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ORIGINAL ARTICLE

Reevaluating Reference Ranges of Oxygen Saturation for Healthy Full-term Neonates Using Pulse Oximetry

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Background: We compared our clinical experience with currently available reference oxygen saturation level (SpO_2) values from the American Academy of Pediatrics/American Heart Association (AAP/AHA) neonatal resuscitation program guidelines.
Methods: We enrolled 145 healthy full-term neonates; infants showing respiratory distress and those with serious congenital anomalies were excluded. SpO_2 values at every 1 minute until 10 minutes after birth were measured and recorded. Infants were classified into the cesarean section (CS) and normal spontaneous delivery (NSD) groups for evaluating differences. The 10th percentiles of SpO_2 at each minute were used as the lower limits of normal oxygen saturation, and these were compared with the lowest target values recommended in the AAP/AHA guidelines.
Results: Overall, 130 vigorous full-term neonates (median gestational age: 38 5/7 weeks; body weight at birth: 2405–3960 g) were analyzed. The median SpO_2 were 67% and 89% at the 1st and 4th minute, respectively. On average, SpO_2 values reached >90% at the 5th minute. No statistical differences were noted in the SpO_2 values between the CS and NSD groups after 5 minutes; however, a trend of higher SpO_2 was observed in the NSD group. We noted a gradually increasing

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trend for SpO_2 values over time, similar to that noted in the AAP/AHA guidelines. However, SpO_2 values at the 10th percentiles of each minute within the first 5 minutes in our study were equal to or significantly lower than those in the AAP/AHA guidelines; moreover, at the 10th minute, SpO_2 values at the 10th percentiles were significantly higher than those in the guidelines.
Conclusion: The delivery modes did not affect the SpO_2 values of full-term healthy neonates. Discrepancies in SpO_2 changes in full-term neonates not requiring resuscitation between this study and the AAP/AHA guidelines were significant. SpO_2 ranges for each time point within the first 10 minutes after birth should therefore be reevaluated locally.

1. Introduction

Although the passage through the birth canal is a hypoxic experience for the fetus, few neonates require breathing assistance at birth.[1–3] Timely successful ventilation may determine the future life of the neonate; however, no indicator can completely indicate the exact status of neonatal pulmonary oxygenation during ventilation. The oxygen saturation level (SpO_2) is one of the common parameters measured during neonatal ventilation. However, the range of SpO_2 in healthy neonates after cesarean section (CS) or normal spontaneous delivery (NSD) varies greatly,[4–8] which leads to confusion and ambiguity regarding the optimal reference range.

Kattwinkel et al[3] recommend that, for full-term neonates in need of resuscitation at birth, the goal should be to achieve an SpO_2 value in the interquartile range (IQR) of preductal saturations measured in healthy term babies following vaginal birth at sea level. They proposed a panel of SpO_2 values at each minute within the first 10 minutes after birth; these values were summarized based on the Consensus on Resuscitation Science and Treatment Recommendations (CoSTR) to set clear and easily accessible guidelines for clinicians for use in the delivery room (DR), along with threshold values for determining whether the infant requires ventilation.[3] This systematic review and well-organized algorithm for directing the decision for the initiation of active ventilation as well as for conducting resuscitation procedures conveys objective and scientific information in this regard. However, several studies have reported SpO_2 changes in term or near-term infants not requiring resuscitation in the first few minutes after birth.[5,6,8] It is possible that genetic variations,[9] considerable interobserver and intraobserver variability, and different settings and facilities for monitoring neonates[3,8] may have led to these changes.

In our experience, the threshold values within the first 5 minutes after birth in the American Academy of Pediatrics/American Heart Association (AAP/AHA) guidelines appeared to be relatively lower than the values observed for full-term healthy neonates delivered in our hospital. To clarify the noted discrepancies, we conducted a prospective study to reevaluate the SpO_2 values of vigorous full-term neonates in the first 10 minutes of life using a new-generation pulse oximeter for minimizing interobserver and intraobserver errors at various settings to represent our data as percentile curves; the 10th percentile SpO_2 values were then used as cutoff points for comparing the data with the lowest SpO_2 limits specified in the AAP/AHA guidelines. We considered that it may be necessary to reevaluate the threshold SpO_2 values provided in the AAP/AHA guidelines used for guiding ventilatory assistance, while taking into account various ethnic and regional differences.

2. Materials and methods

This prospective study was conducted at the DR of the Tri-Service General Hospital, a tertiary center in Taiwan, from November 2011 to May 2013. This hospital has a tertiary neonatal intensive care nursery, with 85—125 full-term and preterm births every month. The inclusion criteria were defined as full-term gestational cases with a single fetus and no maternal or fetal pathologic changes during gestation. All newborn infants were dried, suctioned, and stimulated properly by a senior pediatric resident according to the AAP/AHA guidelines after birth. Any neonate that showed signs of distress,[3] including persistent central cyanosis, apnea, gasping, or bradycardia, which may require supplemental oxygen, assisted ventilation, or expected resuscitation in the first few minutes after birth were excluded. Infants were also excluded if they had congenital anomalies that might interfere with the normal transition to extrauterine life. Before birth, all the prospective parents were required to sign an informed consent form for participation in the study. The design and conduct of this study was approved by the local Institutional Review Board.

Enrolled infants born through either CS or NSD were placed on a resuscitation trolley. The time after birth was measured using a chronometer, and a pulse oximeter sensor (Masimo Radical; Masimo Corporation, Irvine, CA, USA) was attached onto the infant's right wrist and secured with a Coban wrap (3M Health Care, St. Paul, MN, USA) immediately and then connected to an oximeter (LNOP Neo Masimo SET; Masimo Corporation) after birth. For all infants, the pulse oximeter was set to acquire data with better sensitivity. The data were recorded at 1-minute intervals for a 10-minute duration to closely monitor any changes in the SpO_2 and heart beats.

We used SPSS Statistics version 20.0 software (SPSS, Chicago, IL, USA) for all statistical analyses. The characteristics of all infants are presented as proportions and numbers (range) for categorical variables, mean ± standard deviation for normally distributed continuous variables, and median and IQRs for variables with skewed distribution. The