



## Early Predictors of Hearing Loss

The goal of conducting annual audiometric testing for workers exposed to noise is to identify hearing loss at an early stage. At the first sign of hearing loss, interventions to reduce further exposure to noise can be implemented; the goal is to reduce the further development of more severe hearing loss. Possible work place interventions can include:

- ◆ Engineering changes to reduce or eliminate noise
- ◆ Hearing protective devices
  - Providing to employees
  - Assurance of use
  - Education on proper use
  - Provision of hearing protection with a higher noise reduction rating (NRR)
- ◆ Administrative shifts to less noisy jobs

The current OSHA rule for recording a work-related hearing loss is: an average of a 10db or greater loss at 2000, 3000, and 4,000 hertz in either ear from the baseline exam along with a hearing threshold level of 25db or worse averaged over 2000, 3000 and 4000 hertz. Although only a recording requirement, this degree of hearing loss has also become the level at which many companies institute intervention with the affected worker.

A recent article examined changes in hearing loss that are predictive of an OSHA “recordable” hearing loss (1). Using earlier shifts in hearing to initiate intervention would potentially reduce the number of individuals who develop OSHA “recordable” hearing loss as well as even more severe hearing loss.

The authors used data from 11 Alcoa locations. The study included workers with at least three audiometric tests since 1982, and no gap between tests longer than two years. The cohort was comprised of 33,273 individuals. The median follow up for each individual was six years.

Table 1 shows the 12 Early Indicator flags ex-

**Table 1. Candidate “Shift Criteria” of Occupational Noise-Induced Hearing Loss**

### Shift Criteria

1. Non-age-corrected STS (10 dB Shift in (2, 3, 4 kHz)
2. Non-age-corrected STS TWICE (10 dB Shift in (2, 3, 4 kHz twice)
3. AAO (10 dB Shift (0.5, 1, 2 kHz) or 15 dB in (3, 4, 6 kHz)
4. 1972 NIOSH Shift (10 dB Shift (0.5, 1, 2, 3 kHz) or 15 dB in (4, 6 kHz)
5. 15 dB Shift (15 dB Shift in 0.5-6 kHz)
6. 15 dB Shift Twice (15 dB Shift in 0.5-6 kHz twice)
7. 15 dB Shift Twice (1-4 kHz)
8. 10 dB Avg 3-4 kHz (10dB Shift in average of 3 and 4 kHz)
9. 15 dB Shift 3, 4, 6 kHz (15 dB Shift in average of 3, 4, and 6 kHz)
10. Age-corrected 5 dB Shift (age-adjusted 5 dB Shift in 2, 3, 4 kHz)
11. Age-corrected 8 dB Shift (age-adjusted 8 dB Shift in 2, 3, 4 kHz)
12. Age-corrected 10 dB Shift (age-adjusted 10 dB Shifts in 2, 3, 4 kHz)

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amined by the authors to predict individuals who will develop OSHA “recordable” hearing loss. The shift criteria definitions for these flags generally were for 10dB and 15dB shifts in hearing from baseline, using different combinations of frequencies. Other shifts examined included 5dB and 8dB shifts in two different periodic tests.

Table 2 summarizes the likelihood of developing an OSHA “recordable” hearing loss using the 12 shift criteria definitions. The table shows the development of OSHA “recordable” hearing loss at 5 and 10 years after the occurrence of an Early Indicator Flag. The authors found that the best predictors for OSHA “recordable” hearing loss were using the age-

adjusted averages for 8db and 10db shifts occurring twice in different years at 2000, 3000 and 4000 hertz. These two definitions predicted 73.3% and 86.6% of hearing loss, respectively, for workers 10 years after their baseline hearing tests. The third best predictor at 10 years was using the 10 db shift at 2000, 3000, and 4000 hertz occurring twice in different years without age adjustment, with 66.5% of hearing loss predicted.

Initiating intervention when one of these “early flags” occurred would potentially reduce progression of hearing loss from becoming an OSHA “recordable” event or an even more severe case of work-related noise-induced hearing loss.

**Table 2. Probability of Developing an OSHA Recordable Hearing Loss (ORHL) After an Early Indicator (EI) (193 OSHA Recordable Shifts, n = 3273)**

Early Indicator Flags (EI)	No. Flagged	No. With ORHL Flagged	Median Time to EI (yrs)	Median Time to ORHL (yrs)	% Developing ORHL Year After Early Indicator	
					5	10
1. 10 dB STS (10 dB shift in average of 2, 3, 4 kHz)	943	193	3.9	1.7	21.3	40.9
2. 10 dB STS Twice (10 dB shift in average of 2, 3, 4 kHz)	568	193	5.3	1.1	39.9	66.5
3. AAO (10 dB Shift (0.5, 1, 2 kHz) or 15 dB in (3, 4, 6 kHz))	959	185	4.3	1.1	20.8	32.7
4. 1972 NIOSH Shift (10 dB shift (0.5, 1, 2, 3 kHz) or 15 dB in (4, 6 kHz))	2779	193	1.6	4.0	5.9	13.5
5. 15 dB Shift (15 dB shift in 0.5-6 kHz)	2234	192	2.3	3.3	8.3	16.7
6. 15 dB Shift twice (15 dB shift in 0.5-6 kHz twice)	1229	193	3.1	2.3	15.4	28.4
7. 15 dB Shift twice (1-4 kHz)	892	193	4.0	2.0	22.9	38.3
8. 10 dB Average 3-4 kHz (10 dB shift in average of 3 and 4 kHz)	1257	190	3.0	2.6	14.8	27.7
9. 15 dB Shift 3,4, 6 kHz (15 dB shift in average of 3, 4 and 6 kHz)	590	168	5.6	0.4	32.2	45.2
10. Age-adjusted 5 dB Shift twice (age-adjusted 5 dB shift in (2, 3, 4 kHz))	945	193	2.5	2.7	21.0	37.6
11. Age-adjusted 8 dB Shift twice (age-adjusted 8 dB shift in (2, 3, 4 kHz))	457	193	3.8	1.1	49.4	73.3
12. Age-adjusted 10 dB Shift twice (age-adjusted 10 dB shift in (2,3,4 kHz))	263	193	4.7	0.3	81.9	86.6

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## Motivating Individuals To Use Hearing Protection

In the Winter/Spring 2006-2007 *Now Hear This* newsletter we presented research on the Extended Parallel Processing Mode of Persuasion (EPPM) which we had used to evaluate two brochures we developed to encourage farmers and landscape workers to use hearing protection. The article has now been published in the *Journal of Applied Communication Research* (2). There are two steps to this health communication model:

- ✓ First, induce the threat of a hazard. Recipients must believe the threat is severe and that they are susceptible.
- ✓ Second, induce the individual's perception of the effectiveness of the recommended response. Recipients must believe there is an effective action they can take to guard against the threat.

The model predicts that if both the perceived threat and effectiveness is high then people will engage in danger control. The model then predicts that if the threat is high but the perceived effectiveness is not high then people will practice fear rather than danger controls. Surveys of farmers and landscapers pre and post reading of their respective brochure showed the brochure induced the right degree of threat and effectiveness and increased the intention of the readers to use hearing protection in their future work.

## REFERENCES

- (1) Rabinowitz PM, Galusha D, Ernst CD, Slade MD. Audiometric "Early Flags" for Occupational Hearing Loss. *Journal of Occupational and Environmental Medicine* 2007; 49:1310-1316.
- (2) Smith SW, Rosenman K, Kotowski MR, Glazer E, McFeters C, Keesecker N, Law A. Using the EPPM to Create and Evaluate the Effectiveness of Brochures to Increase the Use of Hearing Protection in Farmers and Landscape Workers. *Journal of Applied Communication Research* 2008; 36:200-218.



### **National Institute on Deafness and Other Communication Disorders (NIDCD)...**

[www.nidcd.nih.gov/health/hearing/noise.asp](http://www.nidcd.nih.gov/health/hearing/noise.asp)

Provides straight-forward information on the ear, hearing, pathways of sound, and causes and prevention of noise-induced hearing loss.

### **National Institute for Occupational Safety and Health (NIOSH)...**

[www.cdc.gov/niosh/topics/noise](http://www.cdc.gov/niosh/topics/noise)

Resources on noise and hearing loss prevention, including brochures, checklists and an interactive noise meter.

Now Hear This...

Michigan State University  
College of Human Medicine  
117 West Fee Hall  
East Lansing, MI 48824-1316  
Phone (517) 353-1846

Address service requested.

In this issue:  
v11n2: Early Predictors of Hearing Loss

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1. A history of significant exposure to noise at work; AND
  2. A STS of 10 dB or more in either ear at an average of 2000, 3000 & 4000 Hz. And the employee's total hearing level is 25 dB or more at the same three frequencies. OR
  3. A fixed loss.\*
- \*Suggested definitions: a 25 dB or greater loss in either ear at an average of: 500, 1000 & 2000 Hz; or 1000, 2000 & 3000 Hz; or 3000, 4000 & 6000 Hz; or a 15 dB or greater loss in either ear at an average of 3000 & 4000 Hz.

**Suggested Criteria for Reporting Occupational NIHL**

Internet  
www.oem.msu.edu  
E-Mail  
ODREPORT@ht.msu.edu  
FAX  
517-432-3606  
Telephone  
1-800-446-7805  
Mail  
MIOSHA-MTS Division  
P.O. Box 30649  
Lansing, MI 48909-8149

Michigan Law Requires the Reporting of Known or Suspected Occupational NIHL  
Reporting can be done by:

**Project SENSOR Staff**

*At the Michigan Occupational Safety & Health Administration (MIOSHA)*

Douglas J. Kalinowski, Director MIOSHA  
Project SENSOR, Co-Director  
John Peck, M.S., Director MTS Division  
Byron Panasuk, I.H.  
Project SENSOR Specialist

*At Michigan State University—College of Human Medicine*

Kenneth D. Rosenman, M.D.  
Professor of Medicine  
Project SENSOR, Co-Director  
Mary Jo Reilly, M.S.  
Project SENSOR Coordinator  
TBA  
Project SENSOR NIHL Coordinator-  
Project SENSOR Office Staff:  
Tracy Carey, Now Hear This..., Editor  
Ruth VanderWaal  
Patient Interviewers:  
Amy Krizek  
Shannon Roehl  
Amanda Williams

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(517) 353-1846  
MSU-CHM  
117 West Fee Hall  
East Lansing, MI 48824-1316

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