SPER Publications and Solutions Pvt. Ltd.

Original Article

Effect of two light reduction methods on the physiological responses of preterm infants

Keyvan Mirnia[1], Farinaz Saeidi[2*], Mohammad Bagher Hosseini[3], Mohammad Asgharabadi[4]

[1] Associate Professor, Department of Pediatrics, Faculty of Medicine, Tehran University of Medical Sciences, Tehran, Iran. [2]MSc of Nursing, NICU, Alzahra Educational and Treatment Center,Tabriz, Iran. [3]Associate Professor, Department of Pediatrics, Faculty of Medicine, Tabriz University of Medical Sciences, East Azerbaijan Province, Iran. [4]Assistant Professor of Biostatistics, Medical Education Research Center, Department of Statistics and Epidemiology, Faculty of Health, Tabriz University of Medical Sciences, Tabriz, Iran.

Correspondence: Farinaz Saeidi, MSc of Nursing, NICU, Alzahra Educational and Treatment Center, Tabriz; Tel: +98 9141190756; Email: farinaz_saeidi@yahoo.com.

ABSTRACT

Background: Light is one of the potential sources of harm to preterm infants admitted to the NICU. The physiological changes in response to sound such as an oscillation in heart rate, blood pressure, respiratory rate, and oxygen saturation are among the adverse effects of light on the infants. Thus, this research is developed with a purpose to determine the light reduction on heart rate, respiratory rate, and blood oxygen saturation in preterm infants. Materials and Methods: This clinical trial was performed on 60 preterm infants at 28-32 weeks of pregnancy who were hospitalized from 1/10/94 to 1/2/95 one week after stabilizing the clinical condition in the NICU at Tabriz Al-Zahra Medical Education Center. The samples were randomly divided into two groups. In the intervention group, in addition to the routine light reduction of the department (drawing the curtains, turning off the extra light, and putting a thick cover on incubator), the faces of the infants were also covered by the light insulation covers, however, merely the routine light reduction of the department was applied in the control group. This research lasted for 6 days, and during the intervention days, the heart rate, respiratory rate, and oxygen saturation of infants were evaluated and recorded using checklist in two groups. Results: In the intervention group, the oxygen saturation was increased by 4%, while heart rate was reduced by 27 beats per min and respiratory rate was reduced by 19 breaths per min ($p<0.0005$). The noise variable was under control during the intervention days, and there was no significant statistical effect in accordance to the statistical results. Conclusion: The results indicate the effect of light reduction on the increased oxygen saturation and reduced respiratory rate and heart rate in the preterm infants admitted at NICU, and this process can result in an increase in the preterm infant sleep.

Keywords: Light reduction, vital signs, preterm infant

Introduction

The cellular migration of neuronal neurons of the preterm infants began at week 12 of pregnancy from the nervous system to the neocortex, the process continues to nearly week 24 of pregnancy and development of the brain cortex began at week 26 and completed at week 41 [1, 2]. The external causes of stress and light makes the migration difficult, since the uterus and amniotic sacs are considered dark and safe environments. After birth, the infant is carried into an environment with numerous stimuli on the infant [3]. The growth and developmental period of infant's brain in response to environmental stimuli at weeks 25-40 of pregnancy is faster than the other infant body systems, therefore, the imposition of these stimuli result in impaired development, and side effects of these disorders will have long-term damages on development of the infant [4, 5].

The light in the NICU stimulates the optic nerve in the admitted preterm infants, and leads to disturbance in the sleep and awakening cycle in these infants [6]. According to American standards, the light should be between 100-200 lux during the day and less than 50 lux during the night, and on the other hand, the low light has negative effect on the interactions

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Keyvan Mirnia, Farinaz Saeidi, Mohammad Bagher Hosseini, Mohammad Asgharabadi. Effect of two light reduction methods on the physiological responses of preterm infants. J Adv Pharm Edu Res 2019;9(S2):178-182.
Source of Support: Nil, Conflict of Interest: None declared.

between doctors and nurses and performing nursing and therapeutic care. Thus, the intensity of light in the NICU should be at the level that does not cause any disturbance in the nursing and medical care and having no negative effects on normal development of infant's brain [7, 8]. The functional and structural development of the infant vision system is in the third trimester of pregnancy, therefore, the extra light in NICU is not harmful to term infants, but the intensity of light in NICU is harmful to the preterm infants because of the effect on the development. The high intensity of light in NICU leads to the reduced weighing of preterm infants, inappropriate physiological responses, and impaired sleep and awakening system. One of the most important suggestions for preterm infants admitted at NICU, in accordance to NIDCAP chart, is limiting the visual stimuli and avoiding direct light to the eyes of the preterm infant [9, 10]. The effect of light reduction on infant development has been studied over the past five decades, therefore, this research is developed with the general purpose of determining the effect of two methods of light reduction on physiological responses of preterm infants [9, 11].

Inclusion and exclusion criteria:

The 28-32 weeks old infants were included a week after birth and becoming stable. The exclusion criteria of the infants were brain major anomalies, grade 2 IVH and above, and no need for phototherapy and mechanical ventilation including CPAP, HFNC, and intubation and sepsis. All of these infants have been fed by breast milk of the mother or the donate mother during the study days.

Materials and Methods:

This study was performed on 60 preterm infants at Al-Zahra Medical Education Center at 2014-15. In this study, the routine light reduction of the department was performed from 7 am to 7 pm for 12 hours by drawing the curtains, turning off the extra light, and putting a thick cover on infant incubator. In the intervention group, in addition to routine light reduction, the faces of the infants was covered by the low-weight light insulation cover. The study was carried out for 6 days, and the researcher was next to the infant at the appointed times based on the questionnaire and began observation and records after examining the contents of the case. Since every 24 hours are divided into 3 working shifts, the infant was studied for two hours to complete the questionnaire. In the morning shift 7-9 am, evening shift 4-6 pm, and night shift 2-4 am, the infants were studied. These hours are selected based on Expert panel formed before sampling. In both groups, the heart rate, respiratory rate, and sat were recorded at each hour of the selected hours. Then, the infants were observed during 6 days of intervention for 6 hours. Finally, the average daily hours were given to the SPSS, and the results were analyzed. The basic respiratory rate for infants in this study was 30-60, below 30 was bradypnea and above 60 was tachypnea, while the basic heart rate was 120-160, where above 160 was tachycardia and below 120 was bradycardia. For controlling the noise variables and ambient light, the following measures were taken. The sound inside the incubator next to the infant's face was controlled by the Sound Level meter (RS-232) and the light was controlled by the Lux meter device (EXTECH401027), and the light and sound was maintained within the natural range. The sound level was maintained as a noise factor below 50 dB (according to the Global Standard).

Tool validity and checklist:

The tool validity or the above checklist was studied by 10 faculty members and neonatal super specialists of the Tabriz University of Medical Sciences, and the necessary improvements were made based on their comments. In order to define the scientific trust of the tool, at first, the researcher along with another person who was given necessary training examined the sleep and awakening behaviors of 10 preterm infants in a pilot study, and the average infant sleep was recorded individually by two observer nurses in the sleep checklist, and with regard to Kappa Cohen's agreement, the agreement between the two nurses is 81%. Hence, one of the observers evaluated the rest of the cases.

Data Collection:

In this study, a two-part questionnaire was used for data collection. The first part includes the personal characteristics of the infant and the second part consists of the physiological indices and clinical infant information.

Sample size:

In order to determine the sample size, the Power & Precision V.4 was used, and considering the error level (α=0.05), the statistical power (β=0.80) was determined using MANN, and taking into account the mean and standard deviation in the intervention group (1.32±24.42) and control group (1.45±24.00), the number of samples was 25. Due to the probable sample drop (10% drop), the sample size was increased to 30 for each group (a total of 60 people). This study was carried out on 60 preterm infants, who were randomized using Randlist software.

Before the study, a written permission was obtained from 169th Ethics Committee meeting of the Tabriz University of Medical Sciences on 3/9/93, and registered in the clinical trial site with code (RCT201409114613N13).

Data analysis:

Data obtained from the study were analyzed using SPSS18 software by descriptive statistical methods (frequency, percentage, mean and standard deviation), and heart rate, respiratory rate, and oxygen saturation were analyzed using the independent statistical t-test method. In this study, the P value below 0.05 was considered significant. There was no drop in the samples of the present study (Figure 1), as a result, the study has the required power to reveal the difference based on 60 samples.

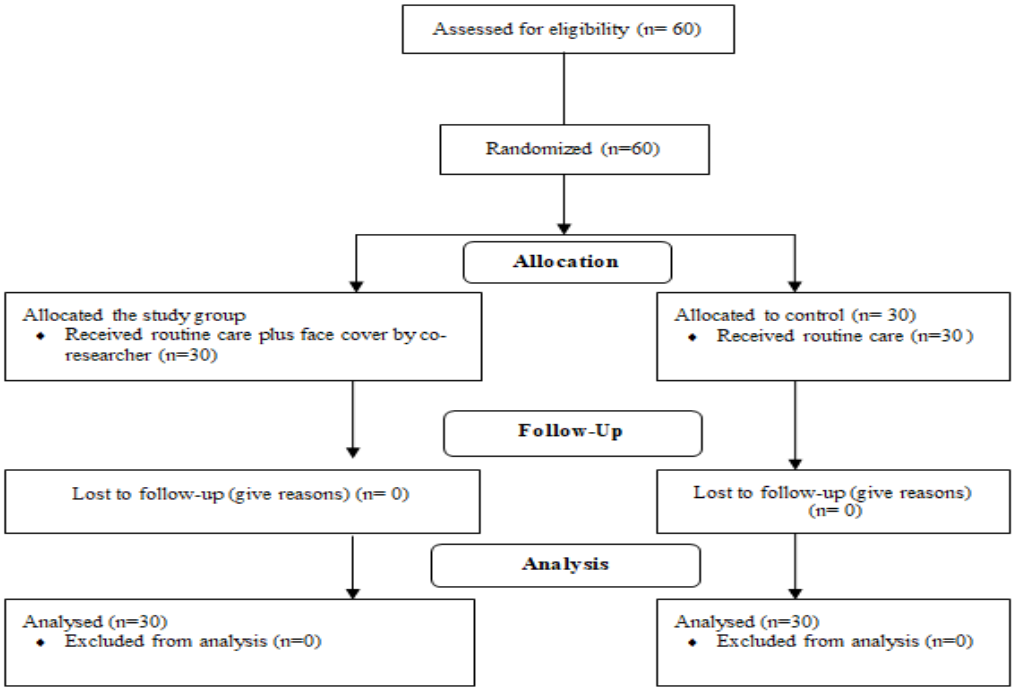

Figure 1: Flow diagram of the study.

Results

The studied infants was at the fetal mean age of 29.1±7.33. The average birth weight of infant in the intervention and control groups was 320±12.30 g and 1358±285 g, respectively, and the first-min Apgar score was 7.1±1.86 compared to 7.2±1.37, and there was no significant difference between the two groups in terms of the individual characteristics.

The mean and standard deviation of the received light of the infant during the intervention days was 1.78±2.2 lux in the group with covered faces and 8.1±1.39 in the group with non-covered faces, so the difference was significant in comparison between the two groups.

Table 1: Demographic characteristics of studied infants

Sex/type of delivery	Covered face group		Non-covered face group		Total		P The result of Chi-square test
	Frequency	%	Frequency	%	Frequency	%	
Girl	17	62.20	18	53.40	35	58.3	0.11
Boy	13	37.8	12	46.60	25	41.7	
Natural	3	8.90	4	15.20	7	12.10	
Cesarean section	27	91.10	26	84.80	53	87.95	0.15

Table 2: Heart rate changes in preterm infants followed by the light reduction

Study days (Study period per min)	Covered face group (N=30)	Non-covered face group (N=30)	The result of the statistical test t-test
First day	154	184	P =0.002
Second day	133	172	P =0.003
Third day	124	156	P =0.001
Fourth day	150	174	P =0.002
Fifth day	131	164	P =0.003
Sixth day	135	176	P =0.002
The difference between the sixth and the first day	19	8	P =0.001

The heart rate changes are shown in Table 2. As can be seen, there is a significant difference in heart rate of infants in both study groups during the 6-day intervention period, and there is also a significant difference in heart rate in both groups. According to the results, the heart rate in the covered face group was reduced by 19 beats per min in the study group.

Table 3: Changes in the number of infant respiratory rate followed by the light reduction:

Study days (Study period per min)	Covered face group (N=30)	Non-covered face group (N=30)	The result of the statistical test t-test
First day	54	74	P =0.001
Second day	36	55	P =0.003
Third day	38	56	P =0.005
Fourth day	41	60	P =0.001
Fifth day	42	57	P =0.002
Sixth day	45	69	P =0.003
The difference between the sixth and the first day	9	5	P =0.002

The respiratory rate changes in Table 3 show that there is a significant difference in the number of

respiratory rate of infants in both study groups during the 6-day intervention period. There is alsoasignificant difference in the respiratory rate in the first and sixth day in both groups. According to the results, the average respiratory rate in the covered face group was reduced by 9 breaths per min in the study group

Table 4: Changes in spo2 of preterm infants followed by the light reduction

Study days (Study period per min)	Covered face group (N=30)	Non-covered face group (N=30)	The result of the statistical test t-test
First day	94	88	P =0.027
Second day	96	90	P =0.03
Third day	95	85	P =0.006
Fourth day	93	90	P =0.001
Fifth day	93	88	P =0.007
Sixth day	99	89	P =0.002
The difference between the sixth and the first day	5	1	P =0.001

The oxygen saturation changes in infant's blood in Table 4 show that there is a significant difference in the oxygen saturation of infant's blood in both study groups during the 6-day intervention. There is also a significant difference in infant's blood oxygen saturation in the first and sixth day in both groups. In accordance to the results, the oxygen saturation of the infant's blood was reduced in the covered face group by 5 breaths per min in the study group.

Discussion

The results indicate that the light reduction leads to the positive effect on the physiological responses of preterm infants and also increases SPO2 in the preterm infants, because the light reduction can comfort the infant, and the results are obtained in the present study by implementing some standards such incubator blanket coating, light reduction of department at night, and noise reduction of the department. These results were in agreement with results of the Taheri et al., on 31 infants with the purpose of a functional program on the oxygen saturation of the infant, because in this study, with the light reduction, the spo2 level of the infants was increased. It can be said that in these infants, the production of melanin hormone is increased, which increases the duration of sleep in the infants. As a result, the comfort sleep also increases spo2 level for the relaxed brain of the infant. On the other hand, according to the results of both studies, an increase in the sleep of preterm infants reduces the heart rate, and results of both studies approve this hypothesis [10].

During the reach that was carried out in 6 days, the results indicate that the light reduction in the department reduces the heart rate of preterm infants that can be explained due to the increased infant sleep, while the results of Taheri et al., show no effect on the heart rate of preterm infants. These results are in contrast to the results of the recent study. It can be said in the recent study that for some standards such as incubator blanket coating, light reduction of department at night, reduced noises, or covering the face of infant, the production of cortisol hormone is reduced. Therefore, it is suggested to control the cortisol hormone level along with light reduction in the upcoming studies [6].

According to the results of the study, with light reduction in the department inside the infant incubator, the infant's respiratory rate was reduced, and these results are in agreement with SHiriwa, indicating lower respiratory rate and activity when the eyes of the infants were closed in comparison with the opened eyes. It can be said that this is due to the increased length of sleep of the preterm infants, because the metabolism is reduced during sleep and the need for oxygen is also decreased, as a result, the respiratory rate is reduced [12].

The results of the study indicate that the average light-related care status in the studied areas is still far from the standards, which can be attributed to lack of attention of caregivers, non-standard physical environment, and lack of equipment. The findings showed that there is a significant difference in the respiratory rate, heart rate, and oxygen saturation during the intervention days. The promotion in the light and sound related conditions in the intensive care departments are the most important measures that can be done before installing the sound protection measures in the departments, and for light control, the devices are used that make the standard light that can be adjusted for each infant for not preventing the sleep. The sound and light reduction protocol finally leads to a decrease in the heart rate and respiratory rate and and increase in the oxygen level in the preterm infants [2]. It seems that the courses planned for light reduction in the NICU are useful for reducing the stress level and increasing the duration of sleep and comfort in the infants.

Acknowledgments

We would like to thank the authorities of Al-Zahra Medical Education Center, head nurses, nurses, and health staff of NICU and mothers participating in the project, as well as Vice President for Research in Tabriz University of Medical Sciences who funded this study.

References

1. Hansen A, Forbes P, Arnold A, O'rourke E. Once-daily gentamicin dosing for the preterm and term newborn: proposal for a simple regimen that achieves target levels. Journal of perinatology. 2003;23(8):635.
2. Valizadeh S, Hosseini M, Jafarabadi MA, Mirnia K, Saeidi F, Jabraeeli M. Comparison of 2 Methods of Light Reduction on Preterm Infants' Sleep Pattern in NICU: A Randomized Controlled Trial. CRESCENT JOURNAL

OF MEDICAL AND BIOLOGICAL SCIENCES. 2017;4(4):211-6.

3. Clinical AC--IOH, Dentistry AAoP. Guideline on infant oral health care. Pediatric Dentistry. 2012;34(5):e148.
4. Coenraad S, Goedegebure A, Van Goudoever J, Hoeve L. Risk factors for sensorineural hearing loss in NICU infants compared to normal hearing NICU controls. International journal of pediatric otorhinolaryngology. 2010;74(9):999-1002.
5. Cox LC, Hack M, Metz DA. Longitudinal ABR in the NICU infant. International journal of pediatric otorhinolaryngology. 1982;4(3):225-31.
6. Blackburn S. Environmental impact of the NICU on developmental outcomes. Journal of pediatric nursing. 1998;13(5):279-89.
7. Lotas M. Effects of light and sound in the neonatal intensive care unit environment on the low-birth-weight infant. NAACOG's clinical issues in perinatal and women's health nursing. 1992;3(1):34-44.
8. Mann N, Haddow R, Stokes L, Goodley S, Rutter N. Effect of night and day on preterm infants in a newborn nursery: randomised trial. Br Med J (Clin Res Ed). 1986;293(6557):1265-7.
9. Peters KL, Rosychuk RJ, Hendson L, Coté JJ, McPherson C, Tyebkhan JM. Improvement of short-and long-term outcomes for very low birth weight infants: Edmonton NIDCAP trial. Pediatrics. 2009;124(4):1009-20.
10. Westrup B. Newborn Individualized Developmental Care and Assessment Program (NIDCAP)—family-centered developmentally supportive care. Early human development. 2007;83(7):443-9.
11. Cope M, Delpy DT. System for long-term measurement of cerebral blood and tissue oxygenation on newborn infants by near infra-red transillumination. Medical and Biological Engineering and Computing. 1988;26(3):289-94.
12. Shiroiwa Y, Kamiya Y, Uchibori S, Inukai K, Kito H, Shibata T, et al. Activity, cardiac and respiratory responses of blindfold preterm infants in a neonatal intensive care unit. Early human development. 1986;14(3-4):259-65.