Peer-reviewed paper: submitted October 2013; accepted July 2014

Noise Levels in Dental School Clinics

Al-Dujaili M, Thomson WM, Meldrum R, Al-Ani AH

Corresponding author: Mohamad Al-Dujaili (mdujaili@gmail.com)

ABSTRACT

Prolonged exposure to noise is a little-investigated occupational hazard in dentistry. There is anecdotal evidence suggesting that noise levels in four student clinics at the School of Dentistry are higher than the current occupational noise level guidelines in New Zealand, Australia and the United Kingdom, which suggest that levels should not exceed 85 dB(A) over a duration of 8 hours. The objectives of this study were to (1) measure the noise levels in the student clinics, and (2) determine whether they exceed current guidelines for occupational noise levels.

Method: a noise level meter was used to measure the decibel recordings in dB(A), before and during clinical sessions. The types of procedures being carried out by the students were recorded.

Results: 127 background recordings and 126 activity recordings were made, with measured noise levels ranging from 50.2 to 77.6 dB(A) for background levels, and 51.4 to 98.0 dB(A) during activity, with means of 60.8 and 70.5 dB(A) respectively. Measurements made in one clinic (the 4SW clinic) were significantly higher than those made in the other clinics ($P<0.001$), and one (clinic 2N) gave the lowest readings.

Conclusion: Noise levels recorded from the clinics at the Otago School of Dentistry exceed those specified in the current New Zealand Occupational Health and Safety guidelines, but they are intermittent rather than continuous.

INTRODUCTION

Dentistry is regarded as a relatively elite occupation, but it remains a significantly hazardous one, with exposure to infectious disease, radiation, hazardous materials, burns, dermatitis, allergies, respiratory disorders, percutaneous injuries, neuropathies, musculoskeletal injuries, eye injuries, psychological problems and acoustic disturbances (Leggat et al, 2007; Ayers et al, 2009). In relation to hearing loss, there are poorly set specific noise level guidelines, minimal holistic understanding of the progressive nature of the disease, and both the quantity and quality of the literature are sparse.

Humans are all accustomed to everyday “normal noise”, which is constantly present. When the sound is undesirable, it is referred to as “noise”. In measuring sound levels, instruments are used which resemble the human ear in the perception of noise of varying frequencies. The instruments measure the sound level in units called dB(A), which are adjusted to account for the approximate loudness perception of the human hearing. The human ear has the greatest sensitivity over the middle range of frequencies, which are those contained in human speech. At high and low frequencies, a much higher sound pressure level is required for those to sound as loud as a middle-frequency sound.

Workplace noise measurements indicate the combined sound levels of noise from a number of sources (such as machinery and materials handling) and background noise (such as that from ventilation systems, outdoor noise, cooling compressors, circulation pumps, and so on). Prolonged exposure to high noise levels by healthcare professionals, may have a negative effect on hearing (Thorne et al, 2008). Physical consequences can include tinnitus, hearing impairment, hypertension, annoyance and sleep disturbance (May, 2000). It is well known that general high sound levels have a negative effect on extra-auditory systems. These effects occur especially with noise levels above 85 dB(A) (Fernandes et al, 2006). Noise-induced hearing loss is the most common cause of acquired hearing loss. It is preventable. It occurs because prolonged exposure to excessive noise damages the delicate hearing mechanism of the inner ear. Noise-induced hearing loss (NIHL) occurs in 3 stages. However, it is not a sequential process and not all the sensory cells need to die prior to hearing loss. With excessive noise, the sensory cells within the cochlea are killed; these cells do not regenerate and healing occurs by scar tissue formation. With high, sustained or prolonged exposure to excessive noise, hearing loss becomes detectable audiometrically. It is the hair cell death associated with excessive noise that leads to the gradual loss of hearing, and it is probably due to the cumulative loss of sensory cells and neurons over time (Walls, 1994). Finally, the loss of hearing involves the lower pitches, which are necessary for understanding speech, and this is when the patient becomes aware of the problem.

Initially, excessive noise causes a temporary hearing loss – known as a temporary threshold shift (TTS) – and hearing recovers to normal over a period of time. A TTS may occur when a person’s exposure to noise exceeds the equivalent of 85 dB(A) for 8 hours or a peak sound pressure of 140 dB. Repeated exposure to such noise levels normally transforms this into a permanent loss, or permanent threshold shift (PTS). However, the transformation to a PTS may be produced by a single exposure, without an intervening TTS. TTS and PTS may be accompanied by a ringing in the ears known as tinnitus. This can also become permanent. The extent of noise-induced hearing loss depends on the noise’s intensity, duration and frequency. Put simply, the longer a person is exposed to excessive noise, the greater the degree of hearing loss which results: more time equals more acoustic energy, and more irreversible damage as a consequence (Walls, 1994; NZ Health and Safety, 2002).

Only one previous study has determined noise levels in a dental school. It was conducted at the University of Porto by Fernandes et al. (2006), who used audiometric recorders at ear level and at a 1m distance from the noise source. Sound level measurements ranged from 60 to 99 dB(A), with used equipment found to be noisier than new equipment. The number of samples in this study was small, and there was no standardisation of recording method.

This investigation at the Dental School at the University of Otago (in Dunedin, New Zealand) was carried out as a result of anecdotal evidence suggesting that noise levels were greater in one particular clinic, and associated concern among staff and students alike that the levels could be well above the "acceptable standard". The aim of this investigation was to measure noise levels in the student clinics and compare the readings in reference to the 4SW clinic.

METHODS

The study was carried out in August 2009. Ethical approval was not required. The four clinics which were investigated were 4Southwest "4SW" (with 22 dental units), 4Southeast "4SE" (n=21), 4North "4N" (n=42) and 2North "2N" (n=42). Practitioners had been given a very brief description of the purpose of our presence and asked for their consent ("We are just going to take sound level measurements, do nothing differently than you were intending", "is that ok?"). Sound recordings measured background and activity levels, and were made beside each dental unit, within 30 cm at the level of the headrest with the dental chair in supine position. One sound level meter (Dick Smith Electronics; model Q1362) was used, with the dB(A) recording setting. The sound level meter was purchased pre-calibrated, and was capable of measuring in the A weighting with both a minimum and maximum dB recording.

Background recordings were made prior to student clinics commencing, during the period 8am to 9.30am, when clinic activity was minimal (neither students nor patients were present). These took place over several days until all dental units were accounted for. Activity recordings were measured during clinic times, approximately 40 minutes after each clinic session had commenced, in order to give the students a chance to reach 'normal' noise levels.

Background measurements were recorded by placing the sound level recorder next to the dental chair headrest for at least 10 seconds. The 'peak dB' setting was used to give the peak decibel level recorded during 10 seconds at the location. The reading was then recorded, the recorder was reset and the same method used again at the next dental unit. Activity measurements were recorded by sometimes explaining to the clinician (if curiosity was raised) at the unit in a non-standardised way. The sound level recorder was then placed within 10 cm of the clinician's right ear, above the shoulder and using the 'peak dB' setting, recording for approximately 10 seconds. The measurement was then recorded and the recorder was reset. The method was repeated until all dental units in each clinic were accounted for, over a period of one week.

Measurements recorded were entered into a data-set and analysed using SPSS. Differences among clinics in mean sound levels were tested for statistical significance using oneway analysis of variance. Background and activity sound level differences were examined using paired t-tests. Differences in prevalence were examined using Chi-square tests; in those, differences between cells were identified by scrutinising the standardised residuals. The alpha level was set at 0.05.

RESULTS

There were 253 baseline and activity recordings in the four clinics (Table 1). Participation consent was not obtained from one operator, meaning that recordings were not made for that particular chair.

Table 1. Number of measurements, by clinic and activity

	Number of chairs measured
All clinics combined	126
Clinic	
4 Southwest	22
4 Southeast	21
4 North	41
2 North	42
Activity type	
Bay empty	50
Talking to patient/Other	55
Suction and drilling/scaling	21

The sound recording data are summarised in Table 2. Sound levels were normally distributed. For all clinics, the mean background recordings were significantly lower than the sound levels during activity. There was a statistically significant difference observed among the four clinics, with clinic 4SW the noisiest during both background and activity measurements. Using suction and drilling or scaling resulted in significantly higher noise levels than talking with patients or undertaking other activities.

No background recordings exceeded the 85dB(A) threshold value for hearing damage, but one in twelve chairs measured during activity exceeded this threshold. Of the chairs that did, just over one-fifth were in clinic 4SW. More than half of the activity measurements made while the operator was using suction and drilling or scaling were over the threshold.

DISCUSSION

This study of noise levels at the University of Otago Dental School was carried out due to anecdotal evidence suggesting higher-than-tolerable noise reported by the staff and students, particularly within clinic 4SW. It found that one in twelve chairs exceeded the current recommendations, and of these, over 20% occurred in one particular clinic. Procedures involving suction, drilling or scaling were more likely to exceed the noise threshold.

There were some limitations to this investigation. The clinics have numerous chairs all producing different noises at the same time, and there is the possibility of a degree of "noise overlap", particularly with adjacent chairs. The dynamic nature of the surroundings when measurements were recorded led to some difficulty categorising the activities, because the environment was continually changing and so were the recordings. Ideally, measurements should have been taken at the same time by multiple recorders at each chair, with standardised locations and over a predetermined period, but resource constraints and the realities of day-to-day clinic usage meant that this was not possible. A wide range of equipment is currently in use at the institution, with differences in age and level of deterioration, which might have contributed to variance in the recordings. Similarly, anecdotal reports suggest that the suction units associated with the chairs in the 4SW clinic are stronger (and perhaps noisier) than those in the other clinics, and this might have led to higher recordings from that clinic. Alternatively, the 4SW clinic could have been the noisiest simply because it is primarily used by final-year dental students, who are likely to be undertaking

Table 2. Mean background and activity noise levels, by clinic and activity type (brackets contain standard deviations unless otherwise indicated)

	Mean noise level in dB(A)		Range of readings		Number (%) exceeding 85 dB(A) threshold	
	Background	Active	Background	Active	Background	Active
All clinics combined	60.8 (4.3)	70.5(10.1)[a]	50.2 to 77.6	51.4 to 98.0	0 (0.0)	10 (7.9)
Clinic						
4 Southwest	61.1 (1.0)[b]	81.9 (6.5)[c]	59.5 to 63.4	73.6 to 98.0	0 (0.0)	5 (22.7)[e]
4 Southeast	62.3 (1.6)	72.1(10.7)	59.6 to 66.5	59.1 to 97.6	0 (0.0)	3 (14.3)
4 North	58.3 (4.2)	69.5 (7.7)	50.2 to 68.4	55.6 to 87.8	0 (0.0)	2 (4.9)
2 North	62.3 (5.4)	64.7 (8.5)	51.1 to 77.6	51.4 to 81.2	0 (0.0)	0 (0.0)
Activity type						
Bay empty	—	63.6 (7.1)[d]	—	51.4 to 79.6	—	0 (0.0)[f]
Talking to patient/Other	—	71.5 (6.9)	—	59.1 to 83.5	—	0 (0.0)
Suction and drilling/scaling	—	84.4 (7.8)	—	67.4 to 98.0	—	10 (47.6)

[a] *P<0.001; paired t-test*
[b] *P<0.001; Oneway ANOVA: 4 North clinic differs from the other three*
[c] *P<0.001; Oneway ANOVA: all clinics differ from one another except for 4 Southeast and 4 North*
[d] *P<0.001; Oneway ANOVA: all activities differ from one another*
[e] *P = 0.008; Chi-square test; the rate in 4 Southwest was higher than that of the other 3*
[f] *P <0.001; Chi-square test; the rate during suction and drilling/scaling was higher than during the other two activities*

more complex procedures requiring the use of high-speed turbines and suction.

There is much interest in the long-term effects of exposure to high levels of noise in dentistry, because dental personnel work with noisy equipment such as handpieces and ultrasonic scalers. The literature provides no consensus on the issue. The current study's findings showed a substantial proportion of recordings exceeding 85 dB(A). Although the noise is not continuous, its effects may aggregate with prolonged exposure. A person would have some hearing damage after exposure to 85 dB(A) for 8 hours (Walls, 1994); given the measurements reported here, this seems well within the working hours of a dentist. Furthermore, for each 3 dB increase in noise after 85 dB, the required exposure time for damage to occur is halved, so that a person subjected to 88 dB(A) for 4 hours would get the equivalent exposure; with 91 dB(A), only 2 hours would be needed.

The consensus of guidelines set in recent publications is that dentists are exposed to high levels of noise but not for long enough durations of time to cause acoustic damage. During equipment testing for the current study, the maximum test recording of 107 dB(A) was measured when the corner of a dental (rubber) dam was caught in the high volume dental suction, as frequently happens in the student clinics. The individual would have to be exposed to this noise for 4 minutes to sustain some hearing damage. Apart from the noise level, hearing loss is affected by the duration and distance from the source of noise, and the age and susceptibility of the individual (Fernandes et al, 2006). It is recommended that noise levels should always be kept as low as possible, in order to minimise any possibility of occupational noise-induced hearing loss.

How can the issue of noise exposure be mitigated in the Dental School environment? Sound absorption and insulation are two principles that can be applied. The installation of acoustic gypsum partitions between cubicles at an appropriate height can be considered. Ceiling tiles and panels, carpets and draperies can also be used (with appropriate concessions to cross-infection control) to absorb the noise rather than reflect it between cubicles. These can prevent transmission of noise, and the use of porous material like fibreglass can help absorb the sound energy and convert it to heat within the material. Earplugs and earmuffs are used in the industrial sector where the noise levels are considerably higher for longer periods of time, and these have been recommended for use in dentistry (Szymanska, 2000). Apart from these modifications, only high-quality equipment should be used, along with periodic inspections of it with respect to noise levels. It is recommended that dental operators should attempt to maintain a maximal distance from the operating field/equipment when working, with appropriate concessions to ergonomics and posture. A minimum distance of 35 cm has been reported between the operator's eye and the patient's mouth (Kilpatrick, 1981).

Recommendations for future investigations should consider other clinical and preclinical areas (such as dental laboratories). The equipment make and age should be recorded. Activities should be further categorised by measuring different instruments individually. The use of multiple recordings over a period of time would provide for a more accurate representation of the noise level at each chair, in each clinic. Consideration should be given to allow multiple operators to take measurements, in order to maximise measurement validity and reliability. Sound decibel recordings should also include the frequency of sound pressure for more accuracy as well as a measure for cumulative exposure with the use of dosimetry. Finally, the extent and nature of hearing loss among dental students and staff should be determined, and regular audiology tests for students and staff could be implemented.

ACKNOWLEDGMENTS

We would like to thank Dr Sahil Soni, along with all of the students, patients and staff who participated in this study.

REFERENCES

Ayers KMS, Thomson WM, Rich AM, Morgaine KC, Newton JT (2009). Self-reported occupational health of general dental practitioners. Occ Med 59: 142-148.

Department of Labour (2002). Management of noise in the workplace. Occupational Health & Safety

Fernandes S, Carvalho AP, Gallas M, Vaz P and Matos PA (2006). Noise levels in dental schools. Eur J Dental Ed 10: 32–37.

Kilpatrick H (1981). Decibel ratings of dental office sounds. J Prosthet Dent 45: 175-178.

Leggat P, Kedjarune U, Smith D (2007). Occupational health problems in modern dentistry; a review. Ind Health 45: 611-621.

May J (2000). Occupational hearing loss. Am J Ind Med 37: 112-120.

Szymanska J (2000). Work related noise hazards in the dental surgery. Ann Agri Environ Med 7: 67–70.

Thorne PR., Ameratunga S, Stewart J, Reid N, Williams W, Purdy S.C, Dodd G., Wallaart, J. (2008). Epidemiology of noise-induced hearing loss in New Zealand. NZ Med J 121; 1-9.

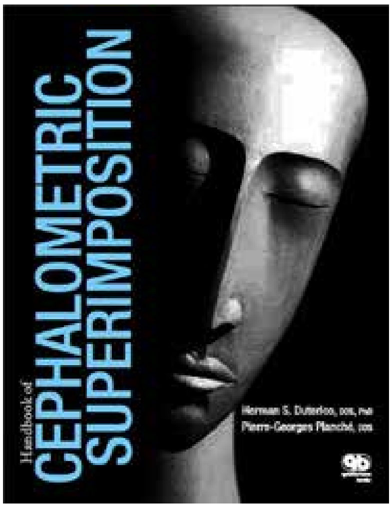
Walls C (1994). Noise-induced hearing loss of occupational origin–a guide for medical practitioners. Occupational Safety and Health Service, Department of Labour, NZ.

Book Reviews

Handbook of Cephalometric Superimposition.

Herman S Duterloo and
Pierre-Georges Planché, 2011.
Chicago: Quintessence.
ISBN: 978-0-86715-508-2.
Contains 220 pages. Price, US$118.00.

Cephalometric superimposition is a useful method for evaluating facial growth and treatment-related effects in orthodontic patients. The book offers a comprehensive guide for orthodontists and postgraduate students on this topic.



This hardcover text is organised into eight chapters that include the history of superimposition methods, the validity, and reliability of the method, and the interpretation of both general and regional superimpositions. The last two chapters provide in-depth instructions for producing manual and computer-based superimpositions (using Adobe® Photoshop/Illustrator).

Based on the reviewer's experiences, the computerised method produces extremely high quality superimpositions but is rather time consuming and requires some degree of experience with Adobe® software products. One of the advantages of the superimposition technique suggested by the authors is the use of transfer guides and implant lines, which greatly simplify the interpretation of the superimpositions.

The book also includes wonderful illustrations throughout, including the three chapters on the interpretation of facial growth, image variation, and treatment-related changes.

Each chapter is also well referenced, allowing clinicians to read further if an area particularly interests them.

It is noteworthy that the authors are strong advocates of (Björk's) structural method, and accordingly, there is a strong focus on this particular superimposition method. Although the structural method is often accepted as the "gold standard" in orthodontic circles, the authors could have mentioned other methods (for example, best fit), useful in some cases where the anatomical landmarks used in the structural method are not clearly visible on the radiographs.

This handbook covers this important topic in a logical and concise manner. Given the limited availability of good resources in this area, this book is likely to be an important reference for every postgraduate orthodontic student, experienced clinicians as well as those interested in cephalometrics and post-natal craniofacial growth.

Joseph S Antoun and Florence Bennani (Dunedin)