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ORIGINAL ARTICLE

Comparison of oxygen saturation values between term and pre-term neonates.

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ABSTRACT… Objective: To determine mean oxygen saturation (SpO2) values in normal newborns and compare mean Spo2 values between term and preterm infants. **Study Design:** Descriptive Case Series. **Setting:** Hameed Latif Teaching Hospital Lahore and HIT Hospital, HITEC, IMS Taxilla. **Period:** March 2023 to November 2023. **Methods:** The study involved 100 neonates from operation theatre and labor room. Informed consent was obtained from parents. Immediately after birth, pulse oximeter was applied and serial monitoring of oxygen saturation was carried out starting at 1 minute and recording values after every 1 minute till 10 minutes of life. **Results:** There were 50% male and 50% female neonates. The average SpO_2 values were 76.13±10.41 at first minute, 89.68±6.62 at 5 minutes & 95.84±3.65 at 10 minutes of life. Mean SpO_2 was significantly high in term babies as compared to preterm babies at one minute and 5 minutes. However there was no significant difference in mean SpO_2 at 10 minutes in term and preterm babies. **Conclusion:** The process of transition to normal postnatal oxygen saturation requires more than 5 minutes in healthy newborns. In healthy term newborn, oxygen saturation rises slowly. SpO2 monitoring may help identifying the infants requiring resuscitation to avoid overexposure to high supplemental oxygen after birth. Many newborns have SpO2 <90% during the first 5 minutes of life. This should be considered when choosing SpO2 targets for infants treated with supplemental oxygen in the delivery room.

Key words: Birth Asphyxia, SpO2 Values, Term and Preterm Infants.

INTRODUCTION

During the first few minutes of life, a newborn undergoes significant physiological changes to adapt to extra uterine life, and one of these changes is the transition from a fetal to neonatal circulation. As a result of these changes, oxygen saturation levels in the blood rapidly increase from the intrapartum levels of 30–40% to more than 90%.[1] The European resuscitation guidelines emphasize a systematic and integrated approach to neonatal resuscitation. Healthcare providers are trained to simultaneously assess the infant's color, heart rate and other vital signs while implementing appropriate interventions such as positive pressure ventilation, chest compressions, and other measures as needed.[2] Studies have indicated that clinical assessment of color during the neonatal transition is not reliable.[3,4] The study by O'Donnell et al. underscores the challenges associated with the clinical assessment of color as a reliable indicator of tissue oxygenation during the early minutes of life in newborns. The wide variation in the SpO_2 levels at which observers perceived infants to be pink highlights the subjectivity and limitations of relying solely on visual assessment.[4]

Kattwinkel suggests the use of pulse oximetry in the delivery room as a valuable tool to monitor and optimize oxygen levels, with the goal of achieving normoxia (normal levels of oxygen) in newborns.[5] The American Heart Association (AHA) and other medical organizations often emphasize the importance of monitoring oxygen saturation (SpO_2) levels during resuscitation to guide the administration of oxygen effectively. The goal is to optimize oxygen levels and achieve normoxia in newborns.[6] The definition of normoxia (normal oxygen levels) and the acceptable time to achieve it during neonatal transition may vary across

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different guidelines and medical literature. The reference to a target oxygen saturation (SpO_2) range of 85% to 90% by three minutes after birth for most infants, as advocated by Leone and Finer, aligns with the idea of establishing specific goals for neonatal oxygenation during the transition from intrauterine to extra uterine life. However certain clinical conditions such as diaphragmatic hernia or cyanotic congenital heart disease may necessitate individualized approaches to oxygenation.[7] Pulse oximetry is increasingly used during neonatal resuscitation and this trend has been observed in international surveys.[8,9]

Pulse oximetry is a non-invasive method for continuously measuring oxygen saturation (SpO_2) in the blood. Pulse oximeters typically do not require regular calibration. Modern devices are designed to provide accurate readings without the need for frequent adjustments. Pulse oximetry is known to correlate closely with arterial oxygen saturation, making it a reliable surrogate measure for assessing oxygen levels in the blood. Pulse oximetry measures SpO_2 continuously and non‐invasively, without the need for calibration, and correlates closely with arterial oxygen saturation.[10] Pulse oximetry works by using light to measure the absorption of red and infrared light by oxygenated and deoxygenated hemoglobin. In pulse oximetry, a sensor, often in the form of a probe, is typically placed on a thin and well-vascularized part of the body, such as a finger, toe or earlobe. By analyzing the variations in light absorption over time, the pulse oximeter can identify the pulsatile flow and distinguish it from the non-pulsatile components. The pulsatile component is mainly associated with the cardiac cycle, and this information is used to calculate both oxygen saturation and heart rate.

Obtaining accurate readings of oxygen saturation immediately after birth can be challenging with variable success rates of 20% and 100% by 1 minute after birth.[11,12,13] The success rates improved to between 63% and 100% by 5 minutes after birth. This indicates that, over a slightly longer period, pulse oximetry becomes more reliable in obtaining SpO_2 measurements. This improvement could be attributed to stabilization of the newborn and better adaptation to the external environment[14,15,16] In early studies, investigators experimented with different sensor placements, including over the right Achilles tendon, the forefoot, or midfoot.[14,15,20] Later studies suggested that measurements were obtained fastest and more reliably from the right hand. This preference for the right hand placement is attributed to factors such as better perfusion, higher blood pressure, and higher oxygenation in preductal vessels[21] Preductal readings of oxygen saturation were significantly higher than postductal readings soon after birth ($p<0.05$). This difference in saturation levels is likely due to the physiological changes that occur in the neonate during the transition from fetal to neonatal circulation.[3] By 17 minutes after birth, there was no longer a statistically significant difference between preductal and postductal measurements of oxygen saturation ($p<0.05$).[3]

In a study conducted by Harris et al., it was found that oxygen saturation (SpO_2) levels were significantly lower in 44 term infants delivered via elective caesarean section compared to 32 term infants delivered vaginally.[15] In this study the mean oxygen saturation at 1 minute was significantly lower in the caesarean delivery group (46%) compared to the vaginal delivery group (61%). There was no significant difference in SpO_2 levels between the two groups by 5 minutes. It may result due to a higher retention of lung fluid.[15] Kamlinet all found that 107 term infants born by elective caesarean section took 2 minutes longer to reach SpO_2 >90% compared to 68 infants born by spontaneous vaginal delivery[13] Rabi et all found a similar difference in a cohort of 115 infants.[21] Some studies found no significant difference in SpO_2 measurements in neonates born vaginally or by caesarean section.[17]

A study by Resair, which focused on infants weighing more than 999 grams and experiencing apnea and bradycardia at birth, concluded that there were no significant differences in the time taken to reach an SpO_2 of 75%.[22] A study conducted by Kopotic and Lindner, involving premature infants born at 24–29 weeks gestation concluded that the SpO_2 was equal to or greater than 80% by a mean time of 4.4 minutes.[18]

Pulse oximetry is commonly used in neonatal care to assess the effectiveness of various clinical interventions such as oropharyngeal suction and endotracheal intubation. Three controlled studies show that suctioning may have a negative impact on oxygenation.[23] A study by O'Donnell et al. regarding the effects of attempted endotracheal intubation on oxygen saturation showed that oxygen sat*uration dropped during the procedure*.[24]

OBJECTIVE

To determine mean SpO_2 values in normal newborns and to compare mean SpO_2 values between term and preterm infants.

METHODS

It's a descriptive case study conducted at Hameed Latif teaching hospital Lahore and HIT Hospital, HITEC, IMS Taxilla. from March 2023 to November 2023. Sample size of 100 neonates was calculated with 95% confidence interval.

Inclusion Criteria

All normal babies of both genders.

Exclusion Criteria

1. Neonates requiring supplemental oxygen or any kind of assisted ventilation.
2. Neonates with congenital anomalies.
3. Neonates whose mothers had complicated pregnancies (acute or chronic infection, fever, anemia, oligohydramnios, rupture of membranes upto 18 h, pre-eclampsia, eclampsia).

Data Collection Technique

Permission from the hospital ethical committee (HLTH/ADMIN-23/296) was taken. Informed written consent was obtained from the parents of the subjects fulfilling the study criteria. Data was collected on Performa attached. Patients fulfilling the criteria were seen in operation theatre and labor room. Pulse oximeter was applied immediately after birth and serial monitoring of oxygen saturation was carried out starting at 1 minute and recording values after every 1 minute till 10 minutes of life.

Data Analysis Procedure

Data was analysed by SPSS (Version 10). Qualitative variables like gender were measured by frequency and percentage. Quantitative variables like gestational age and pulse oximeter values were calculated by mean ± SD. Independent sample t-test was applied to compare mean SpO_2 between term and preterm infants. P value <0.05 was considered significant. Stratification was performed to observe the effect of gender and weight on outcome. After stratification t-test was applied. P value of ≤ 0.05 was considered as significant.

RESULTS

A total of 100 neonates were included in this study. There were 50% male and 50% females. The average weight of the neonates was 2.93±0.54 kg (Table-I). There were 30% preterm and 70% term neonates. The average SpO_2 values were 76.13±10.41 at first minute, 89.68±6.62 at 5 minutes & 95.84±3.65 at 10 minutes of life. Mean SpO_2 was significantly high in term babies as compared to preterm babies at one minute and 5 minutes, while at 10 minutes mean SpO_2 was not significant between term and preterm babies (Table-III). Comparison of mean SpO_2 was also significant between male and female infants at 1, 5 and 10 minutes (Table-IV).

Descriptive Statistics		Weight (kg)	Gestational Age (Weeks)
Mean		2.93	36.91
Std. Deviation		0.54	2.35
95% Confidence Interval for Mean	Lower Bound	2.82	36.44
	Upper Bound	3.04	37.38
Median		3	37
Interquartile Range		.4	3
Minimum		1.4	31
Maximum		4.0	40

Table-I. Descriptive statistics of newborns (n=100)

Time	SPO2 values			
	Mean	SD	95% Confidence Interval for Mean	
			Lower Bound	Upper Bound
1 minute	76.13	10.41	74.06	78.20
5 minutes	89.68	6.62	88.36	91.00
10 minutes	95.84	3.65	95.11	96.57

Table-II. Descriptive statistics of newborns (n=100)

SpO_2	Preterm Infants n=30	Term Infants n=70	P-Value
1 minute	72.63±14.9	77.63±7.89	0.027
5 minutes	87.07±6.89	90.80±6.23	0.009
10 minutes	97.44±4.31	96.3±3.27	0.054

Table-III. Comparison of mean SpO_2 values between term and preterm neonates

SpO_2	Male n=50	Female n=50	P-Value
1 minute	78.94±7.21	73.32±12.29	0.006
5 minutes	91.82±6.25	87.54±6.34	0.001
10 minutes	96.98±3.15	94.70±3.79	0.002

Table-IV. Comparison of mean SpO_2 values between male and female neonates

DISCUSSION

The transition from intrauterine to extra uterine life is a critical and complex process for a neonate. Several major physiologic changes occur during this transition.[25] The majority of newborns successfully adapt to breathing and other physiological changes without the need for external assistance.5-10% 0f newborns may require some form of assistance in initiating or maintaining breathing. Approximately 1% of newborns may require extensive resuscitation efforts. This can involve more advanced life support measures, including the administration of medications, intubation, or other interventions to support the infant's respiratory and cardiovascular systems.[26] The indications and timing of supplemental oxygen therapy for assisting newborns during the transition from intrauterine to extrauterine life have indeed been topics of discussion and research within the medical community. The challenge lies in balancing the need to ensure adequate oxygenation for the newborn with the potential risks associated with excessive oxygen exposure.[27] The issue of variability in the clinical assessment of oxygenation levels in newborn infants, particularly through the observation of color, has been recognized and studied by researchers such as O'Donnell et al. The study by O'Donnell et al demonstrated substantial interobserver (between different observers) and intraobserver (within the same observer) variability in assessments of color. This variability can be influenced by factors such as lighting conditions, skin pigmentation, and individual differences in perception. Traditionally oxygenation levels of newborn infants have been assessed clinically. Given the limitations of visual color assessment, there has been an increased emphasis on the use of objective measures, such as pulse oximetry, to quantify oxygen saturation levels more accurately.[29]

The study results suggest that oxygen saturation (SpO_2) values in newborn infants changed over the first 10 minutes after birth. Specifically, the findings indicate a steady increase in SpO_2 levels during this period. Additionally, the study notes that it took approximately 8 minutes for SpO_2 to exceed 90% in term infants. We found that the average SpO_2 values were 76.13±10.41 at first minute, 89.68±6.62 at 5 minutes and 95.84±3.65 at 10 minutes of life in infants. Toth et al measured the SpO_2 of 50 healthy term infants and found that, on average, it took 12-14 minutes for healthy neonates to reach an oxygen saturation of 95%, either preductally or postductally. Some neonates took as long as 55 minutes to reach this level.[29] The findings from the study by Kamlin et al indicate a median SpO_2 of 63% at 1 minute in healthy term infants. Subsequently, there was a gradual increase in oxygen saturation levels over time, with a median SpO_2 at 5 minutes reaching 90.[13] While studies on healthy term infants provide valuable insights into the normal range of oxygen saturation (SpO_2) levels during the early post-birth period, it's essential to recognize that the SpO_2 range observed in healthy infants may not be directly applicable to infants with health challenges, especially those who are sick, preterm, or term infants experiencing asphyxia.[11,28,31] In our study the mean SpO_2 was also significantly high in those infants whose weight was above 3kg at 1 and 5 minutes but it was not statistically significant between weight groups at 10 minutes. The information from Alet Rosvik et al. suggests that there is a correlation between birth weight and mean oxygen saturation (SpO_2) levels in neonates. According to their findings newborns with birth weights in the range of 2750–2999 g had a mean SpO_2 of 98.3% whereas neonates with birth weights above 4500 g had a slightly lower mean SpO_2 of 97.6%.[32]

We found mean SpO_2 significantly higher in term babies as compared to preterm babies at one minute, while at 10 minutes mean SpO_2 was not significantly different between term and preterm babies. The median SpO_2 at 5 minutes for our preterm infants was 87.07±6.89%, compared with 90.80±6.23% for term infants (P _0.009). The information provided from Kamlin et al. indicates a significant difference in median oxygen saturation (SpO_2) levels between preterm and term infants at 5 minutes after birth. Median SpO_2 at 5 minutes for preterm infants was reported as 87%. In contrast, term infants had a higher median SpO_2 at 5 minutes, which was reported as 90%.[33] Nuntnarumit and Rojnueangnit studied infants born at less than 35 weeks who did not receive supplemental oxygen in the delivery room.According to their findings, they reported slightly higher oxygen saturation (SpO_2) values in the first minute and a shorter time to reach an SpO_2 of 90% compared to our study.[34]

CONCLUSION

The process of transition to normal postnatal oxygen saturation requires more than 5 minutes in healthy newborns. In healthy term newborn infants oxygen saturation rises slowly.SpO_2 monitoring may help in infants requiring resuscitation to avoid overexposure to high O_2 concentrations after birth. Many newborns have SpO_2 <90% during the first 5 minutes of life. This fact should be considered when choosing SpO_2 targets for infants treated with supplemental oxygen in the delivery room.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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2	Bushra Babar	Data collection, Introduction.	
3	Somayya Siddiqa	Data collection, Data complication.	
4	Nazir Ahmed Malik	Statistical analysis.	
5	Sumaiya Javed	Data collection, Proof reading.	
6	Saba Mushtaq	References, Conclusion.	