HOSPITAL NOISE: IS IT A PROBLEM?

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1 INTRODUCTION

Over the past 40 years there has been a growing body of research into the acoustic environment in hospitals. This has provided evidence of the detrimental effects of noise on patient[1] and staff well being[2], and of a significant rise in hospital noise levels[3]. However, most of the evidence concerning the impact of noise has focused on specialist areas of care, with relatively little research into noise levels and acoustic conditions in general inpatient hospital wards, particularly in the UK.

The current study therefore aims to address some of the gaps in knowledge in the area of inpatient care, in order to provide better understanding of the importance of the acoustic design of hospitals, and its relationship with the comfort and well being of staff and patients. A series of questionnaire, noise and acoustic surveys have been carried out in a range of wards in three major UK hospitals[4,5].

This paper will present the results of noise surveys and questionnaire responses of staff and patients in a surgical and medical ward at one of the three study hospitals. The results show comparisons of noise levels in the wards, provide an insight into the causes of noise annoyance and disturbance, and highlight the differences between patient and staff perceptions and between different types of ward.

2 THE STUDY

2.1 Study site

The study took place over an eight month period, from April to November 2010, at Bedford General Hospital. Working in collaboration with the Estates team, two inpatient wards were chosen in the main five storey ward block. This building was constructed in the early 1980's, and is primarily of concrete construction, naturally ventilated and single glazed. It is unknown if any design guidelines were considered during the build as the building was under 'Crown Immunity', which in effect means that it was exempt from building regulations.

The medical and surgical wards are of identical layout and internal finishes. Both have suspended ceiling grids with perforated acoustic ceiling tiles in the majority of the multi-bed bays, single rooms, offices and corridors. Further acoustic absorbency is provided by the fabric privacy curtains, which can be drawn around each bed; upholstered easy chairs where patients can sit when out of bed; window curtaining; mattresses and bedding. All patient accommodation has heavy duty vinyl flooring and solid plastered walls.

Although of different specialties, both wards were subject to a number of routines common throughout the hospital. These routines include meal times, staff shift patterns, visiting hours, cleaning practices and the types of equipment in use, such as rubbish bins and wheeled equipment (trolleys). This enabled meaningful comparisons to be drawn as to the effects on noise of the type of care offered in a medical and surgical ward.

2.2 Methodology

The medical and surgical wards contained 30 and 26 patient beds respectively. Patient accommodation was provided in six or four bed bays, with four single rooms also available. For comparison purposes it was important that the noise level measurements could be made in similar locations in each accommodation type, and be repeatable in both wards. Microphone positioning was discussed with ward managers to ensure that the noise survey would be acceptable to staff and patients. Suitable locations were identified in the multi-bed bays, single rooms and at the nurse station. The measurement interval at each location was seven days where possible, a time period identified during an earlier pilot study[4] as consistently representative of the noise climate in a hospital ward.

To allow an acoustically robust picture of the noise climate to be developed, the following parameters were measured: $L_{Aeq,1hr,}$ L_{Amax}, $L_{A90,}$ L_{Amin} and $L_{Z(SPL)}$. Sources of high level noise were identified using the built-in 'trigger' functionality within the sound level meter. This functionality enabled a short sound file to be captured whenever L_{Amax} exceeded 70 dBA. The sound file could then be reviewed during analysis.

To avoid the microphone being knocked or contaminated, and to be as unobtrusive as possible, it was felt that suspending the microphone from the ceiling would be ideal. A 300 mm bracket was designed which simply clipped around the 'T' shaped ceiling grid without disturbing the ceiling tiles. If the ceiling bracket could not be used, for example in the case of a solid ceiling, the microphone was mounted on a small tripod which was securely fastened out of reach.

Two questionnaire surveys regarding the ward noise environment were designed for completion by staff and patients. The surveys were trialed during the pilot study[4], and were found to give reliable data on the perception of noise. After a review by the ward manager, it was decided that the questionnaires would be distributed by the ward clerk to those patients who had been on the ward for over 24 hours and were felt to be fit enough to complete the survey. Staff questionnaires were to be left for staff to complete in the staff room.

To advertise the study, a number of laminated posters were displayed throughout the ward common areas. These posters were aimed at both staff and patients and explained in simple terms why and how the study was being undertaken. In addition to these posters the ward managers personally discussed the study with all their staff during staff meetings.

3 OBJECTIVE MEASUREMENTS

3.1 Nurse stations

Noise levels were measured at the main nurse stations in the medical and surgical wards. Figure 1, shows the seven day $L_{Aeq,1hr}$ levels averaged over a 24 hour period at both nurse stations, with the average level of the multi-bed bays (see section 3.2) shown for comparison purposes. It can be seen that day and night time levels follow the same general pattern of fluctuation, with night time levels falling to around 45 dB L_{Aeq} at 04.00, and day time levels remaining fairly steady at around 55 dB $L_{Aeq.}$

Viewing averaged noise levels over time, as in Figure 1, provides valuable information with regards to level consistency and overall day and night time variation patterns, but does not illustrate the fluctuating nature of noise in the short term. Figure 2 shows noise levels captured at the nurse station in the medical ward over a ten minute time interval with the microphone approximately 2 m away from the main desk area. Using the trigger sound files captured, certain high level noise events have been identified: noise of furniture scraping on floor, the nurse call and doors closing.

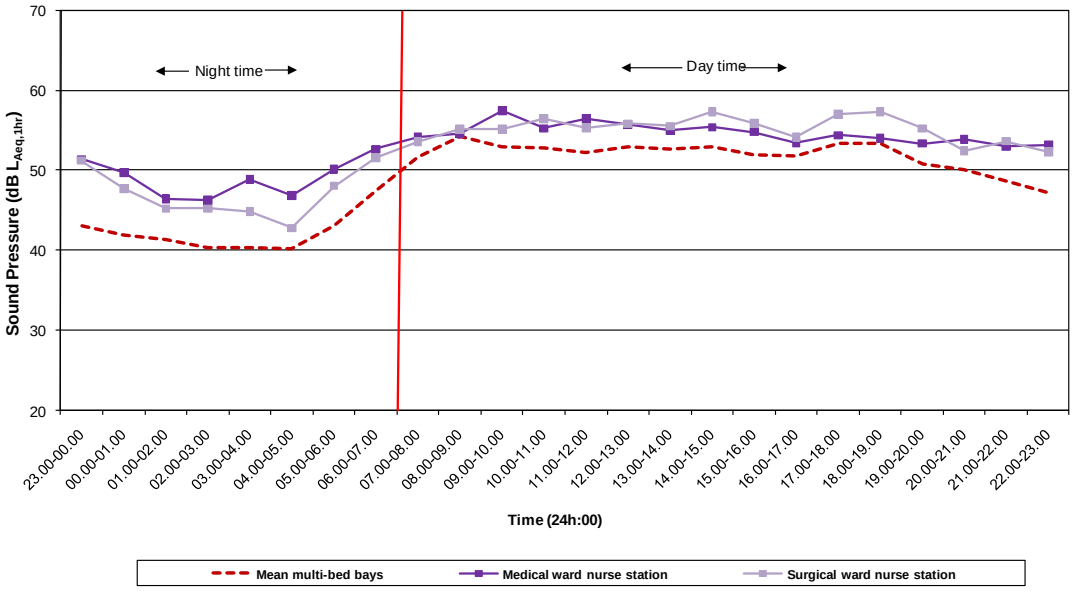

Figure 1 Averaged $L_{Aeq,1hr}$ levels at the nurse stations

The events shown in Figure 2 are a good representation of the types of high level noise events recorded at the nurse station in the medical ward. Other sources of high level noise at this nurse station include the use of rubbish bins, a metal cupboard door and the internal phone. Sources of high level noise at the nurse station in the surgical ward differed slightly from those in the medical ward. The nurse call appeared to be used much more frequently, which was confirmed by staff and patient responses to the questionnaire surveys, discussed in sections 4.1 and 4.2 respectively. High level conversation was also a source of many trigger files on the surgical ward but, unlike the medical ward, high level noise due to furniture scraping on the floor was minimal. Administrative tasks involving the use of ring binders also created a number of trigger files, especially during the night, with L_{Amax} levels of between 75 and 82 dB.

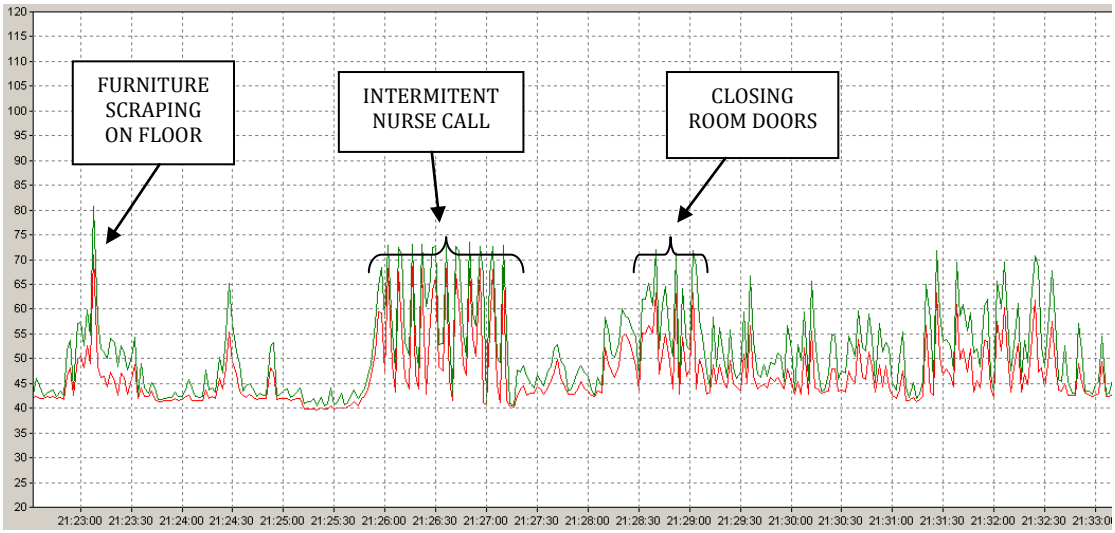

Figure 2 L_{Amax} (green trace) and L_{Aeq} (red trace) fluctuating over a ten minute interval at the medical ward nurse station

3.2 Multi-bed bays

Noise measurements were made in three identically located multi-bed bays on each ward. Measured levels in the three surgical ward bays were very similar, and are shown in Figure 3 as a single 7 day averaged $L_{Aeq,1hr}$ level. For comparison purposes measured levels from the medical ward bays are shown separately in the figure. It can be clearly seen that levels for the measured surgical bays and medical bays 1 and 4 are very similar and follow the same general pattern of fluctuation, with night time levels falling to around 37 to 40 dB L_{Aeq} , and day time levels remaining steady at around 51 to 53 dB $L_{Aeq.}$

However, levels in bay 3 on the medical ward are consistently higher than those in the other bays, by 4 dB L_{Aeq} on average during the day and by up to 8 dB L_{Aeq} during the night. This particular bay is opposite the nurse station, and for observation purposes patients with the most serious conditions are placed here. Due to the type of patients on this ward, the main impact on the noise levels is both from the patients themselves, for example, crying out, coughing and groaning and the increased clinical activity in the bay. Noise generated at the nurse station is not generally thought to affect the measured levels in this bay, except for the nurse call, which was captured at similar levels.

The similarity of measured levels between the four bed and six bed bays suggest that an increase in ward size from four to six patients does not necessarily affect the noise levels. The consistency of the levels confirms that the daily ward routines which contribute to the noise levels are comparable.

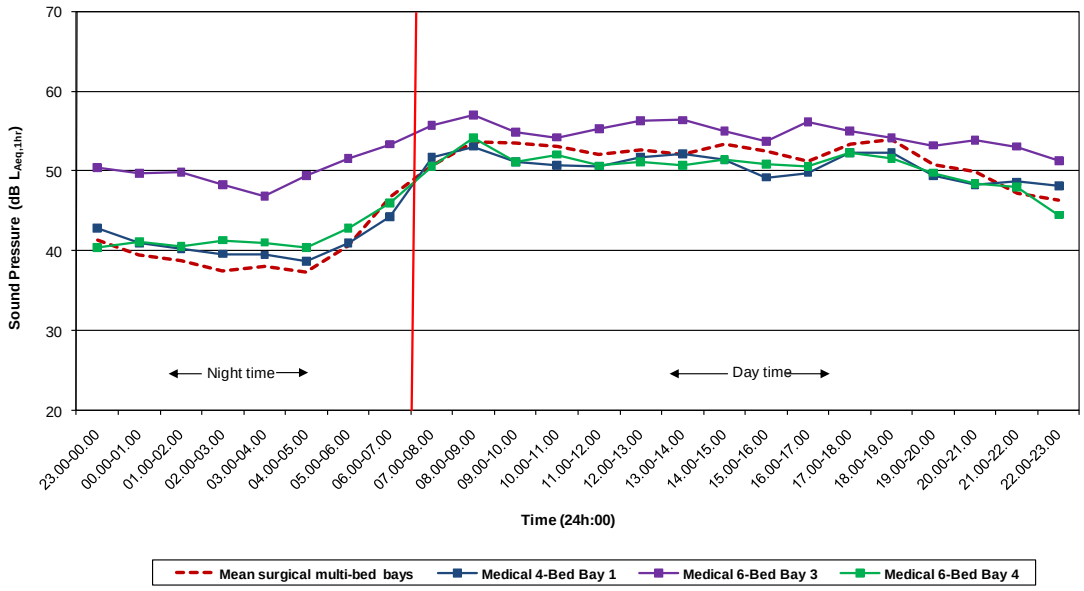

Figure 3 Averaged $L_{Aeq,1hr}$ levels in multi-bed bays

3.3 Single rooms

Noise measurements were made in two identically positioned single rooms on each ward. Figure 4 shows the 7 day averaged $L_{Aeq,1hr}$ levels over 24 hours for each of the four rooms. To allow for comparison with levels measured in the multi-bed bays, an average of all multi-bed bays is shown on the graph.

It can be seen that average noise levels measured in the single rooms are higher than those measured in the bays, and are very inconsistent. A number of major sources of high level noise were identified and these included conversation during prolonged patient visits; staff conversation; clinical activity; and medical equipment alarms which continued for long periods before being reset.

An occurrence of one particular alarm continued for over two and a half hours, with an intermittent bleep measuring 73.6 dB L_{Amax} .

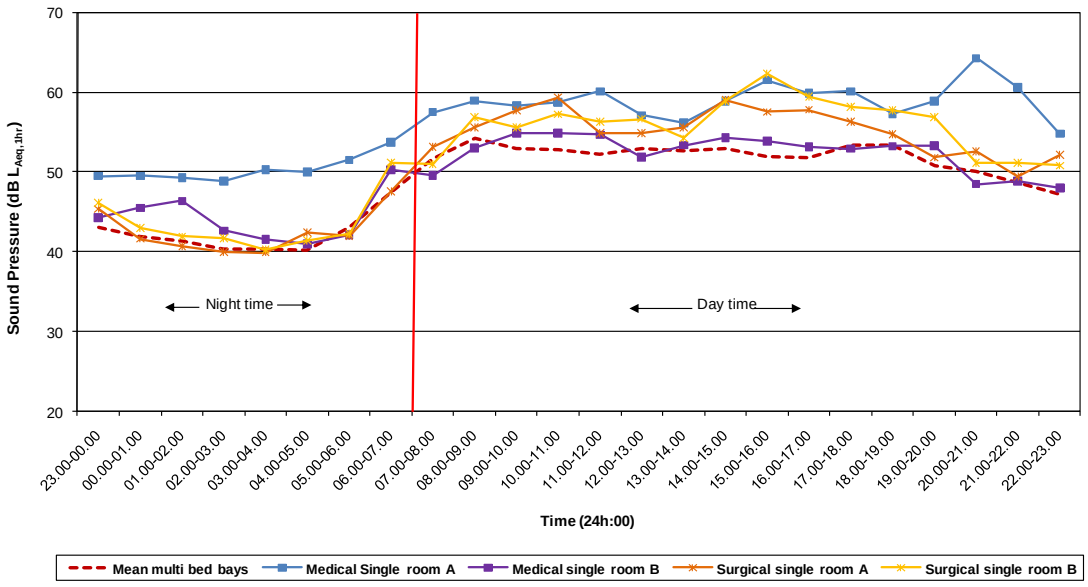

Figure 4 Averaged $L_{Aeq,1hr}$ levels in the single rooms

4 SUBJECTIVE RESULTS

4.1 Staff perceptions

General feelings of annoyance were investigated by a questionnaire asking staff to what extent they were annoyed by noise. Eighteen responses were received from the medical ward, and seven from the surgical. Figure 5 shows the extent of annoyance among staff on the two wards. It can be seen that the highest percentage of staff in the medical ward were moderately annoyed by noise (43 %), but this was not the case in the surgical ward, where the majority (56 %) of those questioned felt only slightly annoyed by noise.

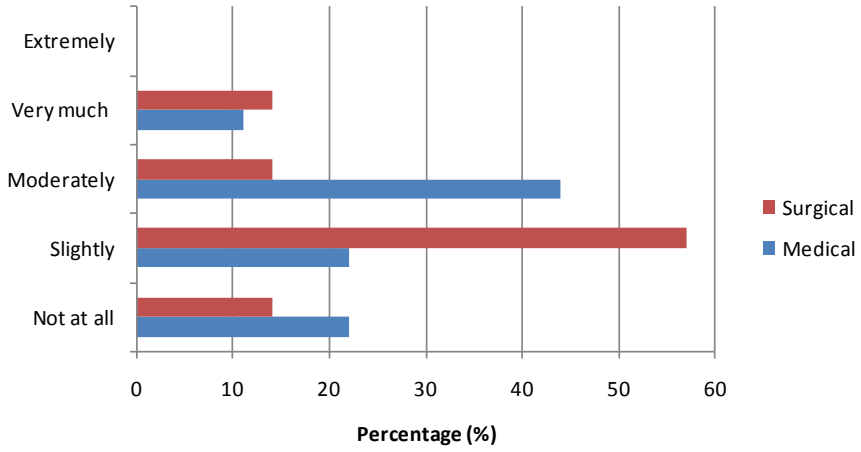

Figure 5 Percentages of staff annoyed by noise

Staff were asked to rate the annoyance of various noise sources (identified from the objective study as the most frequently occurring events with high noise levels) on a scale of 0 to 4, with 0 indicating

'not at all annoying' and 4 indicating 'a great deal'. Figure 6 shows the percentages of staff who rated a noise event with a score of 2, 3 or 4, and therefore could be said to be more than a little annoyed by the event.

It can be seen that the most annoying noise events for the staff on the medical ward were visiting time, medical equipment alarms and the internal telephone. Similarly, staff on the surgical ward felt strongly about these noise sources, but a higher percentage of these staff rated the nurse call as annoying.

Discrepancies of 20-30 % can be seen between the medical and surgical staff ratings for cleaning, people talking and staff talking on the telephone. These events were found to be annoying by staff on the medical ward, but by fewer staff on the surgical ward.

Doors banging and external noise are rated more highly in the surgical ward. There is a particular heavy, ill-fitting fire door at the end of this ward that was mentioned during initial discussions with the ward manager. When this door bangs shut the noise travels down the full length of the ward corridor. With regards to the external noise, the surgical ward was surveyed during the summer months when the weather was warmer, whereas the medical ward was surveyed in the spring. This may account for the difference in annoyance due to external noise, as more windows may have been open in the warmer weather.

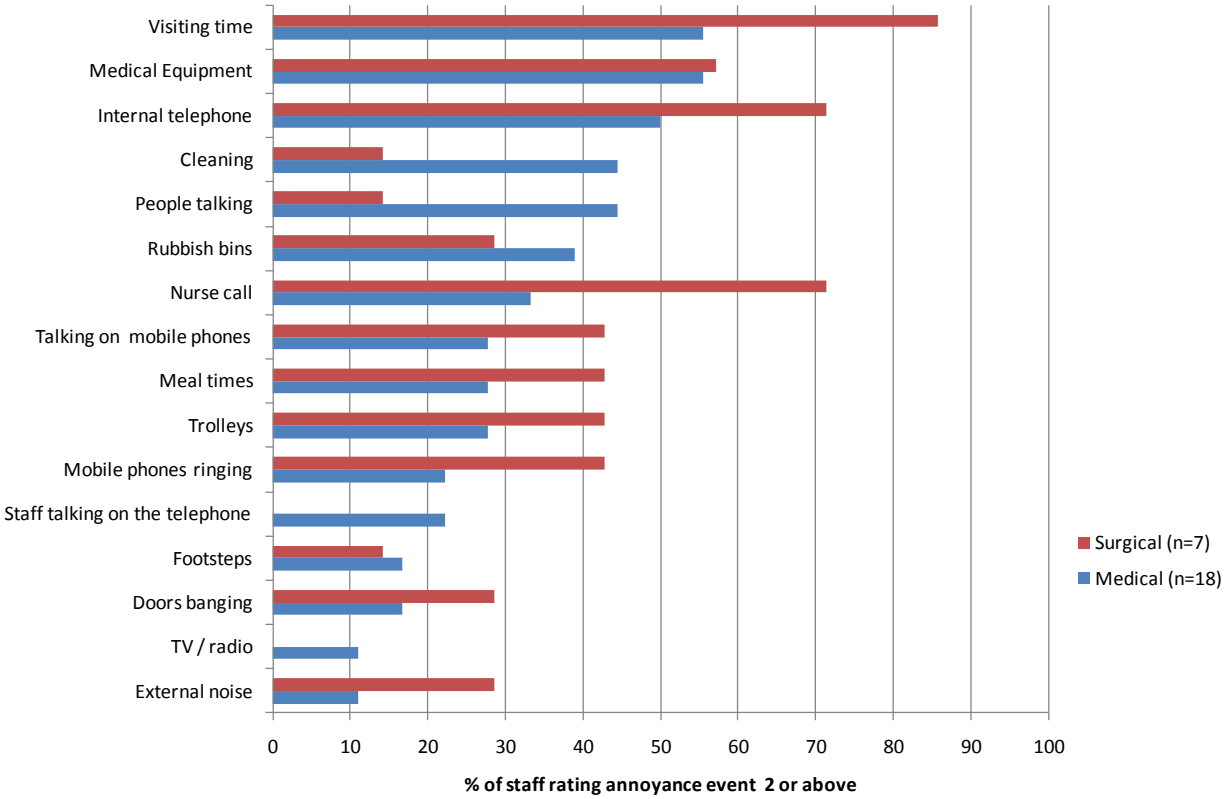

Figure 6 Percentages of staff annoyed by specific noise events

For 10 out of 16 noise sources, the percentage of those annoyed on the surgical ward is higher than on the medical ward. This could be due to the smaller sample size, and the possibility that only those staff who felt strongly about noise felt inclined to complete the questionnaire. However, other factors could also account for this variation in response. Medical and surgical wards are different, and as such may attract staff with different types of personality. Surgical wards are very busy with constant admissions for day or even half day procedures. Operations are booked in advance and efficiency and timing are critical. Medical wards are slower paced and it is possible that staff annoyance caused by particular events could be less extreme.

4.2 Patient perceptions

General feelings of day time annoyance and night time disturbance were investigated by the patient questionnaire. Twenty three responses were received from the medical ward, and 19 from the surgical. Only a relatively small percentage of patients felt annoyed by noise on the wards during the day time – 13% of patients in the medical ward, and 29% of patients on the surgical ward. However, when asked whether they were disturbed by noise at night, 58% of patients in the medical ward and 51% of patients on the surgical ward felt that they were.

Patients who had indicated that they were disturbed by noise during the night were asked to rate the annoyance of various noise sources on a scale of 0 to 4, where 0 indicated no annoyance / disturbance and 4 indicated a great deal. Figure 7 shows the percentages of patients within this sample who rated a noise event with a score of 2, 3 or 4, and thus were more than a little disturbed by the event.

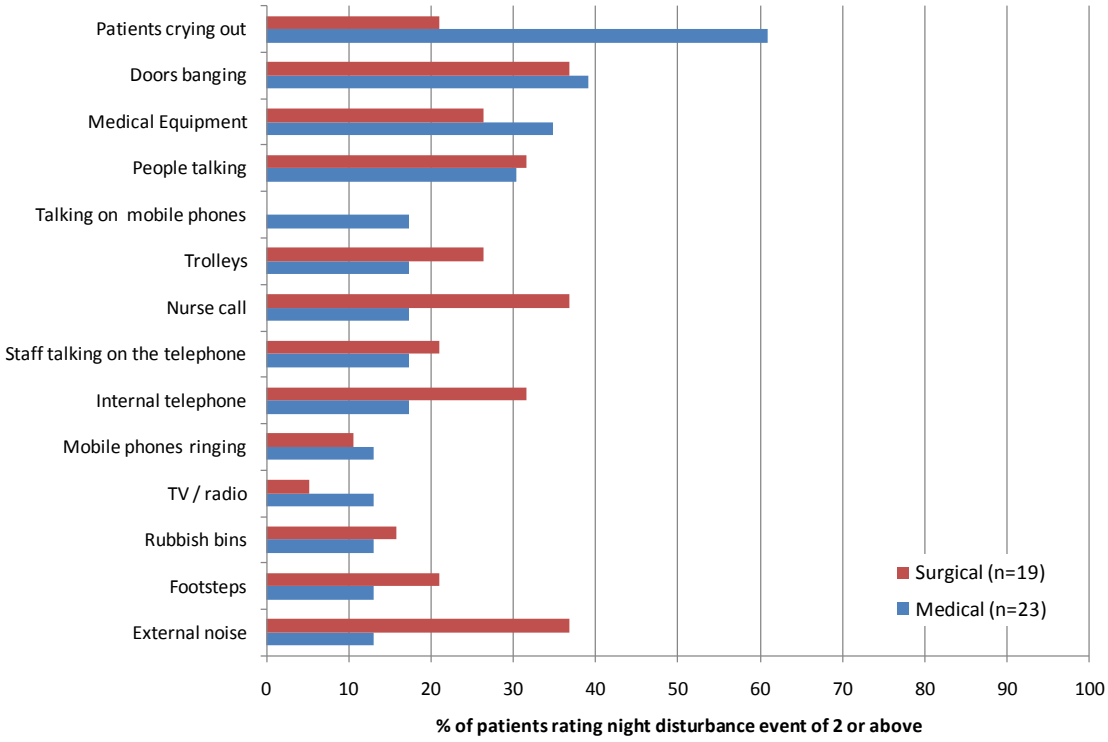

Figure 7 Percentages of patients disturbed by specific noise events at night

One noticeable difference that can clearly be seen is that 'patients crying out' seems to be much more of a problem on the medical ward during the night. This is possibly related to the number of elderly patients suffering from confusion and dementia on this ward, who tend to cry out more often.

Doors banging, medical equipment, trolleys and people talking are rated by similar percentages of patients on both wards. However, the nurse call, the internal telephone and external noise are all rated as more disturbing on the surgical ward, which is a similar pattern to daytime annoyance responses on the two wards. Occurrences of the nurse call were captured more often and continued for longer periods at the nurse station on the surgical ward, which could explain the patient responses to this source. As discussed previously, external noise may have been more of a problem during the study period in the surgical ward as the weather was warmer and more windows would have been open.

'Talking on mobile phones' is cited as a disturbance only on the medical ward. The hospital policy specifies that mobile phones should only be used in the lobby areas and not on the wards. This suggests a lack of policy enforcement by the staff on this ward.

5 DISCUSSION

Noise levels measured at the nurse stations and the multi-bed bays are generally consistent, with day time levels around 55 dB L_{Aeq} and 52 dB L_{Aeq} respectively, and night time levels of around 45 dB L_{Aeq} at the nurse station and 37 to 40 dB L_{Aeq} in the bays. The only exception is the measured levels in bay 3 in the medical ward, which are consistently higher than for the other bays, by 4 dB L_{Aeq} on average during the day and by up to 8 dB L_{Aeq} during the night. This bay is used for more severely ill patients, and it appears that the increased noise levels result from both increased clinical activity and from the patients themselves, for example, crying out, coughing and groaning.

The average noise levels measured in the single rooms are found to be higher than those measured in the multi-bed bays, and are very inconsistent. Much of the high level noise is due to behaviour within the room, for example, protracted visiting times, and use of medical equipment, whose alarms were left for periods of time without being reset.

The impact of many of the noise sources cited by both patients and staff could be reduced with simple changes to behaviour and enforcement of hospital policies, for example, being aware of the high noise levels generated by cleaning and by loud conversations; and ensuring that calls are not made on mobile phones, and that phones are set to silent mode on the ward.

Equipment noise and design is a major issue. Measured noise levels from nurse call systems, internal telephones and medical equipment are high and frequently occurring, with some alarms left for some time before they are reset. These systems are also continually cited by staff and patients as sources of annoyance and disturbance. It should be possible, through collaboration between manufacturers and system users, to design and locate equipment so that noise problems are minimised.

Furniture scraping is found to be a constant source of high level noise at the medical ward nurse station. This could be simply and cheaply controlled by fitting rubber feet or wheels to the chairs and furniture used there. Doors banging is another problem which could be remedied by fitting or adjusting quiet door closers, or in the case of metal cupboards, installing some damping.

Rubbish bins, designed to have lids that close quietly, are often positioned too close to a sink or wall, so that on opening, the lid hits the nearby object, causing a loud bang and defeating the object of the quiet closing mechanism. The body of the bin is also a problem, as it is generally solid and not damped; hence discarding a heavy object will also cause noise.

Much of the equipment used on the wards has wheels to allow for portability. This includes patient beds, ward furniture, medical equipment, as well as the standard 'trolleys' used to deliver meals, drinks, medications, linen and other supplies. Many of these pieces of equipment are metal; have no damping; and have ill-adjusted wheels and unsuitable tyres. Trolleys have been captured by the trigger files, causing noise levels as high as L_{Amax} 85 dB.

6 CONCLUSIONS

Noise level measurements and questionnaire surveys have confirmed that noise is a problem in both medical and surgical hospital wards. Staff responses indicate that they are annoyed by noise, and over half the patients questioned felt that they were disturbed by noise during the night, a time when they should be able to rest and recuperate.

Much of the high level noise identified could be reduced with changes to behaviour, correct enforcement of hospital policies, simple improvements to design and maintenance of equipment.

The design of medical equipment, nurse call systems and communication devices currently in use on the wards is a more difficult problem to solve with regards to the number and tonality of the

alarms emitted. A collaborative approach between manufacturers and system users is needed, to both design and locate equipment so that noise problems are minimised.

7 ACKNOWLEDGEMENTS

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