# Achieving Targeted Pulse Oximetry Values in Preterm Infants in the Delivery Room

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**Objective** To determine whether resuscitation teams can better maintain newborn transitional oxygen saturation ($SpO_2$) values within a prespecified target range using a graphical display of the targets and real-time $SpO_2$ data compared with using only numerical oximeter values.

**Study design** Preterm neonates were enrolled in this prospective cohort evaluation of a change in practice. The Transitional Oxygen Targeting System (TOTS) plots real-time $SpO_2$ values in relation to 10th and 50th percentile $SpO_2$ curves, which provides a visual target. After introduction of the TOTS, the resuscitation team adjusted the fraction of inspired oxygen to maintain the $SpO_2$ within the target range, and before its use neonates were resuscitated in attempt to target normal transitional $SpO_2$ values without using the TOTS monitor. Duration of time within 10th-50th percentile values was compared between 2 cohorts, children evaluated with the TOTS and those not evaluated with the TOTS (controls).

**Results** A total of 40 infants were enrolled, including 20 prospectively evaluated with the TOTS and 20 controls. Mean gestational age, birth weight, total resuscitation time, duration of supplemental oxygen administration, changes in oxygen concentration, and respiratory support provided were similar in the 2 groups. The TOTS cohort spent 52% of time within the target range; the control cohort, 37% ($P = .03$).

**Conclusion** $SpO_2$ values were maintained within a specified target range for significantly longer in preterm neonates resuscitated using the TOTS display compared with those resuscitated without TOTS. *(J Pediatr 2013;163:412-5)*.

The sixth edition of the Neonatal Resuscitation Program (NRP) specifies oxygen saturation ($SpO_2$) target values for the first 10 minutes of life to guide delivery teams.[1] Several previous studies have evaluated pulse oximetry–derived $SpO_2$ values over time in term and near-term infants not requiring resuscitation after birth. Given the toxicity associated with oxygen exposure, a monitoring system to guide oxygen supplementation in the delivery room is of vital importance.[2,3]

Dawson et al[4] has reported the most comprehensive reference ranges for transitional $SpO_2$ values during the first 10 minutes of life published to date. In a study of 468 term and preterm infants who received no medical intervention in the delivery room beyond warming and stimulation, they created graphs plotting the 3rd, 10th, 25th, 50th, 75th, 90th, and 97th percentiles of $SpO_2$ versus minutes of life for infants born at ≥37 weeks, 32-36 weeks, and <32 weeks gestational age (GA).

Based on the 32-36 weeks GA data from the nomogram of Dawson et al, the Neonatology Department at University of California, San Diego developed and tested the Transitional Oxygen Targeting System (TOTS). The TOTS is a graphic display of prespecified high and low $SpO_2$ limits, as well as a real-time display of $SpO_2$ and administered supplemental oxygen values, to give resuscitation teams a visual target in the delivery room.

The present quality improvement study was designed to examine whether use of the TOTS during the first 10 minutes of life would increase the percentage of time that infants' $SpO_2$ values are within the prespecified target range compared with standard practice without the TOTS.

## Methods

This was a prospective nonrandomized cohort comparison with concurrent controls conducted as a quality improvement project at the University of California, San Diego Medical Center. We hypothesized that after the introduction and use of the TOTS, the amount of time infants' $SpO_2$ values were within a prespecified range would increase compared with controls using static saturation targets were used. The primary study outcome was the proportion of time that the $SpO_2$ values were within the prespecified range. Additional outcomes evaluated were the duration of supplemental oxygen administration and the frequency of supplemental oxygen changes. All other aspects of resuscitation

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| $FiO_2$ | Fraction of inspired oxygen |
| GA | Gestational age |
| NRP | Neonatal Resuscitation Program |
| ROAR | Room-Air versus Oxygen Administration for Resuscitation of Preterm Infants |
| $SpO_2$ | Oxygen saturation |
| TOTS | Transitional Oxygen Targeting System |

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were in accordance with standard institutional practice guidelines. The University of California, San Diego's Institutional Review Board approved this study for waiver of consent.

Any infant born at ≤36 weeks GA requiring supplemental oxygen in the delivery room was eligible for inclusion in this study. Exclusion criteria included known cyanotic heart lesion, major congenital malformation, or chest compressions provided in the delivery room. Infants who received chest compressions were excluded because of our institutional policy to resuscitate with 100% oxygen during chest compressions.

Infants who required supplemental oxygen were enrolled. Intervention arm infants were resuscitated using the TOTS, and control arm infants were resuscitated without the TOTS. The TOTS was developed in May 2010; thus, the control infants were resuscitated at a time when the system was available but not used for various reasons. The most common reasons for not using the TOTS were technical issues and the team forgetting to turn on the system.

The upper and lower $SpO_2$ limits on the TOTS display used for this quality improvement project were the 10th and 50th percentile curves from the 32-36 weeks GA cohort of Dawson et al.[4] **Figure 1** presents a sample TOTS curve. The $SpO_2$ limits are fixed curves on the display. The infant's $SpO_2$ is plotted every second on the graph in real time allowing the resuscitation team to monitor whether the $SpO_2$ value is within the target range. Supplemental oxygen use is plotted in real time as well.

In all infants, a pulse oximeter (Radical 7; Masimo, Irvine, California) was placed on a preductal site. The respiratory therapist or nurse placed the pulse oximeter sensor on the infant's hand or wrist before attaching it to the monitor for the most rapid signal acquisition.

All infants received resuscitation initiated with 40% oxygen. In the intervention arm, the team adjusted the fraction of inspired oxygen ($FiO_2$) by 0.1 every 30 seconds as needed to maintain the infant's $SpO_2$ within the target range on the TOTS display. In control infants, the $FiO_2$ value was adjusted based on pulse oximetry alone using static $SpO_2$ targets of 70% at 3 minutes of life and 80% at 5 minutes of life. Pulse oximetry–derived $SpO_2$ data from infants in the control group were plotted on the TOTS graph retrospectively for the purpose of analysis.

Continuous physiological data were collected during each resuscitation using the BIOPAC MP 150 data acquisition system and integrated Acqknowledge software (BIOPAC Systems, Goleta, California). Data included $SpO_2$, heart rate, airway pressure, and concentration of supplemental oxygen administered. Pulse oximetry data were output to a 4-channel A/D board (DI-158U; DATAQ Instruments, Akron, Ohio) and uploaded to Excel (Microsoft, Redmond, Washington) using associated WindaqXL software (DATAQ Instruments). The $SpO_2$ and supplemental oxygen values were plotted at 1 point per second.

The duration of resuscitation, duration of oxygen exposure, number of supplemental oxygen changes, and the total time within the prespecified target range were analyzed using independent *t* tests. Statistical calculations were performed with SPSS software (IBM, Armonk, New York). A *P* value <.05 was considered to indicate statistical significance.

## Results

A total of 40 infants were enrolled between January and November 2011. Demographic data for the study cohort are provided in the **Table**. The intervention and control groups were similar with respect to GA, mean birth weight, method of delivery, antenatal betamethasone exposure, and respiratory support provided in the delivery room. Average duration of time with values within the prespecified 10th-50th percentile target range was significantly greater in the intervention group compared with controls (average time above the 50th percentile, 148 seconds vs 130 seconds; average time below the 10th percentile, 150 seconds vs 87 seconds). The total time of supplemental oxygen exposure, duration of time analyzed, and number of supplemental

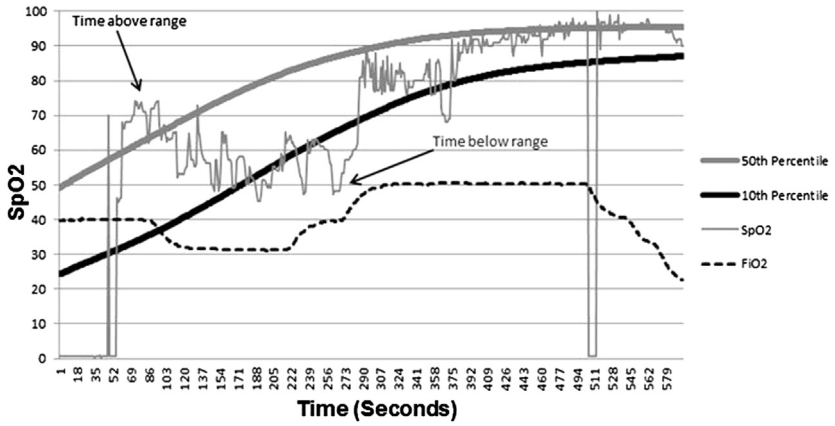


**Figure 1.** Sample plot of an infant in the control arm, with real-time saturation plotted against 10th and 5th percentiles.