

# Evaluation of The Effect of Sound Intensity On Vital Signs In Neonatal Intensive Care Unit

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## ABSTRACT

Newborns, and especially prematures, suffer acute and chronic damage from noise during hospitalization. Therefore, it is important to monitor the noise levels of both the in-tub and out-of-tub environment. In this study we aimed to evaluate the effects of sound level measurement, noise sources and sound level on the vital signs of infants in Neonatal Intensive Care Unit.

We measured the sound levels at three different time point and two different sites during the day to determine the sources of the noise using the Benetech Sound Level Meter GM1352. During each measurement, the number of people in two sections of the NICU, the number of devices working, and the vital signs of the patients were recorded.

The average noise level in the first region was  $58.58 \pm 10.7$  dB and the average noise level in the second region was  $50.17 \pm 6.407$  db. There was a significant decrease in SaO<sub>2</sub> values, especially during periods when the volume was high ( $p < 0.01$ ). It was also determined that the number of breaths, pulse and sleeplessness levels increased during periods when the sound level rose above a certain level. As a source of noise the number of people working devices used and the presence of the nurse desk in the section were found.

It was determined that the recommended sound level in our unit was generally exceeded and that these levels had various adverse effects on infants. It is necessary to take measures to reduce the negative effects of noise on babies.

**Key Words:** Neonatal Intensive Care Unit, noise, vital signs

## Introduction

Advancements in neonatology have increased survival in infants with very low birth weight and over 23 weeks of gestational age. As a result, morbidities have started to appear more frequently. Depending on gestational age and birth weight, babies taken care in the neonatal intensive care unit (NICU) may remain in the incubator for weeks. During the treatment period, they are exposed to completely different physical conditions from the normally required intrauterine environment (1).

Noise is defined as undesirable, disrupting silence and damaging health. The intensity or level of the sound is measured in decibels (dB) (1,2).

Sound limits in hospitals should not exceed 35 dB at night and 45 dB during the day (3). The American Academy of Pediatrics (AAP) recommends that the sound level in NICU be below 45 dB (4,5). It has been reported that the average sound level in NICU in our country should not exceed 50-55 dB and the maximum should not exceed 70 dB (6). However, in spite of all the recommendations, the sound levels

measured in the NICU were higher than the AAP recommendation (7).

It has been shown that the tools and equipment used in the unit are the primary sources of noise, it is sometimes caused by people working in the unit. Noise intensity may vary depending on the size of the unit, the number, and quality of the equipment used in the unit, and the number of employees working in the unit (7). There are significant changes in vital signs and behaviors of premature which exposed to noise (8,9). The stress response of the baby against noise is mostly by the respiratory and cardiovascular system. A decrease in oxygen saturation (SaO<sub>2</sub>), an increase in heart rate, respiratory rate and intracranial pressure may be observed in the baby exposed to noise (9,10).

In this study, we aimed to measure the sound levels, determine the sources of noise and evaluate the effects of the sound level on the vital signs of the babies.

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**Picture 1.** NICU first section



**Picture 2.** NICU second section

## Methods and Materials

Thirteen newborn infants who hospitalized in the NICU of the Faculty of Medicine of Van Yüzüncü Yıl University were included in the study. Ethics committee approval was received for the study. The NICU has consisted of four sections. This study was conducted in the first section, where the sound level was predicted to be higher than the other sections, and the second region, in which the sound level was predicted to be less.

Although the first and second sections had eight incubator capacities, 6 patients were hospitalized in the first section and 7 patients were hospitalized in the second section on the day of sound volume measurement. Both sections had a central ventilation system. Around the incubators in the first and second sections, there were different numbers of suction, oxygen sources, monitors, phototherapy devices and infusion pumps according to the needs of the baby. There were ventilators around the incubators only in the first section. The nurse desk was in the first section (picture 1), but out of in the second section (picture 2).

We measured during the day at the time of the general visit (10:00 am), at the time of the nurse visit 4:00 pm), and at the time of absence of the visit (03:00 am). Measurements at the general visit were recorded as the first, measurements at the nurse visit were the second and measurements at the absence of the visit were recorded as the third. There were 3 nurses in the first region and 1 nurse in the second region. In the first region, there were 13 people in the general visit and 6 people in the nurse visit. In the second region, there were 13 people in the general visit and 2 people in the nurse visit. Measurements were taken 3 times with 5-minute intervals at the

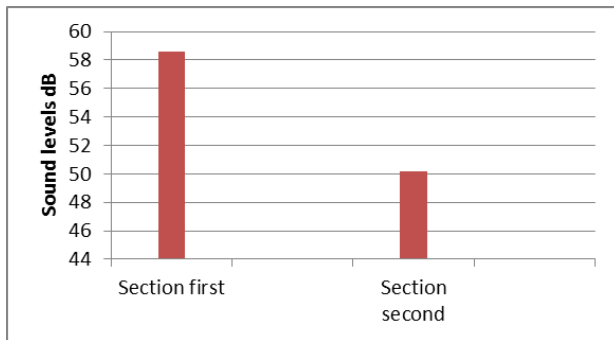
determined time. SaO<sub>2</sub>, respiratory rate (RR), heart rate body temperature, gestational week (GW), postnatal age, body weight (BW), sleeping, feeding, crying, ventilator requirement of the patients were recorded.

All measurements were performed using the Benetech Sound Level Meter GM1352 device (China). The device is capable of measuring sound waves from 30-130 dB and can measure in temperatures between -10 ° C and 60 ° C. Measurements were made in the centre of both sections, equal distance to incubators and one meter above the ground.

**Statistical Analysis:** Descriptive statistics for continuous variables were expressed as mean, standard deviation, minimum and maximum values, while categorical variables were expressed as numbers and percentages. Student t test or Mann-Whitney U test were used to compare groups means for continuous variables. In addition Paired t test was performed to compare first and third measurements. Chi-square (X<sup>2</sup>) test was used to determine the relationship between groups and categorical variables. The level of statistical significance was taken as 5% in the calculations. SPSS (ver: 20) statistical package program was used for the calculations.

## Results

Thirteen newborn infants hospitalized in the NICU of the Faculty of Medicine of Van Yüzüncü Yıl University were included in this study. Six of the patients were in the first section and seven of them were in the second section. On the day of measurement, four of the six patients in the first section were connected to a non-invasive ventilator. Ventilator-related patients were not present in the second section. The average,



**Fig.1.** Sound levels in the first and second section (dB)

minimum, and maximum levels of sound measurements in the first and second regions are shown in table 1 and figure 1. There was a statistically significant difference when the sound levels in the first and second regions were compared, ( $p= 0.001$ ).

Also, the sound level at the third measurement at 03:00 am in both the first and second sections was lower than the sound level at the first measurement at the general visit. The difference was statistically significant ( $p= 0.001$ ) (Table 2).

Demographic characteristics and vital signs of patients in the first and second regions are shown in Table 3. For each parameter; the average, minimum, maximum and p values in the regions are specified.

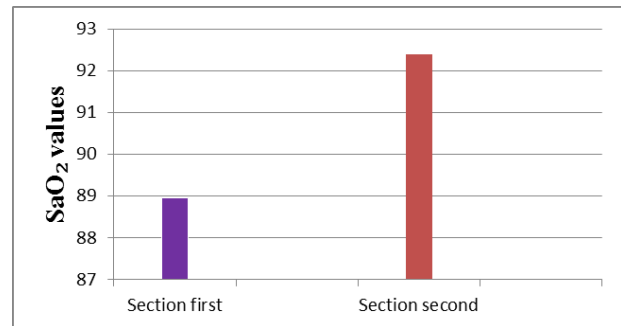
There was no significant difference in heart rate, respiratory rate and body temperature of patients in both sections. However, there was a statistically significant increase in respiratory rate of the patients in the first section, especially when the sound level was 70 dB or higher ( $p= 0.005$ ) (Table 4).

The SaO<sub>2</sub> values of the patients in the first section (mean: 88.96) were lower than the SaO<sub>2</sub> values of the patients in the second section (mean: 92.40) (Figure 2) and the difference was statistically significant ( $p < 0.01$ ).

While the mean gestational week of the patients in the first section was 30.75 hf (28-38), the mean gestational week of the patients in the second section was 32.43 hf (24-34), and the difference was statistically significant ( $p= 0.02$ ).

The mean postnatal age of the patients in the first section was 12.69 days (1-57), while the mean postnatal age of the patients in the second section was 19.1 days (8-54), and the difference was statistically significant ( $p < 0.01$ ).

While the mean bodyweight of the patients in the first section was 1116.25 g (780-3180), the mean bodyweight of the patients in the second section



**Fig.2.** SaO<sub>2</sub> values of patients in the first and second sections

was 1665.71 g (940-1930) and the difference was statistically significant ( $p= 0.01$ ).

In addition, it was observed that the vigilance level increased when the volume was above 70 dB, although it was not statistically significant ( $p= 0.05$ ) (Table 5).

## Discussion

Hearing matures around 28 weeks, although the fetus starts to hear in the 18th week of pregnancy (11,12). In the 30-35 weeks of gestation, the fetus hears the mother's voice, responds to sounds, and begins to understand the difference between speech sounds (13). The sound generated in the uterus is around 50 decibels (dB) (12).

Premature babies spend the first month of their lives mostly in NICUs. During this time they are exposed to sudden, constant and loud sounds. Sound levels in the NICUs are between 57-97 dB and reach a maximum of 120 dB (14). The adverse effects of noise may be increasingly permanent in newborn infants with many systems immature. In various studies, average noise levels in the unit vary between 56.96 dB and 66.7 dB (15-18). In our study, the mean sound level in the first region was 58.58 dB and the mean sound level in the second region was 50.17 dB. The measured sound level was above 45 dB recommended by AAP, although it was below the value in many studies.

In the publications, the source of the noise is the employee or the tools and equipment used. Noise may vary depending on the size of the unit, the number and quality of equipment used, and the number of employees (7). In our study, the main reason that the sound level in the third measurement was higher than the first measurement was that the number of people who participated in the first measurement was higher. As the reasons why the sound in the first part is higher than the sound in the second part; the use

**Table 1.** Sound levels in the first and second sections (dB)

The sound levels		Mean	Standard Deviation	Minimum (dB)	Maximum (dB)	P
Section						
First		58.58	10.778	47	74	0.001
Second		50.17	6.407	44	67	

**Table 2.** Distribution of sound intensity in the first and second section according to the measurement time

The sound levels		Mean	Standard Deviation	Minimum (dB)	Maximum (dB)	P
Section						
First	1. measurement	72.00	1.673	70	74	0.001
	3. measurement	50.61	2.801	47	55	
Second	1. measurement	57.33	7.146	51	67	0.001
	3. measurement	47.31	2.961	44	51	

**Table 3.** Demographic characteristics and vital signs of patients in the first and second sections

	Section	Average	Minimum	Maximum	p
SaO <sub>2</sub>	First	88,96	74	94	<0,01
	Second	92,40	88	96	
Heart rate per minute	First	176,33	125	149	>0,05
	Second	149,49	129	188	
Respiratory rate per minute	First	54,29	40	80	>0,05
	Second	53,13	44	68	
Body temperature(c°)	First	36,55	36	37,8	>0,05
	Second	36,52	36	37,2	
Gestation week(w)	First	30,75	28	38	0,02
	Second	32,43	24	38	
Postnatal Age(day)	First	12,69	1	57	<0,01
	Second	19,10	8	54	
Body Weight (gr)	First	1116,25	780	3180	0,01
	Second	1665,71	940	1930	

of ventilators, the number of infusion pumps used, the number of nurses working and the nursing table in the first section can be shown.

It has been shown that there are significant changes in vital signs and behaviors of premature exposed to noise (8,9). The stress response of the baby against noise is mostly on the respiratory and cardiovascular system (9,10). Noise can cause apnea, hypoxemia and changes in SaO<sub>2</sub>. It can reduce the number of calories required for growth due to an increase in heart-respiration rate and an increase in secondary oxygen consumption (9,19). In our study, SaO<sub>2</sub> values were lower in the first

part, where the sound level was higher, than the second part, in accordance with the literature.

Hassanein SM et al reported that the higher the noise level of the environment, the higher the heart rate and respiratory rate of premature babies (20). In our study, although not statistically significant, the heart rate was higher in babies in the first section where the sound level was high. Although no significant difference was found between the two sections in terms of respiratory rate there was an increase in respiratory rate when the sound level in the first section increased above especially > 70 dB. The absence of a difference in the number of breathing and pulse levels due to



**Table 4.** Effect of sound level on respiratory rate

Breaths per minute The sound levels	Mean	Standard Deviation	Minimum	Maximum	p
	<70 dB	52.56	6,231	40	76
≥70 dB	58,57	13,86	40	80	

**Table 5.** Effect of sound level on sleep

Sleep The sound levels		No	Yes	Total
		<70 dB	Number	11
	%	%10.4	%89.6	%100.0
≥70 dB	Number	4	10	14
	%	%28,6	%71,4	%100,0

chi-square = 3.743; p = 0.05

the sound level in the study may be due to the small number of samples.

It has been found that sound-absorbing panels reduce the noise level in the incubator and positively affect SaO<sub>2</sub> and the sleep status of babies (21). Studies have been reported to affect the transition of newborns to sleep time and deep sleep by changing the sound level (8,10). In our study, babies were found to be more awake when the sound level increased above > 70 dB.

Limitations of our study include; the use of devices that record the sound level and the vital signs of the patients for 24 hours instead of a specific time period and the low number of samples.

Neonates and especially premature babies are susceptible to acute and chronic damage to noise. Therefore, it is necessary to monitor the noise levels of the inside and outside of the incubator environment at regular intervals and take the necessary precautions. We found that the recommended sound level in our unit was generally exceeded and that these levels had various negative effects on infants. Therefore, precautions should be taken to reduce the negative effects of noise on babies.

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