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Noise pollution on an acute surgical ward

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ABSTRACT

INTRODUCTION This study was undertaken to measure and analyse noise levels over a 24-h period on five general surgical wards.

PATIENTS AND METHODS Noise levels were measured on three wards with four bays of six beds each (wards A, B and C), one ward of side-rooms only (ward D) and a surgical high dependency unit (ward E) of eight beds. Noise levels were measured for 15 min at 4-hourly intervals over a period of 24 h midweek. The maximum sound pressure level, baseline sound pressure level and the equivalent continuous level (LEq) were recorded. Peak levels and LEq were compared with World Health Organization (WHO) guidelines for community noise. Control measurements were taken elsewhere in the hospital and at a variety of public places for comparison.

RESULTS The highest peak noise level recorded was 95.6 dB on ward E, a level comparable to a heavy truck. This exceeded all control peak readings except that recorded at the bus stop. Peak readings frequently exceeded 80 dB during the day on all wards. Each ward had at least one measurement which exceeded the peak sound level of 82.5 dB recorded in the supermarket. The highest peak measurements on wards A, B, C and E also exceeded peak readings at the hospital main entrance (83.4 dB) and coffee shop (83.4 dB). Ward E had the highest mean peak reading during the day and at night – 83.45 dB and 81.0 dB, respectively. Ward D, the ward of side-rooms, had the lowest day-time mean LEq (55.9 dB). Analysis of the LEq results showed that readings on ward E were significantly higher than readings on wards A, B and C as a group ($P = 0.001$). LEq readings on ward E were also significantly higher than readings on ward D ($P < 0.001$). Day and night levels differ significantly, but least so on the high dependency unit.

CONCLUSIONS The WHO guidelines state that noise levels on wards should not exceed 30 dB LEq (day and night) and that peak noise levels at night should not exceed 40 dB. Our results exceed these guidelines at all times. It is likely that these findings will translate to other hospitals. Urgent measures are needed to rectify this.

KEYWORDS
Noise – Wards – Surgery

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The World Health Organization (WHO) guidelines state that, on hospital wards, noise levels should not exceed 30 dB LEq (day and night) and that peak noise levels at night should not exceed 40 dB.[1] It was our perception that noise levels on the surgical wards within our busy teaching hospital breached suggested levels possibly to the detriment of patients and staff. The aim of this work was to compare the levels recorded over a 24-h period with controls from other areas of the hospital and levels of other activities reported in the literature.

Patients and Methods

The study involved measuring the levels of noise on five surgical wards at the Queen's Medical Centre, Nottingham. Three of the general surgical wards (wards A, B and C) have four bays of six beds each. On these wards, measurements were taken at the entrance to the second bay approximately 4 m from the nursing station. One of the wards consists of 20 side-rooms (ward D). On this ward, measurements were taken half way down the corridor connecting the side-rooms. The remaining ward is a surgical high dependency unit (ward E) which has two bays, each containing four beds. On this ward, measurements were taken at the entrance to the second bay. All five wards admit both elective and acute patients. Noise levels were measured for 15 min at 4-hourly intervals over a period of 24 h (Wednesday–Thursday) in early June. The following measurements were recorded:

1. **Maximum sound pressure level** – the noise with the maximum intensity within each 15-min period, expressed in dB. Think of this as similar to the loudest noise.

2. **Baseline sound pressure level** – the background noise level, expressed in dB. Where baseline levels were difficult to read because of consistently fluctuating noise, a baseline range was included.
3. **Equivalent continuous level (LEq)** – if one listened to this level of noise constantly for 15 min, your ears would be exposed to the same amount of noise as if you listened to the varying level of noise recorded in each 15-min period. It may be helpful to think of this as an average.

Key events during each measurement period were also noted and sound levels attributable to these events were recorded where possible. A variety of control measurements were recorded. These were taken over 15-min periods in the relatives' room, the hospital main entrance, a supermarket, a shopping centre, a coffee shop and at a bus stop on a busy 'A'-road.

Measurements were taken using an A-weighted Integrating Octave Band Sound Level Meter (Type 230, serial number 0651653). The study was performed blind with no patients or staff members, apart from the senior surgical nurse, aware that noise levels were being recorded.

Results

Results for individual wards are shown in Table 1. Peak readings over 80 dB are shown in bold to illustrate that noise levels frequently exceed this level on all wards. LEq levels below 50 dB are shown in italic to highlight that all wards other than ward E were able to drop their LEq level to below 50 dB for all night-time readings.

Mean day-time and night-time peak and LEq measurements were calculated for each ward (Table 2). Ward E had the highest mean reading for both peak and LEq measurements during the day and at night. Ward D had the lowest day-time mean LEq. Parametric analysis of the LEq results using the general linear model showed that readings on ward E, the high dependency unit, were significantly higher than readings on wards A, B and C as a group ($P = 0.001$). LEq readings on ward E were also significantly higher than readings on ward D, the ward of side-rooms ($P \leq 0.001$).

The mean LEq measurements for each time period and their confidence intervals demonstrate that night-time measurements tended to be the quietest and early morning measurements the loudest (see Table 3). Parametric analysis of the results using the general linear model showed that there was a highly significant difference between noise levels during the day and at night, but that there was also an interaction. The interaction suggests that the magnitude of the difference between day-time and night-time noise levels varies by ward – the drop in noise levels at night on ward E was found to be significantly different from the drop in noise levels on wards A, B, C and D as a group ($P = 0.002$).

Table 1 Readings with time across the five surgical wards

Time	Ward	Peak reading (dB)	Baseline reading (dB)	LEq (dB)
07.30–09.00				
	A	**86.3**	56 (54–58)	62.1
	B	**81**	51 (50–55)	58.7
	C	78.5	50.1	59.3
	D	**82.2**	54	56.4
	E	**95.3**	57	65.4
11.30–13.00				
	A	73.7	51.3	57.2
	B	**85.9**	55 (55–65)	65
	C	78.5	50.1	59.3
	D	**83.1**	50	56.6
	E	74.6	55.2	57.7
15.30–17.00				
	A	**80.9**	51.5 (50–55)	58.4
	B	73.5	53.8 (55–60)	57.8
	C	**81.1**	47	56.1
	D	78.5	51.3 (50–55)	55.9
	E	**83.3**	55.5 (55–65)	60.2
19.30–21.00				
	A	79.6	53.8	60
	B	78.3	48.4 (48–53)	56.7
	C	74.6	48 (49–65)	56.5
	D	**80**	50.8 (50–55)	54.7
	E	**80.6**	56.2 (55–60)	58.3
23.30–01.00				
	A	72.9	45 (44–49)	*49.1*
	B	64.7	42 (42–47)	*47*
	C	65.5	41.7	*46*
	D	70.9	44.3	*46*
	E	85.9	54.4	58.3
03.30– 05.00				
	A	70.1	42.5	*47.1*
	B	64.5	40.3 (40–45)	*44.7*
	C	71.9	39	*44.8*
	D	54.3	43.4	*44.9*
	E	76.1	54.3 (54–55)	55.2

Control measurements are shown in Table 4. The highest peak measurements on all the wards exceeded the peak sound level of 82.5 dB in the supermarket. The highest peak measurements on wards A, B, C and E also exceeded peak readings at the hospital main entrance and coffee shop. The highest peak measurement of 95.3 dB was recorded in ward E during the 07.30 measurements. This exceeded all of the control peak readings except the only slightly higher peak of 95.6 dB that was recorded at the bus stop. The peak reading in the relatives' room

during the day was 55.1 dB, the only peak reading below this level was 54.3 dB, the 03.30 measurement on ward D.

The highest LEq measurements on wards B and E exceeded the LEq recorded in the supermarket but were lower than those recorded at all of the other control locations, except the relatives' room. All LEq measurements recorded on all of the other wards were lower than LEq readings for the controls, again with the exception of the relatives' room. No readings were as low as the LEq reading of 36.4 dB in the relatives' room.

Discussion

The results show that ward structure affected noise exposure levels, with readings on the high dependency unit found to be significantly higher than readings on the ward of side-rooms, ward D, and the standard wards (wards A, B and C). We also found that noise levels vary significantly throughout the day on all wards, with the highest readings early in the morning and the lowest readings at night. However, the drop in noise levels

Table 2 Mean day-time and night-time readings

Ward	Day-time mean LEq (dB)	Day-time mean peak (dB)	Night-time mean LEq (dB)	Night-time mean peak (dB)
A	59.425	80.125	48.1	71.5
B	59.55	79.675	45.85	64.6
C	57.8	78.175	45.4	68.7
D	55.9	80.95	45.45	62.6
E	60.4	83.45	56.75	81
All	58.615	80.475	48.31	69.68

Day-time is readings taken between 07.30–21.00; night-time is readings taken between 23.30–05.00.

Table 3 Mean LEq for each time period

Time	Mean LEq (dB)	SE	95% CI lower	95% CI upper
07.30	60.380	1.246	57.781	62.979
11.30	59.160	1.246	56.561	61.759
15.30	57.680	1.246	55.081	60.279
19.30	57.240	1.246	54.641	59.839
23.30	49.280	1.246	46.681	51.879
03.30	47.340	1.246	44.741	49.939

95% CI, 95% confidence interval.

Table 4 Control measurements

Place	Time and date	Peak reading (dB)	Baseline reading (dB)	LEq (dB)	Events
Relatives' room	15.20–15.35 06/06/06	55.1	33.5	*36.4*	Peak – talking in the corridor outside
QMC entrance	15.05–15.20 07/06/06	**83.4**	64.4	67.7	Ambulance reversing signal outside, automatic doors
Supermarket	18.45–19.00 06/06/06	**82.5**	58.4	63.4	Trolleys, talking, coin machine
Shopping centre	16.45–17.00 6/06/06	**87.9**	68	68.8	Music, near drinks stall, near information desk, child shouting
Bus stop	12.20–12.35 6/06/06	**95.6**	68	69.7	Traffic, buses arriving and leaving
Coffee shop	17.05–17.20 6/06/06	**83.4**	65	68.3	Conversation and laughter, background music, drinks machines

on ward E was significantly lower than the drop in noise levels on the other wards as a group. The results also showed that peak noise levels on the wards frequently exceed 80 dB during the day. However, peak measurements were not ward-specific – the same causes were responsible for several of the highest measurements across all of the different wards (*e.g.* bin lids slamming and the serving of lunch from trolleys near the bay, wheeling past of monitoring equipment and tea trolleys, alarms and telephones as well as coins being returned from the TV card machine).

The control readings help to put these results into context. The results show that peak noise levels on the wards during the day are consistently comparable to, or even exceed, peak noise levels recorded at the main entrance to the hospital (83.4 dB) and in various public areas outside the hospital. The LEq reading recorded in the relatives' room (33.5 dB) was the lowest in the study, with even night-time LEq readings on the wards exceeding this level by at least 10 dB. In addition to our controls, there are results in the literature that also show where our surgical wards are in relation to other activities. The highest recorded level in our study was 95.3 dB. This is clearly not as high as a jet plane taking off (120–130 dB), but does come close to that recorded near a pneumatic drill (100–110 dB), or a heavy truck (90–100 dB).[2] The majority of peak recordings are approximately 10 dB higher than noise levels that would be recorded in an office (60–70 dB). Day-time baseline levels are clearly nothing like as low as noise levels in a library (30–40 dB) or a wood (10–20 dB) but are comparable to noise levels in an office (60–70 dB).

The WHO guidelines for noise in hospitals state that LEq levels should not exceed 35 dB in most rooms in which patients are being treated or observed. They also state that, on wards, noise levels should not exceed 30 dB LEq (day and night) and that peak noise levels at night should not exceed 40 dB. LEq levels on all wards at all times far exceeded WHO guidelines for community noise in hospitals. Every night-time peak noise level exceeded the WHO recommendations for peak noise levels in hospitals at night by at least 14 dB and as much as 45 dB on ward E. Night-time readings on all wards (11.30 and 03.30) exceeded levels necessary for a good night's sleep as specified in the guidelines (30 dB LEq for continuous background noise, and 45 dB for peak noise levels).

Other authors report noise levels in a general surgical ward.[3] Christensen[3] found a mean noise level within a clinical area of 42.28 dB with acute spikes reaching 70 dB. The lowest noise level attained was that of 36 dB during the period midnight to 07.00. This study was conducted on a six-bedded bay of a 28-bedded surgical ward over 72 h. These levels are somewhat lower than ours and we should be cautious about directly comparing values due to differences in ward structure, positioning of the noise meter and ward activity. Both Christensen[3] and Bentley *et al.*[4] suggested that conversations of patients and nurses are a major contributor to average noise levels on hospital wards. Whilst conversation was noted to be an important contributor to baseline noise levels in this study, peak noises were consistently attributable to other sources, such as bin lids slamming.

These results clearly suggest a level of noise pollution in our unit that is unacceptable and warrants immediate action. In one study, strategies to reduce night-time noise in a surgical intensive care unit decreased peak and LEq levels but not background noise.[5] These strategies focused on the co-ordination and limitation of nursing activities with maximal reduction of alarm sounds, conversation only in a low voice, no use of telephones, interphones, television or radio. In another study, there was some success in reducing noise levels on a neuro-intensive care unit by introducing disturbance-free periods along with measures to educate staff about sleep disturbance, noise levels and their effect on humans.[6] We are urgently introducing strategies focused around raising awareness of noise pollution and its detrimental effects. Whilst we anticipate that the causes of peak noise levels may prove easier to alter than contributors to background noise levels, these difficult issues must also be addressed in the longer term.

Conclusions

This study shows that noise pollution is a serious problem within our surgical unit, with levels breaching current WHO guidelines. Other units need to be aware of these findings and address this issue on their own wards as they are likely to have a similar problem.

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