

## **Dangerous Decibels<sup>®</sup> II: Critical components for an effective educational program and special considerations for hearing loss prevention devices for children**

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### **INTRODUCTION**

The World Health Organization - Prevention of Deafness and Hearing Impairment met in October, 1997 in Geneva, Switzerland to address the prevention of noise induced hearing loss (World Health Organization 1997). A subset of key points from that meeting included:

- Exposure to excessive noise is the major avoidable cause of permanent hearing impairment worldwide.
- Noise-induced hearing loss is an important public health priority because, as populations live longer and industrialization spreads, NIHL will add substantially to the global burden of disability.
- In a developed country, excessive noise is at least partially the cause in more than one-third of those with hearing impairment.
- In developed countries, the risk from social noise is increasing for young people.
- National Programs for prevention of noise-induced hearing loss should be established or strengthened in all countries and integrated with Primary Health Care (PHC).
- Because there is widespread ignorance of the hazard, awareness must be increased about the harmful effects of noise on hearing and about the prevention and control of noise-induced hearing loss.
- A positive image of hearing should be promoted, including its contribution to the daily quality of life.
- Communication and collaboration should be strengthened between developed and developing countries to facilitate research and development in this field.

In addition, the summary noted that “In North America recent studies of environmental noise have shown that children may receive more noise at school than workers from an 8-hour work day at a factory” and that globally “Key messages on these topics should be widely disseminated by multiple methods in a coordinated program, to the general public, to schools, for health education, and to PHC workers, for advocacy in the local community”. Significant noise exposures and their

consequences in children and adolescents are well documented (Folmer 2003; Kujawa & Liberman 2006; Martin et al. 2006; Niskar et al. 2001).

Health communication research indicates that early and effective intervention is essential to the prevention of noise-induced hearing loss (NIHL) and tinnitus (Folmer 2003, 2008; Folmer et al. 2002; Griest et al. 2007; Martin et al. 2006; Schunk & Carbonari 1984; Sobel & Meikle 2008). Educational interventions can be effective at changing knowledge, attitudes and behaviors about exposure to loud and dangerous sounds (Griest et al. 2007; Knobloch & Broste 1998; Lukes & Johnson 1999; Randolph et al. 2003; Roeser et al. 1983).

Hearing loss prevention educational content recommended by Lass et al. (1987a, b) included the following topics; instruction about normal auditory mechanisms, types of hearing loss and their causes, noise and its effect on hearing, warning signs of noise-induced hearing loss, and specific recommendations for preventing noise-induced hearing loss. Anderson (1991) added to this list instruction about consequences of hearing loss and how it can affect life quality and what type of noises or noisy activities are most dangerous to hearing.

The classroom represents a special venue for communicating hearing health promotion information and practices. Hearing health can be integrated into other topics including science, health, music, physics and mathematics. The development of hearing health program should be based upon health communication theory (Sobel & Meikle 2008), focus on specific educational messages (Martin et al. 2006), and include formative and summative evaluations (Griest et al. 2006, 2007).

Dangerous Decibels<sup>®</sup> is a public health partnership with the goal of reducing the incidence of noise induced hearing loss and related tinnitus (Martin 2008, Martin et al. 2006). The program uses educational outreach, museum exhibitry and research to promote and study hearing health. All Dangerous Decibels activities are intended to communicate the three educational messages:

- What are sources of dangerous sounds? – It is the intention that participants will acquire the technical and experiential knowledge necessary to know when they are in situations that provides risk of hearing loss and tinnitus due to sound exposure levels and durations.
- What are the consequences of being exposed to dangerous sounds? – It is the intention that participants will understand the value of having normal hearing and the personal loss of having hearing impairment in terms of communication, enjoyment of music and other sounds, and loss of peace and quiet through continual tinnitus.
- How do I protect myself from dangerous sounds? – It is the intention that participants will have knowledge and self-efficacy in simple methods of hearing protection, specifically turning the volume down, moving away from the source of the sound and proper use of hearing protective device. In addition, it is intended that they will know how to select and use appropriate protective measures for specific sound exposure situations and conditions.

Content recommendations have been recommended by Lass et al. (1987a, b) who recommended that hearing loss prevention education include instruction about normal auditory mechanisms, types of hearing loss and their causes, noise and its effect on hearing, warning signs of noise-induced hearing loss, and specific recommendations for preventing noise-induced hearing loss. Anderson (1991) added

to this list instruction about consequences of hearing loss and how it can affect life quality and what type of noises or noisy activities are most dangerous to hearing.

## METHODS

The Dangerous Decibels program has developed numerous resources that are being used to prevent NIHL and tinnitus (Martin 2008, Martin et al. 2006). One component is a classroom program targeting and adaptable to kindergarten through 12th grade students. The scientific content was developed by hearing scientists at the Oregon Hearing Research Center (OHRC) and the format and delivery was developed through three formative evaluations in six counties across Oregon and Southwest Washington.

The formative evaluations included student and teacher surveys and focus groups conducted by external evaluators, review and direction from teacher consultants, and creative input on communicating complex messages in fun, interactive ways from educational experts from the Oregon Museum of Science and Industry (OMSI). Graphical displays, 3-D models and interactive “hands-on” activities provide a multimodality learning experience that can be modified in complexity according to the target grade level. Formative evaluation allowed the developers to determine if the format was acceptable to students and teachers, and whether or not the educational messages were being communicated effectively.

Summative evaluations were performed with 478 fourth grade students and 506 seventh grade students to assess the effectiveness of the classroom program at changing knowledge, attitudes and behaviors regarding exposure to dangerous sound levels and the use of hearing protective strategies (Griest et al. 2007). Summative evaluation of an additional 1,119 fourth grade students, comparing four different forms of educational intervention, is now underway. The program was designed to comply with Science Standards and Benchmarks from the National Science Education Standards (<http://www.nap.edu/readingroom/books/nses/html/>) for Physical Science, Life Science, and Science in Personal and Social Perspectives.

## RESULTS

The Dangerous Decibels classroom program incorporates a series of interactive activities designed to convey basic knowledge and simplified prevention strategies for hearing loss prevention. The program has been delivered by a wide range of individuals including audiologists, classroom teachers, school-nurses, high-school students, graduate students, hearing scientists, deaf educator specialists, speech-language pathologists, museum outreach educators and lay persons.

A script of the classroom program was developed to insure a consistent and orderly flow of concepts and to see that each critical component is covered by the instructor. The educational topics included in the classroom program are as follows:

1. What do we hear? This section uses activities to teach the physics of sound emphasizing that it is the vibrational energy of sound carried through the air that has the power and ability to permanently damage the ear. Tuning forks and ping-pong balls are distributed to students who are directed in playful experimentation of physical concepts (Figure 1). Sound measurement in dBA is taught using household devices (e.g. blenders, radios) as sound sources. The concept of the relationship between sound intensity and duration in causing damage is developed through table-top exhibit pieces and web-based interactives.



**Figure 1:** Students learning how sound requires vibration to exist and that it can have power to permanently damage the ear

2. How do we hear? Students are given age-appropriate instruction and demonstration of the normal anatomy and physiology of hearing including an understanding of hair-cell physiology and transduction. Electron microscope and confocal microscope images of cellular and sub-cellular structures that are damaged by extensive sound exposure are presented.
3. How do our ears break? The pathophysiology of high-level or prolonged sound exposure is presented through images, experiments and modeling of hair cells being damaged through an interactive story-telling activity (Figure 2). Simulations of the challenges of listening with hearing loss are presented as well as a simulation of high-frequency tinnitus, commonly reported by individuals with NIHL. Another interactive demonstrates common sound sources that have the capacity to cause hearing loss base upon standards set by the National Institute for Occupational Safety and Health.



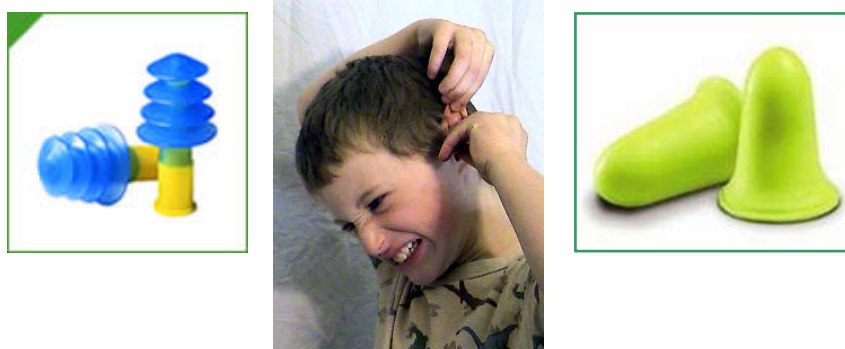
**Figure 2:** Students finding out how loud sound can damage hair bundles on hair cells causing permanent hearing loss and possibly tinnitus

4. How do I protect myself from loud sounds? Three primary methods of hearing protection are presented.
  - a. Turn it down. Whenever possible, the volume of a sound should be reduced to safe listening levels. An emphasis is placed on personal stereo systems in light of their extreme popularity and utilization among young people. “Jolene” is a sound measuring device that gives students the opportunity to measure the sound pressure levels at which they commonly listen in order to develop a subjective reference for potentially dangerous levels (Figure 3).



**Figure 3:** Student using “Jolene” to measure the sound level output of a personal stereo system

- b. **Walk away.** During the demonstrations about the physics of sound, students learn that sound pressure decreases dramatically as one moves away from the sound source. They are taught that if they can not turn the volume of a sound down, they can often move away from the source to a distance at which their ears are no longer in danger.
- c. **Protect your ears.** Hearing protective devices are demonstrated to the students. Protective devices present a great challenge in children. Nearly all hearing protection devices in the United States are designed for use by adults. Ear muffs may be too large or heavy for a child. Ear plugs may also be too large or may be awkward to fit. Our experience in classrooms trials with fourth grade student indicated that the vast majority of students were not able to correctly roll and insert foam type ear plugs without assistance. In contrast, pre-formed, flanged ear plugs were properly inserted the vast majority of the time with instruction (Figure 4). Public health theory indicates that self-efficacy is essential for someone to take the step of implementing a safety intervention. It is important that children not only know how to put in ear plugs from an intellectual stand point, as accomplished through watching a demonstration, but they must also have the confidence attained by a successful hands-on trial of the fitting.



**Figure 4:** Flanged ear plugs (left) are often more easily inserted by children than the foam type (right)

The effectiveness of the Dangerous Decibels classroom program to promote hearing health in students has been evaluated after presentations by museum outreach educators, school nurses and high school students (Griest et al. 2006). In all cases significant improvements were identified in areas of knowledge about the above topics, attitudes about the value of hearing and necessity for hearing protective behavior, and in intended behaviors in situations where potentially dangerous sound levels exist.

Pre- and post-classroom program activities are encouraged in order to increase the likelihood of success of the intervention. These activities can include a visit to the Oregon Museum of Science and Industry permanent Dangerous Decibels exhibit or a visit to the Dangerous Decibels virtual exhibit, a web-based collection of educational interactives, at the Dangerous Decibels website ([www.dangeroudecibels.org](http://www.dangeroudecibels.org)).

## CONCLUSIONS

One very important means of communicating hearing health information to young people is through classroom education. However, it is important that the classroom program is developed based upon health communication theory and practices. It is also essential that the development of any hearing health intervention include formative and summative evaluation to determine whether or not the program is effective and if not, to provide insights into how to improve it.

The Dangerous Decibels staff has developed an in-depth educator training program that has been used to train and equip a wide range of individuals as presenters of the Dangerous Decibels curriculum. Educators receive the extensive background information on the topics mentioned above as well as in common noise risks, health communication theory, classroom management and other essential items. Each participant is required to do a practice presentation of the classroom program while other participants observe. This provides participants with an opportunity to hone their skills as presenters and provides the instructors an opportunity to identify and correct misunderstandings and insure that the essential concepts are correctly presented. Educator workshops are offered periodically through the Dangerous Decibels program (contact [dd@ohsu.edu](mailto:dd@ohsu.edu)).

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