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Determination of Noise Level and Its Sources in the Neonatal Intensive Care Unit and Neonatal Ward

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ABSTRACT

***Background*:** In Neonatal intensive care units (NICU) different sound intensities and frequencies are produced from different sources, which may exert undesirable physiological effects on the infants. The aim of this study was to determine the noise level and its sources in the NICU and neonatal ward of Al-Zahra Hospital of Rasht, Iran.

***Methods*:** In this descriptive cross-sectional study, the intensity of the sounds generated by the internal and external sources in the NICU and neonatal ward was measured using a sound level meter device. The sound produced by each of the sources was individually calculated. Data were analyzed performing descriptive and analytical statistics, using SPSS version 19.

***Results*:** The mean noise levels in six rooms and a hallway during morning, afternoon and night shifts with the electromechanical devices turned on were 61.67±4.5, 61.32±4.32 and 60.71±4.56 dB, respectively. Moreover, with the devices tuned off the mean noise levels during morning, afternoon and evening shifts were 64.97±2.6, 60.6±1.29 and 57.91±4.73 dB, respectively. The differences between the mean noise levels in the neonatal wards (standard noise level=45 dB) during each shift with the electromechanical devices turned on and off were statistically significant (P=0.002 and P<0.05, respectively). Phone ring tones in a one meter distance and neonatal crying registered the highest values (85 and 81 dB, respectively).

Conclusion: According to the obtained results, the highest noise levels were generated by the electromechanical devices inside the NICU and neonatal ward, and there were no significant differences in the noise level with the devices turned on and off. Moreover, personnel's noise-generating behaviors were the main sources of noise. Therefore, it seems that providing educational preparation for the staff can diminish the ambient noise level.

Keywords: Intensive care unit, noise pollution, neonate

Introduction

Noise is defined as the unwanted sounds which can affect people both psychologically and physiologically. The previous studies have reported various adverse effects of noise such as cardiovascular disease stimulation, hearing loss, increased gastric secretion, immune response suppression against infections and decreased female reproductive function (1, 2).

High noise levels can have adverse effects on neonates being kept in neonatal intensive care units (NICU). According to the previous studies on neonates, excessive exposure to noise can affect cardiovascular system (e.g., blood pressure and heart rate), newborn sleep pattern, respiratory system and cerebral circulation. It can also have long-term effects on brain development processes such as language development, growth and hearing (3, 4).

Daytime sound levels in NICU should generally range from 50 to 75 dB. It has been suggested that noise levels higher than 103 dB at night, can disturb sleep patterns (1, 5). However, the US Environmental Protection Agency has stated that sound levels in NICUs should not exceed 45 and 35 dB during the day and night, respectively (6, 7). As was mentioned in the literature, equipment (e.g., incubators) and staff could be the main sources of noise in NICUs (8).

Given the numerous harmful effects of noise on the growth and development of neonates, this study aimed to determine the noise level and its main sources in NICU and neonatal ward of Al-Zahra Hospital of Rasht, Iran.

Method

This descriptive cross-sectional study was conducted in six rooms and a hallway of Al-Zahra

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Hospital of Rasht, Iran, during 2012-2013. The noise level in the NICU and neonatal ward were measured during the morning, afternoon and evening shifts over a week using a sound level meter (SLM) device.

Additionally, the internal and external noise-generating sources in the units were identified, and then, the noise level of each individual source was measured. Sound level calibrator, which calibrates the device for stimulus-range of 94-104 dB at 1000 Hz frequency, was used.

The noise generated by each equipment was measured at a one meter distance from the SLM, which was placed on a tripod. Moreover, noise levels of the available equipment in the rooms such as incubators, heaters and phototherapy devices were measured as follows: A) the overall noise level was measured based on decibel; B) the background noise was measured with all the devices turned off and C) all the equipment were turned off and only the noise from the target device was measured. The noise generated by each device was measured using the following formula: $M=10\log_{10}(10^{\frac{T}{10}}-10^{\frac{B}{10}})$.

The noise level of phototherapy devices, heaters and incubators were determined separately. The intensity of the noise generated by the staff, devices placed outside NICU and neonatal ward, and the noise generated outside the hospital were measured as well.

Results

In this study, the noise levels in the NICU and neonatal ward of Al-Zahra Hospital of Rasht were measured. The results showed significant differences in the noise levels with the devices turned on and off. The level of noise produced by various devices in different shifts can be observed in Table 1.

General linear model and repeated measures ANOVA showed no significant differences in the noise level with the devices turned on and off in the three shifts (morning, afternoon and evening) (P=0.435) (Table 2).

Additionally, the results demonstrated that mean sound level with the devices turned off was higher in the neonatal ward, as compared to the NICU (Table 3). Internal sources including ringtone, neonatal cry and pagers registered the highest values, respectively.

Discussion

Over the past few decades, the rate of very low birth weight (VLBW) has had a marked increase and a growing number of children are diagnosed with neurodevelopmental disorders as they reach school-age. It seems that some of these problems can be secondary to the noisy acoustic environment of the NICU and neonatal wards (9).

Our results did not demonstrate any significant differences in the noise level within the three shifts with the devices turned on; however, a significant difference was noted when the devices were turned off. Assessment done in the NICU and neonatal ward demonstrated no significant differences in the noise levels with the devices turned on and off.

Table 1. The sound level (dB) with the devices turned on and off in different shifts

	Status	Shift	Room count	Mean (dB)	Standard deviation	F	Statistical analysis Intra group	F	Statistical analysis Inner group
Neonatal intensive care unit	Devices turned on	Morning	2	60.05	1.2	12.53	P= 0.175	1.7	P= 0.319
		Afternoon	2	63.45	60.3				
		Evening	2	60.3	6.08				
	Devices turned off	Morning	2	62.45	2.61	2.51	P= 0.358		
		Afternoon	2	59.75	1.9				
		Evening	2	56.9	6.5				
Neonatal ward	Devices turned on	Morning	5	62.32	5.3	1.16	P= 0.341	4.11	P= 0.077
		Afternoon	5	60.48	4.85				
		Evening	5	60.88	4.67				
	Devices turned off	Morning	5	65.98	2.01	7.69	P= 0.05		
		Afternoon	5	60.94	1.05				

	Evening	5	58.32	4.71	

Table 2. Comparison between wards' mean sound levels with the devices turned on and the standard sound level

Shift	Ward	Number of rooms	Mean (dB)	Standard deviation	t	Statistical significance
Morning	Neonatal intensive care unit (NICU)	2	60.05	1.2	17.7	P= 0.036
	Standard		45	0		
Afternoon	NICU	2	63.45	2.33	11.18	P= 0.057
	Standard		45	0		
Evening	NICU	2	60.3	6.08	3.55	P= 0.174
	Standard	2	45	0		
Morning	Neonatal ward	5	62.32	5.33	7.26	P=0.002
	Standard		45	0		
Afternoon	Neonatal ward	5	60.48	4.85	7.13	P=0.002
	Standard		45	0		
Evening	Neonatal ward	5	60.88	4.67	7.58	P=0.002
	Standard		45	0		

Table 3. Comparison between wards' mean sound levels with the devices turned off and the standard sound level

Shift	Ward	Number of rooms	Mean(dB)	Standard deviation	t	Statistical significance
Morning	Neonatal intensive care unit (NICU)	2	62.45	2.61	9.43	P= 0.067
	Standard		45	0		
Afternoon	NICU	2	59.75	1.9	10.92	P= 0.058
	Standard		45	0		
Evening	NICU	2	56.9	6.5	2.58	P= 0.235
	Standard	2	45	0		
Morning	Neonatal ward	5	65.98	2.01	23.26	P= 0.0001
	Standard		45	0		
Afternoon	Neonatal ward	5	60.94	1.05	33.93	P= 0.0001
	Standard		45	0		
Evening	Neonatal ward	5	58.32	4.71	6.31	P= 0.003
	Standard		45	0		

Zanouzi and colleagues (10) reported the mean SPL in 18 stations with all the devices turned off and with absence of staff in NICU to be 48±2 dB and 5.5±52 dB, respectively. With the devices turned on and the absence of personnel the mean noise levels were 48±1.9 dB and 61±1.9 dB, respectively. While with the devices turned on and the presence of personnel the noise levels were 52±6.3 dB and 65±3.6 dB, respectively.

Also Berg and colleagues (8), mentioned that the mean noise level in the NICU was 56.96±2.71 dB (mean noise level range=55.58-58.96 dB and standard deviation range=2.24-3.15). In their study, no significant differences regarding noise level were found in different units.

Considering the high noise level in NICU and neonatal ward and no significant differences in the noise level with the devices turned on and off, it seems that establishing the right protection measures and making physical alterations to the hospitals' layout can be helpful in reducing the sounds induced by the internal and external sources.

American Academy of Pediatrics (AAP) recommended that the average sound intensity for awake and asleep neonates should be up to 45 dB and 35 dB, respectively. In addition, they indicated Lmax and L10 of 65 dB and 50 dB as the standards for the physical environment of NICU and neonatal wards (5).

Although we noted higher level of noise in

comparison to APA guideline, but there were no significant differences between them. Nathan et al. (9) found that the mean sound level measured

Table 4. Mean noise level caused by internal sources

Internal sources	Mean noise level (dB)
Ringtone (1 meter distance)	85
Neonatal cry	81
Pager	78
Pulse oximetry alarm	77
Moving neonatal resuscitation trolley on the ground	76
Incubators	75
Staff	75
Alarm of phototherapy devices	73
Chiller	73
Ringtone on top of neonatal bed	71
Oxygen therapy devices	69
Ventilator	61
Phototherapy devices' fan	58
Heater	45

During two 12-hour monitoring periods were 62.3 dB and 66.7 dB, which was higher than the American and England guidelines for NICU (50 dB and 60 dB, respectively).

Measurement of sound level for each source demonstrated that ringtone, neonatal crying, pager, pulse oximetry alarm and moving the neonatal resuscitation trolleys registered the highest values, respectively. However, Nathan et al. (9) indicated that staff and alarm systems were the greatest sources of noise. Also, Zanouzi et al. (10) mentioned heaters, HP and Novametrix monitors and Infant star 500 Respirators as the prime sources of noise.

Therefore, to reduce the noise pollution caused by care activities, providing educational preparation for personnel to raise their awareness about avoiding unreasonable noise seems to be necessary.

Conclusion

Therefore, to reduce the noise pollution caused by care activities, providing educational preparation for personnel to raise their awareness about avoiding unreasonable noise seems to be necessary.

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