The impact of noise in the intensive care unit

Noise levels in the intensive care unit (ICU) frequently exceed published recommendations. Noise adversely affects a number of physiological and psychological processes of both patients and staff, and is a potential risk factor for communication breakdown and error. Much noise is theoretically avoidable. The aim of this brief article is to explore the impact of noise in the ICU and the measures that might be used to limit the disruption it causes.

by Dr Richard J. Pugh

Noise in the ICU

Noise is more than simply "unwanted sound" [1]. The US Environmental Protection Agency's definition of noise, "any sound that may produce an undesired physiological or psychological effect in an individual or group," is quite appropriate when considering the hospital environment. Noise affects patients and staff. Not only does it disrupt rest and impede concentration and cognition, but it also interferes with communication and increases the risk of accidents.

Directive 2003/10/EC of the European Parliament (EP) sets maximum noise exposure levels for workers in the EU member states to an average of 87 dB(A) over an eight-hour working day. Though the limit of 87 dB(A) is higher than average noise levels generally reported in the literature, healthcare workers (and certainly patients) may be subjected to ICU noise for considerably longer than eight hours a day. Furthermore, the EP directive mandates that "risks arising from exposure to noise shall be eliminated at their source or reduced to a minimum." The WHO recommends that average background noise in hospitals should not exceed 30 dB(A) and that nocturnal peaks should be less than 40 dB(A). The noise levels in hospitals, and particularly in ICUs, are typically much greater than this.

Amplitudes of some everyday noises and causes of noise within the ICU environment are shown in Tables 1 and 2, respectively. Average noise levels ranging between 55 dB(A) and 70 dB(A) have been reported from a number of adult and paediatric ICUs. Peak noise levels of greater than 80 dB(A) are common, and levels up to 120 dB(A) have been described. Furthermore, it is often reported that there is no significant decline in these sound levels overnight. Talking, television sets and alarm signals seem to produce sound peaks of longest duration. Patients also report that staff communication is the most irritating noise, and over 50% of sound peaks have been attributed to modifiable human behaviour. The sound of doors closing can be extremely disruptive to patients' rest. One critical care nurse, whose sleep was repeatedly interrupted when she was a patient on her own care unit, felt compelled, when resuming her nursing duties, to replace the bins with ones whose lids would not crash down every time they were used (www.dipex.org/intensivecare).

The effects of noise on patients

Critically ill patients sleep poorly. The nature of their illness, their physical discomfort, and the effect of medication can all have a detrimental influence on sleep quality, but environmental factors also play their part. Sleep deprivation in the critically ill is associated with cognitive impairment and impaired memory formation, which may in turn contribute to confusion. Lack of sleep is also associated with cardiovascular stress, impaired immune function and catabolic metabolism. Both in ICU patients and in healthy subjects, approximately 20 to 25% of all EEG-monitored arousals from sleep have been associated with peak sound levels. The contribution of noise to sleep disruption is probably more important for those patients in the recovery phase or with less severe illness, when encephalopathy, poly-pharmacy, intensive nursing and ventilatory support may be less prevalent. However, noise produces detrimental effects other than sleep disturbance.

Noise causes stress to patients. Among patients recovering from acute coronary syndrome, adverse

TABLE 1.

Commonplace noises

Source of noise	
Train horn	120 dB(A)
Pneumatic drill	100 dB(A)
Motorcycle	90 dB(A)
Noise on busy urban street	80- 90 dB(A)
Vacuum cleaner	70 dB(A)
Washing machine	65 dB(A)

TABLE 2.

Noises recorded in the intensive care unit

Source of noise	
Items falling onto the floor	Up to 92 dB(A)
Equipment movement (e.g. bed)	90 dB(A)
Connection of gas supply	88 dB(A)
Door closure	85 dB(A)
Pager	84 dB(A)
Talking	75- 85 dB(A)
Ventilator alarm	70- 85 dB(A)
Nebuliser	80 dB(A)
Telephone	70- 80 dB(A)
Television	79 dB(A)
Oximeter	60- 80 dB(A)
Monitor Alarm	79 dB(A)
Ventilator	60- 78 dB(A)
IV infusion alarm	65- 77 dB(A)
Endotracheal aspiration unit	50- 75 dB(A)

coronary care acoustics were associated with increased markers of cardiovascular stress as well as an increased readmission rate. Noise is also associated with greater requirements for sedation and analgesia among ICU patients.

Hearing loss associated with critical illness may be exacerbated by noise. Particularly in patients with hearing impairment, noise may significantly impede communication, and hence understanding of the environment. This is especially the case for the elderly whose speech-processing abilities are more sensitive to noise disruption. Hearing impairment is associated with a greater prevalence of psychotic symptoms in both general and psychiatric populations. It is therefore also possible that loud unfamiliar noises, which not only increase the strangeness of the patient's environment, but also disrupt sleep, memory and cognition, may predispose towards confusion and delirium.

The effects of noise on staff

Though average and peak noise levels reported from critical care units are generally lower than sound levels thought to cause hearing impairment in otherwise healthy individuals, they are universally higher than those recommended by the WHO. Noise is associated with subjective and objective (cardiovascular) measures of stress among critical care nurses, and is a significant risk factor in the "burn-out" of nursing staff.

Noise diminishes the performance of healthcare providers in tests of mental efficiency. In laboratory tests, lack of control over noise seems to make individuals less likely to help out others. Indeed, patients have reported a less desirable staff attitude in noisier conditions. An increased background level of noise tends to lead to a greater amplitude of speech in an attempt to make oneself heard (the "Lombard effect"), which has implications for patient confidentiality. Furthermore, it creates an atmosphere in which communication between staff or between staff and patients may break down, and mistakes may be made.

Minimising the impact of noise in the ICU

Reduction of noise in the critical care environment may involve modification of staff behaviour, design considerations and the introduction of other specific measures. A large proportion of noise generated in the ICU is a direct result of human behaviour, and is at least theoretically modifiable. Educational programmes aimed at raising the awareness of noise disruption to healthcare, introduced together with modifications to staff activity, have shown some positive results. The introduction of "non-disturbance" rest periods with reduced nursing and medical activity and measures to limit sources of noise (no television or radio, reduction of alarm volumes and avoidance of unnecessary conversation) have led to a reduction of average noise levels in several ICUs. In order to sustain the considerable enthusiasm required for a successful noise-reduction project, frequent evaluation, feedback and education would seem to be extremely important.

The design of the critical care unit is important. Increased sound reflectivity leads to propagation of echo, interference and a reduction in speech intelligibility. The acoustics of the critical care unit are affected to a large degree by the presence or absence of single rooms. For less severely ill patients, requiring lower level of intervention, the noise levels recorded from a single room are significantly lower than those on an open ICU. However, noise dispersal from a single room may be very limited. For example, noise levels recorded from the smaller rooms of a paediatric ICU were found to be higher than those of a larger room. In addition, noise is often produced by the opening and closing of doors (and particularly the main ICU entrance door). Siting entrance doors, nursing stations and hand-over rooms at a suitable distance from patients' beds may potentially reduce noise disruption. However, even simple measures, such as replacing ceiling tiles with sound-absorbing material may reduce sound reflectivity and improve speech intelligibility, reducing stress among staff and patients.

Novel solutions to minimise the impact of noise, such as white noise to blunt the arousal response to ICU sound peaks, music to minimise the sympathetic response to noise and ear plugs to minimise sleep disruption caused by ICU noise, have found some success. The use of such techniques for the general medical or surgical ICU patient is to date unreported. However, such devices may potentially impede communication. Indeed, it may actually be more appropriate to use hearing aids for older and/or hard-of-hearing patients in daylight hours.

Conclusions

The volume of noise in ICUs frequently exceeds the recommended limits for hospitals, with significant implications for the psychological and physiological health of patients and staff. Under the terms of the 2003 European Parliament directive, employers are obliged to review and attempt to control noise in the workplace. Efforts to minimise the disruption caused by noise in the ICU should adopt a multi-faceted approach. It would involve a review of staff activities, equipment and the design of the ICU. At the heart of such efforts, however, is to ensure that healthcare workers are aware of the impact of their behaviour on the mental and physical well-being of their patients.

Reference

1. Berglund B, Lindvall T, Schwela DH. Guidelines for community noise. World Health Organisation 1999.

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