ASSSESSMENT OF AMBIENT NOISE LEVELS IN THE INTENSIVE CARE UNIT OF A UNIVERSITY HOSPITAL

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Background: Noise is recognized as a source of hazard to the patient's environment. Studies have also shown that it has a direct impact on mortality and morbidity as a result of sleep deprivation which affects the immunity of critically ill patients.

Objectives: The aim of this study was to measure levels of environmental noise in a six-bed, open-plan general medical intensive care unit (MICU).

Methods: Levels of exposure to environmental noise were assessed in the intensive care unit of King Fahad Hospital of the University (KFHU) where measurements of environmental noise were taken using calibrated sound level meter during shifts of working days and weekends.

Results: Statistical analysis revealed that there were no significant differences between noise levels in the morning, evening and night shifts of working days and weekends in the ICU of KFHU (p value =0.155, 0.53 and 0.711 respectively). There was no significant difference between overall level of exposure to noise in the working days and weekends as well (p-value=0.71). However, the assessed levels of exposures to noise were still higher than stipulated international standards.

Conclusion: Some sources of environmental noise, such as the use of oxygen, suction equipment or respirators are unavoidable. Nevertheless, hospital ICUs should have measures to minimize the level of exposure to noise in the ICU.

Further research in this area might focus on the noise level and other modifiable environmental stress factors in the ICU that affect patients as well as the staff.

Key Words: Noise, Intensive Care Unit, decibel, alarm, sleep.

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INTRODUCTION
The control of exposure to environmental noise in the hospital is becoming a serious issue, particularly in areas where quiet is necessary. The World Health Organization (WHO) recommends that noise levels in the hospital environment should not exceed 35 decibels (dB) during the night and 40 (dB) during the day. However, the American Conference of Governmental Industrial hygienist (ACGIH) stipulate that noise levels in the workplace should not go beyond 85 dB.

Intensive Care Units (ICUs) have complex biomedical equipment for the continuous monitoring of patients who have serious physical conditions, to support their vital functions. This equipment is used by health professionals to give specialized treatment and care. In some earlier studies, researchers showed that noise levels in ICUs ranged from 59-83 dB which exceeds the level recommended by World Health Organization (WHO) and which can stimulate the cardiovascular and endocrine systems and disrupt sleep as result of noise induced stress modulation. It is important to note that exposure to excessive noise levels in the ICU is a contributing factor in the development of the condition known as ‘ICUs delirium’ characterized by delusions, hallucinations, disorientation, sleep deprivation and paranoia.

As for effects on critical care staff, studies have shown that prolonged exposure to excessive noise levels has a deleterious effect on the performance of cognitive tasks and altruistic behavior.

Yet, the source of noise pollution in the ICUs is multifactorial because of close proximity care and the array of medical instrumentation attached to patients to monitor their progress throughout their stay in ICUs. Balogh et al (1993) suggested that the majority of noise created in their ICUs was created by mechanical alarms. The aim of present study was to assess the exposure level of environmental noise in a six-bed, open-plan general medical ICU.

MATERIAL AND METHODS

Sample and Setting
The study area was a six-bed general medical ICU (MICU) in KFHU.

Data Collection
Levels of exposure of environmental noise were measured out during working days (Saturday, Tuesday and Wednesday) and Weekends (Thursday and Friday). Sound levels were measured throughout the shift in dB using a sound level meter. For the most accurate estimate of what a patient would hear, the sound meter was placed in where a patient's head would be while lying in bed.

To provide distinct data on noise levels within this clinical area, the calibrated sound level meter providing a direct reading of sound over the ranges of 22 –140 dB with an accuracy of less than ±1 dB over temperature ranges 0–50°C (SLM, Model TES 1352A) was used to assess the noise level in ICU.

Statistical Analysis
Paired t-tests were used to compare noise data in different working shifts in the six-bed medical ICU (MICU) locations. Statistical calculations were performed using Statistical Package for Social Sciences (SPSS).

RESULTS
Paired t-tests of significance were used to compare noise data in different shifts in the six-bed ICU locations. Table 1 shows the comparison of mean noise levels (dB) between different shifts (morning, evening and night) of working days and weekends in the Intensive Care Unit (ICU) of KFHU. There were no significant differences between noise levels in the morning, evening and night shifts of the working days and the weekends in the ICU with p value = 0.155, 0.53 and 0.711 respectively.

| Shift   | Working days noise (dB) | Weekends noise (dB) | p-value |
|---------|-------------------------|---------------------|---------|
| Morning | 57.2 ± 1.6              | 59.7 ± 5.0          | 0.155   |
| Evening | 62.1 ± 5.4              | 60.6 ± 5.0          | 0.53    |
| Night   | 60.2 ± 9.8              | 58.8 ± 6.0          | 0.711   |

Table 1: Comparison of mean noise levels (dB) in different ICU shifts for the working days and weekends

Table 2 shows a comparison of overall levels of exposure to noise between working days and weekends. There are no significant differences in the overall noise levels between working days and the weekends (p-value=0.71).

Table 2: Overall levels of exposure to noise between working days and weekends

| Overall working days Mean ± SD | Overall weekends Mean ± SD | p-value |
|--------------------------------|----------------------------|---------|
| 60.4 ± 7.1                     | 59.2 ± 5.3                 | 0.71    |
Ambient Noise Levels in ICU

**Figure 1:** Distribution of noise levels in ICU on working days

**Figure 2:** Distribution of noise levels in ICU at the weekend

**Figure 3:** Distribution of overall exposure levels of noise during the working week and at weekends
Figure 1 shows the exposure levels of noise in the working days in the ICU of KFHU. The lowest level of exposure was found in the night shift of Wednesday. The highest noise level was found in the morning shift of Wednesday.

Figure 2 shows a distribution of levels of exposure to noise at weekends. The highest levels of exposure were on Thursday in the evening shift and the lowest level was in the night shift of Thursday.

Figure 3 shows the distribution of overall exposure levels of noise during the week and at weekends. The overall noise exposure levels on working days were higher than overall noise levels at the weekend but the differences were not statistically significant.

DISCUSSION
The literature indicates that Medical Intensive Care Unit (MICU) appears to be the central area within the hospital where studies on noise level are primarily undertaken. Nursing staff in the ICU tend to attribute noise levels to mechanical instrumentation; such as, ventilators, syringe drivers, and cardiac monitors. However, the average noise level (52 dB) in a six-bed ICU was found to be the result of staff conversation (55%).

Likewise, another study found that the average noise level of 50 dB was the result of the patient and staff conversations. The results of the present study revealed that the mean level exposure to noise in the ICU is 60.4±7.1 dB measured on three working days and 59.2±5.3 at weekends. Although, the noise level was high in comparison with the WHO standards there was no significant difference between the level of noise in the different shifts and at the weekends. The results revealed that the level of environmental noise in the ICU rose steadily to 58.0 to 54.0 dB during the day and night respectively. It was noted that the level of noise never fell below 54 dB throughout the shifts. However, it was difficult to differentiate intensity at source since the noises emanated from a variety of sources and the high levels of noise occurred simultaneously.

Our studies are in accord with several studies that have shown that noise in the ICU was often greater than what has been recommended by ACGIH. Recent studies revealed an average sound level of 66 dB and a similar study reported values between 60 and 65 dB in a four-bed ICU with noise levels rising above 65 dB during teaching.

Multiple factors may contribute to sleep disruption of hospitalized patients. These include underlying illnesses, uncomfortable therapeutic or monitoring interventions, mechanical ventilation and environmental factors including light or noise.

In our study, internationally recommended levels are exceeded by approximately 20 dB, both during the day and at night. Even though it is generally claimed that smaller hospitals are less noisy, our findings were equal to those in the ICUs of large hospitals.

The particularly high noise levels registered during the evening and in the night shift correlated to such factors as full bed occupancy, severity of patients’ conditions and inadequate administrative supervision. Under these circumstances, staff failed to work or speak quietly.

Constant exposure to noise levels of >85 dB for eight hours or more has been shown to endanger. The present study revealed that environmental noise in whole shifts is lower than the recommended international value. From our findings, acoustical damage in our setting is unlikely. The small number of beds and patients, the severity of illness of the patients might be the reason for the elevation of the noise levels in the ICUs.

A study by Kahn et al, which examined noise in the Medical ICU and Respiratory ICU, indicated that 51% of the noise that occurred in the ICU was modifiable. In our study, we identified numerous sources of noise that could be easily modified. These included the slamming of doors and drawers and discussion among attending physicians, staff, and medical students.

Further research in this area might focus on the other modifiable environmental factors in the ICUs that contribute to stress such as type of lighting and distribution and air quality.

CONCLUSION
In conclusion, we observed that some sources of noise in MICU in KFHU, such as the use of oxygen, suction equipment or respirators, are inevitable. Nevertheless, the pitch of some alarms could be lowered, especially at night or replaced by a visual system of colored lights. It is recommended that the noise levels in the ICU be reduced and certain designs suggested to reduce the exposure of patients to noise.
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