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Original Research Article

Statistical Study of Noise Levels in an Adult ICU – A Case from India

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Abstract

Objectives: The purpose of this study was to observe and record the levels and sources of noise in an adult ICU. These results and observations are to form the basis of protocols to control noise levels in an ICU. These will also be treated as baseline values for comparison with results obtained in future studies to determine the effectiveness of noise reduction protocols.
Methods: Average noise levels were recorded in the adult ICU of S.L. Raheja Hospital (A Fortis Associate) over a period of 10 days and 10 nights. A digital sound meter was used to record the sound levels and an average of 5 readings at the start of every hour was recorded. Along with measurements, physical observation and a literature review of recent noise studies in ICUs was also undertaken.
Result: Noise levels in the ICU were found to be higher than the guideline values in accordance with most recent studies. It was observed that the major source of high noise levels was caregivers such as ward boys who tended to speak loudly while doing their duties. During the day, noise levels were higher than at night and noise levels increased sharply during shift changes.
Conclusion: Almost 61% of the noise in the ICU was found to be modifiable. In future, on the basis of the results of this study, protocols will be formed and steps will be taken to reduce the modifiable noise to bring down noise levels further to ensure faster recovery and greater patient comfort.
Keywords: ICU, noise control, hospital noise, decibels, modifiable noise

1.Introduction

The adoption of latest technology in healthcare has rendered medical procedures more advanced and effective. Hospitals house an array of specialized equipment to provide the best possible treatment and care. Along with medical treatment and care, hospitals also ensure that a patient can rest adequately and be distanced from any disturbance that may adversely affect the process of healing and recovery. This includes ensuring a quiet and calm environment.

The intensive care unit (ICU) of a hospital is a special facility meant for close observation, monitoring and treatment of critically ill patients under the care of specially trained staff with emergency equipment close at hand. In order to maintain an environment ideal for adequate rest and early recovery, sound levels in ICUs must be kept to a minimum.

Sound and noise are physically identical. Noise is sound that is perceived unwanted, undesired or obtrusive, e.g., a conversation however relevant to its participants may be considered as noise by a listener. Studies have found that noise may lead to hearing impairment, hypertension, ischemic heart disease, changes in the immune system, sleep disturbances, or simply annoyance [1,2]. Since patients have less tolerance to stress, sounds in hospitals, and especially in ICUs, are more likely to be classified as noise. Noise in the ICU may also lead to interference with alarms, which directly affects patient monitoring, treatment and care.

In India, most studies on noise in an ICU and its causes have mainly focused on neonatal ICUs. Very few studies have been performed in adult ICUs.

The present study is aimed at identifying the sources of various noises in the ICU and determining the average and maximum levels of sounds at different stations on different days. In addition, an observational assessment of the various sources of noise in the ICU was also attempted. This study will form the basis for further studies that will be aimed at promulgating, implementing and observing the effectiveness of protocols for noise reduction in the ICU.

2. Literature Review

According to World Health Organization (WHO) guidelines, the average sound level in rooms where patients

are being treated or observed should not exceed 35 dB and the maximum sound level indoors should not exceed 40 dB during the night [3]. The Environmental Protection Agency (EPA) suggests that an average sound level not exceeding 45 dB indoors helps maintain a quiet environment in hospitals and prevents activity interference and annoyance [4].

However, many recent studies have found that sound levels in ICUs are well above these thresholds [5-7]. Darbyshire and Young [8]found that in the five adult ICUs monitored, average sound levels always exceeded 45 dBA with peaks exceeding 85 dBA up to 16 times per hour during the night and more often during the day. Such high levels of noise are known to cause cardiovascular stress and endocrine stimulation and alter the sleep-wake cycle of patients [9,10].This can contribute to an extremely worrisome condition called intensive care unit psychosis or delirium, which is known to extend the length of hospital stay and hence contribute to morbidity[11]. Effects of noise as a health hazard are not only seen in patients, but also in critical care staff. Topf and Dillon [12] found that critical care nurses are susceptible to noise-induced occupational stress.

In India, hospitals are categorized under silence zones and the recommended sound levels are 50 dBA during daytime and 40 dBA during the night in areas within 100 meters from a hospital [13].Noise studies in Indian hospitals [14-16] have found that noise levels in neonatal ICUs are well beyond those prescribed by WHO and EPA. Although many studies on the measurement and effects of noise in ICUs have been performed in India, few have been conducted in adult ICUs.

3. Materials and Methods

The present study was performed in the 16-beddedintensive care unitof S.L. Raheja Hospital (A Fortis Associate), Mumbai, India, over a period of 10 days. Nine stations were selected at various locations within the ICU (Table1) and the sound level at each station was monitored every hour during the day and at night. A sample of 2160 readings was collected. A layout of the ICU is shown in Fig. 1 where each of the 9 stations has been indicated using the corresponding numbers in Table 1.

Figure 1: Layout of ICU

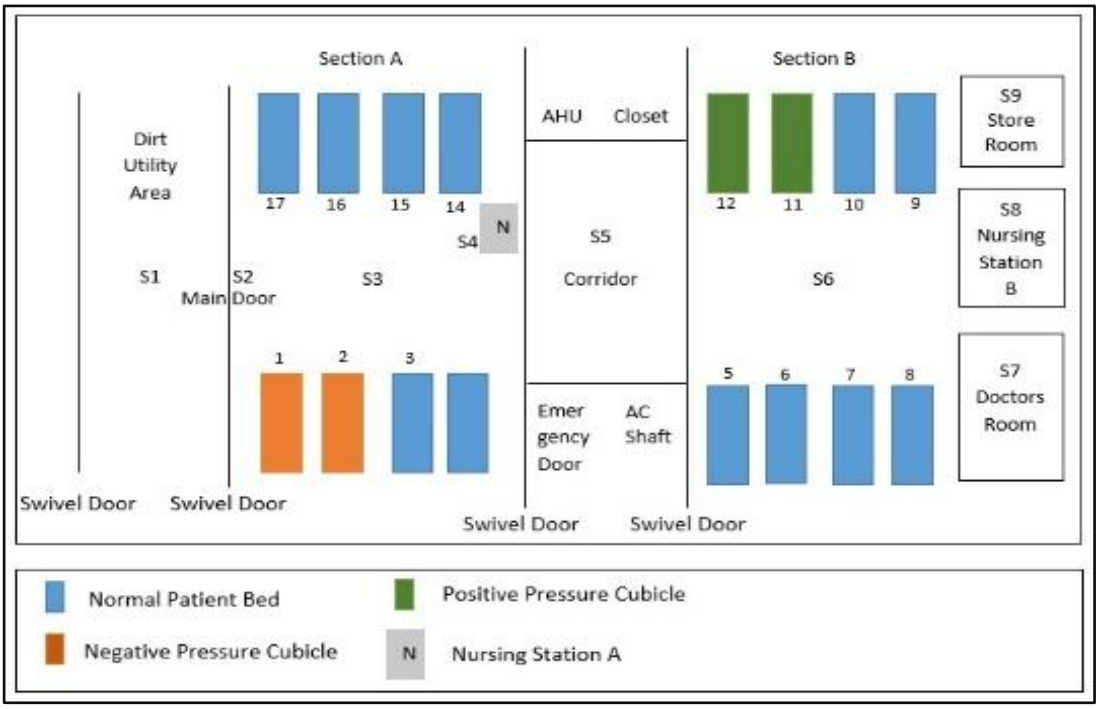


Table 1: List of Stations

Station No.	Station Name
1.	Dirt Utility Area
2.	Main Door
3.	Centre of Section A
4.	Nursing Station A
5.	Corridor
6.	Centre of Section B
7.	Doctors Room
8.	Nursing Station B
9.	Store Room

Sound levels were measured using a digital sound level meter (Model: SL4010) from Lutron placed at the corresponding station for 5 minutes at the start of every hour. One reading was noted per minute and the average of these 5 readings was reported as the reading for every hour.

The following sources of noise were chosen as the parameters for the study: staff talking, equipment alarms, doctor talking on mobile phone, miscellaneous, no noise and non-patient areas. Staff talking parameter included consultants, registrars, nurses and caregivers talking. Alarms included monitor, ventilator and infusion alarms.

Miscellaneous sources were identified as sounds due to opening/closing of doors, equipment cart and equipment handling, patient reacting or screaming and relatives talking. No noise implied that all staff and patients were present but there was no conversation/talking or alarms or any equipment handling, i.e., there was no sound from any person or equipment present at the station. Empty implied that the station was empty, i.e., no treatment is administered at the station and it is generally not meant to house patients or equipment, such as storage stations.

Table 2 lists the type of noise parameters considered in the study and the corresponding decibel values as per previous studies [17-19].

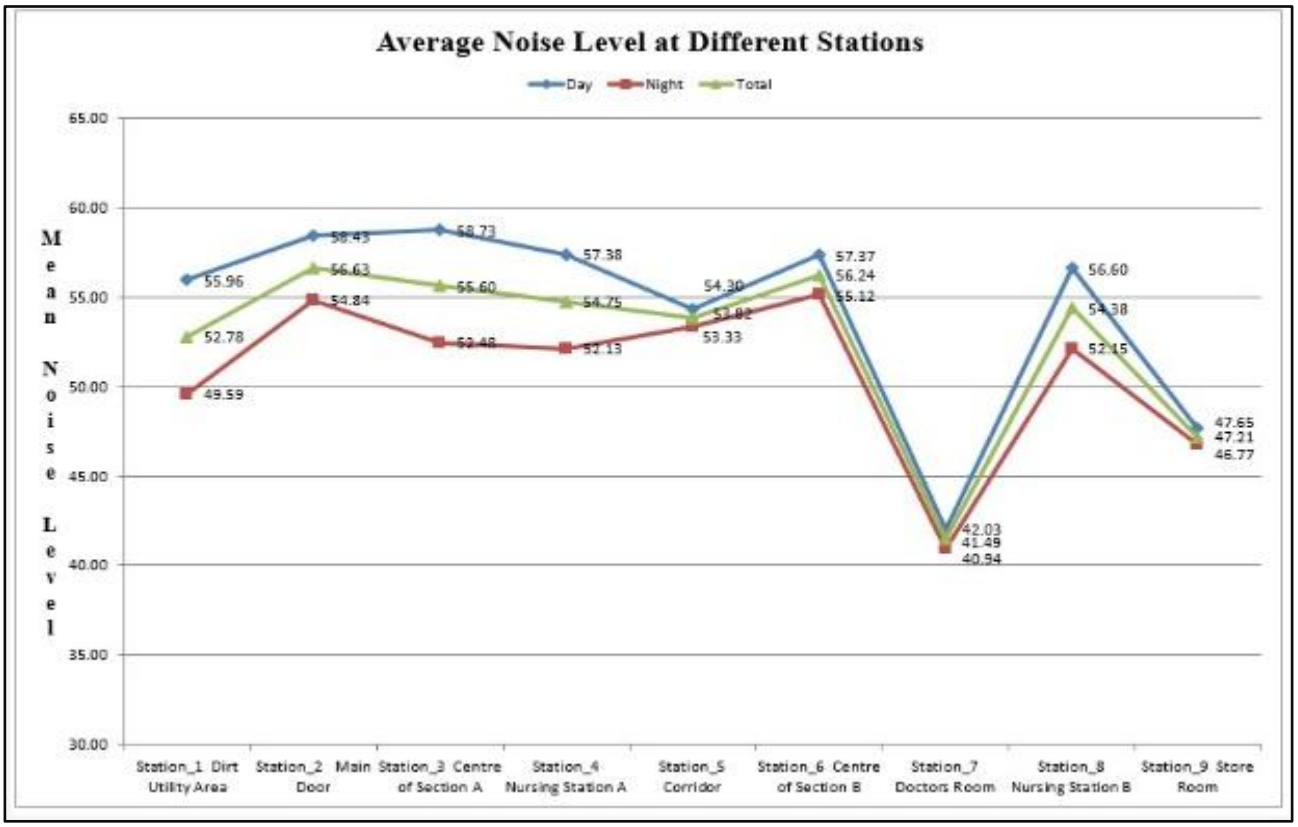
Table 2: Parameters of Noise Study and Corresponding Decibel Values

Parameter	Equivalent Decibels	Corresponding Sound in Non-ICU Environment
	0 dB	Threshold for normal human hearing
Staff Talking (Consultants, ICU registrars, nurses and caregivers talking)	60 dB	Television Air conditioner
Alarms (Monitor, ventilator and infusion alarms)	70 dB	Vacuum cleaner at 1 meter Shower Dishwasher
Doctor Talking on Phone	-	-
Miscellaneous (Door opening/closing, equipment handling, patient screaming and relatives talking)	80 – 90 dB	Alarm clock Motorcycle Circular saw at 1 meter
No Noise	-	-
Empty/No Patient	-	-

4. Results

From the sample of data collected using the method and device mentioned in the previous section, average values of the noise levels at each station were calculated during the day and night and an average of the combined readings of day and night (24 hours) was also calculated. These results are presented in Fig. 2.

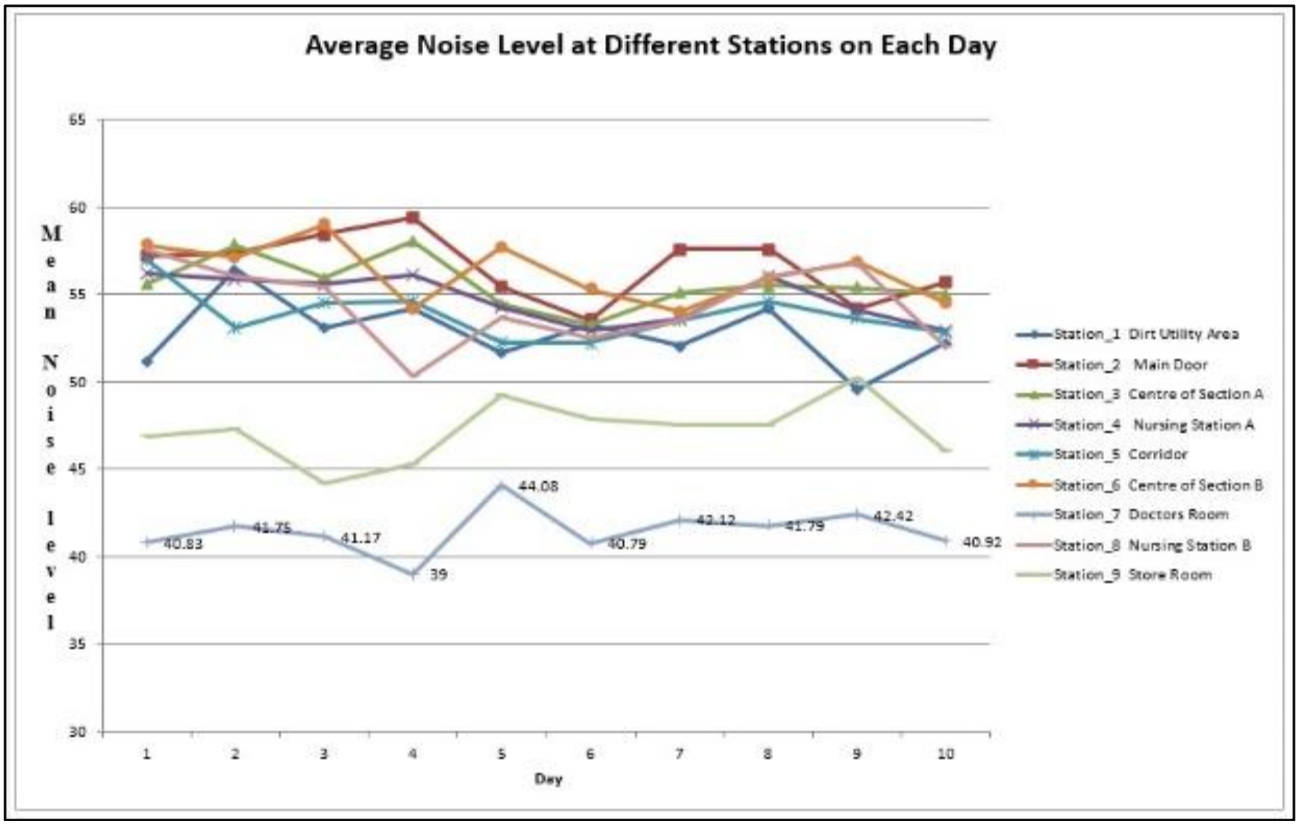
Figure 2: Station-wise Result of Average Sound Level Measurements



The mean sound level was found to be 52.54 dB with a variation of 4.55 dB. The highest sound level was recorded at Stations 1 (Main Door) and 3 (Centre of Section A). Average sound levels were found to be approximately 4 points higher during the day than at night at all stations except Stations 5 (Corridor), 7 (Doctors Room) and 9 (Store Room). The average sound level values closest to WHO guidelines were observed in Station 7 (Doctors Room), where no patient is monitored and hence there are no equipment. It was observed that sound levels were more or less constant where there were no patients and no treatment or care was given and at stations where visitors are not generally allowed (Stations 5, 7, 8). Moreover, where there were no patient beds and less staff movement, average sound levels were also found to be lower (Stations 7 and 9).

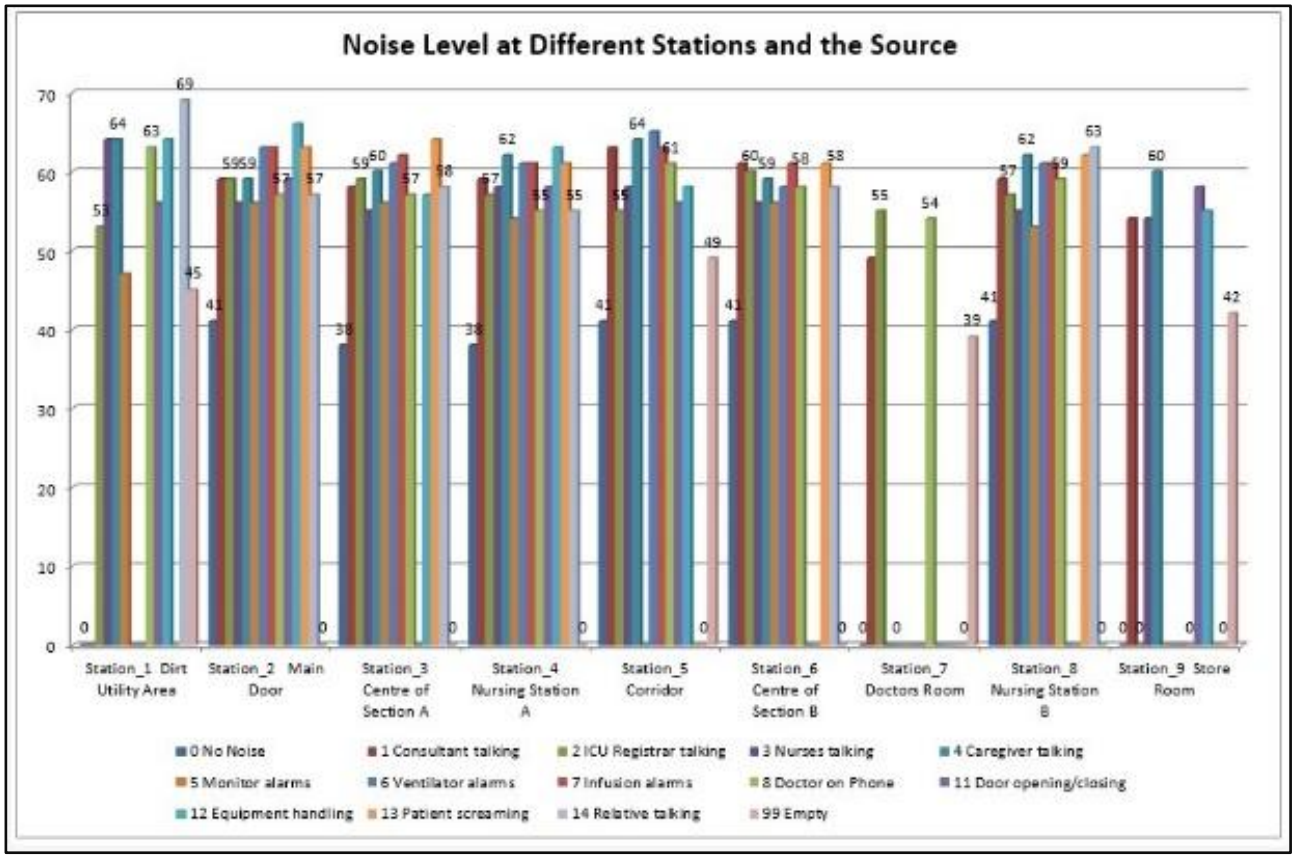
Figure 3 illustrates the day-wise average sound levels at different stations. On different days, average sound levels varied at all stations and identical average sound levels were not observed at any station on different days.

Figure 3: Day-wise Average Sound Levels



It was found that the major source of higher sound levels in the ICU (Fig. 4) was different persons talking. At all stations, it was noticed that caregivers like ward boys contributed most to the noise levels recorded at an average of 61 dB. Ventilator and infusion alarms also made up an average of 62 dB at all stations. Equipment handling and various other alarms also contributed to high average sound levels. At Station 1(Dirt Utility Area), which lies adjoining the main door (see Fig. 1),according to the data collected, maximum average noise levels (69dB) were recorded when relatives were talking. At 64 dB, nurses leaving or entering the ICU was the second highest contributor to noise levels at Station 1.Surprisingly, at Station 2(Main Door), high noise levels were recorded whenever the main door was opened and closed.

Figure 4: Parameter-wise Average Noise Levels at Different Stations



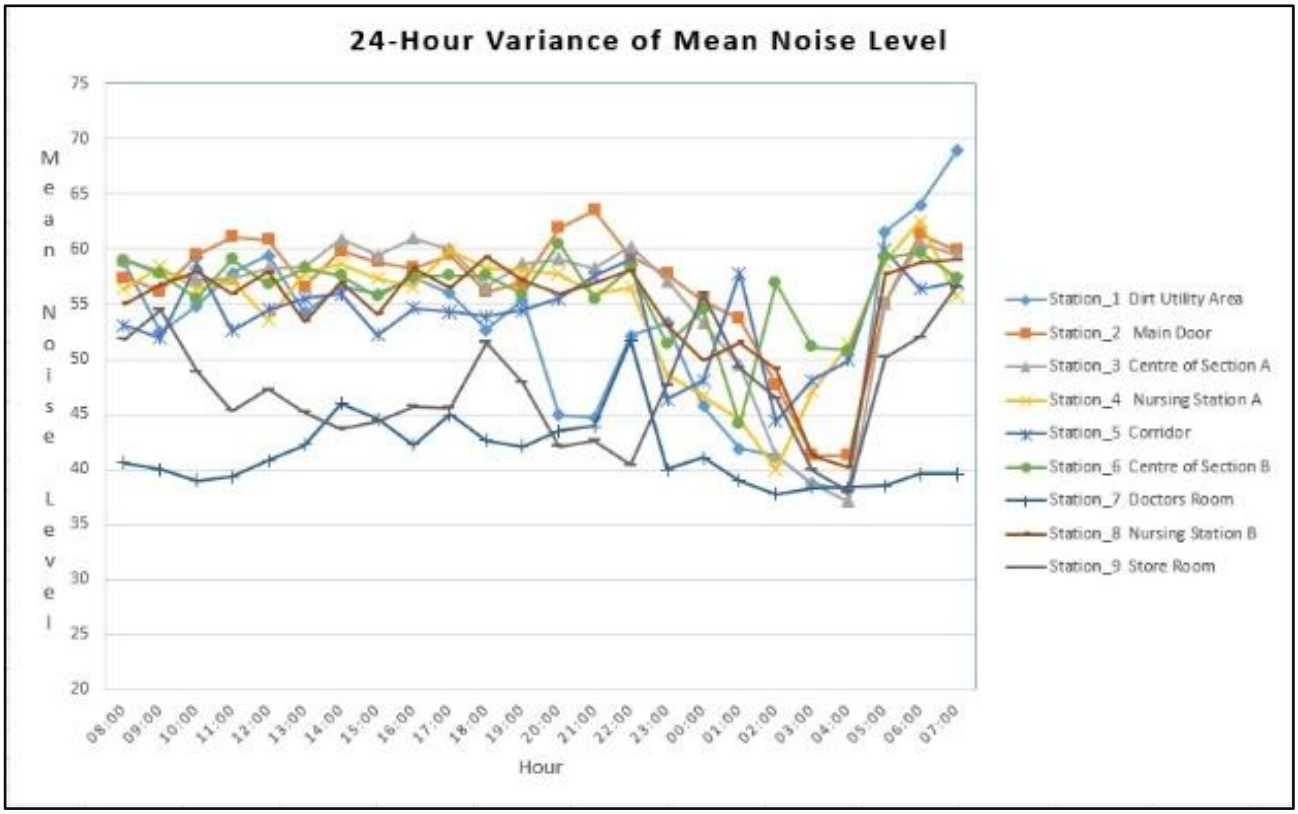
At Station 5 (Corridor), where there are no patients, average sound levels of 41 dB were recorded at times where no staff or relatives were present/passing through because it houses the AHU and AC shaft, which do generate noise. Also, the Corridor houses the emergency exit and closet, where staff activity was observed to generate noise levels of 55-64 dB. Noise due to alarms and equipment handling was also observed here because the doors to the corridor were opened and closed constantly due to staff and relatives' movement.

At stations where treatment and care is administered (Stations 3, 4, 6, 8), all parameters related to the treatment process were observed to have values over 50 dB. Even in the absence of any talking, alarms, or equipment handling, noise values at these stations were recorded to be greater than 35 dB.

Station 9 (Store Room) experienced sound levels above 50 dB due to conversation amongst staff and equipment handling.

A comparison of the mean noise levels at different stations over 24 hours (Fig. 5) for the period of this study shows that noise levels during the day are generally higher at all stations than those at night. Also, during shift change hours or during rounds, noise levels tended to be higher. The highest noise level in this set was recorded at Station 1 (Dirt Utility Area) at the time when the cleaning staff comes in for their daily chores. Section A seems to be noisier during the day than Section B; however, Section B seems to be noisier than Section A during the night according to the data collected for this study.

Figure 5: Station-wise Variation of Noise Level over 24 Hours



5. Discussion

On commencement of this study, it was the authors' general perception that consultants talking would be the cause of most of the noise in the ICU. It was also presumed that Monday would be the noisiest day of the week since it is the day when most patients are shifted from the operation theatre to the ICU, from the emergency room to the ICU (as per the footfalls of the ER and ICU) and from the ICU to the ward (as patients are generally kept in the ICU over the weekend).

It was noted that the results revealed that the major contributing source to high noise levels in the ICU was spurious conversations among caregivers and cleaning staff who tended to speak in loud voices while doing their daily chores. It was also noted that the ICU nursing staff contributed significantly to the level of noise at the main door during shift changes (at the start and end of shifts). The study also revealed that opening and closing of doors also had a significant contribution to the noise levels in the ICU.

Notwithstanding the above-mentioned additional causes of noise in the ICU, the results of the present study were found to be congruous with those of previous studies: in a practical case, the actual noise levels in an ICU are much higher than the recommended levels [20]. Similarly, several studies have shown that noise levels in the ICU are often greater than the levels recommended by AmericanConference of Governmental Industrial Hygienists (ACGIH).

Moreover, Kahn et al revealed that 51% of the noise in the ICU was modifiable [21]. In the present study, it was found that 64% of the noise in the ICU was modifiable. This includes noise caused by consultants, ICU registrars, nurses, caregivers and relatives talking; infusion, ventilator and monitor alarms and doctors talking on phone.

6. Conclusion

In 1859, Florence Nightingale commented that "Unnecessary noise, then, is the most cruel absence of care which can be inflicted either on sick or well" [22]. Knowing that our ICUs are becoming noisier, it is important to ensure that patients get the treatment, care and peace they need for speedy recovery and good mental health. The statistics obtained in this study demonstrate that sound levels in an adult ICU are well above the levels prescribed by WHO and EPA.

As observed in this study, one of the major causes of noise in the ICU is equipment handling and alarms. Speech or talking is also a major noise generating factor. Although it is evident that these sources cannot be eliminated in an ICU environment, protocols may help tame or restrict the sound levels to provide overall lower average sound levels.

In a practical working environment, it seems that sound values will remain above the guideline values because hospitals cannot do away with staff or equipment, which are major contributors to the high sound levels.

This study will form the basis for proposing protocols for noise reduction in the ICU to address the causes of modifiable noise. The effectiveness of the proposed protocols will be the subject of future studies to observe whether noise reduction in the ICU is possible by implementing protocols. Future studies will also observe whether new sources of noise are found.

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