Noise in the postanaesthesia care unit

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Background. Although the postanaesthesia care unit (PACU) can be noisy, the effect of noise on patients recovering from anaesthesia is unknown. We studied the sources and intensity of noise in the PACU and assessed its effect on patients’ comfort.

Methods. We measured noise in a five-bed PACU with a sound level meter. Noise levels were obtained using an A-weighted setting (dBA) and peak sound using a linear scale (dBL). Leq (average noise level at 5-s intervals), maximum Leq (LeqMax), minimum Leq (LeqMin) and noise peaks (Lpc) were calculated. During recording, an independent observer noted the origin of sounds from alarms and noise above 65 dB intensity (P65dB). Two hours after leaving the PACU, patients were asked about their experience and to rank their complaints on a visual analogue scale (VAS) using unstructured and structured questionnaires.

Results. We made 20 187 measurements over 1678 min. The mean Leq, LeqMax and LeqMin were 67.1 (SD 5.0), 75.7 (4.8) and 48.6 (4.1) dBA respectively. The mean Lpc was 126.2 (4.3) dBL. Five per cent of the noise was at a level above 65 dBA. Staff conversation caused 56% of sounds greater than 65 dB and other noise sources (alarm, telephone, nursing care) were each less than 10% of these sounds. Five patients reported disturbance from noise. There was no significant difference in Leq measured for patients who found the PACU noisy and those who did not [59.5 (3.1) and 59.4 (2.4) dBA respectively]. Stepwise multiple logistic regression indicated that only pain was associated with discomfort.

Conclusions. Even though sound in the PACU exceeded the internationally recommended intensity (40 dBA), it did not cause discomfort. Conversation was the most common cause of excess noise.

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The National Institute for Occupational Safety and Health (NIOSH) recommend that the noise intensity in hospitals should not exceed 35 dBA (A-weighted setting) during the night and 40 dBA during the day. Excess noise can have adverse physiological and psychological effects on patients and increase mistakes by medical personnel. Although attention has been focused on noise in intensive care and during major surgery, postanaesthesia care units (PACU) are also noisy places. Noise can come from ventilators, monitors, alarms and other apparatus and can also spread from adjacent areas such as the operating theatre, the transfer area and scrub-up areas. Because patients in the PACU are often sedated or anaesthetized, noise is usually ignored. However, noise can affect anaesthetized patients or animals during arousal. Although the sources and extent of noise are known, the effect of noise on patient comfort is not clear.

We set out to determine the causes of noise in the PACU and to quantify the contribution of noise, compared with other factors, to patient discomfort.

Material and methods

The study was conducted after approval from our Institutional Review Board. Patient consent was not required because the procedure was observational. We performed a prospective study of 26 patients having elective general surgery under general anaesthesia in a 35-bed, university-based teaching department. Operating room and recovery room staff worked without changing their normal practice.

The 9×3.5 m PACU was an open ward with five beds close to the operating theatre (three rooms). Noise level was measured when there were at least four patients in the room.
PACU. All measurements were made between 8.00 a.m. and 1.00 p.m. The PACU opened onto a corridor by a door that remained open. Each bed in the PACU was equipped with a ventilator, a bedside monitor with ECG, pulse oximetry and non-invasive arterial blood pressure measurement, and two motor syringe pumps. At least 12 alarms were set for each patient. During the study period, one or two nurses worked in the unit. Personnel working in this area were informed of the study but no attempt to control noise was made before the beginning of this study.

Sound monitoring
Sound levels were measured in dBA. Noise was measured with a frequency filter called the A-weighting network. This filter correlates well with the human response to noise because it attenuates low-frequency sound by an amount that corresponds to the sensitivity of the human ear. We used a sound level meter with internal storage (model SIP 95 S; Essilor, Créteil, France). This sound meter incorporates a type-1 microphone and records sound ranging from 40 to 140 dBA. The sound meter was calibrated before the study (acoustic calibrator; Essilor). For the accurate measurement of what the patient would be hearing, the sound meter was placed close to the patient’s head. An observer sat next to the head of the patient and noted the source of sounds that had peak values greater than 65 dBA (P65dB). During recording, the noise level was monitored continuously. The sound meter sampled peak sound every 125 ms (Lp) and produced an integrated pressure sound level each 5 s (Leq). An interval of 5 s was chosen as the being the time an observer was expected to require in order to identify a given sound. The stored data were downloaded to an IBM computer for data analysis using commercial software (Alsono; Aclan, Toulouse, France). The following values were derived: Leq (5-s period), maximum Leq (LeqMax), minimum Leq (LeqMin), maximum peak (LpcMax, expressed in dBL). The software also calculated the sound pressure level that included 50 or 90% of peak sound collected (LE 50 and LE 90 respectively).

Patient experience of time in the PACU
Fitness for discharge was determined with an Aldrete score. Two hours after discharge, the patients were interviewed and asked to assess their experience of the unit. Two questionnaires were completed with the help of one of the investigators. The first questionnaire was unstructured (spontaneous complaints, indirect questions). The second was a structured questionnaire asking about common complaints, such as pain, cold, nausea and vomiting, nursing care, light and specifically noise. The patient rated each item in the questionnaire on a visual analogue score (VAS) from 0 to 10 and classified their experience in the unit as stressful or not. VAS values greater than 3 were considered clinically significant.

Statistics
Results are expressed as mean (SD or range). When appropriate, groups were compared using the Mann–Whitney U test. Univariate analysis was done with a statistical program (Statview; Abacus, Berkeley, CA). Significant complaints were incorporated into a stepwise multiple logistic regression to describe the relationship between patient satisfaction and complaints. A P value less than 0.05 was considered statistically significant.

Results
We studied 26 adult patients (14 female, 12 male). Surgical procedures included urology and dental, abdominal and plastic surgery. Mean age was 45 yr (range 19–78 yr).

We made 20 187 measurements over 1678 min of recording. Mean (SD) recording time per patient was 55 (22) min.

The mean integrated sound pressure level (Leq) was 67.1 (5.0) dBA. The maximum and minimum values of this variable were 75.7 (4.8) and 48.6 (4.1) dBA respectively. The mean peak level (Lpc) was 126.2 (4.3) dBL. The LE 50 was 55.9 (3.0) dBA and LE 90 was 52.1 (3.3) dBA.

The intensities of some of the noises are shown in Figure 1. Five per cent of the noises were above 65 dBA (1074 peaks). Staff conversation caused 56% of P65dB; other noise sources (alarm, telephone, nursing care) were each less than 10% of P65dB (Fig. 2). None of the alarm sounds was related to a critical medical event.

Eleven patients reported discomfort during their stay in the unit. Most spontaneous complaints were about pain (six patients) and noise (two patients). The structured questionnaire identified pain (10 patients; 38%), nursing care (10 patients; 38%), cold (nine patients), oxygen face mask (seven patients) and noise (five patients; 19%) as important factors (VAS > 3). The mean VAS was less for noise [4.8 (1.9)] than for other sources of patient discomfort (Table 1). Conversation rather than alarms was the major source of complaint about noise in these five patients (4 vs 1). There
was no significant difference in mean sound level measured for patients who found the PACU noisy and those who did not [59.5 (3.1) and 59.4 (2.4) dBA respectively].

Logistic regression analysis identified pain as the only factor affecting patient discomfort in the PACU (Table 2).

**Discussion**

In the past, patient satisfaction in the PACU has been related to the quality of nursing care and the control of side-effects after anaesthesia and surgery. However, factors such as light intensity, ambient temperature and prevention of infection by air filtration and from water pollution can affect patient perception of care.8 14 We found that noise can be a relevant environmental factor but it is not the main cause of discomfort.

Several studies have shown that hospitals are noisy. In the operating theatre, the average noise level is in the range of 60–65 dBA.2 7 8 Noise in the intensive care unit (ICU) is often greater than that recommended by NIOSH. Soutar and Wilson15 found an average sound level of 66 dBA and Balogh and colleagues4 reported values between 60 and 65 dBA in a four-bed ICU with noise levels above 65 dBA during teaching. Others found noise intensities between 50 and 75 dBA.16 17 In the PACU, a study by Minckley18 identified the sources of noise and found average sound levels ranging from 50 to 70 dBA, and Liu and Tan10 showed that the mean noise level in the PACU could reach 72 dBA. We found the average noise level in our PACU to be 67 dBA. Differences in noise levels may be caused by features of a PACU that affect noise reflection and intensity. Noise is also affected by the amount and type of equipment that is being used. The type of surgery and the level of care needed may also influence noise.

**Table 1** Results of the structured questionnaire about complaints. The 26 patients rated each item with a visual analogue score (VAS). Score 1 is the mean VAS (SD) calculated for all patients; score 2 is the mean VAS (SD) calculated only for patients with VAS>3. n.d.=not done

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Number of patients</th>
<th>Score 1</th>
<th>Score 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>10</td>
<td>2.8 (2.8)</td>
<td>5.6 (2.2)</td>
</tr>
<tr>
<td>Gastric suction drainage</td>
<td>10</td>
<td>2.4 (3.2)</td>
<td>5.8 (2.6)</td>
</tr>
<tr>
<td>Cold</td>
<td>9</td>
<td>2.4 (2.9)</td>
<td>5.0 (2.5)</td>
</tr>
<tr>
<td>Oxygen mask</td>
<td>7</td>
<td>1.9 (2.4)</td>
<td>4.9 (2.0)</td>
</tr>
<tr>
<td>Noise</td>
<td>5</td>
<td>1.2 (2.1)</td>
<td>4.8 (1.9)</td>
</tr>
<tr>
<td>Nausea</td>
<td>1</td>
<td>n.d.</td>
<td>n.d.</td>
</tr>
<tr>
<td>Retching</td>
<td>0</td>
<td>n.d.</td>
<td>n.d.</td>
</tr>
<tr>
<td>Hungry</td>
<td>2</td>
<td>n.d.</td>
<td>n.d.</td>
</tr>
</tbody>
</table>

**Table 2** Relationships (stepwise logistic regression) between patient satisfaction and different complaints in the PACU. Only complaints with a \( P \) level <0.25 in a univariate analysis were entered in the model

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Odds ratio</th>
<th>Lower 95% confidence limit</th>
<th>Upper 95% confidence limit</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>9.4</td>
<td>1.0</td>
<td>82.3</td>
<td>0.04</td>
</tr>
<tr>
<td>Cold</td>
<td>0.44</td>
<td>0.05</td>
<td>4.30</td>
<td>0.48</td>
</tr>
<tr>
<td>Drainage</td>
<td>3.80</td>
<td>0.38</td>
<td>38.12</td>
<td>0.25</td>
</tr>
<tr>
<td>Noise (dB)</td>
<td>1.08</td>
<td>0.76</td>
<td>1.54</td>
<td>0.66</td>
</tr>
<tr>
<td>Peaks &gt;65 dB</td>
<td>1.02</td>
<td>0.89</td>
<td>1.16</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Most noises (95%) were in the 50–65 dB range, a level classified as ‘ambient’. \( \text{Leq} \) is the mean noise level over a period of time. In contrast, \( \text{Lpc} \) is recorded at 0.125 ms intervals and represents peak noise. \( \text{Lpc} \) as high as 130 dB was recorded, a noise level close to that from an aeroplane. Staff conversation was responsible for most of the peaks above 65 dB, and conversation was an important source of complaint in patients who reported that the PACU was noisy. This observation supports previous reports that most noise in operating theatres and ICUs is caused by workers, levels being 70–80 dB.2 8 Even though conversations between workers in the PACU are important for patient care, high sound levels should be avoided and conversations in the PACU should be restricted to essential matters.

Other noises come from equipment alarms,19 mainly \( \text{SpO}_2 \), NIBP and ECG devices. None of these noises caused a potentially serious problem and they arose mainly as a result of patient movement. Both alarms represented 23% of peak above 65 dB, a value close to the 25% reported by Kahn and colleagues.16 Most alarm sounds are related to non-critical events and were reported to account for 99.5% of the total of 1455 alarms recorded over a 3-week period in an ICU.20 An important source of noise in the PACU is false alarms, and we agree with others that a graded and intelligent system of alarms might help to distinguish life-threatening events from unimportant disturbances.21 This would improve monitoring and reduce noise from false alarms.

Noise can distress 30% of patients in a PACU,10 but individual perception is important. We found that those who were distressed by noise were not exposed to sound levels.
that were any greater than those who did not find the unit noisy. Regression analysis did not show that noise was generally a factor causing discomfort. As in the ICU, some patients recovering from anaesthesia may have found some noises reassuring rather than alarming.

Pain remains the major cause of discomfort in our unit despite treatment plans for pain management. The need for pain therapy was not recorded in this study because the type of surgery was not standardized. Minckley found that when noise levels were high (60–70 dB) the number of patients given analgesics increased. However, sound levels were measured at half-hourly intervals, were not measured for each patient, and the type of medication given was not described. In awake patients, music decreased patient-controlled sedative and analgesic requirements. Patients in the control group in this study did not use a headset, so the reduced requirements for treatment could have been caused either by music or by reducing the effect of ambient noise. Whether noise in the PACU pain perception and analgesic requirements needs further study.

Noise is also a source of stress for staff because noise impairs concentration and mental efficiency. Noise is an important stressor of ICU nurses, though the health hazard is not easy to prove. Bayo and colleagues interviewed hospital workers and found that noise interfered with their work and could cause mental fatigue, headaches and hypertension. Even if noise is not an important cause of discomfort for patients, health-care workers should be protected from excessive noise.

Noisy situations can mask vital alarms. Verbal communication may also be impaired, even at noise levels that do not reduce intelligibility. The reliability of oral communication can be assessed by calculating preferred speech interference levels. The value of 67 dB for sound pressure levels in the operating theatre. This could not be achieved by video recording because this would not distinguish noise from different origins, and explains why observers have been used to identify the sources of noise in previous studies.

**Conclusion**

We conclude that high noise levels were present in the PACU and that most of these noises could be prevented. However, noise was not perceived as the main cause of discomfort by patients. The influence of noise on the quality of care and the performance of staff needs further study.

**References**

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