

Noise Levels in Adult and Pediatric Orthopedic Cast Clinics

Jonathan P. Marsh, MD, BSc (Med), Paul Jellicoe, MD, BSc, MBChB, FRCS, LLM, Brian Black, MD, FRCSC, Ronald C. Monson, MD, FRCSC, and Tod A. Clark, MD, MSc, FRCSC

Abstract

Prolonged exposure to high-intensity noise has been associated with noise-induced hearing loss, hypertension, psychological stress, and irritability. The National Institute of Occupational Safety and Health considers levels above 85 decibels (dB) as harmful.

In the study reported here, we sought to determine whether noise levels in orthopedic cast clinics were within safe limits. A calibrated noise dosimeter was worn by cast technologists during 7 adult and 7 pediatric cast clinics, and noise levels were recorded.

Mean equivalent continuous noise levels were 77.8 dB (adult clinics) and 76.5 dB (pediatric clinics), mean noise levels adjusted for an 8-hour day were 76.6 dB (adult) and 75.9 dB (pediatric), and mean peak noise levels were 140.0 dB (adult) and 140.7 dB (pediatric).

Mean noise levels in cast clinics were within safe limits and there was no statistical difference in noise levels between adult and pediatric clinics. However, peak noise levels in all clinics exceeded recommended limits, and even brief exposure to noise of this intensity may be hazardous.

Noise-induced hearing loss (NIHL) is a well-known consequence of prolonged exposure to high levels of noise. It is an irreversible disability linked to other effects, such as hypertension, psychological stress, and irritability.¹ The National Institute for Occupational Safety and Health (NIOSH) estimated that more than 30 million employees in the United States are exposed to hazardous levels of noise each year, rendering NIHL a compensable occupational disability.¹

Dr. Marsh is Orthopedic Surgery Resident, Section of Orthopedic Surgery, University of Manitoba, Winnipeg, Manitoba, Canada.

Dr. Jellicoe, Dr. Black, and Dr. Monson are Pediatric Orthopedic Surgeons, Winnipeg Children's Hospital and Section of Orthopedic Surgery, University of Manitoba, Winnipeg, Manitoba, Canada.

Dr. Clark is Hand Surgeon, Pan Am Clinic, Section of Orthopedic Surgery, University of Manitoba.

Address correspondence to: Jonathan P. Marsh, MD, BSc (Med), Section of Orthopedic Surgery, University of Manitoba, AD 420-820, Sherbrook St, Winnipeg, Manitoba, R3A 1R9, Canada (tel, 204-787-1219; fax, 204-787-2460; e-mail, ummarshj@cc.umanitoba.ca).

Am J Orthop. 2011;40(7):E122-E124. Copyright Quadrant HealthCom Inc. 2011. All rights reserved.

Noise levels are routinely measured in A-weighted decibels (dB), which are within the range detectable by the human auditory system. The NIOSH recommended exposure limit is 85 dB, as an 8-hour time-weighted average (TWA) (Table).¹ Exposures at or above this level are considered hazardous. Noise-reduction measures, including administrative or engineering controls, personal hearing protection devices, and audiometric testing of workers are mandatory for noise levels above 85 dB.¹

Much of the work related to NIHL and occupational noise exposure has focused on the mining, manufacturing, and aerospace industries. However, over the past few decades, the topic of NIHL in health care has emerged. Workplace safety in the health care industry is of utmost concern. Guidelines and policies have been developed to protect workers from needle-stick injuries, infection transmission, low-back injury secondary to heavy lifting, and repetitive use syndromes. In orthopedics, work has been conducted to minimize the risk for intraoperative splash injuries and radiation exposure and, more recently, to determine the risk for noise exposure.²⁻⁶ It has been determined that noise levels in the operating room routinely exceed 100 dB and are occasionally in excess of 120 dB.³ In addition, NIHL has been documented in cast technicians and orthopedic surgeons and has been associated with duration of exposure.^{2,7}

Orthopedic surgeons and cast technicians spend a large amount of time in clinics, where the potential for hazardous noise levels is high. Despite great public interest in occupational safety, and a large amount of work focused on the health care field, there is a paucity of data regarding noise levels in orthopedic cast clinics. In the study reported here, we sought to determine whether noise levels in adult and pediatric orthopedic cast clinics were within safe limits.

MATERIALS AND METHODS

Given the high levels of cast clinic noise reported by orthopedic surgeons, patients, and cast technologists, a pilot study was undertaken. A calibrated noise dosimeter was affixed to the shoulder of an orthopedic technologist for an entire pediatric cast clinic. Recording duration was 4 hours 55 minutes, and TWA for the 8-hour day was 78.3 dB with peak noise level in excess of 111 dB. These findings prompted us to conduct a formal study of noise levels in both adult and pediatric cast clinics.

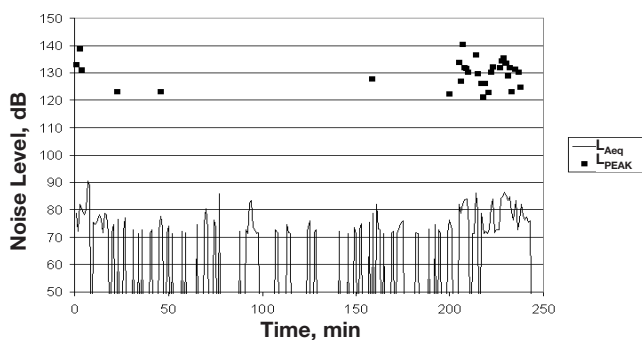


Figure 1. Representative sample of raw noise-recording data from adult cast clinic: mean noise level (L_{Aeq}), instantaneous peak noise level (L_{PEAK}).

The study took place in 2 cast rooms at our institution. The 12×25-foot children’s room could accommodate up to 3 patients at a time and had a 12-foot ceiling. The 48×20-foot adult room could accommodate up to 6 patients at a time and had a 10-foot ceiling. Patients were seen in these rooms for cast application and removal and follow-up assessment and treatment. Each clinic had 2 cast saws (Castvac 986; Stryker, Kalamazoo, Michigan) which were used to remove casts. Both had a vacuum near the blade to remove dust as casts were cut.

All the cast clinics conducted over a 10-day period at our institution were included in the study—yielding 7 adult and 7 pediatric clinic recordings. Between 1 and 4 cast technologists were working each clinic. Before clinic, 1 technologist was randomly assigned to wear a noise dosimeter by an individual not involved in the study. The calibrated noise dosimeter (CR:110A; Cirrus Research, Hunmanby, North Yorkshire, England) was affixed over the shoulder on the side the technologist held the cast saw. Noise levels were recorded during the entirety of each clinic.

The data recorded by the noise dosimeter were downloaded and analyzed with the software provided by the dosimeter manufacturer. Statistical analysis of the data was undertaken using *t* test to determine if a difference in noise levels existed between the adult and pediatric clinics. The results were interpreted using the NIOSH recommendations for a criterion standard.¹

RESULTS

Mean recording duration was 5 hours 50 minutes (adult clinics) and 6 hours 28 minutes (pediatric clinics). Figure 1 shows a representative sample of the raw noise-recording data from 1 clinic. Equivalent continuous noise level (L_{Aeq}) was mean noise level during the recording period. Mean (SD) L_{Aeq} was 77.8 (1.55) dB (adult clinic) and 76.5 (2.56) dB (pediatric clinic). TWA, as calculated by the dosimeter, was used to determine mean noise exposure over an 8-hour period based on noise levels during the recording period. When the recording period was less than 8 hours, the rest of the 8-hour period was assumed to be quiet. Mean (SD) TWA was 76.6 (1.53) dB (adult clinics) and 75.9 (2.77) dB (pediatric clinics). Peak noise

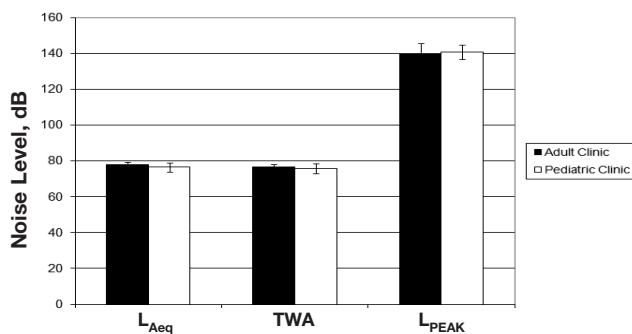


Figure 2. Mean (SD) noise levels in adult and pediatric cast clinics: equivalent continuous noise level (L_{Aeq}), time-weighted average for 8-hour day (TWA), peak noise level (L_{PEAK}), decibels (dB).

level (L_{PEAK}) was maximum impulse noise level at any instant of the recording period. Mean (SD) L_{PEAK} was 140.0 (5.49) dB (adult clinics) and 140.7 (4.15) dB (pediatric clinics). Between the adult and pediatric cast clinics, there was no significant difference with respect to recording duration ($P = .24$), L_{Aeq} ($P = .42$), TWA ($P = .64$), or L_{PEAK} ($P = .73$) (Figure 2).

DISCUSSION

It has been well documented that orthopedic surgeons, support staff, and patients are exposed to very high L_{PEAK} in the operating room, particularly during total knee and total hip replacements.³ Holmes and colleagues² reported NIHL (in cast technologists) related to years of exposure. There was more hearing loss on the side the technologist held the cast saw. These findings imply that NIHL is a disability for which orthopedics staffs are at risk, and that NIHL may be related to the noise produced by cast saws.

Our study results showed that the L_{PEAK} of cast saws plus cast-room voices far exceeded recommended limits and was higher than that reported in operating rooms. Mean L_{PEAK} during all clinics in our study was 140.3 dB, which is a concern, as NIOSH has indicated that impulse noise levels should never exceed 140 dB (Table). Formal hearing-loss prevention programs are not man-

Table. National Institute for Occupational Safety and Health (NIOSH) Noise Exposure Levels and Maximum Permissible Exposure Time¹

Noise Level, dB	Maximum Permissible Exposure Time		
	h	min	s
80	25	24	—
85	8	—	—
90	2	31	—
95	1	—	—
100	—	15	—
105	—	4	43
110	—	1	29
115	—	—	28
120	—	—	9
125	—	—	3
130	—	—	1
135	—	—	<1
140	—	—	0

datory based on high L_{PEAK} if TWA is less than 85 dB. However, it is recommended that workers wear hearing-protection devices, such as earmuffs, during activities that may produce high impulse noise—such as using a cast saw.

The inspiration for this study came from the intense noise levels reported by staff and patients in cast clinics. Good correlation has been found between noise exposure reported by workers and hazardous noise levels recorded by dosimeters.⁸ Warning signs of hazardous noise are the need to raise one's voice to be heard 2 feet away and speech sounds being muffled after departure from a noisy area.⁸ Although TWAs in the cast clinic were under the 85-dB threshold, staff and patient exposure to subjectively high noise levels should raise concern regarding potentially hazardous noise levels.

Intense noise not only causes irreversible hearing loss but may lead to increased patient anxiety. Carmichael and Westmoreland⁹ randomly assigned 20 children to hearing protection or no hearing protection, and measured changes in heart rate as a marker of anxiety as the children entered a cast clinic. There were significantly lower heart rate increases in the children with hearing protection, but 25% of these children did not tolerate wearing that protection. Liu and colleagues¹⁰ found that lullaby music in the cast clinic decreased anxiety among pediatric patients. These findings suggest that noise in the cast clinic increases anxiety among children. The resultant psychological effect of such anxiety may be enormous—further reinforcing the need to decrease noise levels.

We conclude that mean noise levels in these cast clinics were within safe limits. However, L_{PEAK} exceeded the recommended limit, and, for brief periods, clinic noise levels were very high. These noise levels may pose a risk for NIHL.

Cast rooms and cast saws vary in size and design, so it is difficult to generalize our findings to all clinics. As noise levels in very large and very small cast rooms may

differ substantially, we recommend that baseline noise-level testing be performed in all cast clinics. Patients and staff in cast clinics should use personal hearing-protection devices while cast saws are being used. Designers of clinics should consider engineering noise-reduction strategies, and level of noise production should be taken into account when purchasing cast saws.

AUTHORS' DISCLOSURE STATEMENT AND ACKNOWLEDGMENTS

The authors report no actual or potential conflict of interest in relation to this article. They thank the Department of Orthopedic Technology Services at the Health Sciences Centre in Winnipeg for assistance in data collection.

REFERENCES

1. National Institute of Occupational Safety and Health. *Criteria for a Recommended Standard: Occupational Noise Exposure, Revised Criteria 1998*. Cincinnati, OH: National Institute of Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service, US Dept of Health and Human Services. DHHS (NIOSH) publication 98-126. <http://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf>. Published June 1998. Accessed May 17, 2011.
2. Holmes GB Jr, Goodman KL, Hang DW, McCorvey VM. Noise levels of orthopedic instruments and their potential health risks. *Orthopedics*. 1996;19(1):35-37.
3. Kracht JM, Busch-Vishniac IJ, West JE. Noise in the operating rooms of Johns Hopkins Hospital. *J Acoust Soc Am*. 2007;121(5 pt 1):2673-2680.
4. Love H. Noise exposure in the orthopaedic operating theatre: a significant health hazard. *ANZ J Surg*. 2003;73(10):836-838.
5. Nott MR, West PD. Orthopaedic theatre noise: a potential hazard to patients. *Anaesthesia*. 2003;58(8):784-787.
6. Sydney SE, Lepp AJ, Whitehouse SL, Crawford RW. Noise exposure due to orthopedic saws in simulated total knee arthroplasty surgery. *J Arthroplasty*. 2007;22(8):1193-1197.
7. Willett KM. Noise-induced hearing loss in orthopaedic staff. *J Bone Joint Surg Br*. 1991;73(1):113-115.
8. Ahmed HO, Dennis JH, Ballal SG. The accuracy of self-reported high noise exposure level and hearing loss in a working population in eastern Saudi Arabia. *Int J Hyg Environ Health*. 2004;207(3):227-234.
9. Carmichael KD, Westmoreland J. Effectiveness of ear protection in reducing anxiety during cast removal in children. *Am J Orthop*. 2005;34(1):43-46.
10. Liu RW, Mehta P, Fortuna S, et al. A randomized prospective study of music therapy for reducing anxiety during cast room procedures. *J Pediatr Orthop*. 2007;27(7):831-833.

This paper will be judged for the Resident Writer's Award.
