HYGIENIC FEATURES OF THE INFLUENCE PRODUCED BY A COMPLEX OF ENVIRONMENTAL FACTORS OF NICU ON THE HEALTH OF PREMATURE NEWBORNS

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Abstract: Hygienic peculiarities of exposure by complex conditions of environmental factors on premature infants in the NICUs have been investigated.

Key words: neonatal intensive care units, neonate, prematurity, stress.

Background: A neonatal intensive-care unit (NICU) is an intensive-care unit specializing in the care of ill or premature newborn infants. The NICU environment provides challenges as well as benefits. Stressors for the infants can include continual and bright light, unfavorable microclimate conditions, and high levels of noise, electromagnetic fields, reduced physical contact, painful procedures, separation from their mothers [1, 2]. A special aspect of NICU stress for both parents and staff is that infants may survive, but with damage of the brain, ears or eyes. Newborn infants may be particularly sensitive to the effects of pain due to the immaturity of neuroanatomical nociceptive system [3, 4, 5].

Objective: to examine the development of premature infants in complex conditions of environmental factors in the NICU.

Research methods: During our research main attention has focused on studying the effects of continual and bright light, unfavorable microclimate conditions, high levels of noise, and electromagnetic fields on the premature infants, who needs nursing in the NICU for a long period of time. This period can last for several days or several weeks, even months using medical equipment. Our study consisted of 20 premature infants at 25 – 37 weeks gestation, weighing 2043,35±531,67 grams. Sex distribution of

premature infants was 1:1. Participants have been divided into 2 groups: the 1st group (n =10) premature infants in the NICU No. 1 with very high level of a set of physical environmental factors (noise, light, electromagnetic fields, humidity and temperature) and the 2nd group (control) (n =10) premature infants in the NICU No. 2 with low level of physical environmental factors in Kharkov.

Assessment of the light, noise, electromagnetic fields and microclimate conditions: have been conducted by hygienic methods. Sound levels have been measured over the entire spectrum of audible frequencies. The spectrum has been divided into smaller frequency spans, such as octaves or specific narrow bandwidths. Background noise refers to the continuous ambient sound in a space due to the mechanical and electrical systems of the facility or building itself and to permanent equipment. Background noise is produced by sources outside the building and by the building's own heating, ventilation, and air-conditioning systems, vacuum tube systems, elevators, plumbing, automatic doors, etc [6]. Light levels have been measured at each bedside.

APGAR score. A practical method of evaluating the physical condition of a newborn infant shortly after delivery, usually at the 1st and the 5th minutes. APGAR score shows us a number determined by rating the heart rate, respiratory effort, muscle tone, skin color, and response to a catheter, which had gently touched the nostril. Each of these objective signs can receive 0, 1, or 2 points for the maximum best score - 10. The usual Apgar score is 8/9 or 9/9 for a healthy baby. This means the baby had a score of 8 or 9 at the first minute of his life, and at the fifth minutes after his birth, the baby had a score 9. Points are usually taken for the baby’s color [7].

Results and discussion: Scientists study problems of nursing premature infants. However, the medical equipment generating noise and electromagnetic fields, which is in use, disturbs biological rhythms and disrupts microclimate.

The medical equipment generates noise, particularly systems of resuscitation – from 56 to 75 dB, incubators – from 34 to 54 dB, Infusion pumps – from 56 to 63 dB, aspirators – from 53 to 73 dB, artificial lung ventilation – from 53 to 74 dB (Table 1, Figure 1). The highest noise level in the NICU No. 1 – 74 dB, in the NICU No. 2 – 56 dB. Background noise level in the NICU No. 1 – 68 dB, in the NICU No. 2 – 56 dB. It

is important, that within any closed space, the sound levels depends by reflections of sound waves from surfaces. When the surfaces are predominantly hard, sound pressure builds up in the space, increasing the original level with reverberation. Conversely, when the surfaces are soft or acoustically absorptive, reflected energy is reduced and sound pressure does not build up.

The compressor has set the highest noise level. In all cases the noise was broadband. Also, when the alarm of monitors was switched the noise was intermittent.

Table 1

Maximum noise levels of medical equipment, dB

Medical equipment	**NICU No.1**	**NICU No. 2**
Resuscitation systems	74	56
Incubators	54	34
Infusion pumps	63	56
Aspirators	73	53
Artificial lung ventilation systems	74	53

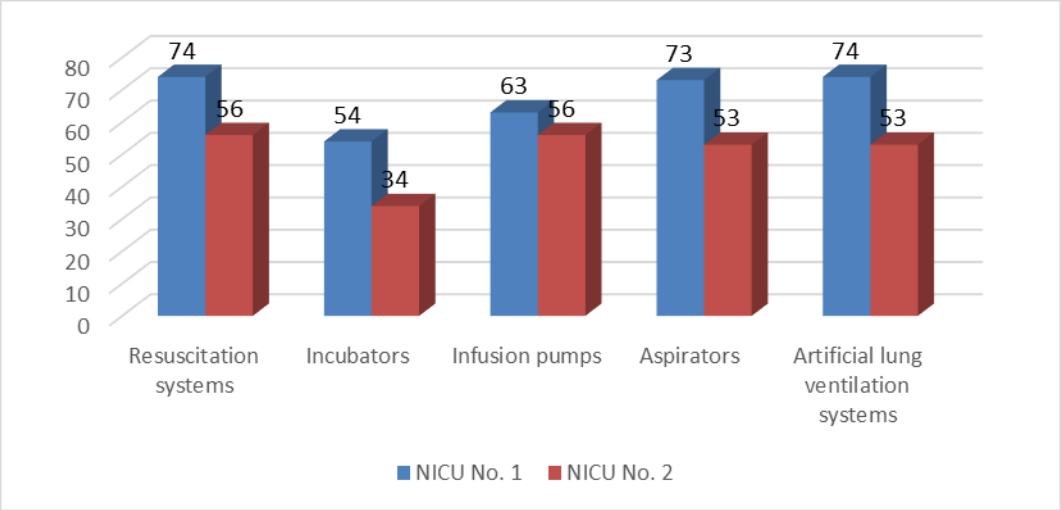

Figure 1. Maximum noise levels of medical equipment, dB

The sources of light generated light levels from 7 to 900 lx in the NICU No. 1, and in the NICU No. 2 – from 200 to 480 lx. There are fluorescent, incandescent and halogen lamps in the NICUs No. 1 and 2. Our studies have confirmed that using double-wall incubators and capes on them decreased light levels from 7 to 15 lx (Table 2).

It is well known that fluorescent, incandescent and halogen lights cause various negative health effects.

The temperature of lamps is the most important characteristic of visible light. There are higher color temperatures, mid-range color temperatures, and lower color temperatures.

Higher color temperatures (4600 K or more) are called daylight colors, which appear blue-white and are associated with vibrancy and feeling of alert.

Mid-range color temperatures (3100 K – 4600 K) look as cool white and are considered friendly and inviting.

Lower color temperatures (up to 3000 K) are called warm white colors, range from red to yellowish-white in tone, and evoke calming, warm and intimate feelings.

For example, the spectrum emitted by incandescent bulbs does not match the sensitivity characteristics of the human eye; the light emitted does not appear white, and most of them are not in the range of wavelengths at which the eye can be the most sensitive. Incandescent lamps are increase brightness and blinding effects.

Nocturnal exposure to light in the short wavelength ranges (below 530 nm) generated by fluorescent lamps may interfere with mammalian circadian rhythms due to its suppressing effect on melatonin production. Fluorescent lamps with magnetic ballasts flicker at a normally unnoticeable frequency of 100 to 120 Hz and this flickering can cause problems for some individuals with a light sensitivity.

But LEDs (light-emitting diode) create a soft, even, and comfortable light. They do not flicker, so do not tire the eyes. Do not emit ultraviolet radiation; their color is similar to daylight. It is very important to the immature structure of preterm infants.

Table 2

Effectiveness of the proposed methods for reducing brightness of light, lx

Measuring place	**Tonedlight apertures**	**Levels of artificial light, lx**	
		Resuscitation system	**Double-wall incubator and capes**
NICU No. 1	+	790	30
NICU No. 2	-	25	15

At the 1st minute 70 % of premature infants had Apgar score of 5-7, and 30 % – "4" in the NICU No. 1 (Table 3). At the 1st minute 20 % of premature infants had Apgar score of 5-7, and 80 % of premature infants – less than "4" as in the NICU No. 2.

At 5th minute of the infants' life 80 % premature infants received Apgar score from "5" to "7", 10 % – less than "4", and 10 % – over "8" in the NICU No. 1. 40 % of premature infants – from "5" to "7", 40 % – less than "4", and 20 % of premature infants – over "8" in the NICU No. 2.

Table 3

Physical condition of premature infants, (%)

Group of premature infants	**APGAR score**					
	1 min.			**5 min.**		
	10–8	7–5	4–1	10–8	7–5	4–1
NICUNo. 1	-	70	30	10	80	10
NICUNo. 2	-	20	80	20	40	40

Anthropometric measurements of premature infants in the NICU No. 1 in the neonatal period and early infancy were more than those in the NICU No. 2, which is explained by higher average age of gestation in the NICU No. 1 in premature infants (33.3 vs. 28.5). The physical parameters of these neonatal period and early infancy, both groups differed from accepted standards weight and growth coefficient and pointed out hypotrophy (Tables 4, 5).

Table 4

Anthropometric measurements of children according to gestation age, (n=10) in the NICU No. 1

Weeks of gestation	**Height**	**Weight**	**Head circumference**	**Chest circumference**	**Body Mass Index**	**Weight of girls**	**Weight of boys**	**Body Mass Index of girls**	**Body Mass Index of boys**
30 – 33	43	1676	30,2	28,5	38,5	1676	-	38,2	-

34 – 36	45,4	2310	30,8	30,1	50,4	2133	2575	47,6	54,5

Table 5

Anthropometric measurements of children according to gestation age, (n=10) in the NICU No.2

Weeks of gestation	**Height**	**Weight**	**Head circumferenc**	**Chest circumferenc**	**Body Mass Index**	**Weight of girls**	**Weight of boys**	**Body Mass Index of girls**	**Body Mass Index of boys**
26 – 27	32	952	24,2	21,6	33,6	886,17	1050	26,6	33,5
28 – 31	38,4	1332	26,8	24,8	29,4	1377,5	1150	34,25	31

According to the child development, which depends on environmental factors, we have studied anthropometric measurements in preterm infants during the highest rate of growth and development of the child's body, namely in infancy and early childhood (Tables 6, 7). The average age of the infancy in group 1 - 5.4 months, in-group 2 - 5.4 months. Thus, early childhood in group 1 - 21 months, in group 2 - 20 months. In infancy established weight loss in the 1st group: 6730 and in the 2nd group: 6895.7. Also we can see a decrease level in growth: 64.3 - 1st group against 64.5 in 2nd group of children. This trend was observed among 4625 boys in the 1st group vs. 6406.7 boys in the 2nd group and 7033 girls vs. 7162.5. In early childhood, different weight loss were set too, as we can see 10110 in the first group against 10550 (the 2nd group) and a decrease in a body growth 78.2 vs 84.3.

Table 6

Anthropometric measurements of children in the dynamics (n=10) in the NICU No. 1

The period of Observation:	**Height**	**Weight**	**Head circumference**	**Chest circumference**	**Weight of girls**	**Weight of boys**
Infancy	63,4	6730	41,4	41,8	7033	4625
Early childhood	78,2	10110	46	47	10110	-

Table 7

Anthropometric measurements of children in the dynamics (n=10) in the NICU No. 2

The period of Observation:	**Height**	**Weight**	**Head circumference**	**Chest circumference**	**Weight of girls**	**Weight of boys**
Infancy	64,5	6895,7	41,86	42,7	6812,5	6406,7
Early childhood	84,3	10550	45,6	47	10550	-

The error of anthropometric indicators cannot be considered as signs of health. It is well known that in modern conditions, such as accelerated, same as retarded development of children should be considered as a risk factor for a pathological disease. The data, which showed that the standard deviation of a group of children, who were nursed in the NICU with higher levels of environmental factors may be a manifestation of violation of regulatory mechanisms of energy and metabolic level, which take place at an unsatisfactory adaptation level and what is even worse, failure of adaptation of the body. Children who were nurse in the NICU No. 1 had most of all disharmonious development, compared with children who were nurse in the NICU No. 2.

Conclusions:

1. It is shown that increased level of environmental factors may have a negative influence on the performance for the harmonious children development, which will risk factor of pathology in the future.

2. The noise should be considered as a factor that can complicate nursing of premature infants. Effects of bright light may cause the violation of growth, development and differentiation of the visual analyzer in premature infants.

3. Incubators and capes are reducing lighting levels to 760 lx and should be encouraged to reduce the effects of bright light in the neonatal intensive care units.

Recommendations:

Ambient lighting levels in infant spaces should be adjustable through a range of at least 10 but not more than 600 lx, as measured at each bedside. Both natural and electric light sources should have controls that allow immediately darkening of any bed position sufficient for trans illumination, when it is necessary. The sources should avoid unnecessary ultraviolet or infrared radiation by the use of appropriate lamps, lens, or filters. Any lighting used outside the infant care area should be located so as to avoid any infant's direct line of sight to the fixture.

References:

1. Pineles B.L. Sensitization of cardiac responses to pain preterm infants // Neonatology. – 2007. – Vol. 91. – P. 190 – 195.

2. Abdulkader H., Freer Y., Garry E. et al. Prematurity and neonatal noxious events exert lasting effects on infant pain behave our // Early Hum. Dev. – 2008. – Vol. 84, № 6. – P. 351 – 355.

3. Bartocci M., Bergqvist L., Lagercrantz H. et al. Pain activates cortical areas in the preterm newborn brain // Pain. – 2006. – Vol. 122, № 1 – 2. – P. 109 – 117.

4. Davidson S., Truong H., Giesler G. Quantitative analysis of spinothalamic tract neurons in adult and developing mouse // Comp. Neurol. – 2010. – Vol. 518, № 16. – P. 3193 – 3204.

5. Fitzgerald M., Walker S. Infant pain management: a developmental neurobiological approach // Nat. Clin. Pract. Neurol. – 2009. – Vol. 5, № 1. – P. 35 – 50.

6. Report of the sixth census conference on Newborn ICU Design, Recommended Standarts for Newborn ICU Design. Orlando, Florida, January, 25–27, 2006.

7. Bovo MJ. The baby. Available http://www.mjbovo.com/Pregnancy/BabyWell.htm, Accessed February 8, 2012.

ГИГИЕНИЧЕСКИЕ ОСОБЕННОСТИ ВЛИЯНИЯ КОМПЛЕКСА ФАКТОРОВ ОКРУЖАЮЩЕЙ СРЕДЫ ОТДЕЛЕНИЙ ИНТЕНСИВНОЙ ТЕРАПИИ НОВОРОЖДЕННЫХ НА ЗДОРОВЬЕ НЕДОНОШЕННЫХ НОВОРОЖДЕННЫХ

Резюме. Исследованы гигиенические особенности влияния комплекса факторов окружающей среды на здоровье недоношенных детей в отделениях реанимации и интенсивной терапии новорожденных.

Ключевые слова: отделение реанимации и интенсивной терапии недоношенных новорожденных, недоношенный новорожденный, недоношенность, стресс.

ГІГІЄНІЧНІ ОСОБЛИВОСТІ ВПЛИВУ КОМПЛЕКСУ ЧИННИКІВ НАВКОЛИШНЬОГО СЕРЕДОВИЩА ВІДДІЛЕНЬ ІНТЕНСИВНОЇ ТЕРАПІЇ НОВОНАРОДЖЕНИХ НА ЗДОРОВ'Я НЕДОНОШЕНИХ НОВОНАРОДЖЕНИХ.

Резюме. Досліджені гігієнічні особливості впливу комплексу чинників навколишнього середовища на здоров'я недоношених дітей у відділеннях реанімації та інтенсивної терапії новонароджених.

Ключові слова: відділення реанімації та інтенсивної терапії недоношених новонароджених, недоношений новонароджений, недоношеність, стрес.