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Live recordings of sound levels during the use of powered instruments in ENT surgery

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Abstract
Otolaryngology is one of the surgical specialities employing high-powered instruments and this study was designed in order to establish whether sound levels at work conform to HSE guidelines. No study to date has measured intra-operative noise levels in ENT operation theatres. A prospective observational study was therefore performed. Sound levels were measured during the use of bone drills for mastoid surgery and microdebriders for endoscopic sinus surgery. A SLM/IS Acos Class I sound level meter calibrated to BS 1259 was employed. A spectrum analysis of drill-generated noise was measured using a calibrated B and K precision sound level meter. Sound levels emitted varied as follows: Large burrs- 72.4 dB (A), medium size; 71.2 dB (A), small sized burrs- 68.8 dB (A) (all values for cutting burrs) and 60.8 dB (A) for diamond burs. With microdebriders, the average sound level was 60.1 dBA. Spectrum analysis revealed that the maximum intensity was at 3.15 kHz, followed by 4 kHz, while the least sound was produced at 40 kHz and 31.5 kHz. Essentially sound produced by drills was between 1.6 kHz and 6.3 kHz. Powered instruments used in ENT surgery are safe and pose no occupational hazard.

Key words: Acoustic Stimulation; Surgical Procedures, Operative; Noise, Occupational

Introduction

Noise has long been recognized as a potential occupational hazard, because of its deleterious effects on hearing.[1] The Department of Employment has estimated that at least 6 000 000 workers in the UK are currently exposed to the risk of occupational deafness. The current EC directive is that the maximum noise permissible is 85 dB for an eight-hour working day.[2] With changing attitudes to hazards at work, legal claims for noise-induced deafness are increasing. In April 1972, the Department of Employment issued the ‘Code of Practice’ for reducing the exposure of employed personnel to noise and made it obligatory for the use of approved hearing protectors, if warranted.[3] The Health and Safety at Work Act (1974), made it possible for a civil claim for damages to be raised in case of breach of statutory duty vide the Factories Act 1961, for each injury.[4] It is therefore paramount to ensure that noise levels are within acceptable levels at the workplace, irrespective of any profession, the medical profession included.

Otolaryngology, Dental surgery and Orthopaedic surgery are three specialities in which the operating surgeons use high-speed tools. Additionally the use of noise attenuators/hearing protectors is not common. Therefore, there is scope for exposure to loud, possibly potentially harmful levels of noise in the work environment. Assuming that consultants in any of the above specialities on average work in the NHS for 20 years, there could be serious scope for breach of statutory rights. It is, therefore, appropriate to physically measure the noise levels generated by commonly used high-impact tools. This could serve two purposes: one, to find whether noise levels generated in the work environment are within stipulated levels; and two, if not, to find out the time taken to exceed ‘first action level’ i.e. the point at which steps should be taken to limit noise exposure.[5]

Such studies have been performed infrequently in the past. But even they have reported bench testing where sound levels were measured in laboratory-type settings. There has been one attempt to measure intra-operative noise during the use of orthopaedic instruments.[6] To date no such analysis has been carried out in otolaryngology. We report a study wherein sound levels were recorded ‘live’ in operating theatres. We aimed to explore whether the routine use of powered instruments poses an occupational hazard.

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Materials and methods

This was a prospective observational study carried out in the ENT operating rooms of the Warrington Hospital, between March and August 2002. Sound levels were measured during the use of pneumatic bone drills for mastoid surgery and microdebriders for endoscopic sinus surgery (Karl Storz systems Model No 20712120), on patients listed in the routine theatre list. This was done using a SLM 3/IS ACOS (Camcord Ltd) Class I sound level meter calibrated to BS 1259. Ambient noise (including sound from conversation and monitoring equipment) levels were first recorded. Multiple readings were then taken at different phases of each procedure, mentioned above. Recordings were made at the level of the ear of the operating surgeon. Care was taken not to compromise the sterility of the operating procedure. Interference from extraneous sounds (alarms/bleeps/movement of trolleys and doors) was avoided, when noise levels were recorded. The operating rooms had a length of 8 m; breadth of 6 m and a height of 2.7 m with 7.6 cm hollow walls with a metal partition and plaster wood on either side. There was no sound absorbing material incorporated within the walls. During recordings, theatre doors were kept closed to avoid dissipation of sound energy. Additionally, a spectrum analysis of drill-generated noise was performed using a calibrated Bruel and Kjaer precision sound level meter, under similar conditions.

The noise levels were then correlated with the length of time necessary for the instruments to be used, before Health and Safety guidelines were breached. These recommendations stipulate that the maximum daily noise exposure should not exceed an equivalent dose (Leq d) of 85 dB. Once this stage has been reached steps should be taken to limit any further exposure to noise in the interest of hearing protection. This is also referred to as the 'First Action Level'.

Results

The results are shown in Table I. Overall, drills produced a louder sound than microdebriders. Large cutting burrs were the noisiest. Spectrum analysis revealed that the maximum intensity was at 3.15 kHz, closely followed by 4 kHz. The least sound was produced at 40 kHz and 31.5 kHz, followed by 0.63 kHz and 0.8 kHz. Essentially the sound produced by drills was between 1.6 kHz and 6.3 kHz (Table II). The results were then converted using the HSE 'Noise at Work guidance on regulations conversion' scale into the minimum time requried to breach the safety guidelines. This was found to be greater than 480 minutes on all occasions.

TABLE I
SOUND LEVELS OF POWERED INSTRUMENTS

Instruments	Decibel A mean	Standard deviation
Drills		
A) Cutting burrs		
1) Large	72.4	+/−1.79
2) Medium	71.2	+/−1.37
3) Small	68.8	+/−1.25
B) Diamond burrs	60.8	+/−0.82
Microdebriders	60.1	+/−0.74

TABLE II
FREQUENCY ANALYSIS OF DRILL GENERATED NOISE

Frequency (Hz)	Sound levels (dBA)
100	50
125	56
160	54
200	52
250	50
315	50
400	55
500	50
630	46
800	48
1000	52
1250	58
1600	60
2000	60
2500	60
3150	70
4000	66
5000	60
6300	62
8000	56
10000	60
12500	60
16000	56
20000	60
25000	50
31500	45
40000	40

Discussion

Studies of health hazards in the hospital environment identify noise as a significant contributor to anxiety, headaches, interference with problem solving and overall performance. On the other hand, noise level is not the only factor that causes permanent damage viz. loss of acuity, tinnitus or both. The duration of exposure should also be significant, since the entire effect is cumulative.[6] Studies usually report bench-tested results performed in experimental settings. In a typical example, it was found that, although most instruments respected HSE directives, it was possible to breach them during the use of certain orthopaedic devices eg. during intra-medullary nailing of long bone fractures or with the use of a plaster saw. The author, however, identified the need to measure actual sound levels during various standard operations in order to obtain the picture of daily noise exposure of surgeons.[7]

Assessment of risk to hearing can be quite challenging in an environment as subtle and variable as that associated with surgery. Attempts have been made to record the effects of noise from powered instruments, in specialities other than otolaryngology. In one study, high frequency hearing loss was found presumably from the use of air driven hand pieces in dental school faculty members but not in dental students.[8] Likewise it was found that powered bone cutting tools could cause hearing damage in orthopaedic surgeons and assistants. The authors said that half of the subjects showed high-frequency noise induced hearing loss.[9] However these only indirectly reflect actual sound levels. Beside, there are a number of additional factors that could influence the clinical picture.

- **Otolaryngological procedures may involve the use of drills or debriders**
- **The potentially deleterious effects on surgeons and ancillary staff of the noise levels produced when such instruments are used has not been measured previously**
- **This paper is a prospective study that reports the measured ambient noise levels and the spectrum of the sound produced by such equipment**
- **The conclusion of the study is that such instruments are not hazardous as the sound produced does not exceed current Health and Safety guidelines**

It is logical therefore, to find out intra-operative sound levels. In the only significant study, recordings were made in orthopaedic operating theatres. The authors checked noise at the level of the ear of the surgeon, anaesthetists, circulator and patient, during the use of different devices. They found potentially danagerous readings and advocated that all members of the surgical team and the patient wear OSHA certified ear protectors on such occasions.[6]

Our findings in contrast, show that sounds from powered tools used in ENT procedures are within permissible limits. Considering the length of procedures and corroborating the data for strength-duration i.e. noise-power, it can be said that their routine use does not represent an occupational hazard. This is borne out by our observation that the 'First Action Level' was found to be greater than 480 minutes. If on the other hand, higher intensities had been recorded, there would have been a need to curtail further exposure. The actual time would have differed depending on the level of noise. This would have translated as 55 minutes, 21 minutes and just 4.5 minutes, if the recorded intensities were 93 dB (A), 98 dB (A) and 105 dB (A) respectively.[7] The measurement of actual daily noise exposure, as was done here, is much more meaningful in quantifying risk to surgeons, than merely recording levels in the laboratory.

It has been remarked that often little or no attention is given to the design of the operating room itself, in order to deal with auditory effects.[10] In our study, we found that the theatre walls had no sound absorbing material. This implied a long reverberation time for sounds. Had noisier instruments been used, this could have led to significant noise pollution.

Analysis of the drill generated sound showed that the maximum intensity was at 3.15 and 4 kHz, followed by 6 kHz. This finding could provide an explanation for the pattern of noise-induced permanent threshold shift, which commences between 3 and 6 kHz, with a maximal effect at 4 kHz. By contrast, in another study high frequency loss was found typically peaking at 6000 Hz.[9]

It should be borne in mind that the HSE guidelines are a code of practice and are therefore for reference only. It clearly recognizes the fact that there are large inherent variations in susceptibility to noise damage between individuals. Confounding factors can raise the likelihood of damage despite 'safe' levels of sound. These include age, cumulative prior to exposure to noise, fatigue, inter-current disease, vascular status and medications.[6] Therefore the interpretation of our findings would vary from surgeon to surgeon, depending on whether they have 'tough' ears (absent risk factors) or 'tender' ears (in the presence of these factors).

Our results can also be used to address the question as to whether sound from the use of powered instruments, can affect the patient during surgery. There have been attempts to do so in the past. In a prospective study on patients undergoing mastoidectomy, bone conduction thresholds were studied to evaluate any adverse effect on cochlear function. The authors found that excession drilling caused only a temporary threshold shift, which had resolved at the time of unpacking the ear.[11] Parkin *et al.* reported that the average noise levels of drilling range from 65 to 96 dB (A) varying with the drill and burr used. But simultaneous drilling and suction irrigation generated noise ranged from 91 to 108 dB (A). They added that exposure to these noise levels could account for shifts in the hearing thresholds sometimes apparent in post-operative audiograms.[12] In another study, the authors found significant drop in hearing levels, in the upper limits of the audible frequencies. They said that high-frequency audiometry would be a sensitive tool to assess any damage caused to the inner ear by the use of bone drills.[13] The sound levels seen in our study are less likely to result in any significant permanent threshold shift in hearing, in patients. This confirmed what was claimed in the literature of the manufacturers who provided the powered instruments for our study. However, it was our intention to primarily find out whether sound levels pose an occupational risk to the surgeons. Hence a detailed evaluation was not done to find out the effects on hearing of patients. Future studies are needed in this direction.

Conclusion

To conclude, sound levels generated by powered instruments currently in use in ENT surgery, conform to HSE guidelines. Considering the duration of their use in any procedure, they are safe and do not pose an occupational hazard. There is neither a necessity to curb exposure to such noise nor is there any need to routinely use hearing protectors. However there are a number of confounding factors that can cause a wide variation in individual susceptibility to noise damage. These must be kept in mind while interpreting the results of the present study.

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