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Original Research Article

Analysis of noise level in neonatal intensive care unit and post natal ward of a tertiary care hospital in an urban city

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ABSTRACT

Background: Noise levels in neonatal intensive care unit (NICU) and post natal ward (PNW) could have an adverse impact on the neonates hence it is necessary to know the level of sound prevailing in these places particularly in busy and overcrowded urban hospitals.
Methods: The measurement of noise levels was recorded at every hourly and five second intervals with Leq, Lmin, Lmax in the NICU and PNW in different shifts. Noise level generated due to structural and operational factors was analyzed. Noise levels in different shifts was compared with standard and recommended sound level.
Results: The noise generated by structural and operational factors were between 60-90 dB. The range of noise generated in NICU and PNW was between 50-95 dB and 51-95 dB respectively with Leq, Lmin, Lmax for both NICU and PNW were 72 dB, 51 dB, 92 dB and 76 dB, 62 dB, and 87 dB respectively. Morning Shifts had maximum noise levels, when compared with other shifts.
Conclusions: Noise levels were significantly higher than standard recommended levels and morning shifts were noisiest of all in NICU and PNW of an urban hospital.

Keywords: Noise, Newborn, NICU, PNW, Sound

INTRODUCTION

Noise is defined as an unwanted sound. Acoustic signals producing a pleasant sensation are referred to as "sound" whereas the unpleasant sounds are referred to as "noise".[1] As per American Academy of Pediatrics Committee on environmental hazards, which recommends a safe limit of sound to be below Leq of 45 dB in NICU, exceeding which, may result in cochlear damage or disrupt the normal growth and development of premature infants.[2] Migration of population in urban, industrial and developing cities in India exerts a significant overload on NICU admissions in tertiary urban hospitals with increasing attendants, use of advanced equipments, generate noise and create a possible stressful environment for these newborns. An analysis of sound levels in NICU of urban hospital, is therefore required, to which these fragile neonates are exposed to.

METHODS

A prospective analytical study was conducted in NICU and post natal ward in the pediatric department of tertiary hospital in industrial city of Surat, Gujarat, India. The hospital has a facility of level III neonatal care. NICU consists of four cubical areas each measuring (length×breadth×height in feet) as area A- 20.6×20.6×11, area B-20.6×21.6×11, area C-20.6×19.6.6×11 and area D-13.3×10×11 which are separated by glass partition with individual doors. NICU is open to roof terrace on top, on two lateral sides, it is covered by walls of milk bank and other side by wall of washroom of PICU, whereas the third side there is a closed roof and on fourth

side it consists of a double entrance door with wall and a passage separated from main hospital building. A digital Sound level meter (Mastech MS 6701 rs 232/data logger with a range of 30-130 db, resolution 0.1 db, accuracy ±2.0 db, frequency range 30Hz˜8 KHz, memory 16000 records) was calibrated and used for the study with the assistance and guidance from a faculty member of a Sardar Vallabh bhai National Institute of technology (a regional govt. engineering college, Surat). The instruments and equipments which could generate operational and structural sounds/noises in NICU were servo controlled warmers Neonatal ventilators, cardio-respiratory monitors, pulse oximeters, syringe pumps, electronic suction machines, ventilator attached compressors, nebulizers, central oxygen supply and a land line telephone, automatic opening and closing door and staff conversations.

The range of noise generated by these instruments were noted and recorded. Mean sequential hourly noise level for 24 hour as Leq, Lmin, Lmax for both NICU and PNW were calculated. Overall sound generated in the NICU and PNW was measured and recorded at the end of every one hour and every 5 seconds interval by placing instrument in the middle of each of the four cubical areas of NICU and also in PNW.

One hourly intervals were recorded according to staff duty shifts of morning (8 a.m - 2 p.m.) afternoon (2 p.m.- 8 p.m.) night (8 p.m.- 8 a.m.) and sound levels were recorded over a total of 504 hours and 240 hours in NICU and PNW respectively and similarly also for 5 second interval measurements for a total of 24 hours each in the NICU and PNW respectively. The data recorded were collected and transferred to a personal computer and subjected to statistical calculations and the analysis was performed by SPSS 16.0.

RESULTS

Table 1 showed the structural and operational sounds generated in the NICU. The overall range in which these sounds generated were in the range of 60- 90 dB, which was well above the threshold levels. The NICU working staff in the morning duty shift consisted of a total of 8 persons including 6 nurses, 1 servant 1 female mistress in addition resident doctors, the mothers of admitted newborns were also allowed for feeding the newborns. In the afternoon and night the staff was reduced to four or five persons on an average.

Table 1: Range of structural and operational sounds generated in NICU.

Source of noise	Sound in decibels (dB)
Door closure	80-90
Conversation	80-95
Ventilator alarm	80-90
Nebulizer	70-80
Landline telephone	75-85
Monitor's alarms	60-85
Ventilator compressor	70-80
Intravenous infusion alarm	65-75
Endotracheal aspiration unit	70-85
Central gas supply	80-90

Table 2: Mean sound level in different shifts in NICU (ANNOVA test).

Area	Shifts	Mean sound level (dB)	Std. dev.	Range (dB)	95%confidence interval	P-value
Area -A	Morning	78.1	10.2	55.23 - 100.40	77.84 - 78.37	< 0.01
	Afternoon	73.0	10.4	50.11 - 93.00	72.72 - 73.26	
	Evening	68.9	10.7	50.20 - 92.18	68.44 - 68.99	
Area -B	Morning	77.4	10.1	56.42 - 99.20	77.20 - 77.73	< 0.01
	Afternoon	73.3	10.4	50.03 - 94.58	73.12 - 73.66	
	Evening	69.1	11.0	50.01 - 92.36	68.86 - 69.43	
Area -C	Morning	77.5	10.3	56.27 - 100.39	77.29 - 77.83	< 0.01
	Afternoon	73.1	10.8	52.41 - 98.60	72.89 - 73.45	
	Evening	69.4	10.5	54.41 - 90.59	69.20 - 69.74	
Area -D	Morning	75.9	10.7	50.42 - 98.26	75.66 - 76.22	< 0.01
	Afternoon	72.8	10.2	53.20 - 92.16	72.16 - 73.13	
	Evening	68.7	10.9	50.24 - 92.08	68.63 - 69.20	

The list of equipments and instruments consisted of 6 ventilators, 4 compressors, 19 radiant warmers, 15 Infusion pumps, 12 phototherapy units, 9 multi paramonitors 6 portable pulse oximeters and one land line telephone. The mean sequential one hourly noise level for a recording of 24 hours, as Leq, Lmin, Lmax for both NICU and PNW were 72 dB, 51 dB, 92 dB and 76 dB, 62 dB, and 87 dB respectively with a range of minimum and maximum level of 50 dB to 95 dB in NICU and 51 db to 95 dB in PNW these levels were above the recommended threshold levels of Leq 45 dB, Lmax 65 dB by American Academy of Pediatrics (2007). The mean sound level of

every five second interval in different areas and different duty shifts of NICU are given in Table 2 which were statistically significant (p <0.01). In all the areas of NICU the maximum level of mean sound was during the morning shift. Similarly every five second interval mean sound level in different areas and of different duty shifts of post natal ward are given in Table 3 which was also statistically significant (p <0.01).

Table 3: Mean sound level in different shifts in post natal ward (PNW).

Area	Shifts	Mean sound level (dB)	Std. dev.	Range (dB)	95% confidence interval	P value
Post natal ward	Morning	79.2	13.19	56.40-106.54	78.85-79.54	<0.01
	Afternoon	76.9	12.58	53.42-100.09	76.65-77.30	
	Night	73.4	12.39	52.40-92.40	73.14-73.78	

Table 4: Comparison of noise in different shifts in NICU and PNW with recommended level of 45 Db.

Type of shift	Area	Mean sound level (dB)	Std. dev.	t-test	Statistical significance
Morning	NICU	77.89	11.11	5.9	P < 0.05
	Standard	45			
Afternoon	NICU	73.30	10.11	5.6	
	Standard	45			
Evening	NICU	69.11	10.84	4.4	
	Standard	45			
Morning	PNW	77.66	13.39	2.4	P < 0.05
	Standard	45			
Afternoon	PNW	77.56	12.84	2.5	
	Standard	45			
Evening	PNW	75.12	12.44	2.4	
	Standard	45			

At both places, it was observed that morning shifts had a higher level of noise generation than other two shifts. On comparison of mean noise levels (five seconds interval) between 3 shifts of NICU and PNW it was found that levels of noise were also statistically significant and the levels decreased from morning shift (77.89 db) to night shift (69.09 db) in NICU ,in the PNW also the maximum level (79.20 db), was during the morning shift. The reason for this may be due to more activities in morning such as faculty residents, undergraduate, nursing students round, administrative activities, in addition to noise generation as above in NICU whereas in PNW, although there were no instruments and equipments with alarm systems in PNW, but sound generation, might be due to more number of beds, persons (mother and child) attendants and relative visits being allowed, administrative and ward work etc.

On comparison of mean noise levels in all three shifts of NICU and PNW with recommended standard sound levels (45 db) in NICU and PICU, it was found significant in NICU and for PNW (Table 4).

DISCUSSION

Indian academy of pediatrics has not issued any guidelines on tolerable sounds and modes of prevention of excessive noises for Indian set up. American academy of pediatrics recommends a thresh hold value of 45 dB. Neonatal intensive care unit (NICU) environment is characterized by continuous sounds from monitors, ventilators alarms, infusion pumps, incubators, conversation between doctors, staff and family persons.[2] Kruger et al classified the sources of sound in NICU as being either operational or structural specifically.[3] Operational sounds are those generated by the staff and equipment in the NICU. Structural sounds are those generated by infrastructure, for example, sounds generated by ventilation air-conditioning system and doors.[3] Preterm infants are more vulnerable to adverse effects of noise on various parameters like blood pressure increase in heart rate, respiratory rate and decreased oxygen saturation.[3-10] Studies reporting mean operational and structural sound levels in NICU had a variation of ranges from 50 - 75 dB in Morris et al, Philbin et al and Bose et al, 45 - 85dB in Blourchian et al and Garrido et al and 61-80dB in Guimaraes et al, Benin et al, Nzama et al whereas in present study it was 50 - 95dB in NICU.[15-18] The maximum mean sound level was during the morning shift as compared to other shifts ,which was consistent with other studies of Argot et al, Matook et al, Dube et al and Blourchian.[19-21] The factors which might have contributed to the generation of noise could be more no. of staff and administrative work in the morning shifts.

However additionally, it was studied that mean sound levels in PNW where normal babies were kept with the mother, these neonates too were also exposed to noise higher than recommended level ,as the mean sound level range was 51 - 95 dB, in spite of the fact that there was absence of sophisticated equipments and instruments in PNW, but other factors such as more number of neonates, family attendant visits, ward staffs and administrative work could have been significantly responsible for generation of noise beyond the recommended level.

CONCLUSION

There is a significant generation of noise, not only in the NICU but also in PNW of an urban hospital exceeding the recommended standard limit. This noise level was maximum during the morning shifts at both these places. The noise generated was significant when compared with the recommended standard limit. Proper protocol should be designed to detect the cause responsible for generation of structural and operational noise in NICU and PNW hence to reduce noise levels.

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