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Oxygen Saturation Profile in Healthy Term Neonates in the Immediate Post Natal Period

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Abstract

Background: A neonate undergoes major physiologic changes during transition from intrauterine to extrauterine period. The percentage saturation of hemoglobin takes about 10 minutes to reach a level of more than 90%. This fact is to be borne in mind while resuscitating a newborn with oxygen to avoid its toxicity. It is still unclear whether the oxygen saturation profile could be affected by racial/ethnic variation, birth weight, sex, APGAR score or maternal factors (age, hemoglobin, type of labor) in term healthy babies. This study aimed: 1) To note the time taken for SpO_2 to reach a value of 90%; 2) To note the time taken for preductal and post ductal SpO_2 to equalize; 3) To look for the association between SpO_2 and various infant and maternal factors.

Methods: Two hundred and seventy eight full term neonates born by normal vaginal delivery were included in this study. After birth, sensors were placed simultaneously on the pre (right hand) and the post ductal site (either foot) of the neonate. The SpO_2 readings were recorded at 1, 3, 5, 7 and 10 minutes after birth and every 5 minutes thereafter till readings from both these sites crossed 90% and equalized.

Results: The mean (SD) time taken for the preductal and postductal saturation to reach 90% was 7.4 minutes (4.5) and 9.5 minutes (5.36) respectively. The mean (S.D) time taken for equalization of preductal and post ductal saturation was 11.46 (6.27) minutes. No statistically significant correlation was seen between the time taken for equalization of preductal and postductal SpO_2 and for it to reach 90% and factors such as maternal age, hemoglobin, type of labor, birth weight and sex of the baby.

Conclusion: SpO_2 at 10 minutes reaches a value of > 90% in most of the healthy term neonates born through vaginal delivery, and these values had no statistically significant correlation with the neonatal or maternal factors.

Keywords: SpO_2; Pulse oxymetry; Term neonate

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Introduction

A neonate undergoes major physiologic changes during transition from intrauterine to extra-uterine period [1]. In most of the babies this transition is smooth; however 5-10% needs some assistance in breathing, while 1% requires extensive resuscitation [2, 3]. The indications and timing of supplemental oxygen therapy to assist the newborn in this transition has been a matter of debate [4-9]. The 2010 ILCOR recommendations state that resuscitation can be initiated with room air or blended oxygen but it should be guided by measurement of oxygen saturation using pulse oximetry and the target saturation should fall in the interquartile range of preductal saturations measured in healthy term babies following vaginal birth at sea level [2]. These recommendations are based on the existing data on oxygen saturation of healthy term newborns in the first few minutes of life [10-16]. While such data exists in abundance, it is lacking as far as Indian population is concerned.

We hypothesized that these recommendations may not have a universal applicability across all populations as the values of 90% of SpO_2 may not be attained in the same duration in healthy term Indian newborns, in view of the differences in ethnic, socioeconomic and health parameters of our population. Hence we studied the SpO_2 pattern of healthy term Indian newborns to prove or disprove the above hypothesis. We also correlated the above values with various variables including maternal age, sex of the baby, mode of labor (spontaneous, induced with prostaglandin or with oxytocin) and baby weight.

Table 1. Maternal and Neonatal Baseline Variables

Patient Characteristic	Value/No. of Patients (%)
Birth weight (kg)	
≤ 2.5	23 (8.3)
2.5 - 3.5	233 (83.8)
≥ 3.5	22 (7.9)
Sex	
Male	143 (51.4)
Female	135 (48.6)
Maternal age	
< 20 years	15 (5.4)
20 - 30 years	249 (89.2)
> 30 years	15 (5.4)
Maternal Hemoglobin (gm%)	
< 11	123 (44.2)
11 - 14	148 (53.2)
> 14	7 (2.6)
Type of labour	
Spontaneous	100 (36)
Induced	178 (64)
Method of Induction	
Oxytocin (i/v)	157 (88.2)
Prostaglandin E2 vaginal gel	21 (11.8)

Materials and Methods

This was a cross sectional study conducted in the labour room of a tertiary care hospital over a period of 6 months, from May to October 2011. All full term neonates born by normal vaginal delivery were included, however those who required resuscitation or supplemental oxygen or had major congenital malformations were excluded. A written and informed consent was obtained from the mother before delivery in all cases. A total of 320 mothers were enrolled who were planned for normal vaginal delivery. The team of investigators were not involved in the care of infants in the delivery room. We used the Masimo rad 5 pulse oximeter with signal extraction technology (SET) which provides reliable readings even in low perfusion states and with patient movement [17]. After birth, the umbilical cord was clamped immediately (as is the convention at our centre) and a stopwatch was started. The sensors were placed simultaneously on the pre ductal site (right hand) and post ductal site of the neonate (either foot). The sensors were then connected to the oximeters, as recommended for faster acquisition of the values [18]. The time taken to apply the sensor and to obtain the display was noted. The readings were recorded at 1, 3, 5, 7 and 10 minutes after birth and every 5 minutes thereafter till readings from both these sites crossed 90% and equalized. The care of the neonate was not interrupted while doing this procedure. The sensors remained attached even when the baby was handed over to the mother. The APGAR score assigned by the care giver was simultaneously recorded.

Neonatal details such as date and time of birth, birth weight, sex, gestational age as well as maternal details including her age, hemoglobin concentration, blood group, medical illness and pregnancy related problems were recorded (Table 1). Details of labor, for example, presentation, duration, spontaneous/induced, evidence of fetal distress, and passage of meconium were also noted.

Table 2. Comparison of Pre and Post Ductal SpO_2 Values at 1, 3 and 5 and 10 Minutes of Life

Time	Pre ductal regions		Post ductal regions		P value
	Mean (S.D)	Range	Mean (S.D)	Range	
1 minute	70.13 (8.74)	40 - 88	62.90 (10)	19 - 88	0.000 (P < 0.001)
3 minute	81.35 (6.76)	52 - 95	77.01 (7.99)	43 - 89	0.000 (P < 0.001)
5 minutes	87.65 (5.71)	71 - 97	84.74 (6.85)	51 - 95	0.000 (P < 0.001)
10 minutes	92.77(3.89)	77 - 98	91.53 (5.6)	70 - 98	0.000 (P < 0.001)

Statistical analysis

The data was analyzed using SPSS-16 statistical software. Correlation between the time taken for pre-ductal and post-ductal saturation to reach 90% and time for equalization of pre and post-ductal saturation with Apgar scores at 1 and 5 minutes were determined by the Spearman correlation.

Kruskal Wallis test (non-parametric method) was used to compare the following three times taken, namely the time for pre ductal saturation to reach 90%, time for post ductal saturation to reach 90%, and time for equalization of pre and post ductal saturations in different groups of maternal age, Hb, and infant weight. Paired t-test was used to compare mean pre and post ductal saturations at 1, 3 and 5 minutes and p-value was adjusted for Bonferroni correction. Paired t-test and Wilcoxon signed ranked test were applied to compare mean and median pre and post ductal saturations respectively.

Discussion

A total of 320 mothers were enrolled who had to undergo normal vaginal delivery and antenatal ultrasounds if available, showing normal fetuses. Forty two babies were excluded as 23 required resuscitation in some form, 11 babies did not have initial SpO_2 readings due to technical problems, 6 babies were preterm and the gestational age assessment was not correct (mother did not remember the last menstrual period correctly and antenatal USG was not done) and 2 babies were born with major congenital malformations (lumbosacral meningomyelocoele, which could not be detected as USG scan was not done). Therefore, SpO_2 readings were obtained from 278 healthy term newborns.

In this study, the mean (SD) oxygen saturation values at 1 minute, 5 and 10 minutes after birth were 70.13% (8.74), 87.65% (5.71) and 92.77% (3.89) respectively in the pre-ductal site and 62.90% (10), 84.74% (6.85), 91.53% (5.6) respectively in the post- ductal sites (Table 2). There was a statistically significant difference between pre and post ductal saturations (P value < 0.01). The mean time taken for the pre-ductal saturation to reach 90% was 7.4 minutes (SD 4.5) and for post-ductal 9.5 minutes (SD 5.36) (Table 3). The mean (S.D) time taken for equalization of pre and post-ductal saturation was11.46 (6.27) minutes. None of the time variables had a significant correlation with any of the maternal or neonatal variables like maternal age, mode of labour (spontaneous, induced with PG, induced with oxytocin) sex and birth weight of the baby, Furthermore, by 10 minutes of life 93.1% of the neonates had attained preductal SpO_2 value of 90%, while only 84.5% neonates achieved post ductal value of 90%. Similarly, 74% of the neonates had equalization of pre and post ductal SpO_2 values by 10 minutes of life.

Discussion

We found that it took 7.4 minutes to reach a median pre-

Table 3. Time to Reach 90% Saturation

	Pre ductal	Post ductal	P value
Mean	7.40 minutes (SD = 4.5)	9.5 minutes (SD = 5.36)	P = 0.000, < 0.001
Median	7 minutes (IQR = 2)	7 minutes (IQR = 3)	P = 0.000, < 0.001

ductal SpO_2 of 90%; other studies have reported times of between 8 and 15 minutes [10-13]. Our study supports the assertion that during neonatal transition oxyhemoglobin saturation does not reach 90% until approximately 10 minutes of life. The practice of supplementing 100% oxygen based on visual interpretation of cyanosis without doing pulse oximetry could potentially lead to adverse outcome in the baby resulting from even a brief exposure to excess oxygen [19]. In a resource limited setting with a low staff- patient ratio as ours, it becomes all the more relevant to judiciously conserve and utilize the resources for more deserving areas.

It is believed that this delay in reaching normal SpO_2 values is physiological, as there are residual cardiopulmonary shunts [1]. In our study, 74% of the babies had an equalization of pre and post- ductal SpO_2 at 10 minutes. Toth et al too reported that the difference between pre and post ductal values was insignificant after 10 minutes [10]. Hence it is only logical not to actively intervene with the aim of overcorrecting SpO_2 values before 10 minutes, given that there is enough evidence that excessive administration of oxygen may lead to prolonged oxidative injury [19]. As a resuscitation strategy, reproducing the normal rate of increase in SpO_2 observed in healthy newborns is likely to reduce this injury.

It has been shown that infants born by caesarean section have lower SpO_2 values when compared with those born through vaginal delivery, and take a longer time to attain SpO_2 values of more than 85% [11]. In our study, though we included only vaginally delivered babies for the purpose maintaining uniformity, we may presume that the time taken by a neonate delivered through caesarean section, to reach 90% SpO_2 should be more than the median value found in our results. It may be noted that ILCOR guidelines make no recommendations for using different time cut offs for these differing sets of babies [2].

None of the babies in our study, even when they had SpO_2 values well below 90%, were observed to have central cyanosis by the team of investigators, a finding also supported by other studies [11]. The skin tone of a majority of our patients does not allow an easy detection of cyanosis, and a higher incidence of polycythemia in our babies makes central cyanosis an unreliable index of oxygenation. Hence, we agree that routine pulse oximetry is a more reliable and objective method of monitoring newborn babies in our population. Importantly, many maternity and newborn units in India lack pulse oximetry facilities in labour rooms, a scenario which makes the use of clinical assessment mandatory in deciding when oxygen is to be supplemented. In view of the above, this study on the profile of SpO_2 in Indian population assumes significance.

There have been similar studies both in the past and more recently, having smaller and even larger numbers of infants, from centres across all continents [10-16]. Kamlin et al determined the range of only pre-ductal SpO_2 in 92 patients who were found to have a median SpO_2 of 90% at 5 minutes [12]. Toth et al on the other hand showed that it took about 12 - 14 minutes for the 50 term vaginally delivered infants to attain SpO_2 values of 90% or above [10]. Rabi et al found that median SpO_2 did not reach 90% until 8 minutes of life, a little earlier in vaginally born neonates when compared to those born through a caesarean section [11]. Dawson and co workers also presented reference ranges of SpO_2 values for term, pre term and extremely pre term infants [13].

However, in the absence of any such study on Indian newborns, we hypothesised that our population could exhibit a different pattern of attainment of normal SpO_2 values in the first few minutes of life, and hence may deserve a resuscitation policy different from that established for the western population. This assumption was based on the fact that the SpO_2 values of the newborn would reflect a suboptimal maternal nutrition, oxygenation and inadequate antenatal care leading to a higher incidence of IUGR and polycythemia in our newborns. However no statistically significant correlation was seen between the time taken for equalization of pre-ductal and post-ductal SpO_2 and for it to reach 90% and factors such as maternal age, haemoglobin, type of labour, birth weight and sex of the baby. Our results were in fact in accordance with the western data, showing that term healthy Indian newborns do not attain SpO_2 values of 90% before 10 minutes, and SpO_2 values within 10 minutes of life should be interpreted with caution.

Conclusion

In most of the healthy term neonates born through vaginal delivery, the SpO_2 at 10 minutes reaches a value of > 90%, and these values had no statistically significant correlation with the neonatal or maternal factors. We hence conclude that the recommendation of ILCOR guidelines is very well applicable to our population, even with its variable maternal factors and ethnic differences from the western population.

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