

# Assessing the Performance of Nurses in the Proper Adjustment of Monitoring Instruments in the Neonatal Intensive Care Unit

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## ABSTRACT

**Background:** Monitoring serves to maintain physiologic variables within normal limits and when a parameter crosses a set threshold, an alarm is triggered. Therefore, this study aimed to determine whether alarm limits are properly adjusted in the neonatal intensive care unit (NICU) by nursing staff or not.

**Methods:** The data concerning alarm limits corresponding to the three shifts of nursing work were recorded for the newborns with cardiorespiratory problems, such as hyaline membrane disease, transient tachypnea of the newborns, and pneumonia, who were admitted to the NICU of Imam Reza Hospital, Mashhad, Iran during March 2016-December 2016.

**Results:** The findings of this study showed that 75.1% of the 95 subjects of this study were preterm infants, while the others were cases with a gestational age of more than 37 weeks. The mean birth weight of the neonates was 1939.15±899.2 g. The upper alarm limit of pulse oximetry (95%) had been set correctly just in almost 26% of the patients. On the other hand, only at about 21% of all the cases, a normal lower alarm limit (85%) was observed for this variable. Compliance with the normal lower and upper limits of alarm for heart rate (i.e., 90 and 180 beats/min, respectively) was reported only in 10.46% and 18.6% of the infants, respectively.

**Conclusion:** This study revealed that the alarm limits in NICU for unstable neonates were frequently set outside the normal range.

**Keywords:** Alarm limits, Monitoring tools, Nursing staff, Preterm infants

## Introduction

Enough oxygen is essential for preterm infants who are susceptible to too high or too low oxygen (1). Therefore, strict adherence to the desired range of target values for oxygen saturation has vital importance to avoid hypo- or hyperoxaemia (2). Exposure to the excessive supply of oxygen is not a natural phenomenon and is caused by healthcare providers who may not well understand the neonatal oxygenation (3).

Pulse oximetry (PO) is the standard method used for the continuous monitoring of arterial oxygen saturation (SpO<sub>2</sub>) in neonates in a noninvasive manner (4). Setting the compliance

with oximeter alarm limits is among the responsibilities of nurses (2). In addition to the SpO<sub>2</sub>, other parameters of vital signs, including heart rate, respiratory rate, and systolic, as well as diastolic pressures are checked by computerized monitoring devices (5).

When any of the mentioned physiologic variables crosses a set threshold as “too low” or “too high” alarm limits (6), an alarm is triggered which may sound an audible tone or visual text message (5). Therefore, monitoring can maintain a parameter within the normal range (7). Physiologic monitor devices provide minute-to-

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minute information for critical care clinicians (5). These devices are needed to attract their attention to a patient, a change occurred in the physiology of the patient, or a problem created for the device (8).

Chow et al. provided an educational program in terms of O<sub>2</sub> management and monitoring to NICU staff, implementation of which caused a significant decrease in the incidence of severe retinopathy of prematurity in infants with very low birth weight (9).

With respect to the critical role of the correct setting of monitoring tools in maintaining the vital signs of NICU stable infants, the purpose of this study was to determine whether the alarm limits of monitoring instruments in the NICU were properly adjusted by nursing staff or not.

## Methods

We conducted this cross-sectional study on the usage and setting of monitoring for pulse oximetry, heart rate, and respiratory rate in the neonatal unit of Imam Reza Educational, Research, and Treatment Center, Mashhad University of Medical Sciences, Mashhad, Iran. The sample size of this study was determined by the number of infants admitted to the unit within the study period and met the inclusion criteria. Moreover, the number of days that those newborns were monitored during their admission was important.

The infants were recruited during March 2016-December 2016. The inclusion criteria entailed being admitted for medical problems, especially respiratory problems, such as hyaline membrane disease, transient tachypnea of the newborns, and pneumonia. All the neonates were admitted on the first day of their lives. The exclusion criteria encompassed leaving the unit after 24 h of admission and being affected with meconium aspiration syndrome or primary pulmonary hypertension of the newborns.

The monitoring instruments that were set up by the nursing staff included pulse oximetry and heart rate. However, the respiratory rate monitor was just used for routine care (routine care means the baby just needs feeding) implemented for well premature neonates of less than 1800 gram weight.

The required targets were oxygen saturation between 85% and 95% with the alarm limits set at 85% and 95%, heart rate between 90 and 180 beat/min with the alarm limits set at 90 and 180, and respiratory rate between 30 and 60 breath/min with the alarm limits set at 30 and 60. Data was collected for each infant in three shifts of nursing care to show in which shift of nursing work we have more monitoring set up problems.

In addition, we evaluated the experience of each of the NICU nurses in three shifts who checked and recorded the monitoring variables.

Ethics approval for this study was obtained from the neonatal research center of Imam Reza Hospital and the Ethics Committees.

## Data Analysis

All the data were described as mean±standard deviation (SD). All the statistical analyses were performed using Statistical Package for Social Sciences (SPSS) software version 11.

## Results

A total of 95 infants were examined in the current study. The demographic characteristics, such as weight and case of admission are shown in Table 1.

Lower and upper limits alarm for all variables in our research, namely pulse oximetry, heart rate, and respiratory rate were set up in the monitoring instruments based on the medical protocol in NICU.

The lower alarm limit of pulse oximetry in our study was 85% and analysis of our data showed that 25% of the 91 infants that were recruited in our study had a lower alarm limit of oxygen saturation below 85%. In addition, 75% of the newborns had a lower alarm limit of oxygen saturation above 85%. Only 17 neonates had a normal lower alarm limit of oxygen saturation equal to 85% (Figure 1).

The upper alarm limit of pulse oximetry in the present study was 95%. According to the results, it was concluded that just 21 infants in NICU had normal upper alarm limit as 95% and almost 75 neonates had an upper alarm limit of more than 95% (Figure 2).

The upper alarm limit of heart rate in the current study was 180 and we demonstrated that 90% of the infants in NICU had upper alarm limit of heart rate below 180 and just 16 infants in our study had normal upper alarm limit of heart rate equal to 180/min (Figure 3).

The lower alarm limit of heart rate in our study was 90 and we showed that just nine subjects had

**Table 1.** Characteristics of the neonates and nurses

Characteristics	Data
Weight of infants	1939.15±899.2 g (mean±SD)
Gestational age	Preterm < 37 weeks: 75.1% Term > 37 weeks: 24.4%
Shift of nursing work	Morning=68.1% Afternoon=21.3% Night=10.6%
Experiences of nurses	6.08±5.5 years (mean±SD)

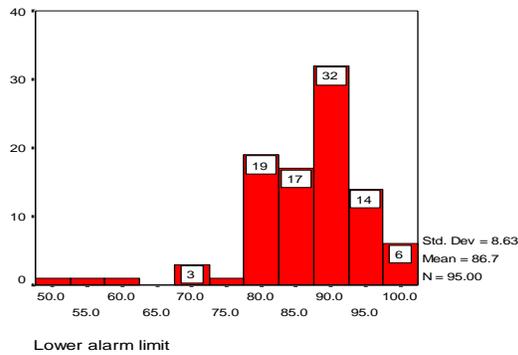


Figure 1. Lower limit alarm of pulse oximetry in the hospitalized infants

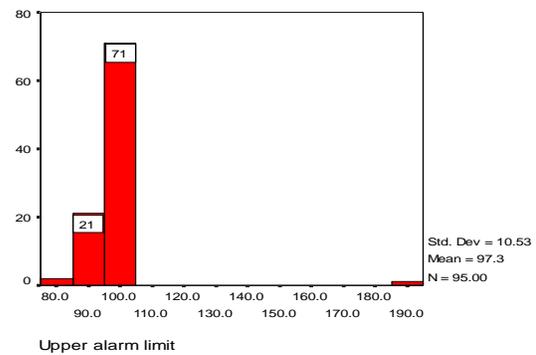


Figure 2. Upper alarm limit of pulse oximetry in the hospitalized

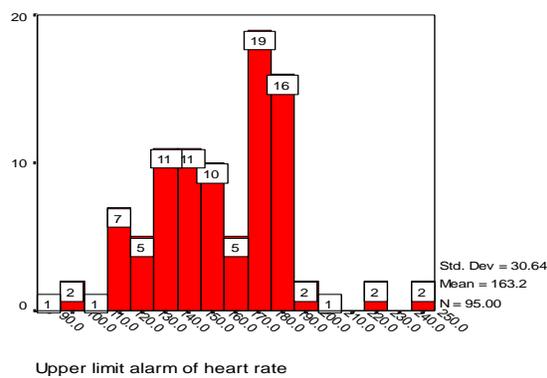


Figure 3. Upper alarm limit of heart rate in the hospitalized infants

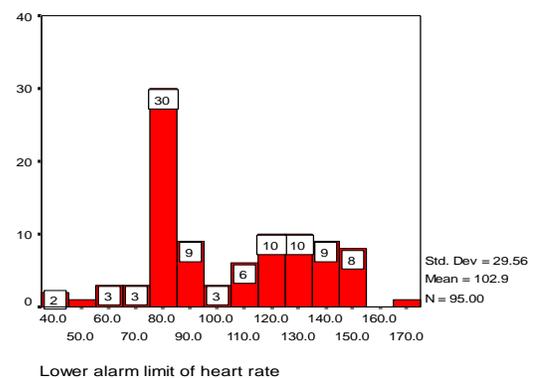


Figure 4. Lower alarm limit of heart rate in the hospitalized infants

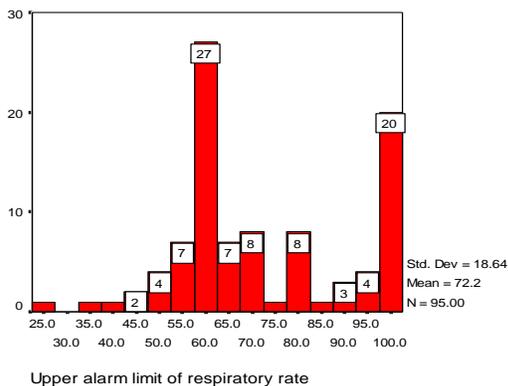


Figure 5. Upper alarm limit of respiratory rate in the hospitalized infants

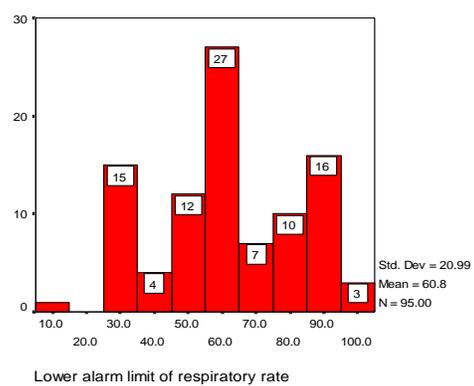


Figure 6. Lower alarm limit of respiratory rate in the hospitalized infants

a lower alarm limit of heart rate equal to 90. Furthermore, about 50% of the 86 studied neonates had a lower alarm limit of heart rate above 90/min (Figure 4).

Other criteria that we checked were the lower and upper alarm limits of respiratory rate. The upper alarm limit of respiratory rate in this study was 60 and we demonstrated that just 27 infants in NICU had a normal upper alarm limit of respiratory

rate equal to 60/min. Moreover, it was revealed that about 75% of the infants had an upper alarm limit of respiratory rate above 60/min (Figure 5).

The lower alarm limit of respiratory rate in our study was 30 and we found that 15 infants in NICU had a normal lower alarm limit of respiratory rate as 30/min. In addition, 90% of the rest of the subjects had a lower alarm limit of respiratory rate above 30/min (Figure 6).

## Discussion

In the study on alarm limit compliance conducted by Clucas et al. in the preterm infants, the alarm limits of pulse oximetry were set at 85% and 94%. They showed that in most cases the upper alarm was not set at the correct limit. It was set remarkably higher than the normal value and in 76.5% of the cases it was set at 100%. In contrary, the correct lower alarm limit was observed at 91.1% of the subjects (10).

In the interventional study performed by Solsona et al., the alarms for expired volume, heart rate, and systolic blood pressure were indicated to have statistically significant improvement after intervention. The latter result was attributed to the more proper adjustment of the alarms to the real values of the patients (11).

In the study performed by Van der Eijk et al., consistency of the alarm limits with the protocol (88–94%) was reported in 64% of the cases. On the other hand, in 30% of the subjects, SpO<sub>2</sub> was higher than 94% and in 16% of the samples was lower than 88% (12). In another study by Hagadorn, it was shown that 31% of the times the infants reported as the target range were lower than the mean time found in the previous research (13).

## Conclusion

Overall, according to the results of this study, the alarm limits in NICU stable neonates were frequently set outside the normal range.

## Acknowledgments

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## Conflicts of interests

There are no conflicts of interest.

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