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Noise in the intensive care unit: quantification and perception by healthcare professionals

Ruídos na unidade de terapia intensiva: quantificação e percepção dos profissionais de saúde

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ABSTRACT

Objective: The several multidisciplinary team personnel and device alarms make intensive care units noisy environments. This study aimed to measure the noise level of a medical-surgical intensive care unit in Recife, Brazil, and to assess the noise perception by the unit's healthcare professionals.

Methods: A decibel meter was used for continuous every five seconds one week noise levels recording. After this measurement, an interview shaped noise perception questionnaire was applied to the healthcare professionals, approaching the discomfort level and noise control possibilities.

Results: Mean 58.21 ± 5.93 dB noise was recorded. The morning noise level was higher than at night (60.85 ± 4.90 versus 55.60 ± 5.98 , p

<0.001), as well as work-days versus weekend (58.77 ± 6.05 versus 56.83 ± 5.90 , p <0.001). The evening staff shift change noise was louder than by daytime change (62.31 ± 4.70 versus 61.35 ± 5.08 dB; p < 0.001). Of the 73 questionnaire respondents, 97.3% believe that the intensive care unit has moderate or intense noise levels; 50.7% consider the noise harmful; and 98.6% believe that noise levels can be reduced.

Conclusion: The measured noise levels were above the recommended. Preventive and educational programs approaching the importance of noise levels reduction should be encouraged in intensive care units.

Keywords: Intensive care units; Noise; Noise levels; Humanization of assistance; Monitoring; Outcome assessment (Healthcare)

INTRODUCTION

Intensive care unit (ICU) environmental work issues parallel with the advance in severely ill patients' care. Modern monitoring and life-support devices, and multidisciplinary teams involving several professionals, make ICUs noisy environments, causing discomfort for both patients and healthcare professionals.⁽¹⁻³⁾

According to Aurelio,⁽⁴⁾ noise may be described as a mixture of sounds and frequencies not pertaining to any precise law, and diverging by values which are imperceptible to the human ear, or also as any sound causing unexpected and unpleasant effects.

Regarding noise levels, a safe 55 dB (decibels) threshold was es-

established for the workers, and ear protection above these values.^(5,6) The Associação Brasileira de Normas Técnicas (ABNT) [Brazilian technical rules association] establishes by 45 and 35 dB the allowed day and night time noise levels, respectively.⁽⁷⁻⁹⁾ The World Health Organization (WHO) recommends mean 30 dB by night, and 40 dB during day.^(10,11)

Devices are one of the major ICU noise causes. These have sound alarms to alert the multiprofessional team on patients' parameters or malfunctioning. The most common examples of noisy devices are aspirators, oxymeters, mechanical ventilators, oxygen and compressed air sources, printers and phones.^(1,2,12-16) Another relevant cause of noise is team professionals and other non-ICU personnel conversation.^(5,17)

Intensive care environment studies have shown that high noise levels interfere with communication, leads to attention loss, irritability, fatigue, headache, muscle contractures, increased heart rate and blood pressure, in addition to worsened quality of sleep both in the healthcare professionals' team and patients.^(1,2,9,14,18-21)

Considering the lack studies on noise levels monitoring and ICU patients and professional harm, this study aimed to measure noise levels in an intensive care unit and its healthcare professionals' perception.

METHODS

This was a transversal study conducted in a private network reference tertiary hospital in Recife – PE, Brazil, during May 2010 after approved by the Ethics Committee of Fundação Altino Ventura, protocol #004/2010. All professionals who responded the questionnaire had their doubts clarified and signed an Informed Consent Form (ICF) for study participation.

For noise analysis, an ICEL® DL-4200 (Brazil, Manaus) decibel meter configured for short time response was used, measuring the sound pressure level (NPS) and the ponderation A, mostly used for measuring environmental noise, simulating the human ear response curve. The measuring range was adjusted from 30 to 130 dB.

The device was tripod mounted about one meter above the floor, over a table, close to the nursing station, without previous professionals information. The device remained in place for one

entire week, 24 hours daily, recording every five seconds measurements.

Data collection

During the recording week, at 24 hours intervals the device was connected to a computer with the Sound Level Meter software (provided with the device), that stored and read the data specifics. When the collection was complete, the data were transferred to a Microsoft Office Excel sheet, for analysis.

Some interest periods were considered in the analysis: the day shift (7:00 a.m. to 7:00 p.m.), versus night shift (7:00 p.m. to 7:00 a.m.); work days (Monday to Friday) were compared to weekend days (Saturday and Sunday); staff shift changes (7:00 a.m. – morning; 7:00 p.m. – evening); family visit times (11:00 to 12:00 a.m. – morning; 3:00 to 4:00 p.m. – afternoon; and 8:00 to 9:00 p.m. – evening).

After the recording time, an interview-shaped adapted questionnaire⁽⁴⁾ was applied to the unit's professionals, involving questions on noise perception and perceived harms. Also it was directly questioned their beliefs regarding the noise reduction possibility. The questionnaire was always applied by the same previously trained investigator, in order to minimize interference with the responses.

Statistical analysis

The variables were analyzed using the SPSS 13.0 for Windows and Excel 2003 softwares. All tests considered a 95% confidence interval. The normality Kolmogorov-Smirnov test, the Student's T test for pairwise groups comparison and more than two groups variance analysis (ANOVA) were used, followed by the Tukey's test.

RESULTS

A total of 119,960 measurements were recorded during the entire week, and the period's beds occupation rate was 79%, 15 beds. The total number of regular ICU professionals averaged 15 per shift. During the family visiting times, the number of other than ICU personnel people ranged from 8 to 15 people.

Mean day time noise was significantly louder than night time. Regarding staff shift changes, evening shift had the louder noise, while work

days had louder noise levels versus weekend days. For the family visiting times, the louder noise level was by the afternoon (Table 1).

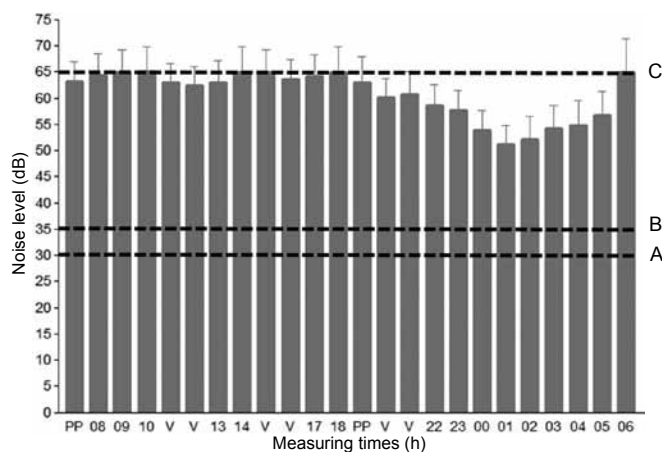
Figure 1 presents the noise level for one entire recording day, comparing the hourly values with the day and night time recommended values, and the maximal ABNT recommended value. Values above the recommended were found, sometimes close to the acceptable.

Were interviewed 73 volunteers, 32 male and 41 female, mean age 32 ± 4.8 years, including physicians (20.5%), physiotherapists (17.8%), nurses (12.3%) and nursing technicians (49.3%). These professionals' noise level perception is shown in

Table 1- Noise level recorded by shift, week time, staff shift change time and visiting time

| Variables | Result | p value |
|---------------------------|--------------|-----------|
| Shift | | |
| Day | 60.86 ± 4.90 | < 0.001* |
| Night | 55.60 ± 5.98 | |
| Week time | | |
| Work days | 58.77 ± 6.05 | < 0.001* |
| Weekend | 56.83 ± 5.90 | |
| Staff shift change | | |
| Day | 61.35 ± 5.08 | < 0.001* |
| Night | 62.31 ± 4.70 | |
| Visiting time | | |
| Morning | 60.50 ± 4.59 | |
| Afternoon | 62.04 ± 4.48 | < 0.001** |
| Night | 60.05 ± 4.27 | |

Results expressed as mean ± standard deviation.*Student's T test; **One-way ANOVA test and Tukey's post-test (comparing the afternoon versus morning and night visiting times).



A – ABNT [Associação Brasileira de Normas Técnicas] recommended night shift noise level; B – ABNT [Associação Brasileira de Normas Técnicas] recommended day shift noise level; C – acceptable noise level according to the Regulation Rule (NR) – 17; PP – staff shift change; V – family visiting.

Figure 1 – Hourly measured noise level in a week day, versus normal Associação Brasileira de Normas Técnicas proposed values, emphasizing the day (7:00 a.m.) and night (7:00 p.m.) time staff shift change, and family visiting times 11:00 to 12:00 a.m., 3:00 to 4:00 p.m. and 8:00 to 9:00 p.m.

table 2. It can be seen that 97.3% of the respondents perceive ICU as a moderate to intense noisy environment, 50.7% consider that are harmed by the noise, and 98.6% believe that it is possible reducing the noise levels.

DISCUSSION

Noise may disrupt human work, communication, rest and sleep, and additionally harm or trig-

Table 2 – Noise perception and impact for intensive care unit professionals

| Variables | Physicians | Nurses | Physiotherapists | Nursing technicians | All |
|--------------------------------------|------------|----------|------------------|---------------------|-----------|
| Noise level | | | | | |
| Low | 0 (0) | 0 (0) | 1 (7.7) | 1 (2.8) | 2 (2.7) |
| Moderate/Intense | 15 (100) | 9 (100) | 12 (92.3) | 35 (97.2) | 71 (97.3) |
| Troubled by the noise | | | | | |
| Yes | 7 (46.7) | 6 (66.7) | 6 (46.2) | 18 (50) | 37 (50.7) |
| No | 8 (53.3) | 3 (33.3) | 7 (53.8) | 18 (50) | 36 (49.3) |
| Believes noise may be reduced | | | | | |
| Yes | 15 (100) | 9 (100) | 13 (100) | 34 (94.5) | 71 (97.3) |
| No | 0 (0) | 0 (0) | 0 (0) | 2 (5.5) | 2 (2.7) |

Values expressed as absolute (n) and percent (%) numbers.

ger physiological, psychological or even pathological reactions in susceptible persons.^(1,2) The noise levels found in this investigation were above the allowed by Brazilian rules⁽¹¹⁾ and the professionals working in this environment perceived it as noisy.

The WHO recommends maximal hospital noise to be around 55 dB. The maximal human ear tolerance is below 80 dB, which in turn is below a noisy avenue level (100 dB), a vuvuzela horn sound (120 dB) or a jet engine noise (140 dB).⁽²²⁾

Previous studies have shown that increased noise levels are associated with reduced quality of sleep, leading to its fragmentation and reduced REM (rapid eye movements) phases, which may lead to vital functions (including some hormones production) disorders and clinical recovery delay.^(19-21,23,24)

The last years' technological advance improved the critically ill patient's care, however the increasing number of sound alarm devices, added to professionals conversation, make ICU a stressful noisy place.^(1,2,24-27)

Long term noise exposure may induce noise-induced hearing loss (NIHL), defined as a progressive and permanent disease. The longer noise exposure, the higher hearing loss risk.^(3,5,11,28)

For Cordeiro et al.⁽¹⁷⁾ the specialized literature shows that professionals exposed to severe occupational noise had three to four fold increased risk of work accidents versus non-exposed professionals. A top occupational exposure limit, considered able to protect workers from hearing loss, is 85 dB for 8 hours exposure.^(5,11,18) This level was not reached during our recording time.

For the different hospital environments, ABNT recommends 35 dB for the night time and 45 dB for the day time as acceptable noise levels.^(7,8) All of our recorded values were within this range. From 55 dB on, WHO recommends hear protection devices use. However, the Brazilian Work Ministry regulation #17⁽²⁹⁾ recommends the maximal acceptable noise level as 65 dB. Our study found levels above this; however this was for short times.

Mean noise level during our study was 58.21 ± 5.93 dB. Similar values were found in Austrian (60 to 65 dB),⁽³⁰⁾ Spanish (55 dB),⁽³¹⁾ Italian (56.9 to 61.2 dB)⁽¹⁴⁾ and Greek (60.3 to 67.4 dB)⁽³²⁾ hospitals, evidencing that noise pollution is not just a local issue, involving several countries and cultures.

Pereira et al.⁽¹⁾ found in a general ICU a noise

level of 65.36 dB, and that the night shift noise was lower than the day shift's level. Torres et al.⁽⁵⁾ found day and night time ICU noise levels of 72.25 dB and 65 dB, respectively. Otenio et al.,⁽²⁾ using twelve hours mean 1 minute hourly measurements from 7:00 a.m. to 7:00 p.m., found mean 62.7 dB noise, ranging between 58 and 65 dB. In our study, mean day time noise was 60.86 dB, and night time 55.60 dB, explained by less professionals being in the ICU main room due to rest periods.

So far, no study was found analyzing work days' versus weekend days' noise. Work days were shown in this trial to be more noisy (55.77 ± 6.05 versus 56.83 ± 5.90 dB; $p < 0.001$), although this difference was not clinically significant. A possible explanation is that this hospital has a more intensive work days' routine, involving external professionals' visits and an increased people flow.

Although the difference between the evening and morning staff shift change (63.31 versus 61.35 dB, respectively) does not have a clinically relevant difference, the divergence between the measured levels would recommend attention for this time noise prevention. The increased number of professionals during the morning change is believed to contribute for this, while many patients are still awaking and the regular ICU routine is to start; by the night shift change, many patients are still receiving their hygiene care and being prepared to receive their family visiting.

Regarding the professionals' noise perception questionnaire, only 2.7% of the respondents said considering the ICU environment not noisy, while 97.3% considered the noise to be moderate or intense. However, although professionals perceive the environment to be noisy, only 50.7% of them believe that this can be harmful to their health. It should be highlighted that 98.6% of the respondents believe that noise reducing measures can be implemented.

This study only evaluated the noise level plus professionals' perception in one general hospital ICU. The comparison between different ICUs, having with different physical aspects, human resources and assistance profiles noise levels may provide results that can establish the factors influencing noise, identifying targets for attenuation measures.

No concomitantly evaluating ICU noise levels and professionals' perceptions previous stud-

ies were found. This study results underline the negative impact excessive noise may have on both professionals and patients, and stimulate managers to seek attenuating measures.

CONCLUSION

This study identified considerably above the recommended ICU noise levels. Most of the healthcare professionals considered these as moderate or intense.

RESUMO

Objetivo: Em uma unidade de terapia intensiva, a circulação de pessoas da equipe multidisciplinar e o número considerável de equipamentos e alarmes sonoros deixam o ambiente ruidoso. O objetivo desta pesquisa foi mensurar os níveis de ruídos de uma unidade de terapia intensiva da cidade de Recife e avaliar sua percepção pelos profissionais da unidade.

Métodos: Durante uma semana, 24 horas por dia, foi utilizado um decibelímetro para realizar mensurações a cada cinco segundos. Após as aferições, foi aplicado um

questionário aos profissionais sobre sua percepção e incômodo causados pelo ruído, e se eles achavam possível reduzir o barulho.

Resultados: A média de ruído verificada foi de $58,21 \pm 5,93$ dB. O período diurno apresentou maiores níveis de ruídos que o noturno ($60,86 \pm 4,90$ vs $55,60 \pm 5,98$ dB; $p < 0,001$), assim como os dias úteis quando comparados ao final de semana ($58,77 \pm 6,05$ vs $56,83 \pm 5,90$ dB; $p < 0,001$) e a passagem de plantão noturna quando comparada a diurna ($62,31 \pm 4,70$ vs $61,35 \pm 5,08$ dB; $p < 0,001$). Dos 73 profissionais que responderam o questionário, 97,3% acham que a unidade de terapia intensiva tem ruído de moderado a intenso, 50,7% se sentem prejudicados pelo barulho e 98,6% acham que é possível reduzir o nível de ruídos.

Conclusão: Os níveis de ruídos encontrados estavam acima dos recomendados. Programas preventivos e educativos conscientizando da importância da redução do nível de ruído devem ser estimulados, envolvendo todos os profissionais que compõem a equipe da unidade de terapia intensiva.

Descritores: Unidades de terapia intensiva; Ruídos; Controle de ruído; Humanização da assistência hospitalar; Monitorização; Avaliação de resultados (Cuidados de saúde)

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