SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

The objective of this study was to determine the overnight amplitude and peak occurrences of sound in patient rooms of an MICU and investigate the relation of these sound levels with patient characteristics.

Comparing average levels and peak occurrence of overnight sound in the medical intensive care unit on A-weighted and C-weighted decibel scales

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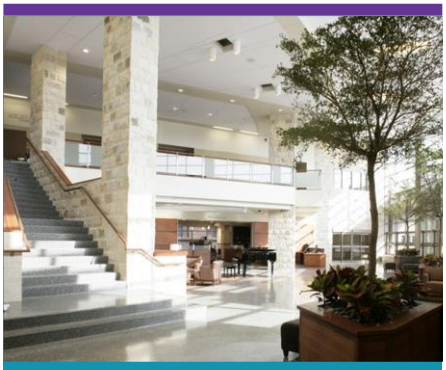
Key Concepts/Context

The loss of sleep, poor quality of sleep, and circadian misalignment experienced by patients in intensive care units (ICUs) are attributed to a multitude of factors – physiological, psychological, and environmental. ICUs are characterized by loud noises that disrupt a patient's ability to sleep. Authors cite studies that show that average ICU sounds are between 55 and 65dBA, much higher than the 30-40dBA recommendation for hospitals by the World Health Organization (WHO). In this study the authors aim to document overnight sound levels in a medical intensive care unit (MICU) of a tertiary-care hospital and to investigate possible associations between sound levels and patient characteristics. The study concluded that sound levels in an MICU are high throughout the night, that low-frequency sounds are a major source of MICU sounds, and that sound levels and peak occurrences are not associated with patient clinical characteristics.

Methods

This was a prospective observational study that took place in the MICU of a 1000-bed tertiary hospital built in 2009. The MICU was rectangular in shape, with patient rooms on all four sides with workstations, conference rooms, and supply closets in the center and no central nursing station. The wall (of each patient room) facing the hallway had a curtain and a clear glass sliding door. The rooms selected for the study were those not close to the main entrance (to avoid loud noise resulting from high staff and equipment traffic) or in the corners (low noise because of low traffic). The sample for the study included English-speaking patients over 18 years of age admitted to the MICU 48 hours before the next sound recording. Excluded patients were those expected to die in 24 hours, receiving comfort care only, expected to be transferred from MICU before the end of sound recording period, and those



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undergoing therapeutic hypothermia. Patient data pertaining to contact precautions, mechanical ventilation, vasopressor use, presence of delirium, and severity of illness were sourced from respective Electronic Medical Records. Two sound meters were set up in each selected room to gather sound data. The meters were placed adjacent to the foot of the patient's bed – the centralmost location in the room. Sound level equivalent or Leq was recorded every 10 seconds either on an A- or a C- weighted scale all through the night from 8 p.m. to 8 a.m. the next morning. Data were statistically analyzed using SAS software V9.3 (SAS Institute, Cary, NC). Mean Leq was calculated for the total overnight time from 8 p.m. till 8 a.m. the next morning; from 8 p.m. till 11:59 p.m., from 12 a.m. till 3:59 a.m., and from 4 a.m. till 8 a.m. Average sound extremes were also calculated. The following criteria were set to identify sound peaks – absolute A-weighted sound level > 60dBA or absolute C-weighted sound level > 70dBC; and, relative sound level >10dB above local mean sound level (A- or C- weighted).

Findings

Of a total of potential 266 patients, 59 were included in the study (mean age was 63 years, 31% were male; 13% were non-white). The reason for MICU admission included sepsis (30.5%), respiratory failure (28.8%), gastrointestinal bleed (10.2%), liver disease (3.4%), pulmonary embolism (3.4%), and heart failure (1.7%). Their mean length of stay in the MICU was five days. Severity of illness was determined by mean APACHE II score, which was 19.4. 35.6% of patients were mechanically ventilated and 39% had delirium.

Mean sound level equivalents (Leq) were 53.5dBA and 63.1dBC – these did not vary significantly across any of the time periods. The mean sound extremes were 80.0dBA and 84.9dBC (maxima) and 46.5dBA and 57.5dBC (minima). The C-weighted mean of minimal sound was 10dB higher than its A-weighted mean for all time periods. This was statistically significant ($p<0.0001$), suggesting that the MICU has a high level of constant low-frequency sounds. The sources of low frequency sounds in the MICU were identified to be the air handling systems, climate control mechanisms, mechanical ventilation machinery, and the humming sounds of mobile computer workstations, medical beds, and televisions.

Sound peaks occurred frequently throughout the overnight period. For the A-weighted sound measures a median of 23.3 absolute peaks and 5.6 relative peaks were recorded per hour in the overnight period. For the C-weighted sound measures a median of 7.9 absolute peaks and 1.8 relative peaks were recorded per hour in the overnight period. For both A- and C-weighted measures, there were no significant differences in either peak during different the time periods and there was a decrease in absolute peaks in the middle of the night. The differences in the numbers of A- and C- weighted peaks, were found to be statistically significant ($p<0.0001$).

On plotting the raw A-weighted sound levels to observe sound patterns, the authors found that Leq does not satisfactorily depict the variations of sound levels. There was a negative correlation between Leq and relative sound peaks (Correlation Coefficient = -0.186 and R^2=0.0345).

There was no association found between either A- or C- weighted measures of overnight sound level equivalents and patient characteristics of severity of illness, delirium, use of vasopressor, mechanical ventilation, and need for contact precautions.

Limitations

Authors identified their study to have several limitations:

1. Data was collected on a small sample of only 59 patients.
2. Data was collected from only one ICU.
3. Inability to study sound level differences by patient clinical characteristics.
4. Inability to do spectral analysis of ICU sounds (to define individual sound frequencies).
5. The absence of a sleep study to investigate the association of sound levels with MICU patient sleep.

Design Implications

The use of C-weighted scale to measure sound levels suggested that the low frequency of machine sounds is higher than WHO-recommended levels. The authors think that these sounds may not be modifiable unless changes are made to the structural unit. Also, the authors recommend cautious use of Leq as a measure for sounds in the ICU as they do not effectively record sound characteristics like peak occurrences and local variations in sound.