But due to bad weather and adverse condition our study was limited to 75 Yatris only. A pulse oximeter was used for this study and method was pulse oximetry. SpO_2 were measured by pulse oximetry, which is an indirect, non-invasive method. It works by emitting and then absorbing a light wave passing through capillaries in the fingertip. A variation of the light wave passing through the finger gives the value of the SpO_2 measurement because the oxygen saturation causes variations in the blood's colour. A pulse oximeter relies on the light absorption characteristics of saturated hemoglobin to give oxygen saturation [2]. Peripheral oxygen saturation is usually measured with a pulse oximeter device. It can be calculated with pulse oximetry according to the following formula [3] $SpO_2=HbO_2/HbO_2+Hb$ where HbO_2 is oxygenated hemoglobin and Hb is deoxygenated hemoglobin. In 1935, Karl Matthes developed the first 2-wavelength ear O_2 saturation meter with red and green. His meter was the first device to measure O_2 saturation. The pulse oximeter was clipped to the finger and its readings were noted. The device uses light-emitting diodes in conjunction with a light-sensitive sensor to measure the absorption of red and infrared light in the fingertips. The difference in absorption between oxygenated and deoxygenated hemoglobin makes the calculation possible. The pulse oximeter emits red (R) and infrared (IR) LED light that passes through the body, receives data from a photo detector, and calculates the oxygen saturation by determining the ratio of the two waveforms. The pulse oximeter determines oxygen saturation by measuring the ratio of oxygenated hemoglobin to deoxygenated hemoglobin. One LED is red whose wavelength is 660 nm, and the other is infrared with a wavelength of 940 nm. Absorption of light at these wavelengths differs significantly between blood saturated with oxygen and blood lacking oxygen. Oxygenated hemoglobin absorbs more infrared light and allows more red lights to pass through. The LEDs sequence through their cycle of one on, then the other, then both off about thirty times per second which allows the photodiode to respond to the red and infrared light separately.[4] Pulse oximetry is very convenient for noninvasive continuous measurement of blood oxygen saturation. Because of their simplicity of use and the ability to provide continuous and immediate oxygen saturation values, pulse oximeter are of critical importance in emergency medicine and High altitude. When the amarnath yatris reaches around 2,100 m or 7,000 feet above sea level then the saturation of oxyhemoglobin decreases rapidly.[5] The concentration of oxygen (O_2) in sea-level air is 20.9%. In healthy individuals, this saturates hemoglobin, the oxygen-binding red pigment in red blood cells.[6] Atmospheric pressure decreases exponentially with altitude while the O_2 fraction remains constant to about 100 km, so pO_2 decreases exponentially with altitude as well. It is about half of its sea-level value at 5,000 m (16,000 ft), the altitude of the Everest Base Camp, and only a third at 8,848 m (29,029 ft), the summit of Mount Everest.[7] When pO_2 drops, the body responds with altitude acclimatization.[8] Mountain medicine recognizes three altitude regions that reflect the lowered amount of oxygen in the atmosphere: [9]

- High altitude = 1,500–3,500 metres (4,900–11,500 ft)
- Very high altitude = 3,500–5,500 metres (11,500–18,000 ft)
- Extreme altitude = above 5,500 metres (18,000 ft)

Travel to each of these altitude regions can lead to medical problems, from the mild symptoms of acute mountain sickness to the potentially fatal high-altitude pulmonary edema(HAPE) and high-altitude cerebral edema (HACE). Use of pulse oximeter on Amarnath Yatris.

(a) Pulse oximeter was turned on on after internal calibration and checks.
(b) The appropriate probe was selected with particular attention to correct sizing and where it will go (usually finger).
(c) Clean and Remove any nail varnish.
(d) The probe was connected to the pulse oximeter.
(e) The probe was positioned carefully; make sure it fits easily without being too loose or too tight.

3. RESULT

There was a significant decrease in Peripheral oxygen saturation (SpO_2). It was decreased from 98% to 75.31% mean with standard deviation 9.54.

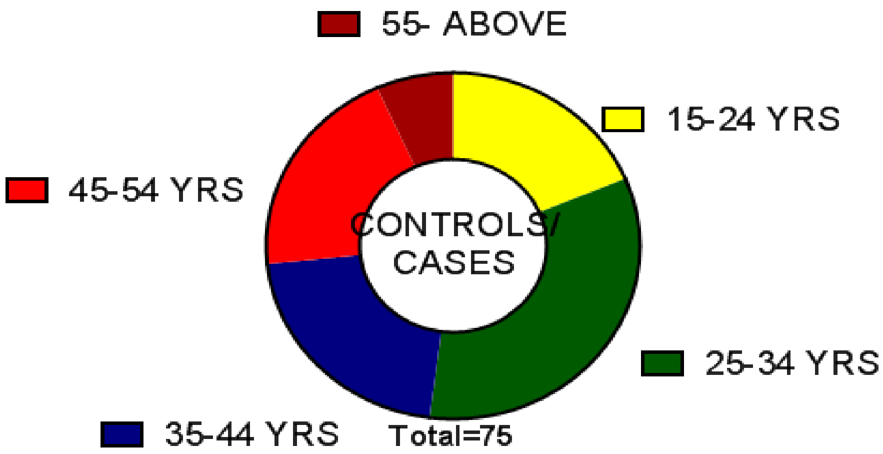

Table 1: Results

S no.	Age Group(YRS)	Mean value (%)	Total Yatries	% Age Group
1	15 - 24	76	14	18.7
2	25 - 34	78	25	33.3
3	35 - 44	75.4	16	21.4
4	45 - 54	75.8	15	20
5	55 - ABOVE	71.1	05	6.6
	Mean value (%)	75.31	75	100

Out of 75 healthy Yatris 65 were male while 10 were female subject. It was found that Peripheral oxygen saturation (SpO_2) of female subjects was reduced to 67.7% mean value with Standard Deviation (S.D.) 24.47 in compare to 76.48% in male subjects with S.D. 3.26. Peripheral oxygen saturation (SpO_2) of younger age group 15yrs to 24 yrs was 76% in males while it was 71.1% in case of elderly age group. There were 5 age groups for both male Yatris and female Yatris. Among the entire 5 age groups one thing was same that Peripheral oxygen saturation (SpO_2) was reduced to hypoxemic level resulting in acute mountain sickness.

4. CONCLUSION

In the study there was a significant decrease in Peripheral oxygen saturation (SpO_2) in all the subjects at the height of Amarnath cave. Purpose of this study was to know the Peripheral oxygen saturation (SpO_2) by pulse oximetry of Amarnath Yatris so that complications can be managed effectively. Preventive measures can be taken before beginning of Amarnath yatra by giving advices like slow ascent and fast descent.

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