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Canadian Hearing Report

Revue canadienne d'audition

CAA Canadian Academy of Audiology Heard. Understood.
ACA Académie canadienne d'audiologie Entendus. Compris.

Vol. 5 No 3

Pharmaceuticals and Prevention of NIHL

Protection of Hearing in Europe from Portable Music Players

Verification Considerations for Baha

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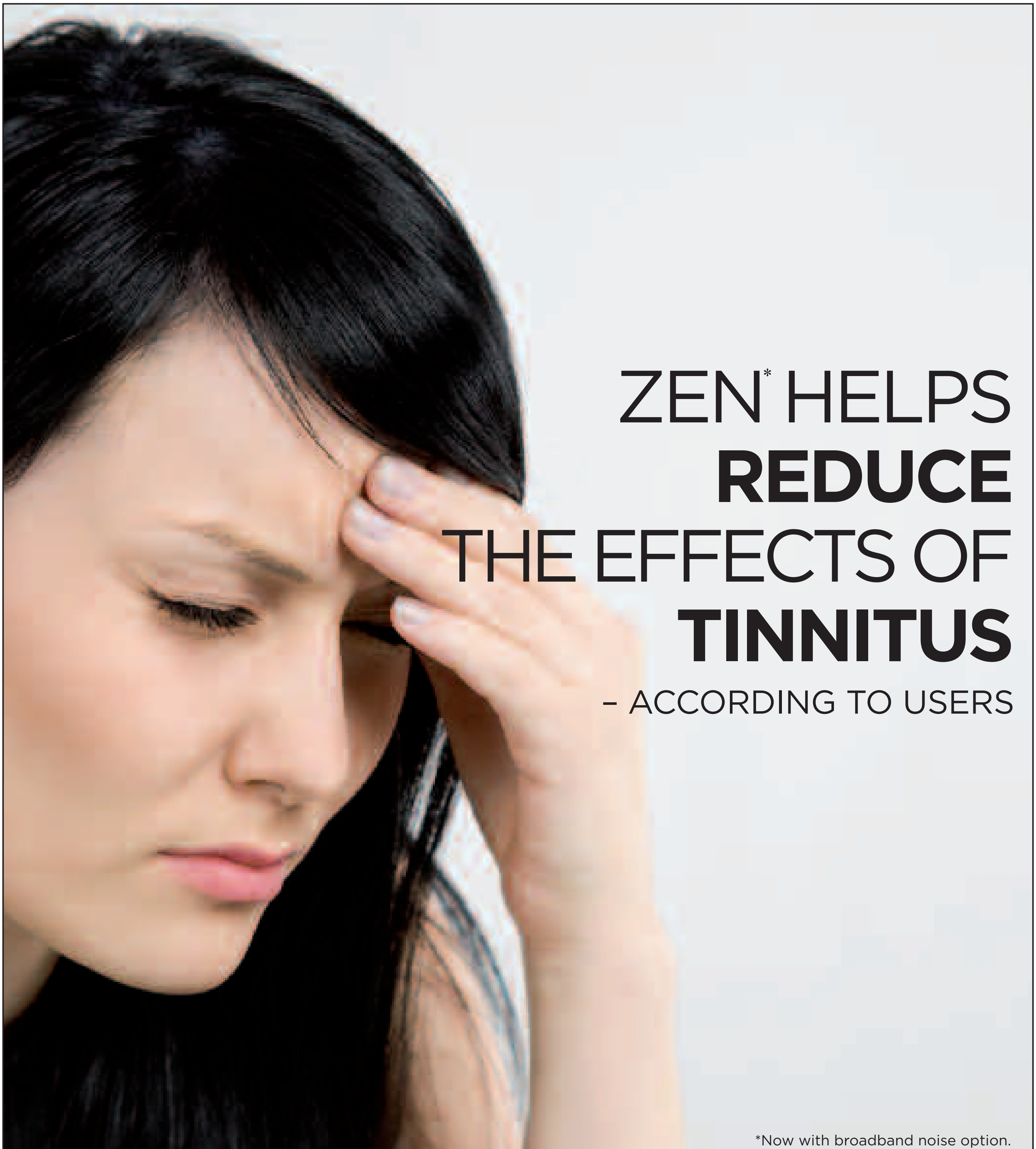

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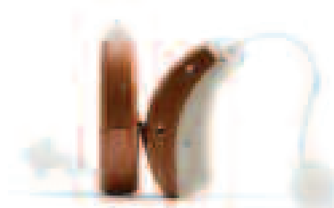

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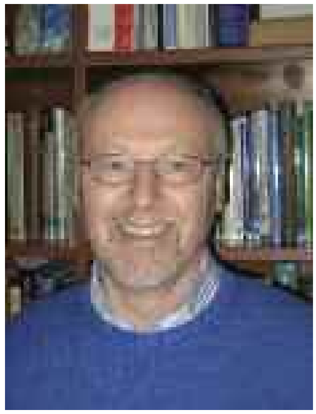

Developing a consensus on the maximum output of MP3 players is not an easy task. Developing a set of regulations or laws is even more difficult. The best that we can currently say is the 80/90 rule which according to Fligor and Portnuff is that we can listen to our MP3 player at 80% volume for 90 minutes a day and this will give us about 50% of our daily exposure. This, of course, depends on the type of earphone used, but is a good starting point. John Woodgate from England has written this issue's "E for Engineering" column on some of the efforts of consultants and regulators to enshrine what little we know about recreational music exposure in a document that can be used for regulation- no easy task.

The "80/90" dose of music exposure is not the final answer however. Like industrial noise exposure some people are more or less susceptible to damage from loud music. One of the interesting issues concerns the chemistry of the cochlear fluids. Some of this is genetically pre-determined and a future issue of the *Canadian Hearing Report* will have an article on this issue, but sometimes the chemistry can be selectively altered. Dr. Donald Henderson and Cheimi Tanaka from the State University of New York-Buffalo discuss what is known about the use of pharmaceuticals such as antioxidants to minimize the effects of loud noise and loud music on the hearing mechanism. If you are not familiar with Dr. Henderson's work, he is considered a world authority on hearing loss from noise and its pharmaceutical prevention. (And as a bit of trivia, he was also a player with the BC Lions of the Canadian Football League.)

And while we are talking about hearing loss prevention in children we have a submission for the "From the Classroom" column, by Mélanie Poirier (supervised by Dr. Chantal Laroche) at the University of Ottawa. This is a French translation and Internet tool based on the Widex-sponsored Dangerous Decibels program, "An Internet Tool to Prevent hearing Loss in Kids." We also have a submission by Julie Nielson (supervised by Dr. André Marcoux), "The Measure of Sensitivity of the Infants' Auditory System as Assessed by the Auditory Steady-State Response."

In the "Spotlight on Science column," Dr. Lendra Friesen from the Sunnybrook Health Sciences Centre in Toronto looks at a recent study by Moore et al. (2010) on Tinnitus and the Edge Frequency. The edge frequency is defined as that frequency where hearing acuity decreases from the normal range to a non-normal range and it was found that with proper octave interval training, subjects with tonal-type tinnitus were able to perform this task quite well, and that the tinnitus was matched to a frequency close to the edge frequency on the audiogram. I suppose that tinnitus matching (as well as communication) would be better if we were all ferrets. Recent research from the *Journal of the Acoustical Society of America* points out that whereas perfect pitch is rare in humans, it is omnipresent in the animal kingdom … so much for the evolution of our species!

Marshall Chasin, AuD,
Editor-in-Chief

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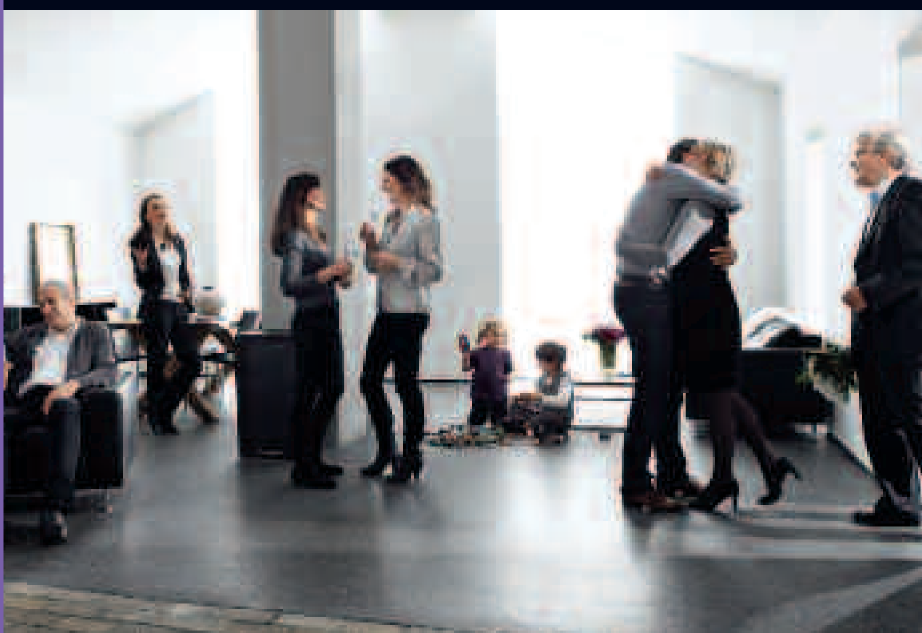

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Développer un consensus sur le maximum de sortie des lecteur MP3 n'est guère facile. Développer un ensemble de règlements ou lois est encore plus difficile. Le mieux qu'on puisse retenir actuellement est la règle 80/90 selon laquelle, conformément à Fligor et Portnuff, nous pouvons utiliser notre lecteur MP3 à un volume de 80% pendant 90 minutes par jour et ça constitue approximativement 50% de notre exposition journalière. Ceci bien entendu, dépend du type d'écouteur utilisé, mais c'est un bon point de départ. John Woodgate d'Angleterre traite dans la colonne E for engineering (Le I pour Ingénierie) de ce numéro de certains efforts des consultants et régulateurs pour inscrire le peu que nous savons sur l'exposition récréative à la musique dans un document qui pourrait être utilisé pour la réglementation – pas facile.

Cependant la dose "80/90" d'exposition à la musique n'est pas la réponse ultime. Comme dans le cas de l'exposition au bruit industriel, certaines personnes sont plus ou moins susceptibles aux dommages à cause de la musique forte, un enjeux ayant à voir avec la chimie des fluides cochléaires. Cette susceptibilité est parfois génétiquement prédéterminée et on aura un article élaborant plus sur le sujet dans le prochain numéro de la *Revue canadienne d'audition*, mais la chimie peut des fois être sélectivement altérée. Dr. Donald Henderson et Cheimi Tanaka de l'Université de New York-Buffalo discutent de ce qu'on connait sur l'utilisation de produits pharmaceutiques comme les antioxydants pour minimiser les effets du bruit intense et de la musique forte sur les mécanismes de l'ouïe. Si vous n'êtes pas familier avec le travail du Dr. Henderson, il est considéré comme une autorité mondiale dans le thème de la perte auditive causée par le bruit et sa prévention pharmaceutique. (et sur une note anecdotique, il est aussi un joueur des Lions de la Colombie Britannique de la ligue canadienne de football.)

En parlant de la prévention de la perte auditive chez les enfants, nous avons une présentation pour la rubrique From the Classrooms (Des classes), "un outil Internet pour prévenir la perte auditive chez les enfants." de Mélanie Poirier (supervisée par Dr. Chantal Laroche) de l'Université d'Ottawa. C'est un outil de traduction française et internet basé sur le programme décibels dangereux commandité par Widex. Nous avons aussi une présentation de Julie Nielson (supervisée par Dr. André Marcoux), "La mesure de la sensibilité du système auditif chez les bébés évaluée par la réponse des niveaux d'équilibre auditifs ."

Dans le Spotlight de la colonne Science, Dr. Lendra Friesen du centre des sciences de la santé de Sunnybrook de Toronto examine une étude récente par Moore et al. (2010) sur le Tinnitus et la fréquence limite, la fréquence limite étant la fréquence à partir de laquelle l'acuité auditive baisse de la portée normale à une portée non-normale et il a été déterminé qu'avec une formation en intervalle d'octave appropriée, les personnes avec le tinnitus de type tonal étaient capables d'exécuter cette tache assez bien, et que le tinnuits a été adapte à une fréquence proche la fréquence limite sur L'audiogramme. Je suppose que l'adaptation du tinnitus (et aussi la communication) pourrait être meilleure si nous étions tous et toutes des putois. Des recherches récentes dans le *Journal of the Acoustical Society of America* note que si l'ouïe parfaite est rare chez les êtres humains, elle est omniprésente dans le règne animal ... voilà donc pour ce qui est de l'évolution de notre espèce!

Marshall Chasin, AuD,
Éditeur en chef

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FEATURES

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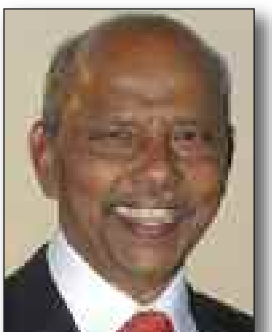
University of Northern Colorado Audiologist Earns National Excellence Award

University of Northern Colorado Associate Professor of Audiology Deanna Meinke recently earned the outstanding service award for her work in the field from the National Hearing Conservation Association.

Meinke, who's been involved with the association for 20 years most recently as past president, was presented with the organization's Michael Beall Threadgill Award at the NHCA's national conference in Orlando, Florida.

Meinke's research focuses on the prevention of noise-induced hearing loss. Currently, she's leading research - funded by a three-year, $435,000 grant from the Office of Naval Research and Dartmouth - to develop specialized hearing testing for military personnel who are susceptible to noise-induced hearing loss and tinnitus (ear ringing). The goal is to facilitate early detection and intervention. Hearing loss and tinnitus accounts for nearly 10 percent of the total number of disabilities among veterans.

In Memoriam: Dr. Sadanand Singh



The Plural Publishing family and the professions it serves lost a great friend and a visionary leader with the passing of Dr. Sadanand Singh, on February 27.

Though Dr. Singh was a respected university educator, he was best known as a publisher. Speech-language pathologists, audiologists, otolaryngologists, and a host of other specialists need only look at their bookshelves to see the numerous titles published by College-Hill Press, Singular Publishing Group, and Plural Publishing, Inc., to realize the magnitude of the contribution Dr. Singh made to the education of everyone in those professions.

In honour of Dr. Singh's many educational philanthropies, a fund has been established: **The San Diego Foundation Dr. Sadanand Singh Fund**

Friends who wish to join in honouring Dr. Singh may send contributions to:
TSDF/Dr. Sadanand Singh Fund
2508 Historic Decatur Road Suite 200
San Diego, CA 92106

Study Links Coral Growth to Sound

Coral larvae, tiny hair-covered sacs of cells, can "hear" reefs and actually swim toward them, researchers report. The finding suggests that sound is far more important in underwater ecosystem development than previously thought.

Further, marine biologists say, human noise pollution has the potential to block the larvae's ability to seek out nearby reefs and settle there, ultimately harming other marine life.

http://articles.latimes.com/2010/may/20/science/la-sci-coral-20100516

Prof. Dr. Fritz Sennheiser Dies

Prof. Dr. Fritz Sennheiser in front of the building in which he founded the company in summer 1945.

Late during the evening of May 17, 2010, only a few days after his 98th birthday, Prof. Dr.-Ing. Fritz Sennheiser, audio pioneer and founder of today's Sennheiser electronic GmbH & Co. KG, passed away. The audio industry has lost a huge figure, not only in terms of his technical expertise but also in terms of his humanity.

Through his company Prof. Dr. Fritz Sennheiser had a crucial influence on the development of sound transmission technologies and was instrumental in forging many ground-breaking developments in electroacoustics and transmission technologies. Under his guidance the first shotgun microphones and open headphones were created and he oversaw important developments in wireless radio and infra-red transmission. It was completely natural for Fritz Sennheiser to give his developers the "creative and technical freedom" they required. His humanity also shone through when – considering the significant workload involved in running an expanding company – he took time to share his knowledge with students, inspiring them with an enthusiasm for audio technology. In 1982 he retired from the management of the company, handing over to his son, Prof. Dr. sc. techn. Jörg Sennheiser.

The history of the European audio industry will forever remain inextricably linked with the name of Fritz Sennheiser.

The Consumer Handbook on Hearing Loss and Noise

Auricle Ink Publishers announces the release of The Consumer Handbook on Hearing Loss and Noise, Marshall Chasin, AuD, Editor. "This book was prompted by the need for education. As we know, noise is the number one most preventable cause of hearing loss worldwide," said Richard Carmen, Publisher, "and while there have been significant strides toward getting the word out about the dangers of noise, there remain high risk factors in many segments of industry and even for recreational participants."

The roster of contributors includes top scholars in their respective areas including Alberto Behar, Richard Salvi, Ed Lobarinas and Wei Sun, Arline Bronzaft, Brian Fligor, Margaret Cheesman, Thais Morata, David Baguley, Ken Einhorn, Douglas Lewis, Lee Hager, and William Gastmeier. This 224-page handbook covers information that both consumers and industry need to know, and would be a highly useful and beneficial educational tool for university courses. Chapter topics include basics of hearing loss, noise and measurement; anatomy/physiology; harmful physical/mental effects; recreational noise; hearing in noise; combination of noise with chemicals in the workplace; tinnitus/hyperacusis; medical consequences; hearing health care and the law; standards and protection; and architectural strategies. There is an extensive glossary and index. Those interested in previewing this book may visit the publisher's website for excerpts from all chapters.

Excerpts can be viewed at www.hearingproblems.com.

Appeals Court Affirms Patent Infringement Ruling against Shure

Examples of Shure's straight-nozzled (top) and barb-nozzled earphones, inserted in ducts of cross-sectioned foam.

Washington — In the case of Hearing Components Inc v. Shure Inc, the US Court of Appeals for the Federal Circuit ruled last month in favour of plaintiff Hearing Components on Shure's infringement and validity of two patents on the use of foam tips and sound isolation earphones. The appellate court decision affirms a jury verdict that should result in an award to the company of $4.6 million. The court also ruled that a third Hearing Components patent for wax guards for hearing devices should be incorporated back into the infringement lawsuit against Shure.

Hearing Components, Oakdale, Minn, holds a strong portfolio of patents incorporated into its products - including its Comply Foam Tips, which improve the interface between the ear and personal audio devices.

In May 2007, Hearing Components filed a patent infringement lawsuit against Chicago-based Shure in the US District Court in East Texas involving Shure's earphone products. The lawsuit accused Shure of infringing two patents held by Hearing Components, both related to the use of replaceable foam tips in combination with earphones to provide sound isolation. Specifically, the patent infringement focused on Shure's disposable earphone tips made of soft foam that connect to earphone devices by straight and barbed nozzle fasteners (pictured at right), and funnel sound into the ear canal.

In January 2009, with Dr. Marshall Chasin acting as the expert witness, Hearing Components won jury and bench trials in the District Court, which were subsequently appealed.

"The products patented by Hearing Components were developed from years of research," says Hearing Components President/CEO Bob Oliveira, PhD. "We take our intellectual property very seriously and are glad to have resolution of the use of foam tips on hearing devices."

Comply Foam Tips and Comply Whoomp! Earbud Enhancers are manufactured and sold by Hearing Components, a 3M spinoff founded in1990 by Oliveira, a biochemist and inventor. In addition to broad applications in consumer electronics, the technology is currently used in hearing aids, military and general aviation communications, and in industrial high-noise environments.

The 33-page decision is available from the US Court of Appeals for the Federal Circuit Web site as a downloadable PDF.
SOURCE: Hearing Components Inc

Can Viagra Cause Hearing Loss?

Men who have taken sildenafil are more likely to experience sudden sensorineural hearing loss, according to an study published in the May issue of the Archives of Otolaryngology–Head & Neck Surgery.
http://www.medscape.com/viewarticle/722268

May is Speech and Hearing Awareness Month Activities

By Marshall Chasin, AuD, MSc, Aud(C), Audiologist

In the early spring I was approached by Energizer Canada in order to partner in providing public education regarding hearing awareness issues for "May is Speech and Hearing Awareness Month." As a result, Energizer Canada commissioned a nationwide telephone survey in March 2010 of 1000 Canadians (± 3.1% at α= .05 level of significance) called the Energizer *Getting Canadians To Listen* survey. This survey was conducted by Harris/Decima Research.

The questions were designed by Energizer Canada, Harris/Decima Research, and myself and were based on current knowledge of hearing loss and hearing loss prevention. For example, relatively new data suggest that being in poor physical shape and smoking, are two risk factors for hearing loss (and both are related to poorer oxygen flow to the cochlea).

The content of the various media interviews were based on the survey results and our current knowledge of hearing loss prevention.

The following are some of the survey results:

- Close to 20% (19%) of Canadians continuously listen to music for an hour or more. Among this group, the majority are young Canadians ages 18–34 (32% – almost 1/3 or respondents) are among those who admit to listening to their music for an hour or more at a time.
- Close to 10% (9%) of Canadians listen to their music (using earphones) at 80% volume or more. Among this group, it is young Canadians ages 18 to 34 (31% – almost 1/3 of respondents) who are the loud music culprits.
- Though the majority of Canadians (83%) agree that a rock concert is loud, less than a quarter (21%) think that a phone's ring tone or dial tone is loud and only 5% think a baby rattle is loud.
- Thirteen percent of Canadians surveyed say they smoke regularly. Among this group, young Canadians between the ages of 18 and 24 (22%) were the smoking majority.
- More than 1/3 (44%) of Canadians admit to not exercising regularly. More than half of those respondents (51%) were between the ages of 18and 24.
- Almost half of Canadians surveyed (46%) say they know someone in their family or circle of friends who suffers from poor hearing.

During the month of May a number of talks to TV, radio, Internet and print media were given using the information from the Energizer Getting Canadian Canadians to Listen Survey. Healthy listening habits and ideas were given and these include moderation, the "80/90 rule" for MP-3 players (80% volume for 90 minutes a day yields about 50% of one's daily dose of music exposure), the long term benefits of being physically fit with respect to hearing levels, and the long-term auditory dangers of smoking. Future issues of the *Canadian Hearing Report* will contain articles written by some of the front-line researchers working on these topics, and how they may potentially affect our long-term hearing abilities.

"QUICK NOTES"

FROM THE EXECUTIVE DIRECTOR

The big news this issue from the academy is the long awaited launch of the **new CAA website**, including a Facebook page. The site went live in mid-June and featured a big splash about the upcoming **CAA Conference in Montreal from October 5 to 8** at Le Centre Sheraton. For registration and program information go to www.canadianaudiology.ca.

CAA representatives met on May 22 with the **Inter-organizational Steering Group for Audiology and Speech Language Pathology** during the CASLPA Conference in Whitehorse. Now that the initial project to develop Infection Control Guidelines has been completed, CAA is taking the lead role in the next project to develop **Guidelines for the Assessment, Diagnosis and Intervention/Mediation of Auditory Processing Disorders (APD**). The committee chair/author is Pam Millett, PhD, assistant professor, and Deaf & Hard of Hearing Program at York University in Toronto. Members of her committee include Charlene Watson from Alberta; Greg Noel from Nova Scotia; Arden Nelson from Manitoba; Benoit Jutras from Quebec; and Kathy Pichora-Fuller from Toronto.

I also attended a meeting on May 18 in Whitehorse with the **Federal Healthcare Partners/Third Party Payers** group to discuss items of concern to audiologists. Some items discussed included funding and billing issues related to cochlear implants; NIHB regulations for dispensing fees and hearing aid approval procedures; coverage for assistive listening devices; spray cleaner codes; pre-authorization of home visits; Veterans Affairs Canada's (VAC) coverage of hearing aid chargers, as well as TV and telephone amplifiers; VAC billing codes; OAE testing; and VAC pension forms for tinnitus sufferers. A full report on decisions and recommendations coming out of our meeting will be posted on the Third Party Payer page of our website within the next couple of months.

CAA President Carri Johnson and I attended the **American Academy of Audiology** national "Audiology Now" conference in San Diego in April. Events like these offer terrific opportunities to learn and bring back new ideas about member programs and member services that can be implemented here in Canada.

CAA's **strategic marketing and branding exercise** continues to advance CAA and the profession to government agencies, universities and colleges, the Canadian auditory industry, and the general public. A number of new audiology tools and products – posters, stickers, "connect the dots" colouring sheets and hearing test pads – have been produced for members and are available on the CAA website.

One final exciting development, our bid to co-host with CASLPA the International Society of Audiology Conference in Vancouver, British Columbia in October 2016 was accepted with flying colours! Now the real work begins as we search for a hotel venue in Vancouver, recruit a conference chairperson and members to participate on the planning committee, and a conference planning group to manage the event. If you are interested or know of someone who is within CAA, contact me at director@canadianaudiology.ca.

Tom McFadden
CAA Executive Director

"DÉPÊCHES RAPIDES"

DU DIRECTEUR EXCECUTIF

La grande nouvelle de l'académie dans ce numéro est le lancement tant attendu du **nouveau site web de l'ACA**, y compris une page Facebook. Le site est en direct depuis la mi juin et en grande vedette **la prochaine conférence de l'ACA au Centre Sheraton à Montréal du 5 au 8 Octobre**. Pour inscription et information sur le programme, veuillez visiter le site www.canadianaudiology.ca.

Les représentants de l'ACA se sont réunis le 22 Mai avec **le groupe directeur interorganisations pour l'audiologie et l'orthophonie** durant la conférence de l'ACOA à Whitehorse. Maintenant que le projet initial pour développer des lignes directrices de contrôle des infections a été complété, l'ACA est totalement impliquée dans le prochain projet pour développer **Des lignes directrices pour l'évaluation, le diagnostic et l'intervention/ médiation des troubles des traitements des informations auditives.** La présidente/ auteur du comité est Dr. Pam Millet, Professeur adjointe, du programme des sourds et des malentendants à l'Université York de Toronto. Parmi les membres de son comité, Charlene Watson de l'Alberta; Greg Noel de la Nouvelle Écosse; Arden Nelson du Manitoba; Benoit Jutras du Québec; et Kathy Pichora-Fuller de Toronto.

J'ai aussi assisté le 18 mai à une réunion à Whitehorse avec le groupe **Partenaires au niveau fédéral en matière de soins de santé/Tiers payants** pour discuter de sujets de préoccupations des audiologistes. Certains enjeux ont été discutés dont le financement et les problèmes de facturation relatifs aux implants cochléaires; les règlements de NIHB pour les honoraires professionnels et les procédures d'approbation des appareils auditifs; la couverture des appareils fonctionnels d'écoute et leurs accessoires; les codes des nettoyeurs de pulvérisation; l'autorisation préalable des visites à domicile; la couverture de L'ACC (Anciens Combattants Canada) des chargeurs des appareils auditifs, des amplificateurs de télévision et de téléphone; les codes de facturation de l'ACC; les tests d' EOA; et le régime de pensions des ACC pour les personnes qui souffrent du tinnutis. Un rapport complet des décisions et recommandations découlant de notre réunion sera affiché sur la page tiers payants de notre site web dans les deux prochains mois.

La présidente de L'ACA Carri Johnson et moi-même avons assisté au mois d'avril à la conférence nationale "Audiology Now"(Audiologie maintenant) de l'**American Academy of Audiology** (Académie Américaine d'audiologie) à San Diego. Ce type d'événements offrent des opportunités sans égales pour apprendre et ramener de nouvelles idées de programmes et services qu'on peut mettre en place pour nos membres ici au Canada.

L'exercice de la stratégie marketing et image de marque de l'ACA continue de propulser l'ACA et la profession devant les agences gouvernementales, les universités et collèges, l'industrie auditive canadienne, et le grand public. De nouveaux outils et produits d'audiologie – affiches, autocollants, feuilles de coloriage "connecter les points" et bloc- notes de tests auditifs – ont été crées à l'intention des membres et sont disponibles sur le site web de l'ACA.

Et finalement le passionnant développement: Notre soumission pour être le co-hôte avec l'ACOA, de la conférence de la **Société internationale d'audiologie** à Vancouver, en Colombie Britannique en Octobre 2016 a été acceptée haut la main! Maintenant commence le vrai travail, d'abord par la recherche de l'hôtel à Vancouver, le recrutement du président ou de la présidente et les membres pour participer au comité de planification, et le recrutement d'un groupe de planification de la conférence pour gérer l'événement. Si vous êtes ou connaissez quelqu'un de L'ACA qui serait intéressé(e), veuillez me contacter au director@canadianaudiology.ca.

Tom McFadden
Directeur exécutif de l'ACA

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Canadian Hearing Report: Call for Reviewers

Canadian Hearing Report is published six times per year and is the official publication of the Canadian Academy of Audiology (CAA).

CHR is pleased to offer peer reviewing to all interested authors who submit manuscripts to the journal.

To carry out this process, the editorial board of Canadian Hearing Report is currently assembling a group of volunteer peer reviewers. We are looking for dynamic experts in various fields of audiology to serve on our peer-review panel. The list of the peer reviewers will be published annually in the journal. The manuscripts would be sent and received via email.

If you are interested in becoming a peer reviewer for CHR, please contact Marshall Chasin (marshall.chasin@rogers.com), editor-in-chief to discuss your particular area of expertise.

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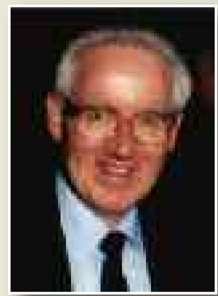
caaconference@canadianaudiology.ca

Protection of Hearing in Europe by Controlling Sound Levels from Portable Music Players

By JM Woodgate, BSc(Eng), CEng, MIET MIEEE FAES FInstSCE

About the Author



John Woodgate was awarded the bachelor of science (engineering) degree of London University in 1958. After a background in the consumer products and sound reinforcement sectors of the electronics industry, he became responsible for audio, including radio and loudspeaker, products design and development in a large multinational company. Latterly, he had experience in product management and marketing of audio, high fidelity and video products, and became an independent consultant in 1984.

The history of attempts in Europe to limit hearing damage to young people, due to listening to portable music players at high sound levels, covers more than two decades and is not very edifying. Sometime before 1999, the CENELEC (European electrotechnical standards body) Technical Board was asked by the French national standards committee to introduce standards limiting the sound levels available from portable music players, based on evidence of hearing damage and research into measurements by government-sponsored bodies. The ensuring work in CENELEC was characterized by a resilience against critiques, notably from the British national standards committee involved, which I chair. (However, opinions expressed here are mine alone and not necessarily those of the committee.) It proved quite difficult to elicit any interest in this development from the large manufacturers of portable players.

In due course, a standard EN 50332-1, applying to players sold with headphones, was published. It requires the player to be operated with all relevant controls set at maximum, under which conditions any program material would be horribly distorted, and measuring the A-weighted sound pressure level from the headphones with a weighted noise test signal (so distortion is not readily perceived), using preferably a Head and Torso Simulator (HATS). Three years later, a companion standard, EN 50332-2, applying to players and headphones marketed separately, was published. It uses the test methods specified in EN 50332-1. The sound level averaged over 30 seconds must not exceed 100 dBA, which is said to equate to a "long term" (duration not defined) average of 90 dBA.

It is necessary to bear in mind that portable players are only one source of noise exposure, and the standards do not apply if only one earphone is supplied or used. Sound levels in clubs, and from home hi-fi and in-car audio, remain uncontrolled. This is why public education is the most effective way of preventing hearing loss.
(See, for example, http://www.dontlose-themusic.com/home/ and http://www.noisy-planet.nidcd.nih.gov/.)

These standards had little effect in Europe, except in France, where they were made legally enforceable. However, publicity surrounding pressure from a Netherlands consumer organization on the European Commission, to make the requirements mandatory, led to a protest in 2007 against this law from a consortium of European manufacturers, EICTA (now Digital Europe). Nevertheless, in 2009, the commission demanded that CENELEC re-visit the matter in a very short time-period, with the effective result that the provisions of both parts of EN 50332 will be normatively referenced in safety standards EN 60065 and (probably) EN 60950-1, together with the new standard EN 62368-1, with the mandatory addition of some type of audible or visible warning if a sound level of 85 dBA is exceeded. It is not clear how this can be applied to a player whose headphones have been substituted by another type. However, the EN 50332 standards are significantly out-of-date. For example, they call up a sound level meter standard, EN 60804, which has been withdrawn. The test signal has a spectrum typical of music and speech of the 1970s, and was developed in Eastern Europe. It is unlikely that its spectrum is typical of that of 21st century popular music of the most intensive kind, which often has considerable low-frequency emphasis, not correctly measured with A-weighting (the application of which to any sound pressure levels above about 70 dB SPL has not, as far as I know, been unequivocally justified). The test schedule requires five measurements, the headphones being removed from the HATS and replaced. Work in Japan reported in 2006 to IEC TC100 called attention to the poor reproducibility of such measurements and has introduced new designs of pinna giving improved results, but these are not yet widely in use.

The requirements in EN 50332-2 are that players shall have an unweighted, 30 second average output voltage (from the clipped noise signal) not exceeding 150 mV across a resistive load of 32 ohms (0.7 mW), and the "wideband characteristic voltage" (defined in the standard, for a sound pressure level, unweighted, of 94 dB SPL) of a headphone shall not be less than 75 mV. But the requirements proposed in a draft amendment to EN 60065 differ in that no load impedance is specified for the output voltage measurement, and it is not specified whether A-weighting shall be applied, as it is to the corresponding sound pressure levels limits.

Headphones of the types used for these players are available with impedances from 8Ω to 64Ω, and "sensitivities" from less than 100 dB SPL/mW to over 120 dB SPL/mW.

NOTE: It is, of course incorrect to express sensitivity as the ratio of the field quantity SPL to the energy quantity power. However, it is claimed that for moving-coil headphones of identical construction but differing voice-coil impedances, the "sensitivity" expressed in this way is approximately constant.

Players and headphones are required to have their specifications marked on the product or stated in the manual, but it seems unlikely, given the wide range of values indicated above, that users will understand what they are supposed to do. The sensitivities of headphones marketed with players have to be drastically reduced, and there will be a ready market for the more sensitive types, purchased, of course, on the clear understanding that they will never be used with a portable player.

In the design of a portable player, the most crucial choice is the specification of the battery. There are several critical characteristics, and the considerations are partly engineering and partly marketing, as with all consumer products and they include the following:

- volume;
- mass/weight;
- energy density;
- whether rechargeable; and
- environmental factors.

The battery is the largest single component and the heaviest by far, so these have major influence on the product size and portability. Energy density and rechargeability are important for the user, in terms of product availability for sufficient time-periods and cost of ownership.

Consideration of these factors and making a choice determines the electrical characteristics such as:

- voltage; and
- optimum rate of usage of stored energy.

It should be extremely obvious that *restricting the efficiency of the associated headphones or earphones* in a safety standard has a very serious negative effect on the necessary rate of usage of stored energy, and therefore on battery life or time between recharges, and battery mass/weight and volume. An optimum product design (smallest, lightest, longest battery life or charge duration) must use the most efficient headphones whose cost can be justified.

NOTE: "Efficiency" is correct; the ratio of sound power out to electrical power in. For the present purpose, where headphone characteristics are measured with a broadband noise signal and a coupler, the sound power can be assumed to be proportional to the square of the sound pressure.

Over the past 10 years or so, the subject of noise-induced hearing loss (NIHL), especially among young people, has prompted an increased level of research. It has to be said that some of this research was not of the best quality. The following three matters, in particular, tended to create a credibility gap for informed readers:

1. Uncritical acceptance of the 85 dBA "threshold" for NIHL, which is based on industrial noise having (most often) a very different spectrum and a far higher crest factor (ratio of peak sound pressure to r.m.s. sound pressure) than those of music.
2. Uncritical acceptance of the application of A weighting, which causes the measurement of sound levels to be relatively insensitive to low frequencies, which are often very prominent indeed in modern popular music.
3. A discernible intention to prove a prior assumption, rather than conduct an open-minded investigation.

It is not clear whether everyone is equally likely to suffer NIHL at a given exposure level, and of course, this cannot be deliberately tested. Studies in animals are suspect, because listeners report that their perception of "loudness" of music depends on whether they like it, and other mental factors that can surely not be present in non-human test subjects. To what extent these factors may affect the pathology of the outer hair cells appears to be as yet unknown.

Results reported at: http://www.medscape.com/viewarticle/586943 indicate putative NIHL in younger people not starting at 4 kHz, as is traditionally assumed, although the older subjects did seem to show this effect, but it was also found that heavy levels of cerumen affected the 4 kHz responses.* While the sample was small, it appears that the results are reasonably credible.

In conclusion, it appears that for the reasons given above, the proposed requirements in safety standards will prove ineffective, and of course, as always, more research is needed.

**www.medscape.com is a free site but that the user needs to register in order to see the articles*

Canadian Hearing Report 2010;5(3):17-19.

Tinnitus and the Edge Frequency

By Lendra Friesen, PhD, Sunnybrook Health Sciences Centre

Tinnitus is the involuntary perception of a sound originating in the ears or head when no external source is present. It is often associated with hearing loss. Although no cure is currently available for tinnitus, there are several treatment options. One of these involves tinnitus masking where the pitch and loudness of the tinnitus are matched and the results are used in conjunction with a device to mask the tinnitus. A recent study has revealed that with training, individuals with tonal tinnitus, i.e., tinnitus that sounds like a single tone, were able to more closely match both the level and pitch of their tinnitus to a pure tone. These study results have potential clinical implications for tinnitus matching protocols.[1]

There are several theories regarding the mechanisms of tinnitus. One of these involves tonal tinnitus. This theory predicts that the tinnitus pitch should be related to the "edge frequency" of the audiogram. This is the boundary between a region of normal or near-normal hearing and a region with greater hearing loss. For instance, when a region of the cochlea is damaged, the cortical area that is normally tuned to frequencies maximally exciting that region can become tuned to adjacent frequencies.[2] This reorganization leads to a cortical over-representation of the adjacent frequencies, which might be associated with tinnitus corresponding to the edge frequency.[3]

Little support for this prediction has been provided in studies examining the relationship between the pitch of tonal tinnitus and the audiogram characteristics. Therefore, researchers re-examined tinnitus matching and the relationship to the audiogram in subjects with mild-to-moderate hearing loss and having tonal tinnitus.[1]

As audiometric frequencies were presented to them during the matching procedure, subjects were asked to indicate which one best matched the pitch of their tinnitus. The sound level was then adjusted in 5-dB steps until the subject indicated that the tone matched their tinnitus in loudness. After the initial testing, it was suspected that participants might be making octave errors in their tinnitus matches. The concept of octave and octave errors was explained to the participants. To help them better understand the concept, two successive tones were presented, with frequencies that were separated by one octave. The participants could listen to these tones as many times as they liked. They were then asked to ensure that their subsequent selected matches were at the correct octave.

The matching procedure was then repeated with audiometric frequencies between 250 and 8,000 Hz. This time when the subject indicated the frequency that most closely matched their tinnitus, the tone was adjusted in 100 Hz steps above and below the selected frequency and the subject was asked to indicate whether any of these frequencies were better matches for their tinnitus pitch. Intensity levels were then adjusted to match the tinnitus loudness, but in smaller steps (2 dB). The whole matching procedure was repeated many times for each ear in order to obtain the mean matching frequency and level and also to measure the variability of the matches.

The definition of the edge frequency was based on the difference in threshold between successive audiometric frequencies (e.g., between 250 Hz and 500 Hz). When a difference in threshold between two successive audiometric frequencies was larger than all other successive audiometric pairs, the edge frequency was assigned to the lower of the two in frequency. For instance, if 30 dB was the largest difference in threshold and it occurred between 250 and 500 Hz, then 250 Hz was defined as the edge frequency. If there were two equally large values in terms of threshold differences among the frequency pairs, and they were adjacent to each other, the lowest frequency among these was designated as the edge frequency.

Results showed that in every case where matches were made before and after training, the matching frequency was lower after training than before, and in some cases by about two octaves. There was also a strong correlation between the tinnitus matching frequency and the edge frequency. In previous studies, there was either a weak correlation or no correlation. Also, the matching frequency was close to the edge frequency, whereas in previous studies, the matching frequency tended to be well above the edge frequency.

The authors conclude that the difference in study results was largely due to the octave training. Prior to training in this study, the matching frequencies were higher than after training (on average, over an octave higher). This difference in matching frequency before training is consistent with previous studies which included no training.

These study results have potential clinical application in tinnitus matching protocols where tinnitus pitch and loudness are matched and the results are used to fit a tinnitus masker. By ensuring that patients are making correct matches due to training, perhaps improved results with tinnitus maskers can be achieved.

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Canadian Hearing Report 2010;5(3):20-21.

University of Ottawa Student Research Projects

Translation and Adaptation in French of the Dangerous Decibels Virtual Exhibit: An Internet Tool to Prevent Hearing Loss in Kids

Student: Mélanie Poirier
Supervisor: Chantal Laroche, PhD

ABSTRACT

Exposure to loud noises causes health issues such as permanent or temporary hearing loss, tinnitus, and communication problems. A significant portion of the adult population experiences these symptoms, despite the fact that they can be avoided by adequate preventive measures. Some studies suggest that children are progressively more affected by exposure to loud noises than before. To prevent negative impacts, it is necessary to increase awareness of hearing protection early on, as to change noise exposure behaviours. Few educational tools currently exist in French. The goal of the current study is to translate and adapt the Dangerous Decibels virtual exhibit in French for 4th and 5th grade students, and to assess their appreciation of the educational tool. Four groups of participants, two in each grade, were asked to browse the virtual exhibit, fill out a questionnaire related to their appreciation of the exhibit, and take part in an informal discussion with the researchers. Results show that, participants generally provided positive statements about the virtual exhibit. Fourth grade students, however, gave significantly higher ratings than 5th grade students, suggesting that the virtual exhibit may be more appropriately tailored for use with this age group. Results also show that participants preferred activities which include interactive games. In order to validate the tool, educational and behavioural impact of the francophone version needs to be addressed in future studies.

The Measure of Sensitivity of the Infants' Auditory System as Assessed by the Auditory Steady-State Response

Student: Julie Nielson
Supervisor: André Marcoux, PhD

ABSTRACT

Universal Newborn Hearing Screening (UNHS) programs have proliferated in the past few years. These programs have been made possible because of the development of electrophysiological measures that are used to screen for and diagnose hearing loss in infancy. These techniques include the Auditory Brainstem Response (ABR) and the Auditory Steady-State Response (ASSR) which, much like several other UNHS programs, is used in the province of Ontario to quantify an infant's level of hearing loss. However, there remain unresolved issues related to these techniques which may limit its accuracy and create a real risk for misdiagnosis during the first months of an infant's life. The risks associated with such misdiagnoses include: (1) the failure to identify children with mild hearing losses who may later exhibit poor academic performance and (2) the failure to provide optimal amplification levels for hearing-impaired infants during a critical period for speech and language development. Thus, the hearing-impaired infant's full hearing potential may not be realized because of an incomplete understanding of the accuracy of current diagnostic equipment used to assess hearing loss in infants. These risks stem from not understanding how maturation of the infant's auditory system influences ABR or ASSR thresholds over time and hence, from not understanding what ABR or ASSR thresholds depict normal auditory function during infancy. A recent study conducted in our lab has documented these influences with the ABR technique. The purpose of this study will be to accomplish a similar documentation using the ASSR technique.

Verification Considerations for Baha

By Bill Hodgetts, PhD

About the Author

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Some people are unable to wear air conduction hearing aids for a variety of reasons (e.g., aural atresia, chronic ear disease).[1,2] Assuming there is sufficient residual cochlear function in at least one ear, the alternative mode of sound delivery for these patients is bone conduction amplification through skull vibration.

Today, the most common type of bone conduction amplification is the Baha. The Baha consists of a sound processor connected via an abutment to a surgically implanted titanium screw in the parietal-mastoid region of the patient's skull. Most Baha users do very well with their devices; however, some patients fail to perform as well as might be expected based on current clinical Baha fitting procedures. Even for those patients who are performing well, the current procedures often shed little light on what aspects of their hearing abilities or the hearing aid fitting have led to their success. Consequently, each patient serves as a mini experiment in fitting. In this brief article, I summarize parts of my doctoral dissertation research, the goal of which was to increase our understanding of fitting and verification procedures for Baha users.

CURRENT FITTING AND VERIFICATION APPROACHES

Current approaches to fitting Baha surely vary from clinic to clinic. However, common elements of the fitting typically include: standard audiometric bone conduction thresholds, aided soundfield thresholds with the Baha in place, and outcome measures related to performance with the device (e.g., subjective questionnaires and/or aided speech testing). Standard bone conduction thresholds are used to select appropriate candidates and are also used to guide the selection of an appropriate sound processor for that individual. Aided soundfield thresholds are obtained to determine if the device is providing an appropriate aided response for that individual and outcome measures are used to validate the fitting. All hearing aid fitting should be validated with appropriate outcome measures and most Baha clinicians do an excellent job at this. However, there are some limitations to using traditional bone conduction thresholds and aided soundfield thresholds for the verification of Baha that warrant consideration.

TRANSCUTANEOUS VS. PERCUTANEOUS BONE CONDUCTION

Traditional audiometric bone conduction thresholds are obtained with a headband through skin and subcutaneous tissue (transcutaneous), while the Baha is rigidly anchored to the skull (percutaneous). Several researchers have explored the relationship between thresholds obtained on the same patient trans- and percutaneously.[3–6] On average, there is an advantage to delivering bone conduction sounds directly to the Baha abutment at most frequencies. Unfortunately, the advantage of percutaneous thresholds over transcutaneous thresholds varies considerably from person to person and is virtually unpredictable.[5] Consequently, transcutaneous threshold information does not necessarily represent a valid

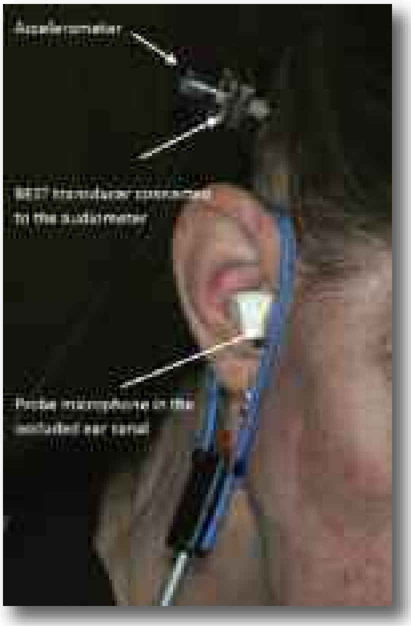

Figure 1. Setup for the two "real-ear-like" approaches to verifying Baha

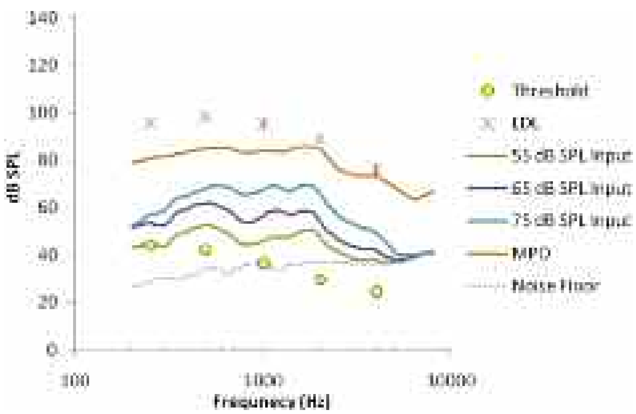

Figure 2. SPLogram approach to verifying Baha

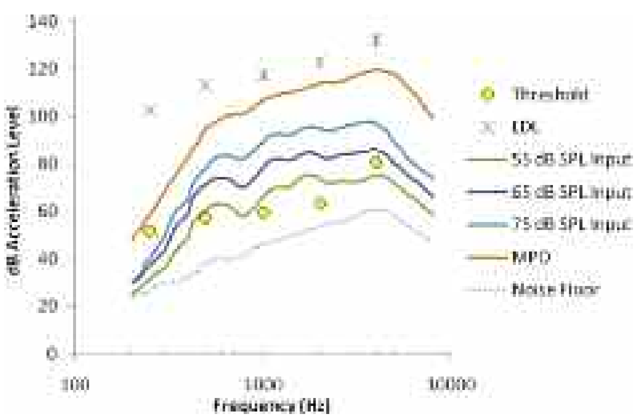

Figure 3. Accelogram approach to verifying Baha

reference for comparison to aided percutaneous bone conduction hearing through the Baha abutment. Therefore I advocate that audiometric information for fitting and verification be obtained directly through the Baha abutment (once the implant is in place). Percutaneous threshold (and loudness discomfort levels) should be used as the reference for aided responses with the Baha.

AIDED SOUNDFIELD THRESHOLDS

Aided soundfield thresholds have some significant limitations as a verification tool. For example, there are noise floor effects, test-retest reliability issues and confusion about the definition of the speech spectrum in dB HL. Also, they only inform the clinician about the hearing aid response to low level inputs (a challenge for WDRC aids) and provide no information regarding the MPO of the device[7,8] for excellent reviews of these issues). Real ear measures have supplanted the aided soundfield threshold approach for verifying the majority of air conduction hearing aid fittings. Unfortunately, a similar approach for verifying Baha has not emerged.

COMPARISON OF THREE VERIFICATION APPROACHES

We developed two in-situ “real-ear-like” approaches to verifying Baha that we then compared to the aided soundfield approach to Baha verification. The first real ear approach actually used a probe microphone in the ear canal of Baha patients as a reference for bone conducted responses (see Figure 1). By vibrating the skull, the bony and cartilaginous portions of the canal radiate air conducted sound into the external ear.[9,10] We measured the ear canal SPL generated by a direct bone conduction oscillator connected to the Baha abutment (percutaneous) for both thresholds and loudness discomfort levels (direct bone conduction dynamic range). We then connected a Baha to measure the SPL associated with the aided Baha responses to a variety of real-life speech inputs and high-level tones (MPO). Figure 1 shows an SPLogram of the average results from a series of 23 Baha subjects. While this approach worked fairly well for the mid frequencies, two significant disadvantages emerged. The first, seen clearly in Figure 2, has to do with the noise floor of the probe microphone system at high frequencies. The air conducted ear canal SPLs are so tiny that they are routinely buried in the noise floor above approximately 1000 Hz. A second problem with the ear canal SPL approach has to do with the low frequency energy of speech entering the ear canal (in spite the of the ear plug used in the study) and creating an "apparent" increase in low frequency response of the Baha that does not exist.

Our second "real-ear-like" approach used accelerometers placed on the backside of a special transducer known as the Balanced Electromagnetic Separation Transducer.[11] This arrangement can also be seen in Figure 1. The BEST transducer is rigid through its entire vibrating core. So, vibrations delivered to the patients are reflected in the acceleration response on the transducer. Instead of ear canal SPL, acceleration (in dB) was used as a reference for direct bone conduction dynamic range of hearing and aided Baha responses. Figure 3 shows the average acceleration responses (Accelogram) for the 23 Baha subjects used in this study (keep in mind this is the same Baha with the same settings that was used in the ear canal approach). The low frequency response of the Baha is as expected and the high frequencies are above the noise floor of the measuring system. This direct mechanical verification approach was found to be superior to the real ear approach and it eliminated many of the shortcomings associated with the aided soundfield approach for Baha.

VALIDATING THE ACCELOGRAM APPROACH

In another study, we used the Accelogram approach in conjunction with a modified DSL (version 5 targets) prescriptive method. The modified DSL method allowed us to use the direct bone conduction dynamic range of hearing to generate acceleration targets for aided speech. We used a master Baha and a repeated-measures design. There were 2 conditions: (1) the master Baha matched to the current user's Baha settings, and (2) the master Baha set to the modified DSL prescriptive targets (and compression settings). We then compared the Baha subjects' performance on a series of outcome measures.

Significant improvements were found on the HINT in quiet and in noise and on a consonant identification in noise task when using the Baha fitted to the modified DSL targets. No differences were found in terms of aided loudness between the two approaches. Interestingly, when we asked people to rate the percentage of sentences understood there were no differences between the two approaches. In other words, subjects in this study felt, subjectively, that speech was just as intelligible with both fittings. However, their objective data revealed a different story. More work is needed in this area to continue to validate the prescription of bone conduction targets. However, this early work is quite promising.

FUTURE CONSIDERATIONS

While acceleration is the most direct method of measuring the vibratory response on a given patient, there are limitations for this approach in terms of clinical uptake. Since the current models of Baha do not use the BEST transducer, it is not possible at this time to use this approach with patients. We are currently validating an alternative approach that uses "Force" (in dB) referenced to a skull simulating coupler that could be used with current real ear systems to measure Baha. If this approach proves valid (and early indications are promising), then it may be as easy for clinicians to measure Baha as it is for them to measure air conduction hearing aids in a 2-cc coupler.

CONCLUSIONS

Thresholds from a standard bone conduction oscillator are not an ideal reference for the direct bone conduction hearing used with the Baha system and aided soundfield thresholds do little to inform the clinician about the appropriateness of the fitting (e.g., two people with the same aided thresholds can show vastly different outcomes). Essentially we have a black box analogy, where, professionally, we are often doing the best we can do with the techniques that we have and hoping for the best. While the work summarized in this brief article may not quite be ready for Monday morning's clinic, audiologists seeking alternatives to the current Baha fitting and verification approaches should be optimistic that we are not far from making clinically deliverable alternatives a reality.

CONFLICTS

None declared.

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Pharmaceuticals and Prevention of Noise-Induced Hearing Loss (NIHL)

By Donald Henderson, PhD and Chiemi Tanaka, MA

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Exposure to prolonged high level noise or impact/impulse noise can be dangerous for our ears and can cause damage to inner ear sensory cells (also known as hair cells) leading to a loss of hearing sensitivity.[1] Traditionally, the prevention of noise induced hearing loss (NIHL) involved shielding the ear from the noise, either by using a hearing protection device (HPD) such as muffs or ear plugs. The HPD solution has some problems, such as the devices are not worn properly,[2] the noise reduction is considerably less than the device-rated attenuation, or there are situations where the HPD are not routinely used, either for safety or comfort reasons.

In the past five or ten years, there has been the development of several drugs for the prevention of NIHL. The development of these drugs was made possible because of recent basic research on the mechanism of NIHL. The cochlea is an amazingly complex organ, but it is damage to the hair cells that result in hearing loss. Specifically, for our purposes, the most vulnerable set of hair cells are the outer hair cells (OHCs) and these are shown, along with a cut-away view of the cochlea in Figure 1. In many cases of mild to moderate sensorineural (or inner ear) hearing loss, it is the OHCs that are damaged and the IHCs are still relatively intact.

Normally, the OHC shrinks and elongates with the movement of the basilar membrane and stereocilia. The stereocilia are the microscopically small fibres emanating from the top of the hair cells. The function of the OHC is to mechanically assist the vibration of the organ of Corti which enhances the sensitivity of the ear and the frequency tuning of the inner ear. Specifically, the

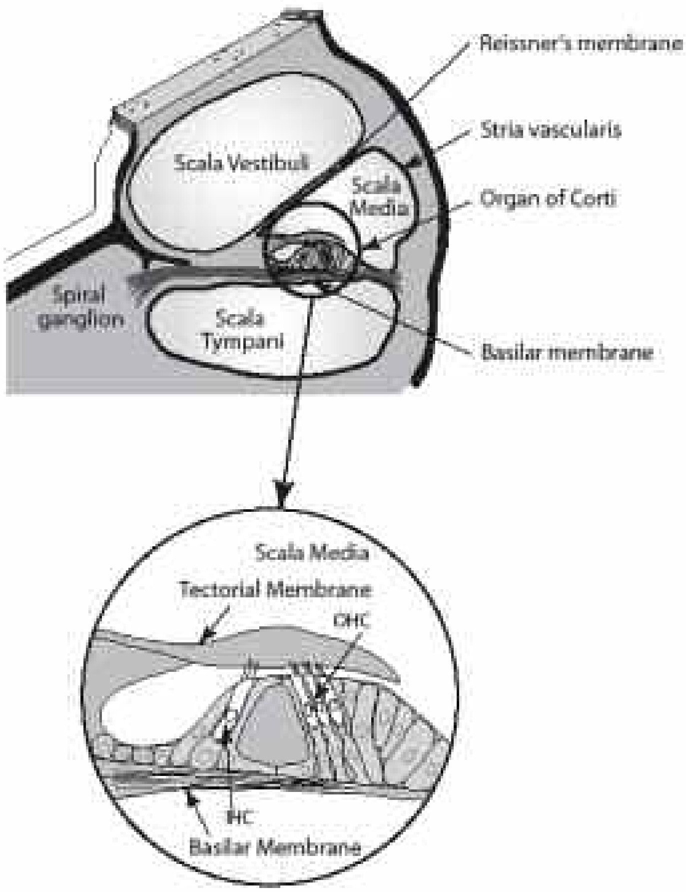

Figure 1. Schematic showing radial cross section (looking down the length of the scala media) through a turn of the snail-shaped cochlea. Each turn of the cochlea contains three fluid filled compartments; scala vestibuli and scala tympani (both filled with perilymph), and scala media (filled with endolymph). The organ of Corti (shown in the inset) contains the sensory hair cells that convert sound into neural activity. Both the inner hair cells (IHC) and the outer hair cells (OHC) are shown in the inset. Picture courtesy of Doctors Salvi, Lobarinas, and Sun. Used with permission.

OHC serves to amplify the very soft sounds. This is the primary reason why we have the incredibly large hearing range – from being able to hear the rustle of leafs and to tolerate a jet plane taking off while standing on the airport tarmac. When the OHCs are damaged or lost due to a traumatic noise exposure, a person's hearing can be reduced 40 to 50 dB and the ability of understand speech in a noisy background is compromised because the tuning of the basilar membrane is degraded.[1]

THE EFFECT OF NOISE ON THE EAR

We know that noise can damage the cochlea by significantly increasing metabolism or by direct mechanical failure, i.e., exposure to noise with high peak levels, such as gunfire, jackhammers, and so on. We have learned recently that exposure to noise creates an increase in toxic free radicals in the cochlea, and the free radicals react and damage cell membranes, protein, mitochondria, and DNA.[3] These free radicals are also referred to as reactive oxygen species or ROS. In a recent experiment, the distribution of free radicals was analyzed in a noise exposed cochlea and compared to normal cochlea. Fifteen minutes after impulse noise exposure, the cochleae were opened and a fluorescent dye was introduced to the noise exposed ear and the normal ear. By examining the pattern of discoloration caused by the dye, it was found that the areas of toxic free radicals were clustered around the three rows of OHC. Additional experiments have shown that the initial free radical activity (minutes after exposure) is comprised of superoxide (O^{2-}), a main element in the development of ROS.

The generation of the toxic free radical is a complicated process. The most prevalent locations in the body such as the brain, heart, and liver, create large amount of free radicals because of the normally high metabolic activity.[4] In the cochlea, the OHC and stria vascularis (the lining of the wall of the scala media) generate large quantities of free radicals since both are metabolically quite active. The most common free radical is the superoxide radical which is created as a by-product of the conversion of ADP to ATP in mitochondria. (For those of us that remember our high school biology class, ADP is Adenosine Di-Phosphate and ATP Adenosine Tri-Phosphate is and the conversion between the two is important in many metabolic processes. The mitochondria can be thought of as the battery for the cell. And for those of us who do not remember our biology classes, unfortunately it is still the same.) For approximately every 1,000 ADP/ATP reactions, there is a breakdown in the mitochondrial chemistry and a superoxide molecule is generated. Free radical formation is a normal aspect of cochlear homeostasis and the toxicity of the free radicals is normally neutralized (reduced) by antioxidants. Antioxidants can be thought of as a sponge that mops up excessive oxidants. The body is equipped with a family of antioxidant including superoxide dismutase, catalase, and the family of glutathione enzymes.[4]

With exposure to high levels of noise, the level of metabolism increases, the demand for ATP is increased and consequently the superoxide generation also increases. The situation is exacerbated by "ischemia-reperfusion" because noise exposure initially increases the blood flow to the cochlea and then decreases it leading to ischemia or oxygen deprivation. The implication of ischemia, or oxygen deprivation, is that the superoxide generation rate increases dramatically due to lack of enough oxygen for ADP/ATP conversions creating a situation where the free radical level is greater than the available protective antioxidant molecules. The increased free radical presence leads to tissue damage – membranes, proteins, mitochondria, DNA, and eventually cell death.

SENSORY CELL DEATH

Noise exposure causes sensory cells to die by either necrosis or apoptosis. These processes are quite different but have the same fatal ending. In the case of necrosis, the cell gradually swells in size until the cell wall breaks and the cytoplasm and other material of the cell pours out into the surrounding area. This can have a toxic effect on the entire neighborhood of cells. There are some subtle aspects of this process that are beyond the scope of this article such as change in the size and morphology of the mitochondra (the cell batteries) but suffice to say, that this type of cell death is well studied. In contrast to necrosis, apoptosis is a much less dramatic form of cell death which involves the gradual breaking apart of the cell whose constituent components have intact cell boundaries such that the cytoplasm does not pour out of the cell or poison the cellular neighborhood. Like necrosis, the apoptotic process has other well-defined properties such as a maintenance of the mitochondrial morphology. And like necrosis, this form of cell death has been well studied. In the normal cochlea, most of the OHC nuclei are round, and have consistent diameters. However the cell nuclei of apoptotic cells have shrunken nuclei, and necrotic cells are larger and are typically "swollen." Initially, most of OHCs die by apoptosis after traumatic noise exposure. Figure 2 shows a schematic of the two types of cell death with necrosis shown in panel A and apoptosis shown in panel B.

Studies have shown that cell death can continue for days after an exposure, and in many cases, the damage is worse after several days than immediately after a noise exposure insult. Studies such as those that look at cell death after noise exposure typically show two primary results – most of the cells die by apoptosis and the cell death process continues for days after the exposure.[5] In other studies, cell death has been observed up to 30 days post exposure.[6,7] We have also learned in other studies that the increase in free radical activity with a noise exposure can persist for days after the exposure. Consequently, an extended period of increased free radicals is likely the causes for prolonged cell death.

WHAT THE BASIC SCIENCE OF

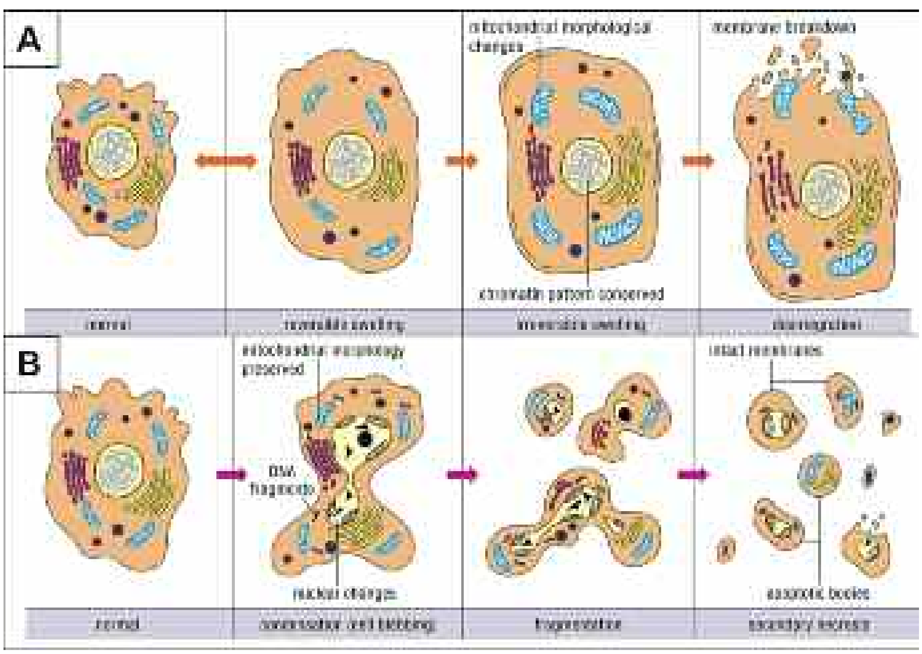

Figure 2. Schematic diagram of necrotic cell death (A) and apoptotic cell death (B). From Apoptosis, Cell Death and Cell Differentiation, 3rd Edition, published online by Roche Applied Science. From Henderson D, Bielefeld EC, Harris KC, Hu BH. (2006) The role of oxidative stress in noise-induced hearing loss. Ear and Hearing 27:1–19. Used with permission.

NOISE-INDUCED CELL DEATH SUGGESTS FOR PREVENTION AND TREATMENT OF NIHL

The observation that noise exposure increases free radical activity in the cochlea suggests that increasing the ear's normal concentration of protective antioxidants should reduce the hearing loss and cellular damage caused by increased free radical activities associated with noise. An experiment has proven this concept by showing that placing drugs of antioxidant, pro-glutathione (glutathione mono-ethylester), on the round window (that separates the middle ear from the stria tympani of the cochlea – see Figure 1) reduced the hearing loss from excessive exposure to noise.[8]

The protection afforded by the antioxidant applied to the round window confirms the principle that excessive noise leads to increased free radical activity and increasing levels of antioxidants can reduce the toxic effects of free radicals and protect hearing. However, delivering the drug to the round window is not clinically practical. It is clinically difficult, and potentially uncomfortable, to extend a needle syringe through the ear drum into the middle ear cavity and place the antioxidant material on the round window adjacent to the inner ear. A second wave of research has shown that oral, or systemic, delivery of antioxidants or glutathione prodrugs (L-N-acetyl-L-cystine [L-NAC], acetyl-L-carnitine [ALCAR], or D-methione) are also protective of the ear.[9–12]

Figure 3 shows that oral delivery of L-NAC, one of the three peptides that are used to make glutathione, given before a noise exposure protects the ear.

L-NAC is a supplier of a building block, known as cysteine, for antioxidant glutathione synthesis. L-NAC is used in the United States as a nutritional supplement as well as a prescription drug to treat acute acetaminophen (e.g., Tylenol) overdose which causes over-production of a highly reactive free radical, *N*-acetyl-*p*-benzoquinoneimine in the liver.[13,14]

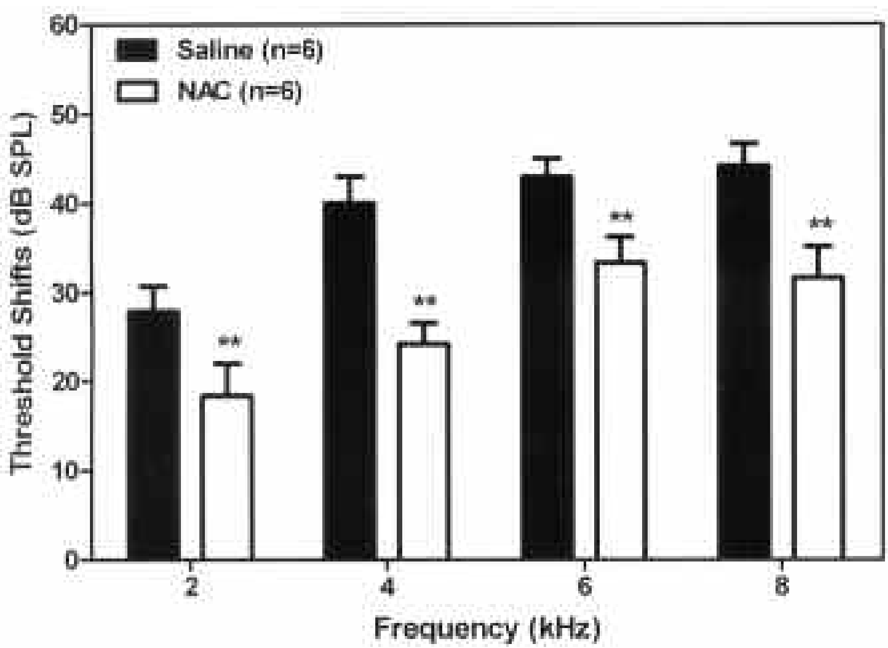

Figure 3. Permanent threshold shifts of control (black bar) and NAC-orally treated (white bars) chinchillas as tested 3 weeks after exposure to a 6 hour, 105 dB SPL 4 kHz octave-band noise. Error bars are +1 SEM. **: $p < .01$.

Like most areas of medical research the basic science is first performed on animal models, and only much later, if at all, in human trials. The animal studies showing antioxidant protection against NIHL are quite convincing. A number of antioxidant preparations are offered commercially or being tested in clinical trials for NIHL prevention, such as the Hearing Pill (special formulation of NAC), Auraquell (combination of vitamins A, C, E, and magnesium), D-methione, ALCAR, and ebselen (glutathione peroxidase mimetic), however a comprehensive evaluation of their relative effectiveness of the antioxidant preparations for human and for different noise situations is needed.

IF APOPTOSIS IS PROGRAMMED CELL DEATH, CAN THE "PROGRAM" BE CANCELLED?

As seen previously, noise exposure can lead to apoptotic cell deaths. The process of apoptosis with exposure to noise can be initiated by a number of different triggers in the sensory cells. Cells can be stressed by increasing free radical activity which turns on cell death pathways (Bcl2/Bax family of genes). Apoptosis can also be triggered when a cell is separated from its surrounding matrix of cells. Traumatic noise is associated with large vibrational displacements in the cochlea, which in turn, mechanically stresses or breaks the connections between the highly organized cellular structures of the cochlea possibly leading to increased expression of the Src gene (one of oncogenes). Experiments have shown that if Src is blocked, the effects of noise can be substantially reduced.[15] Figure 4 shows that hearing loss and hair cell difference between noise-exposed ears that were treated with either an Src inhibitor (KX1-004) or saline (control). Note the Src inhibitor-treated ears developed only 5 to 10 dB hearing loss (A) and substantially less OHC loss (B). Another antiapoptotic drug is called AM-111 which is an inhibitor of c-Jun N-terminal kinases (JNK), one of the apoptosis signaling molecules. A large-scale clinical trial for AM-111 is currently underway to treatment acute acoustic trauma or sudden deafness.

Antiapoptotic drugs that prevent hair cell death are interesting, but much more complicated pharmacologically than antioxidants. Consequently, the Src inhibitor approach is new and much more needs to be known before it will be of clinical use.

CURRENT STATUS OF PROTECTIVE DRUGS FOR THE EAR

The development of drugs to prevent NIHL is still a minor effort and even though NIHL is an extremely prevalent health problem. There are no hearing loss drug development programs in any of the major pharmaceutical companies. There is no question that for most noise exposures, HPDs are effective and the most reasonable choice. There are, however, many situations where HPDs are not used. For example, hunters expect to be exposed to potentially dangerous impulse noise, but "when" is difficult to predict. Therefore, until the noise event, the hunters want normal hearing sensitivity and do not want to contend with the artificial reduction in hearing associated with wearing the HPD. Hunters (and musicians) might benefit from the protection provided by a safe, uncomplicated drug such as the class of antioxidants. Currently there are a few formulations available that are glutathione prodrugs (the Hearing Pill, ALCAR, or D-methione), free radical scavengers (Auraquell), and glutathione peroxidase mimetic (ebselen). The alternative approach of using an antiapoptotic drugs such as AM-111 and Src inhibitors are more complicated and need more research before FDA approval.

CONFLICTS

None declared.

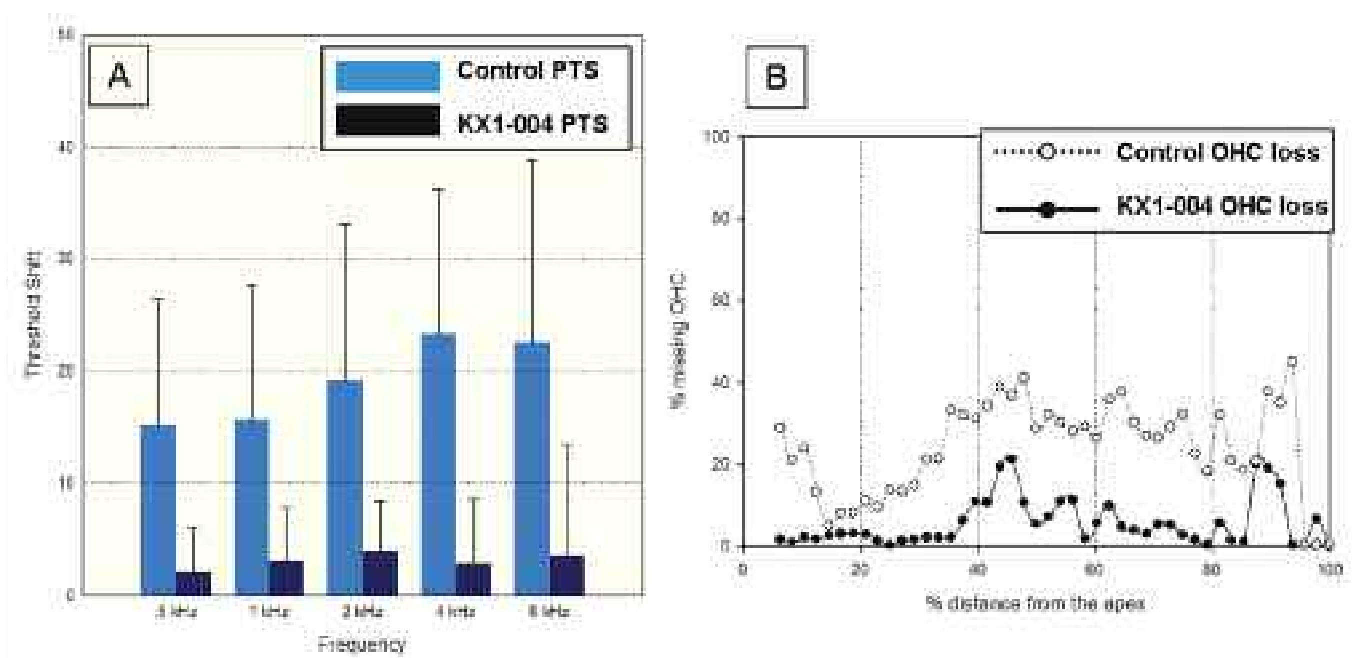

Figure 4. (*A*): Threshold shift in chinchillas from an impulse noise exposure that consisted of 75 pairs of impulses of 155-dB pSPL intensity. Dark blue bars represent KX1-004–treated ears. Light blue bars are control ears. Error bars are standard deviations. (*B*): OHC cochleograms from the same experiment. Dark circles represent KX1-004–treated ears. Open circles are control ears. From Henderson D, Bielefeld EC, Harris KC, Hu BH. (2006) The role of oxidative stress in noise-induced hearing loss. *Ear and Hearing* 27:1-19. Used with permission.

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University of Iowa Invites Participants for Cochlear Implant and Tinnitus Web Surveys

By Monika Kordus, PhD, Camille Dunn, PhD, CCC-A, Stephanie Gogel, MA, CCC-A, and Richard Tyler, PhD

About the Authors

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According to a US Food and Drug Administration (FDA) report in 2006, approximately 112,000 people worldwide have been implanted with cochlear implants and this number is continuing to grow each year. There is evidence from laboratory settings that suggests that listeners with bilateral cochlear implants (CI+CI) and listeners with one cochlear implant and a hearing aid in opposite ears (CI+HA) might have improved listening abilities of speech perception in noise compared to listeners using only one cochlear implant or one hearing aid.[1–5] Although a variety of objective hearing measurements exist to evaluate and describe quantitative improvements in hearing abilities due to cochlear implants and other assistive devices, it is important to have an understanding of the qualitative benefits that these users perceive as well.

The University of Iowa has developed an online survey designed to gain information from cochlear implant users about their perceived benefits of cochlear implant use.

In the present paper four surveys: one related to cochlear implants recipients, one related to cochlear implants with tinnitus, and two related to tinnitus are described. The next two sections will provide detailed information on the "Benefits of Receiving a Cochlear Implant: Study for Adults Survey" and the "Cochlear Implant, and Cochlear Implants Tinnitus Survey" (Section I) as well information on two tinnitus web surveys entitled: "Dietary Supplements and Herbal Supplements for the Treatment of Tinnitus Survey, and Tinnitus Questionnaire Survey (Section II)."

SECTION I

The first two web surveys titled: "Benefits of Receiving a Cochlear Implant: Study for Adults and Cochlear Implants," and "Cochlear Implants Tinnitus Survey" evaluate the benefits of cochlear implant devices, as well make it possible to compare the perceptions of various groups of cochlear implant users (e.g., users with one cochlear implant compared to users with bilateral cochlear implants). The specific cochlear implant groups addressed are those with the following listening configurations:

- One cochlear implant
- Bilateral cochlear implants received during the same surgical procedure (simultaneous bilateral)
- Bilateral cochlear implants received during two separate surgical procedures (sequential bilateral)
- One cochlear implant and hearing aid in non-implanted ear

Benefits of Receiving a Cochlear Implant: Study for Adults Survey

This survey was developed to assess the perceived benefits that cochlear implant listeners obtain in the areas of localization of sound and speech perception in noise. In order to get a worldwide perspective on these benefits, this survey has been translated from English into seven languages, including: Chinese, French, German, Korean, Polish, Spanish, and Swedish (we are also looking to translate into Italian).

This survey consists of approximately 60 questions divided into the following four sections:

Section 1: Related to subject demographic data, such as current age, age of deafness, whether or not they are affected by tinnitus, and device configuration.

Section 2: Possesses questions related to subjective evaluation and expectations from the use of cochlear implant devices. For example, listeners are asked to rate their speech perception and localization ability using a scale from 0 to 100 where 0 represents no abilities and 100 represents perfect ability. Also in this section, we ask the listener about their expected and realized advantages and disadvantages of their particular cochlear implant listening configuration.

Section 3: provides the Iowa Spatial Hearing Questionnaire (ISHQ)[6] which is a 24-question self-report measure with eight subscales addressing the perception of different voice gender, localization, music, and speech perception with spatially separated noises as well as in quiet.

Section 4: includes questions related to speech understanding as objectively measured by tests conducted in an audiology clinic. This section may require the cochlear implant user to contact with audiologist if they do not know their measured scores.

Figure 1. shows preliminary average localization and speech perception rating scores for listeners wearing sequential bilateral cochlear implants (CICI sequential), a cochlear implant and a hearing aid on opposite ears (CI+HA), or one cochlear implant (CI only). In this figure, 0 represents no ability and 100 represents perfect ability. Results indicated that listeners who are implanted with sequential bilateral devices rate their localization abilities higher than all other users in the other groups, while the listeners with only one cochlear implant rate their localization abilities the poorest.

Results for the speech perception ratings demonstrate that CICI sequential and CI+HA listeners rate their speech understanding similarly, while listeners with one cochlear implant rate their speech understanding lower than those wearing two devices. It should be noted that data from simultaneous bilateral users was not included in this figure because the number or responses from this group was still very small.

Figure 2 shows preliminary overall ISHQ spatial hearing scores for all 8 subscales with CICI sequential, CI+HA, and CI only listeners. In this figure, 0 represents very difficult listening situations and 100 very easy listening situations.

Results show that listeners who are implanted with sequential bilateral devices rate their ease of listening much higher (better) than all other users in the group, while the listeners with only one cochlear implant rate their ease of listening much more difficult.

These preliminary results shown in Figure 1 and Figure 2 suggest that listeners with two cochlear implants perceive their speech understanding, localization abilities, and spatial hearing abilities to be much better than those wearing one cochlear implant or one cochlear implant and a hearing aid.

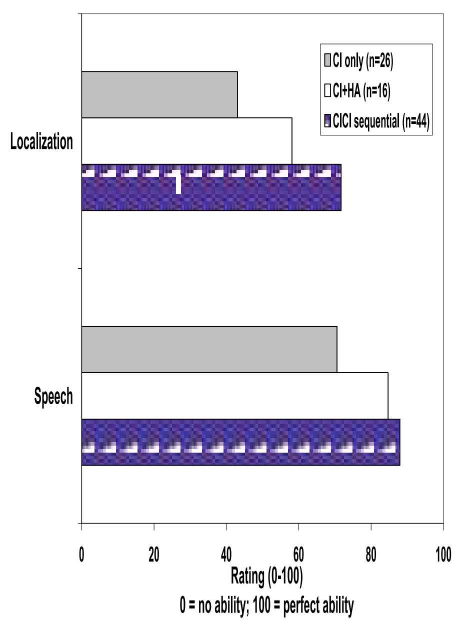

Figure.1. Average localization and speech understanding ratings by listeners with sequential bilateral implants (CICI sequential) – dashed bars, a cochlear implant in one ear and a hearing aid on the opposite ear (CI+HA) – open bars, one cochlear implant (CI-Only) – grey bars.

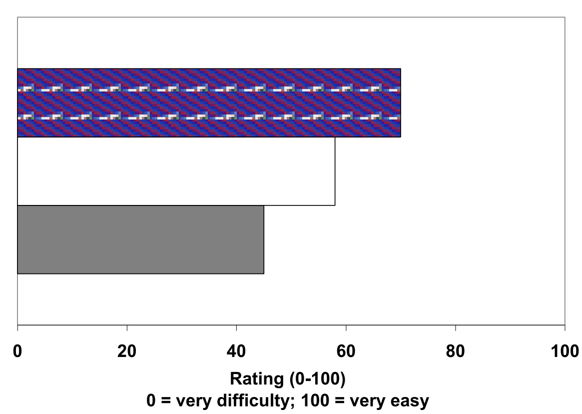

Figure.2. Average overall ISHQ spatial hearing ratings by listeners with sequential bilateral implants (CICI sequential) – dashed bars, a cochlear implant in one ear and a hearing aid on the opposite ear (CI+HA) – open bars, one cochlear implant (CI-Only) – grey bars.

More data is currently being collected in these areas with these groups to verify the validity of this preliminary data with a much larger number of subjects. Please view the "Benefits of Receiving a Cochlear Implant: Study for Adults" web survey at the following location: https://survey.uiowa.edu/wsb.dll/127/cochlearimplant.htm

Cochlear Implants and Tinnitus Survey

A second web survey "Cochlear Implants and Tinnitus" is designed for cochlear implant users who also suffer from tinnitus. The purpose of this inventory is to identify cochlear implant users with tinnitus to determine the benefit this population may receive through the use of a CI(s). This questionnaire consists of 51 questions subdivided into three subsections. The first section focuses on demographic information related to the CI and the second section focuses on individual information regarding tinnitus. The third section is the Iowa Tinnitus Activities Questionnaire,[7] comprised of 20 items asking about problems associated with one's emotional well being, concentration, hearing, and sleep problems. This questionnaire attempts to explore situational difficulties as well as psychosocial effects caused by of tinnitus. Please view the "Cochlear Implants and Tinnitus" web survey at the following location: https://survey.uiowa.edu/wsb.dll/127/citinpart1.htm

SECTION II

Dietary Supplements and Herbal Supplements for the Treatment of Tinnitus Survey

Many tinnitus patients also try to relieve their tinnitus through the use of dietary and alternative medications. Although none have been shown to be effective across a large population of tinnitus patients, it may be the case that there are subgroups of patients that a particular medication may help. The goal of this particular web survey is to list many different alternative medications to see if any have been helpful with reducing or eliminating tinnitus. Specific information is asked about the concentration of the medication and any possible side effects. Our group is not recommending a particular supplement, but is just interested in gathering a large amount of information that individuals around the world may be trying to help with their tinnitus.

To complete our survey or to direct patients with tinnitus who have tried dietary supplements or herbal supplements to treat their tinnitus, please go to the following website: https://survey.uiowa.edu/wsb.dll/127/dietary.htm

Tinnitus Questionnaire Survey

Lastly, another web survey pertains to any individual who experiences tinnitus. We call this our global tinnitus web survey that asks many questions about experiences with managing and dealing with tinnitus. Our hope from this survey is to be able to subgroup patients by asking many different questions about tinnitus.

To complete our survey or to direct patients with tinnitus to our survey, please go to the following website: https://survey.uiowa.edu/wsb.dll/127/tinglobalpart1.htm

We are currently in the process of combining the three tinnitus surveys in to one unified survey. This will eliminate any repeated questions for those patients that want to participate in more than one survey. Please feel free to pass along these web surveys to your patients and any individuals you work with that have a cochlear implant(s), tinnitus, or both!

CONFLICTS

None declared.

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Peak Versus Root Mean Square in Movies and TV Commercials

By Marshall Chasin, AuD, MSc, Aud(C), Audiologist

The regulations (FCC in the United Sates and the DOT in Canada), requires that only the "peak" intensity be stated and that it should not exceed a certain level. This is for all forms of broadcast audio media – TV, commercials, and movies. The regulation makes no mention of the average (or RMS "root mean square"). The reason why the “peak intensity” was chosen rather than RMS intensity was to prevent spillover from one carrier frequency to an adjacent one. Specifying and limiting the peak intensity will control the spillover issue. This is really the primary reason why we have any regulation on this issue. This is not a noise control issue. However, in listening to speech or music, it is the average intenisty (or RMS) that defines how loud we perceive something to be, and not the peak intensity.

The technique that is used is called compression, and depending on the jargon of the industry that one is in, it is also also known as automatic volume control or AVC. Compression brings the level of the average intensity up to within a few decibels of the peak intensity. For speech, the difference between the peak and the average is about 12 decibels. This is called the "crest factor" and has nothing to do with toothpaste. With compression, one can reduce the crest factor to several decibels – the speech sounds louder (higher average) but the peak is the same. Compression brings the RMS level up to just below the peak intensity level. Television commercials and movies do this routinely. Compressed commercials have a higher average or RMS level (crest factor of maybe only 4–5 dB vs. 12 dB) than the normal TV show, but the same peak intensity So ... movies and commercials tend to be more compressed than real-life speech, and tend to sound louder.

Movie projectionists do not typically have the capability to undo the compression (i.e., bring the average down to a level that is about 12 db quieter than the peak), although there is inexpensive expansion circuitry that can easily do this. A side effect of a compressed signal is obviously that the difference between the quietest elements and the loudest ones are not that large. In movies, we have quiet love scenes and loud action scenes – with compression, there still is a difference between the scenes, but it is smaller. Assuming no expansion circuitry is available, the interested projectionist can use his or her overall master volume control to manually make the soft scenes soft and the louder scenes louder. Therefore the projectionist has some global control over the scene-by-scene volume, but unless he has a degree in audiology, he cannot change the compression that allows the movie (and commercial) industries to make everything louder.

There are no commerically available hearing aids with “wide dynamic range expansion” that would effectively undo the compressed transmission of television commercials and movies in theatres, but such a hearing aid, or hearing aid program, could be used to resolve this issue.