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Canadian Hearing Report

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Vol. 4 No 2

Revue canadienne d'audition

Practice Management:
The State of Statements
Analyzing the Practice for Success

Founders of Our Profession:
Charles I. Berlin

A Tutorial On
Ear Impressions, Hearing Aid Shells & Earmolds

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I hope you enjoy this issue of the *Canadian Hearing Report* – the official organ of the Canadian Academy of Audiology. We have put together a diverse range of articles, columns, and reprints which should make for some interesting reading. But first I would like to welcome the newest member of the editorial committee, Calvin Staples. Calvin (who was an author in the last issue of *CHR*) comes to us with a range of clinical and more recently, manufacturing experiences. His insights and perspectives are sure to be welcomed by our readers. Also, Calvin is an Olympic-calibre runner, so if you don't know who he is, he is the person running in the rain at 6 AM when we are all still sleeping in a warm bed at CAA conventions (or not to bed yet from the preceding night's parties).

This issue sees the introduction of a new column called From the Library which is a critical review of recent publications in our field. This issue's column is from Ted Venema who has reviewed a wonderful book called *Digital Hearing Aids* by Arthur Schaub. I have this book on my bookshelf but had asked Ted to review it because he also happened to have written the preface to the book as well. Nevertheless his review is unbiased and quite accurate. My copy of *Digital Hearing Aids* is well "thumbed through" and has reinforced much of what I know about hearing aids in general and not just those with digital processing.

And following the promise made in a previous issue of the *Canadian Hearing Report* about providing articles that review the basics and can act as an accessible primer, Chester Pirzanski has provided us with a tutorial on earmolds. Tim Kelsall has also written a clear and concise overview of acoustic silencers. This is more in the realm of architectural and mechanical acoustics but the acoustic tools used by these silencers or mufflers are the same as those found in other areas of room (and even earmold) acoustics.

Without wanting to re-invent the wheel, the *Canadian Hearing Report* has obtained permission from *Audiology Practices*, the official publication of the Academy of Doctors of Audiology to reprint several excellent articles that would be of interest to our readers. These are by Doctors Robert G. Glaser and Robert Traynor, and are a series of articles on practice manage-

J'espère que vous allez savourer la lecture de ce numéro de la *Revue Canadienne d'Audition*- l'organe officiel de l'Académie Canadienne d'Audiologie. Nous avons assemblé un éventail varié d'articles, colonnes et rééditions qui devraient nous donner matière à une lecture intéressante. Mais en premier, je voudrai souhaiter la bienvenue à notre nouveau membre du comite éditorial, Calvin Staples. Calvin (qui a été un auteur dans le dernier numéro de la *RCA*) nous viens avec une gamme d'expérience clinique et plus récemment d'expérience manufacturière. Nos lecteurs vont surement apprécier ses réflexions et ses perspectives. Calvin est aussi un coureur de calibre olympique, donc si vous ne le connaissez pas encore, il est cette personne qui court à 6 heure du matin quand nous dormons encore dans nos lits chauds aux congrès de l'ACA (ou pas encore au lit à faire la fête le soir d'avant).

Ce numéro verra la présentation d'une nouvelle colonne appelée De la Bibliothèque, qui est un examen critique des dernières publications dans notre domaine. La colonne de ce numéro est de Ted Venema qui a examiné un livre merveilleux intitulé *Digital Hearing Aids* par Arthur Schaub. J'ai ce livre dans ma bibliothèque et j'ai demandé à Ted de l'examiner parce qu'il a aussi écrit la préface de ce livre. Pourtant son examen est impartial et bien juste. Ma copie de *Digital Hearing Aids* est bien usée à force de lecture et ne fait que renforcer ce que je sais sur les appareils auditifs en général et pas seulement ceux avec des processeurs numériques.

Et pour tenir une promesse faite dans un numéro précédent de *la Revue Canadienne d'Audition* de fournir des articles qui examinent les bases et peuvent agir comme guide accessible, Chester Pirzanski nous a fournit un tutoriel en embouts auriculaires. Tim Kelsall a aussi écrit un aperçu clair et bref des silencieux acoustiques. Ceci est plus du domaine des acoustiques architecturels et mécaniques mais les outils acoustiques utilisés par les silencieux sont les mêmes que ceux qu'on trouve dans d'autres zones de la chambre des acoustiques (et même des embouts auriculaires).

Sand vouloir réinventer la roue, *La Revue Canadienne d'Audition* a obtenu la permission de *Audiology Practices*, la publication officielle de l'Académie des Docteurs en Audiologie, pour réimprimer plusieurs excellents articles qui seraient intéressants pour nos lecteurs. Ceux-ci sont des Docteurs Robert G. Glaser et Robert Traynor, et sont une série d'articles en gestion de cabinet et en processus d'évaluation

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ment and how a practice can be financially evaluated. A clear overview of the software programs that purport to rehabilitate central auditory functions of hard of hearing people by Brian Taylor has also be reprinted with permission from www.audiologyonline.com.

And what would an issue of the *CHR* be without Spotlight on Science, From the Labs, and the E in ENT. Lorienne Jenstad has once again written this issue's "Spotlight"column on universal adult hearing screening. Most of the previous research has focused on infant and child hearing screening, but Lorienne reviews some interesting newer articles on adult hearing screening. Navid Shahnaz has written a very interesting "From the Labs" column on his current projects at the University of British Columbia. Navid has also contributed an original article which will appear in a future issue of *CHR*. The E in ENT column is an informative article written by one of Canada's leading otolaryngologists, Dr. Joseph Chen and his colleagues about a minor surgical procedure to treat some of the symptoms of Meniere's syndrome.

We also get to hear from another Founders of Our Profession, Dr. Chuck Berlin whose name has been associated with almost every aspect of the field of audiology. And for those who attend the American Academy of Audiology meetings, he is the young man who is frequently found playing jazz at a grand piano.

Submissions

Bridging the gap between universities, research facilities, and the clinics is an ongoing problem in ours and other clinical fields. I would like to see input from those of us who work with clinical populations write in about their experiences regarding interesting cases and they may have been handled. This new prospective column will be called From the Clinics, and depending on the input of our members it is hoped that it will be a regular feature in upcoming issues of *Canadian Hearing Report*.

Finally this is a call for "information sheets." If anyone has an information sheet about some aspect of their clinical practice that is written for their clients, we would like to publish them. The copyright would still belong to the author but permission should be granted for the readers of the *Canadian Hearing Report* to reprint them for use in their clinics, with the appropriate citation of the source.

Marshall Chasin, AuD, MSc, Reg. CASLPO, Aud(C),
Doctor of Audiology
Editor-in-Chief

financière d'un cabinet. Un aperçu clair des logiciels qui sont censés réhabiliter les fonctions auditives centrales des personnes malentendantes de Brian Taylor a été aussi réimprimé avec la permission de www.audiologyonline.com.

Et que serait un numéro de la *RCA* sans le Spotlight on Science, Des laboratoires, et le O dans l'ORL. Lorienne Jenstad a encore écrit la colonne "Spotlight" de ce numéro traitant du dépistage universel de l'ouïe chez les adultes. La plupart des recherches précédentes sont focalisées sur le dépistage de l'ouïe chez les nourrissons et les enfants, mais Lorienne examine des articles intéressants plus récents traitant du dépistage de l'ouïe chez les adultes. Navid Shahnaz a écrit un article très intéressant dans la colonne "Des laboratoires" dans le cadre de ses projets en cours à l'université de la Colombie britannique. Navid a aussi contribué à la rédaction d'un article original qui va apparaitre dans un prochain numéro de la *RCA*. La colonne le O dans l'ORL inclut un article très informatif écrit par un des chefs de file des Oto-rhino-laryngologistes canadiens, Dr. Joseph Chen, et ses collègues au sujet d'une procédure chirurgicale mineure pour traiter certains symptômes du syndrome de Meniere.

Nous avons aussi l'occasion d'entendre un autre fondateur de notre profession, Dr. Chuck Berlin dont le nom a été associé à presque tous les aspects de l'audiologie. Et pour ceux qui assistent aux réunions de l'Académie Américaine d'Audiologie, il est le jeune homme qui très souvent joue du jazz sur un grand piano.

Soumissions

Combler l'écart entre les universités, les établissements de recherches, et les cliniques est un problème continu dans notre secteur et aussi dans d'autres secteurs cliniques. Je voudrais voir l'apport de ceux d'entre nous qui travaillons avec des populations cliniques en écrivant au sujet de leur expériences concernant des cas intéressants qu'ils ou qu'elles ont eu à prendre en main. Cette éventuelle colonne sera nommée Des Cabinets, et selon l'implication de nos membres, nous espérons qu'elle sera une apparition régulière dans nos prochains numéros de *la Revue Canadienne d'Audition*.

Finalement, voila un appel pour "Des feuilles d'information." Si quelqu'un a des feuilles d'information concernant quelques aspects de leur pratique clinique qui est prescrite pour leurs clients (es), nous voudrions les publier. Les droits réservés vont toujours revenir à l'auteur mais la permission devrait être garantie pour les lecteurs de *la Revue Canadienne d'Audition* pour les réimprimer pour leur utilisation dans leurs cabinets, avec la citation appropriée de la source.

Marshall Chasin, AuD, MSc, Reg. CASLPO, Aud(C),
Docteur en Audiologie
Éditeur en chef

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Canadian
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Revue canadienne d'audition

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contents

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"Never doubt that a small group of thoughtful committed citizens can change the world. Indeed, it is the only thing that ever has."

– Margaret Mead

Over the past few months I have written to you about what the Canadian Academy of Audiology is doing for our members and the profession of audiology across Canada. This time I would like to discuss what you can do to help CAA.

CAA is a living breathing example of just how true Margaret Mead's words are. Thirteen years ago it started with a dedicated group of concerned audiologists and a note on a napkin. Today it is a thriving entity with its own executive director, a world class conference, nearly 500 members and, although the faces have changed, there is still that dedicated group of concerned audiologists. But that is not enough for us. CAA wants to be THE voice of audiology in Canada, we want to be the group that the public, the government and the media come to when they have a question or need advice.

So how can you help us with this?

RENEW YOUR MEMBERSHIP

There is power in numbers and for us to become the voice of audiology we need to represent the majority of audiologists in Canada. Your membership not only shows your commitment to the mission of CAA, but it shows your desire to promote the profession of audiology. Your membership also gives you:

- Access to the *Canadian Hearing Report*
- A member's only rate on the annual conference registration
- Exclusive personal and professional liability insurance
- Full access to our members only sections of the website
- Regular E-Blast updates on current issues including third-party funding and advocacy work

And all of this for only $150!

That's less than most of us spend on coffee in three months and renewing is easy. With our new system all you need are your username and password and you can renew your membership and update your information at www.canadianaudiology.ca. If you are not sure if you've

"Ne doutez jamais qu'un petit groupe de citoyens engagés puisse changer le monde. En réalité, c'est la seule chose qui a toujours été."

– Margaret Mead

Au cours des derniers mois, j'ai surtout souligné ce l'Académie Canadienne d'Audiologie fait pour ses membres et pour la profession de l'Audiologie au Canada. Cette fois, J'aimerai discuter de l'aide que vous pouvez offrir à l'ACA.

L'ACA est l'exemple vivant de la vérité des mots de Margaret Mead. Du départ, il y'a treize ans avec un groupe engagé d'Audiologistes préoccupés et une note sur une serviette, jusqu'aujourd'hui, avec l'ACA en tant qu'entité prospère avec son directeur exécutif, une conférence de renommée mondiale et prés de 500 membres. Et même si les visages ont changé, ce groupe d'Audiologistes engagés est toujours la. Mais ceci n'est pas suffisant pour nous. L'ACA veut être LA voix de l'Audiologie au Canada, nous voulons être ce groupe auquel, le public, le gouvernement et les média font appel quand une question est posée ou un conseil est requis.

Alors comment pouvez- vous nous aider dans cette tache?

RENOUVELEZ VOTRE ADHESION

Le pouvoir est dans les chiffres et nous avons besoin de représenter la majorité des audiologistes au Canada pour devenir la voix de l'Audiologie. Votre adhésion montre non seulement votre engagement à la mission de l'ACA, mais aussi votre désir de promouvoir la profession de l'Audiologie. Votre adhésion aussi vous assure:

- Un accès à la Revue Canadienne de l'Audition
- Un tarif de membre pour l'inscription à la conférence annuelle
- Une assurance exclusive de responsabilité personnelle et professionnelle
- Un accès total aux sections pour membres du site web.
- Des mises à jour régulières E-Blast des enjeux du moment tels que le financement offert par une tierce partie et la représentation.

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C'est moins que ce que la plupart d'entre nous dépensons en café en trois mois et le renouvèlement est facile.

renewed, or if you need your username or password please contact Executive Director Tom McFadden at director@canadianaudiology.ca

INVITE A FRIEND TO JOIN

I am putting out a challenge to you to register one new member to CAA. If each of us got one audiologist to join, the Canadian Academy of Audiology would represent over 80% of audiologist across Canada. Imagine the power that would give our voice. The procedure is the same as above; visit our website at www.canadianaudiology.ca for our easy online registration.

VOLUNTEER

Susan J. Ellis, president of Energize, a group that advocates for the power of volunteers, once said

> "Paul Revere earned his living as a silversmith.
> But what do we remember him for? His *volunteer* work. All activism is volunteering in that it's done above and beyond earning a living and deals with what people really care passionately about. Remember, no one gets *paid* to rebel. All revolutions start with volunteers."

There are so many different ways in which you can volunteer within our organization. Our committees are always looking for new faces and fresh ideas to spice things up.

- Are you one of the technologically gifted? Then why not join the website committee.
- Do you have a penchant for promotion? The public relations and awareness committee awaits.
- Does your blood boil when you see a policy or program that seems to limit audiologists or compromise the quality of care we can give our clients? The third-party relations committee might be for you.
- Do you excel at planning and organizing? Our conference committee is always looking for new ideas.
- Are you looking to help shape the future of audiology in Canada? Is *Roberts Rules* on your top 10 book list? The board of directors is looking for you
- Want to get your feet wet a bit before jumping right in? You can participate in our surveys. Take part in our forums. Let us know what we can do to help you, help us.

The Canadian Academy of Audiology is your voice, your professional association and your way of making a difference in the world of audiology.

> "I am only one, but I am still one. I cannot do everything but still I can do something.
> I will not refuse to do that something I can do."
>
> *– Helen Keller*

I look forward to hearing from all of you.

Carri Johnson
President
Canadian Academy of Audiology
president@canadianaudiology.ca

FSC INFO HERE

Avec notre nouveau système, vous avez seulement besoin de votre nom d'utilisateur et votre mot de passe et vous pouvez renouveler votre adhésion et mettre à jour votre information au www.canadianaudiology.ca. Si vous n'êtes pas certain que vous avez renouvelé votre adhésion, ou si vous avez besoin de votre nom d'utilisateur ou votre mot de passe, veuillez, s'il vous plait contacter le Directeur Exécutif Tom McFadden au director@canadianaudiology.ca

INVITEZ UN AMI

Je vous lance le défi d'inscrire un nouveau membre à l'ACA. Si chacun d'entre nous amène un audiologiste à s'adhérer, l'Académie Canadienne D'Audiologie représentera plus de 80% des audiologistes au Canada. Imaginez le pouvoir qu'aura notre voix. Le processus est le même que plus haut; visitez notre site web au www.canadianaudiology.ca pour une inscription en ligne facile.

BENEVOLAT

Susan J. Ellis, présidente de Energize, un groupe qui fait de la représentation pour le pouvoir des bénévoles, avait dit une fois

> "Paul Revere a gagné sa vie comme orfèvre. Mais comment se souvient-on de lui? Son bénévolat. Tout activisme est du bénévolat dans le sens que c'est fait au dessus et au delà d'une perspective de rémunération et touche les passions réelles des gens. Souvenez-vous, personne n'est payé pour se rebeller. Toutefois, toutes les révolutions ont commencé avec des bénévoles"

Vous pouvez faire du bénévolat dans notre organisation de plusieurs façons. Nos comités sont toujours à la recherche de nouveaux visages et de nouvelles idées.

- tes-vous de ceux qui sont doués pour la technologie ? Alors pourquoi ne pas faire partie du comité en charge du site web.
- Avez-vous un penchant pour la promotion? Le comité des relations publiques et sensibilisation est la.
- Est ce que votre sang bouille quand vous voyez une politique ou un programme qui limite les audiologistes ou compromet la qualité des soins que nous pouvons fournir à nos clients? Le comité des tierces parties peut être pour vous.
- tes-vous excellent en planification et organisation? Notre comité de conférence est toujours en quête de nouvelles idées.
- Cherchez-vous à aider à définir le future de l'audiologie au Canada? Est-ce Roberts Rules dans votre liste des 10 meilleurs livres? Le conseil d'administration vous convoite.
- tes vous de ceux qui aiment tâter l'eau avant le grand plongeon? Vous pouvez participer à nos sondages. Participez à nos forums. Faites nous part de l'aide que nous pouvons vous fournir, pour que vous nous aidiez.

L'Académie Canadienne d'Audiologie est votre voix, votre association professionnelle, et votre moyen de faire la différence dans le monde de l'audiologie.

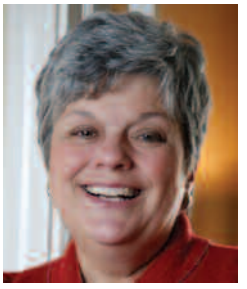
"Je suis seulement une, mais je suis toujours une. Je ne peux tout faire mais je peux toujours faire quelque chose. Je ne vais pas refuser de faire quelque chose que je peux faire."

– Helen Keller

J'attends avec impatience vos commentaires.

Carri Johnson
Présidente
L'Académie canadienne d'Audiologie
president@canadianaudiology.ca

In Memoriam



Dr. Judith S. Gravel
December 1948 –
December 2008

Dr. Judith S. Gravel passed away on December 31, 2008 following a courageous two-and-a-half year battle with cancer. The field of pediatric audiology will forever be strengthened by her wisdom, passion, and personal integrity. Those who knew her loved and respected her, and were inspired by her.

Judy was involved in the field of audiology for nearly 40 years. Her bachelor's degree in communication disorders in 1970 was followed by a master's in audiology in 1971, both from the University of Massachusetts at Amherst. She completed her PhD at Vanderbilt in 1985 and went on to a distinguished academic career that has included faculty appointments at Columbia University, Albert Einstein College of Medicine, the City University of New York, and the University of Pennsylvania. At the time of her passing, Judy was the director of the Center for Childhood Communication at Children's Hospital of Philadelphia where she also held the William P. Potsic Chair in Pediatric Otolaryngology and Childhood Communication.

This past year has been one of recognition for Judy's many contributions to our field. Early in 2008, Judy received the inaugural Antonia Brancia Maxon Award for Early Hearing Detection and Intervention Excellence at the National EHDI Conference and in April, received the Distinguished Achievement Award from the American Academy of Audiology and the 2008 Leadership Award at the 98th Annual Meeting of the League for the Hard of Hearing in New York City. In November, Judy was awarded the Honors of the American Speech-Language-Hearing Association. She was given recognition for a lifetime of innovative clinical practice, insightful and rigorous research, creative administration, effective legislative activity, outstanding teaching and other distinguished professional contributions. Most recently, in early December, Judy was honored with the Sylvan Stool Award from The Society of Ear Nose and Throat Advances in Children (SENTAC) for her innovative research in the area of otitis media in children.

Over the years, Judy spent many days with us in Canada, teaching courses in Pediatric Audiology at Western, serving as a consultant to the Ontario Infant Hearing Program and presenting at numerous Canadian conferences. Judy had family roots in Quebec and she often told me how very proud she was of her Canadian heritage.

Judy was beautifully unique. She was a scholar, a scientist, a teacher, and a master clinician whose career

exemplified the highest standards of professionalism and ethical conduct. Above all she was a warm and caring person with a remarkable way of bringing out the best in everyone whose life she touched.

– Richard Seewald

To continue the work to which Judy devoted so much of her time and talent, Vanderbilt University is establishing the Judy Gravel Pediatric Audiology Fund at the Vanderbilt Bill Wilkerson Center. In lieu of flowers, Judy's family requests that donations be made to:

Judy Gravel Pediatric Audiology Fund

c/o The Vanderbilt Bill Wilkerson Center
1215 21st Avenue South
Nashville, TN 37240

| LETTER TO THE EDITOR

I found the *Canadian Hearing Report* to be an impressive and very attractive journal. Besides reading my interview (Founders of Our Profession), I just finished the article by Calvin Staples. He writes very well and I enjoyed reading it. Calvin gave the most coherent explanation of the different possibilities of fast and slow compression that I've ever read. And his coverage of the kinds of response differences that occur with different manufacturers should be required reading by all audiologists.

Thank you.

Mark Ross, PhD,
Professor Emeritus,
University of Connecticut,
Storrs, Connecticut, USA

B.C. Creates Speech and Hearing Regulatory College

VICTORIA – The professions of audiology, speech-language pathology and hearing instrument dispensing will come under the Health Professions Act through a new regulatory college for speech and hearing professionals, Health Services Minister George Abbott announced.

"The College of Speech and Hearing Health Professionals will give British Columbians a new level of accountability, protection and transparency in dealing with speech and hearing professionals," said Abbott. "This is the first time British Columbia has established a new umbrella college for multiple distinct professions, and it represents the collaboration of many people who worked hard to make it happen."

Abbott also appointed members to the new college's board for the first year. The board consists of eight members from the three professions and four members representing the public. After the first year, the board members from the professions will be elected.

The board of the new College of Speech and Hearing Health Professions of BC held its first meeting on January 14th to begin a 15-month long process to set up the new College.

The meeting began with an Oath of Office Ceremony. Mr. Justice Paul Williamson of the BC Supreme Court took the board members' oaths and the Hon. George Abbott, Minister of Health Services, acted as the official witness. Craig Knight, an A.D.M for the ministry, was master of ceremonies.

During the course of this first meeting, the college board set a foundation for its future meetings, and made a number of decisions so that members can be registered by April 1, 2010.

The new College is the first three-profession college established under BC's *Health Professions Act*, and is responsible for regulating the health professions of audiology, hearing instrument dispensing and speech-language pathology. This is the first time in Canada that a single college has regulated these three professions.

The college board also appointed George Bryce, a Vancouver-based administrative law lawyer, to be the college's interim registrar, and to act as legal counsel.

Review of 24th Annual Seminars on Audition

Seminars on Audition is a one day conference relevant to audiologists, hearing instrument practitioners, researchers, and engineers interested in hearing loss, its prevention, assessment, and remediation. A forum is provided where participants can exchange experiences, information, and philosophies. This last seminar was held in the Toronto area on Saturday Feb. 28, 2009.

All proceeds from Seminars on Audition go to sponsor the Seminars on Audition Scholarship which enables a University of Western Ontario Audiology student in their final year of study to visit an extraordinary facility anywhere in North America. Support is also provided to the Poul B. Madsen Award through the University of Toronto Institute of Biomaterials and Biomedical Engineering. This is for a graduate student who demonstrates excellence in applied biomedical engineering.

The speakers at this year's seminar were Dr. Mead Killion and Dr. Susan Scollie.

Mead Killion, PhD, founded Etymotic Research, Inc. in 1983. Prior to starting ER, he worked for over 20 years for a major electronic component manufacturer, where he designed hearing aid microphones that were so accurate they were also used in recording and broadcast studios. Dr. Killion earned degrees in mathematics from Wabash College and the Illinois Institute of Technology, and completed his doctorate in audiology at Northwestern University. He was awarded an honorary doctor of science (ScD) degree from Wabash College. Dr. Killion is a Fellow of ASA and the AES. He is an accomplished choir director, jazz pianist and violinist.

Susan Scollie, PhD, is an assistant professor at the National Centre for Audiology at the University of Western Ontario in London, Ontario, Canada. She collaborates with Richard Seewald, Sheila Moodie, and Marlene Bagatto in the development of the recently released version 5.0 of the DSL Method for hearing aid fitting. Dr. Scollie's current research focuses on the evaluation of digital signal processing for high frequency hearing losses, sound localization in children who use hearing aids and the prediction of speech recognition scores using the Speech Intelligibility Index.

Dr. Killion spoke on several topics:

High Fidelity Hearing Aids and Listening Tests

Speech is composed of a rich harmonic "fine-structure" and a "coarse-structure" reflecting the shape of the vocal tract and movements of the primary articulators. Although the peripheral auditory system provides a detailed representation of fine-structure, this detail does not appear to be necessary for speech understanding. This session explored the roles of fine structure and coarse structure in speech understanding, hearing in noise, and music perception. The presentation then introduced steady-state electrophysiologic responses that can be recorded to fine-structure and coarse-structure from the brainstem and cortex. These responses may be useful for assessing the encoding of speech sounds at different levels of the auditory system, and may be particularly valuable for validating infant hearing aid fittings.

The pleasant relationship between hearing aid fidelity and intelligibility in noise was reviewed, and attendees were given practice to demonstrate that they can readily predict the fidelity that will be experienced by their patients.

Finally, the area of hair cell loss, the SNR loss and the generalized AI that allows a good estimate of the inner hair cell loss, was discussed.

How to Have Teenage Ears When You Are Old

Lost hair cells was discussed from the perspective of hearing conservation. An estimate of one hair cell lost for each 2x noise overdose suggests that a Slipknot concert can cause the loss of 160 hair cells. Loss of only two hair cells a day can result in complete

deafness after approximately 20 years.

Brain Rewiring: Good and Bad

Our brains are constantly rewiring to apply their processing power to the problems identified. Examples from motion, vision, and hearing will provide the background for the good news that the brain can be rewired with appropriate training to decrease SNR loss.

Dr. Scollie spoke on the **Evaluation of Frequency Lowering DSP Hearing Aids**.

New technologies are now available for moving high frequency sound energy to lower frequency regions through DSP in a hearing instrument. These technologies attempt to increase access to high frequency speech cues, over and above the audibility that can be provided with today's conventional processing (i.e., multichannel WDRC). The presentation reviewed a clinical trial of a multichannel nonlinear frequency compression (NFC) processor. The development and evaluation of a fitting rationale for NFC, along with the clinical outcomes obtained with both adults and children were reviewed. Electroacoustic measures and evaluations of both frequency lowering and sound quality were used to illustrate the effects of frequency lowering beyond what can be viewed on a conventional aided spectrum. Clinical implications for candidacy and fitting were also discussed.

Review of Current Research Projects in Middle-Ear Lab (MEL)

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Currently my lab works on three research themes

(1)Understanding effects of maturation, aging, and ethnicity on middle-ear transmission properties and their impact on auditory sensitivity and differential diagnosis of different middle-ear pathologies.

The major goal for the first theme is to understand the effects of maturation, aging, and ethnicity related changes on the middle-ear (ME) transmission properties with the aim of better understanding the impact of these changes on auditory sensitivity and differential diagnosis of the middle-ear pathologies. This theme is currently being investigated in three separate but related projects:

(a) Maturation of the ear canal and the middle ear in newborns (N. Shahnaz; L. Qi, A. Cai; K. Bingham; L. Jenstad; S. Small; R. Funnell). The middle-ear and external auditory canal undergo structural changes over the first two years after birth which can affect the physical properties by which sound is transferred into the cochlea. The overall objectives of this project are to define the time course during which functional maturation of middle-ear occurs in human infants and determine the implications of these developmental changes for commonly performed clinical and research measurements; namely, tympanometry, wide-band reflectance, and hearing instrument verification real-ear measures. This project was initiated with a grant awarded by The Hearing Foundation of Canada and then supported by the British Columbia Early Hearing Screening Program (BCEHP). Co-operation with Dr. Lorienne Jenstad resulted in using advanced middle-ear analysis techniques along with real ear to coupler difference (RECD) in newborns close to the birth. These newborns are being followed on one month interval for total of six visits. So far 31 babies have been recruited and more than 120 visits have been conducted. Recently, we have expanded the project to determine the effects that these developmental changes have on hearing sensitivity as measured by air and bone conduction evoked response audiometry. I have teamed up with Dr. Susan Small who is an expert in physiological assessment of newborn's hearing. To accomplish this goal, the mechano-acoustical properties of the middle-ear and hearing sensitivity in infants are being examined at a wide range of frequencies during a series of longitudinal sessions. It is expected that the outcome of this research will reveal significant mechano-acoustical differences in the middle-ear transmission properties between different follow-up intervals for each newborn. Since the ear canal and the middle ear are in series with the inner ear, these changes could potentially affect the hearing sensitivity as measured by AC and BC evoked response audiometry.

(b)Mechano-acoustical properties of the normal ear canal and ME in different ethnic groups and its potential impact on hearing sensitivity and clinical decision analysis (N.Shahnaz; D. Davies; K. Bork; C. Spencer; J. Shaw): This is an important issue to investigate in today's increasingly multicultural societies. It has been shown that the average height and weight is larger in the Caucasian than in the Chinese group in both males and females. The results of several research studies have shown that body size in animal models correlates with the size of the ear canal, ME volume, area of tympanic membrane, and footplate. These studies have shown that increasing body size in animal models is accompanied by

an increase in the compliance of the ME air space. It has been shown that Chinese normal hearing adults have significantly different middle ear characteristics than the Caucasian adults (Shahnaz and Davies; Shahnaz and Bork, 2006). Middle-ear studies have revealed differences between Caucasian and Chinese adults that are presumably related to differences in body size among these groups. More recently, we have observed similar differences between the Caucasian and the Chinese school-aged children. The differences observed can also affect physiologic tests such as OAE. Because the stimulus for generating the OAE must pass through the ME (forward transmission) to stimulate the cochlea and the OAE response must travel back through the ME (backward transmission) to be detected in the ear canal, the status of the ME can also greatly influence OAE results. We have found statistically stronger absolute TEOAE amplitude in the Chinese group than the Caucasian group (Shahnaz, 2008a). The observed differences in OAE responses between different racial groups have also been attributed to pigmentation, given the similar embryological origin of the inner ear and skin cells. It has been suggested that different levels of melanin may potentially affect the function of the cochlea. Melanin level varies between different ethnic groups, with Asians having the higher levels of melanin than Caucasians. Recently we have investigated the racial differences in hearing thresholds between Caucasian and Chinese young adults at conventional (250–8000 Hz) and extended high frequencies (9–16 kHz) in 14 Caucasian and 14 Chinese young, normal hearing adults. The Chinese were found to have significantly better thresholds than Caucasians at 14 and 16 kHz. Middle-ear efficiency in humans tapers off at higher frequencies; therefore, any observed differences in hearing sensitivity at higher frequencies (above 8 kHz) may provide further insight into the potential contribution of cochlear function to the observed racial differences. In the adult group, Laser Doppler Vibrometry (LDV) is also being used to assess ME function. LDV is a well-established research tool for exploring ME function. It can be used to measure the sub-microscopic movements of eardrum and middle-ear ossicles in response to a sound. We are currently collecting normative data for this project.

(c)Differential diagnosis of middle ear pathologies in newborn, children, and adult using multi-frequency tympanometry (MFT) and wideband energy reflectance (WBER-N. Shahnaz; A. Beers; V. Bosaghzadeh; F. Kozak; B. Westerberg; L. Usher; N. Longridge; D. Bell; E. David): The main goal of this project is to establish guidelines and normative data to characterize the mechano-acoustical properties of the normal ear canal and middle-ear in newborn infants, children, and adults and to explore overall test performance of MFT and WBER in differential diagnosis of different middle ear pathologies. Our preliminary data have shown that both high frequency tympanometry and WBER are superior to conventional low frequency tympanometry in detecting middle ear effusion in newborns (Shahnaz, Miranda and Polka 2008; Shahnaz 2008b). Our recent study using MFT and WBER (Beers et al. 2008) in school aged children and children with middle ear effusion revealed that WBER measures are able to distinguish normal ears from those with middle ear effusion at a hit rate of 100% while maintaining a false alarm rate of 10%. We are expanding this project to investigate whether WBER can be used to detect different types of middle ear fluid (mucoid versus non-mucoid) as confirmed by the surgery. The WBER results of normal adult Caucasians has also been compared to surgically confirmed otosclerotic ears before and after the surgery (Shahnaz et al. 2009). Findings show that the overall changes of WBER across frequencies can distinguish otosclerotic ears from normal ears and from other sources of conductive hearing loss. Incorporating WBER in general practice will improve the identification of otosclerotic ears when conventional tympanometry and MFT may fail to do so. We are expanding this project to include ossicular discontinuity and to explore whether WBER can be used as a viable option to test the effectiveness of reconstructive surgical protocols.

(2)Prevalence of Cochlear Dead Region in Typical Clinical Case loads (N. Shahaz; L. Jenstad; N. Davies, H. Lee; J. DiCecco)

The main goal of this project is to explore the prevalence of cochlear dead region using a The Threshold Equalizing Noise (TEN-HL) Test in different clinical settings. The outcome of this project will help us to determine whether this test needs to be included as routine test in audiologic test battery. So far we have tested more than 60 individuals with sensorineural hearing loss (N. Davies MSc thesis student). During the course of this project clinicians asked us if this test can

be conducted using an insert earphone. The TEN test has been calibrated for use with supra-aural headphones, but not with insert earphones (ER-3A). Insert earphones are often preferred by clinicians because of the reduced interaural attenuation, occlusion, and possibility of collapsing canals when compared with supra-aural headphones. In addition, insert earphones are often easier for clinicians to place. It would, therefore, be beneficial to administer the TEN tests with insert earphones. Two separate projects was conducted to determine whether significant differences in the diagnosis of dead regions are seen between supra-aural headphones and insert earphones when administering the TEN (HL) test.

(3)Determining Preferred Listening Levels of Personal Listening Devices in Young Adults in Real life Environments Using Real Ear Measures (N. Shahnaz; L. Jenstad; C. Lane)

The aim of this study is to determine whether the Preferred Listening Levels (PLLs) for Personal Listening Devices (PLDs), as set by typical users in their daily acoustic environments, are sufficiently high to damage hearing. PLLs are being measured in the real ear for the settings and musical stimuli to which the participants typically listen. Typical user settings will be determined from listening-log data and stimuli chosen by each participant; thus these lab-based measures will be more representative of the participants' everyday listening experiences than previous research has been, as listeners may choose different PLLs in a quiet lab versus their everyday environments. PLD users with normal hearing will be asked to keep a log of their average listening volumes, including listening durations at these levels, in three common listening environments (e.g., library, cafeteria, and public transit). The SPL value at the eardrum will be measured and the average listening duration for each environment will be used to assess whether each subject is potentially damaging their hearing as a result of PLD use. The results will be used (1) to increase public awareness of the real-world potential for hearing loss resulting from use of these devices and (2) to promote the adoption of guidelines to ensure a safe daily-noise dose for consumers of recreational music.

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Intratympanic Aminoglycoside Treatment for Meniere's Disease

By Paul Mick, MD, Julija Adamonis, MSc (Aud), and Joseph Chen, MD, FRCSC

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Brenda sat in the examination room with an exhausted, pained and stressed expression on her face. She was a 52-year-old woman diagnosed with right-sided Meniere's disease nine months previously.

"Doc, things are terrible. I get dizzy attacks almost every day. I can't work, drive, or do housework. I'm terrified that I will get an attack in public so I don't go out. My social life is non-existent and my family is having a hard time dealing with my problems. I think I'm depressed. I took the pills that you prescribed and cut down on salt like you said, but nothing's working. Isn't there anything else you can do for me?"

Meniere's disease, like many other otologic conditions, is incompletely understood. There is no cure, which frustrates both patients and physicians. Its typical symptoms (sudden attacks of vertigo lasting between 20 minutes and 12 hours, unilateral sensorineural hearing loss, tinnitus, and aural fullness) have been well described, as has its relapsing and remitting natural course. Histologically, patients with Meniere's disease have elevated endolymphatic fluid pressure (endolymphatic hydrops), but the underlying cause of the hydrops is unknown. Treatment is directed towards alleviation of symptoms, the most debilitating being attacks of vertigo. The classic audiologic feature of endolymphatic hydrops is a fluctuating low frequency sensorineural hearing loss (Figure 1), diminished peripheral vestibular function on electronystagmography, and an elevated summation potential (SP) to action potential (AP) ratio on the electrocochleography (ECoG) – Figure 2.

If the vertigo is mild, the patient may decide to forgo treatment and live with the disease, returning for check-ups every six months or so. If the vertigo is more severe, medical therapy may be attempted despite weak evidence of its effectiveness.[1] A low salt diet and diuretics can be prescribed with the goal of decreasing water retention in the body and therefore endolymphatic pressure. Vestibular suppressants such as betahistine (Serc) and prochlorperazine (Stematil) as well as anti-nausea medications may also be prescribed.

Some patients, like Brenda, do not experience symptomatic relief from these therapies and become incapacitated. Surgical therapy can be considered for these people. There are two types of surgery. One type, called endolymphatic sac surgery, is performed to create space around the endolymphatic sac, in the hope of

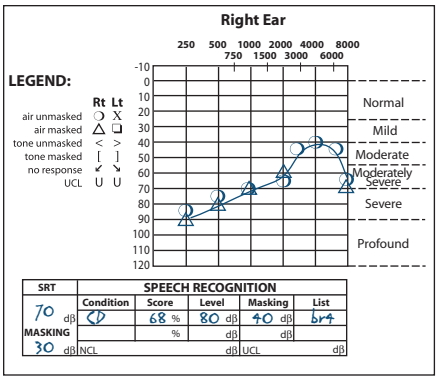

Figure 1. Audiogram of patient.

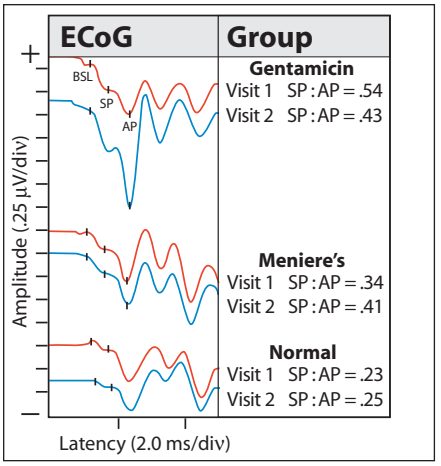

Figure 2. Typical electrocochleographic (ECoG) responses to alternating clicks from a gentamicin-treated subject (group G), a Meniere's control subject (group M), and a normal control subject (group N). Responses are shown for two visits for each subject; for the gentamicin-treated subject. Visit one is before treatment and visit two is after treatment. On each waveform the baseline (BSL) summation potential (SP), and action potential (AP) are shown. The SP/AP ratio for each waveform is also provided.[5]

relieving hydrops. Endolymphatic sac surgery is rarely performed because its outcomes have been shown to be no better than placebo.[2] The other type of surgery, called ablative surgery, is performed with the goal of eliminating (ablating) all vestibular function in the diseased ear. Patients who undergo ablative surgery must subsequently rely on only the opposite ear for balance. Within a few weeks most patients adjust and have only mild residual imbalance. An oft-used analogy compares a patient with Meniere's disease to an airplane with one functional engine (the healthy ear) and one sputtering engine (the diseased ear). Despite the loss of performance caused by turning off the faulty engine, the plane can be flown more easily and predictably without it. Determining the correct side of disease is critical – destroying the functional ear (or engine) would be disastrous. Audiograms and electronystagmography are useful in this regard. Patients with poor vestibular function in the contralateral ear (from old age, bilateral Meniere's disease, or other central or peripheral disorders) are poor candidates for ablative surgery because they cannot compensate for any loss of balance function, resulting in oscillopsia. Unfortunately, up to 44% of patients with unilateral Meniere's disease will develop contralateral disease within 20 years.[3] Patients considering ablative surgery must be counselled about this risk.

There are three ways to ablate the diseased vestibular organ: labyrinthectomy, vestibular nerve section, and intratympanic gentamicin instillation. The first two techniques are very successful at eliminating vertigo, but are surgical in nature with potentially serious risks. Labyrinthectomy results in an obligatory deafness. Consequentially, instillation of gentamicin has become the mainstay of ablative treatment with the other two reserved for treatment failures.

Gentamicin is an aminoglycoside antibiotic with a well established toxicity to certain cell types, targeting the inner ear and the kidney. Gentamicin, given its molecular makeup appears to have a higher affinity for the vestibular hair cells (vestibule-toxic) than cochlear hair cells (cochleo-toxic). Its application in Meniere's disease is with the intent of creating selective destruction of the vestibular end-organ to achieve "de-afferentation." Compared to the aforementioned surgical techniques, Gentamicin therapy is a simple and safe technique with a similar end-point.

When targeting the inner ear, gentamicin is instilled into the middle ear space thus allowing diffusion into the labyrinth via the round window membrane and (to a lesser extent) the annular ligament of the oval window. Other than hair cells, gentamicin may also impair endolymph production by injuring the dark cells of the stria vascularis. Approximately 25% of patients will lose hearing as a consequence of therapy.[4]

Treatment is continued until either a pre-determined dose has been given or there is evidence of cochlear or vestibular damage (nystagmus, hearing loss, or imbalance). A myriad of delivery schemes have been proposed, some with maximal efficacy in mind, others focused on decreasing the risk of side effects.

Gentamicin can be delivered into the middle ear via a tubing system through a myringotomy (Sunnybrook Technique). Patients receive repeated injections over 4 days until there is evidence of cochleo-vestibular impairment or until a total of 12 injections have been administered, whichever comes first. In a study of 90 patients with two-year follow-up, this protocol resulted in complete resolution of vertigo in 84.4% of patients and substantial resolution in an additional 8.9%. Twenty-five percent of patients lost hearing, the majority within a month of therapy.[4] Other centres may elect to use a weekly injection protocol with a different end-point to therapy. Results of vertigo control vis-à-vis hearing loss

amongst recent studies are generally within the range of acceptable outcomes. An improvement in the ECoG responses may be evident following a successful gentamicin treatment to suggest a positive correlation with a reduction of endolymphatic pressure.[5]

Brenda was educated about her options. She was not interested in continuing her current medical regime, which had been ineffective for over a year while a major surgical alternative that leads to the destruction of the inner ear was unacceptable in the event of a possible contralateral inner ear involvement. In the end, Brenda, desperate for an improvement in her quality of life, agreed to gentamicin therapy. Her outcome was excellent – the vertigo resolved and she did not realize additional hearing loss. She was left with a slight imbalance but her life essentially returned to normal, with the exception of having to slow down a bit on the ski hill.

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Digital Hearing Aids,

By Arthur Schaub,
Thieme Publishers,
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Reviewed by
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This book is very unusual, in that it bridges the fields of electrical engineering and audiology. The author's specialty is electrical engineering and my own is audiology. As all of us struggle to grasp the latest in digital technology, we have come to realize that these two specialties intersect many times. Most of us in the hearing health care field are trained more in the psycho-social realm, and we tend to observe developments from our unique audiologic fusion of psychology, anatomy, and a smattering of basic electronics.

From that standpoint, let's have a look at where analog hearing aid technology ended.

Our passage begins with the "heady" days of the early to mid 1990s, when we all became introduced to the concepts of wide dynamic range compression (WDRC) and multi-channel technology. Hearing aid development had quickened its pace and hearing health care professionals suddenly had lots to absorb. Hearing aid manufacturers in the 1990s began hiring audiologists in earnest, to explain new technology back to their customers. These audiologists, however, had to pay regular visits to the engineers who worked at the same manufacturers, to learn things they had never learned in university. Yet, the hearing aids of that day were all analog, not digital. I think the 1990s (especially the first half of that decade) was the "golden age" of compression precisely because of this fact. The compression used in analog hearing aids was hardware based, meaning it was determined by the particular circuit utilized by the hearing aid. Analog hearing aids were thus confined to using one type of compression or another, and it behooved of clinicians to know their compression types. With today's digital hearing aids, this is no longer the case. The fitting software automatically provides specific types of compression for various types and degrees of hearing loss. Just a small question here: Are we losing our edge?

When the first digital hearing aids appeared in the late 1990s, the pace

of developments became faster still! Digital signal processing (DSP) continually reduces chip size and speed. More and more features and benefits constantly appear. We have all heard of bits and bytes, but we don't know *how* digital hearing aids actually work. That's OK because to be good at what we do, we don't really *have* to know *how* DSP works! It is really an option on our parts to have further specific training in DSP. That is why this book is not for everyone.

For the person who really does want to know more, however, this book is a gem. It is written by an engineer who spends his waking hours developing DSP. The book explains some fundamentals to hearing health care professionals in a way that most of us have not heard before. Throughout reading this book, you will note that Arthur Schaub writes in short sentences and he eschews detailed explanations. To best understand, just follow along patiently, step by step. The illustrations in each chapter are plentiful and excellent. What's more, they are coloured, which, in my experience, is unusual to find in a relatively small textbook such as this one. The illustrations render the verbal explanations clear and compliment them very well. They are an exceptionally good feature in Schaub's book.

In chapters 1–4, the author goes over familiar materials such as venting, but he also explains some DSP algorithms such as, feedback reduction, WDRC, and adaptive changes to various programs. Algorithms, by the way, are simply series of mathematical instructions employed by digital hearing aids. In these early chapters, readers will notice that he explains in further detail some characteristics of signals that we might think we know, but all too often we really cannot articulate all that well. His discussion of digital noise reduction in Chapter 3 is particularly interesting and informative. The discussion of "transfer functions" in Chapter 4 is also highly informative; most audiologists hear this term on a regular basis but few of us can truly say what one is.

In Chapters 5–10, we are drawn in further to look more specifically and closely at DSP itself, how it works, what it can do and what it cannot do. We still focus on five essential elements of digital hearing aids: amplification, directionality, noise reduction, feedback cancellation, and sound classification. In these chapters, however, we are not yet brought into the numerical world of digital signal representation.

In Chapters 11–14 it becomes impossible to refrain anymore from the math. Fourier transforms, digital finite impulse response and infinite impulse response filters, autocorrelation, and linear prediction are covered. Here, Schaub refers often to simple formulas and lays them out on Excel spreadsheets. He uses, clear and plain numerical examples. These serve to make it as easy as possible for readers to form a mental picture of events. Still, for a non-mathematical mind like my own, the examples remain challenging. Many will notice that this part is not that different from the math we needed to learn in our speech sciences classes- an area where "digital" preceded hearing aids by about a decade.

Readers with training that was anything like my own (typical audiology) must be patient, and spend the requisite time to slowly read these later chapters. When overwhelmed, I suggest one might simply put the book down and try again later. It often works. Any good learning always takes work. Who knows? You might just gain a new appreciation for DSP in hearing aids! I'll end here as I began; this book is a unique "bridge" between two worlds that often collide in our field: electrical engineering and audiology.

Now that Newborn Hearing Screening is Universal, What About Adults?

By *Lorienne Jenstad, PhD*
Associate Editor

In June 2010, the first (that I know of) conference on Adult Hearing Screening will be held in Cernobbio, Italy (www.ahs2010.polimi.it/index.html). A recent literature search of the term "hearing screening" revealed that the published articles over the last year or so have their focus in three different areas.

First, there are still articles on newborn hearing screening, but those tend to be about program evaluation. The emphasis is on "Did the program work?" "How well did we do?" "What evidence do we have that screening made a difference?" That is, the programs have been solidly established and their success is now being evaluated. Second, there are some articles emerging on whether school-age hearing screening is necessary. And finally, the topic of focus for today's column, research is being published on the necessity and feasibility of *universal adult hearing screening*.

Some of the Background

Why is there now an interest in adult hearing screening? To answer that, we can look back at the process that occurred when Universal Newborn Hearing Screening was introduced.

From Fred Bess (Bess and Paradise 1993), three main areas must be considered when deciding whether to screen a population for a particular disorder: the consequences of the disorder, the availability of a good screening procedure, and the availability of an intervention. Let's look at each of these criteria in relation to how they might apply to adult hearing screening.

"*The disorder must be important*" (Bess and Paradise 1993, 331).

"Importance" of a disorder can be specified in several different ways:

- **Prevalence.** A disorder can be considered important if it's highly prevalent in the population. We know that adult hearing loss is highly prevalent; how prevalence is quantified partly depends on the definition of the target hearing loss (25 dB HL? 40 dB HL? At one frequency? The pure tone average?) and the definition of "older" adult. Prevalence estimates depend on whether the cut-off for "older" starts at 55, 65, 80, 90-plus years old.
- **Damaging effects or suffering.** We have pretty compelling evidence that untreated hearing loss in older adults leads to social isolation and loss of independence, among other results (Kramer et al. 2002; NCOA, 1999). What we don't know yet is the cost of untreated hearing loss for health care as a whole. For example, social isolation is an important risk factor for disease recovery or coping with chronic illness (DeLongis and Holtzman 2005; Holtzman et al. 2004; Holtzman and DeLongis 2007). Because hearing loss contributes to social isolation, it may contribute to mortality in specific diseases. We don't have clear data yet in that area, so the true cost of hearing loss is still not known, but we can speculate that it may be high.

"The screening procedure must be safe, acceptable, simple, reliable, valid, reasonably low in cost, and practicable" (Bess and Paradise 1993, 331).

What screening tools do we have available for adult hearing loss? The three most acceptable screening tools, as shown in recent systematic reviews (Bagai et al 2006; Yueh et al 2003), are the Whispered Voice Test, pure-tone screening, or the Hearing Handicap Inventory for the Elderly – Short Form (HHIE-S).

- **Whispered Voice Test.** Are you surprised this one ended up on the list? It's actually not a bad test if the instructions for administration are followed. The instructions include a lot of steps to ensure that the level of the examiner's voice is somewhat standardized. This test is valid for

detecting difficulty in understanding soft speech and can be reliable if administered properly. It's also low cost, quick, safe, and non-invasive.

- **Pure-tone screening.** Hand-held screeners that have automated procedures for a pure tone screen (at 20, 25, or 40 dB HL cut-offs) make it simple for almost anyone to administer the test and interpret the results as a pass or refer for further testing. Imagine the possibilities for who can screen for hearing loss in the elderly: pharmacists, staff at driver's license offices, any health care professional, etc. The more people who are able to screen, the more likely that we can move towards universal screening in adults.
- The **HHIE-S** is quick, low-cost, and is good for detecting hearing loss in individuals who are likely ready to seek treatment, but may not detect those in early stages of hearing loss; i.e., those who have some loss but are not likely to seek treatment.

"Finally, when the disorder is found to be present, the treatment that follows must be efficacious, available, accessible, and readily complied with, and, crucially, early treatment must be more effective than later treatment" (Bess and Paradise 1993, 331).

The main treatment we have is hearing aids, with a lot of evidence showing that hearing aids are efficacious. Are they accessible? Many people cite hearing aid cost as the main barrier preventing them from purchasing hearing aids. There are other barriers to accessibility, including lack of knowledge about how and whether hearing aids can work. All of these barriers need to be addressed.

Is the treatment readily complied with? We know that hearing aid use among those who could benefit is low. At this point, the treatment is not readily complied with universally. This is clearly an area that needs work if adult hearing screening is to be effective.

What evidence do we have about early treatment versus later treatment? We know that many people wait several years between beginning to acknowledge a hearing loss and actually seeking treatment. So there certainly is room for us to implement earlier treatment (10 years or more in some cases). Some possibilities come to mind for ways that early treatment may be better than late. For example, early treatment may help prevent the phenomenon of auditory deprivation. Also, the adjustment to hearing aid use can be easier in younger adults than older adults (Davis et al. 2007). Perhaps earlier treatment will help stop the concomitant social isolation and depression associated with untreated hearing loss.

What to Watch for In the Literature

Over the next little while, look for further research about the epidemiology of adult hearing loss, sensitivity of hearing screening procedures, debates about defining the target disorder in adults, questions about who should be screened and when, and ultimately, whether hearing screening will have any impact on people seeking, and complying with, earlier treatments for hearing loss.

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In the News

All the Basics of Audiology Available in a Single Book

Audiology primarily deals with hearing and balance disorders. The field encompasses a body of knowledge that is of interest to professionals working in a wide range of disciplines in addition to audiology, including speech-language pathologists, teachers of the deaf and hearing impaired, engineers, physicians, and psychologists. The recently released third edition of Essentials of Audiology, published by Thieme, provides students and professionals in communication sciences and disorders current, practical information on a field that is steadily growing and developing.

Much has occurred since publication of the last edition of this best-selling title. Guidelines as well as standards and regulations have changed. This new edition includes up-to-date coverage of developments in areas such as hearing aids, electrophysiological assessment, and cochlear implants.

Essentials of Audiology adeptly capitalizes on its more than 300 illustrations in order to demonstrate key concepts in the field. A full range of topics from acoustics, anatomy, and physiology to auditory disorders and hearing impairments, screening techniques, assessment, and clinical management are thoroughly covered.

"The book is intended to serve as the core text for undergraduate students in communication sciences and disorders, as well as to serve the needs of beginning-level speech-language pathology and audiology graduate students who need to learn or review the fundamentals of audiology. I hope that students will find this text useful as a reference source long after their courses have been completed," says author Stanley A. Gelfand, PhD.

Nearly 1,500 DC-area first- and second-graders filled the George Washington University Lisner Auditorium for ASHA's Listen To Your Buds concert.

The concert, headlined by Billy Jonas, educated children on the risk of noise-induced hearing loss from misuse of personal audio technology. The American Speech-Language-Hearing Association presented the concert in collaboration with Parents' Choice Foundation and the National Institute on Deafness and Other Communication Disorders. Visit **listentoyourbuds.org** for more information.

Next up – a concert in LA in September and New Orleans in November.

iPhone Hearing Test App

UHear is a sound app that features two tests and a questionnaire to evaluate your hearing performance.

One test evaluates your hearing sensitivity by prompting you to tap a button whenever you hear tones, which are played at various volume levels. The other test assesses your ability to hear speech in a noisy environment by asking you to crank up a noise track as high as you can until you can just barely understand the voice track. The questionnaire asks you how your hearing is in different environments and situations, and it tells you whether you should consult a physician about your hearing.

www.wired.com/gadgetlab/2009/05/uhear/

UK Study Finds Hearing Loss Leads to Social Isolation

Nearly two out of three Britons **with hearing loss feel socially isolated** because of their condition, according to a new survey.

However; one in 10 of the 700 people surveyed by high-street chain Specsavers said they would not wear a hearing aid due to the stigma attached to it.

www.nursingtimes.net/whats-new-in-nursing/specialists/older-people/hearing-loss-leads-to-social-isolation/5001036.article

Program Benefits Children With Hearing Loss

Early Intervention Improves Language Skills; Earlier Enrollment May Lead to Greater Gains

In young children with permanent hearing loss, enrollment in an early intervention program significantly increases the likelihood of achieving and maintaining appropriate language skills, according to research presented at the annual meeting of the Pediatric Academic Societies, held from May 2 to 5 in Baltimore.

www.modernmedicine.com/modernmedicine/Modern+Medicine+Now/PAS-Program-Benefits-Children-With-Hearing-Loss/ArticleNews Feed/Article/detail/596553?contextCategoryId=40137

Students Try Wearing Earplugs During Lessons

The pupils at Westlands school in South Devon, UK, were encouraged to muffle the voice of the teachers as part of a program of events for Deaf Awareness Week.

The special lessons gave the teenagers an impression of what it is like to be hard of hearing.

Hazel Sutherland, coordinator of services for hearing impaired pupils said: "Hopefully it gave them a small insight into what it is like to have to cope with a hearing loss in the classroom and will maybe make them a little more understanding of their peers who have hearing difficulties."

www.thisissouthdevon.co.uk/news/Students-learning-s-like-live-world-silence/article-981465-detail/article.html

Unitron Hearing Named One of the Top 50 Best Small and Medium Employers in Canada.

"**This distinction is** really indicative of the culture in our workplace," said Cameron Hay, President and CEO of Unitron Hearing worldwide. "We've very consciously nurtured a work environment that energizes people through shared purpose and mutual respect. This award is a strong reflection of the extraordinary calibre of people that work at Unitron and the culture we collectively foster."

Continued Hay, "The findings of this study clearly show that employees right across the company are engaged and passionate about what they do. They share a strong belief in the value of the products we develop and they understand how their work contributes to the overall goal of making life better for people living with hearing loss. This helps create a workplace in which people build careers – not just jobs – and feel very connected by common purpose."

Becoming a Top Best Small and Medium Employer is a very detailed and competitive process. This national awards program recognizes top employers with between 50 and 400 employees. The study mirrors the renowned Best Employer in Canada initiative run by partner, Hewitt Associates. This study, however, is specific to smaller businesses.

The rankings are primarily determined using the results from Employee Opinion Surveys. In the survey, 18 key engagement drivers are detailed and analyzed. The evaluation process also includes the assessment of organization practices and perspectives from the leadership team. This year, more than 250 companies across Canada registered to participate in the study.

Study partners include Queen's School of Business, Queen's Centre for Business Venturing and Hewitt Associates. More information about the Best Small & Medium Employers in Canada is available online at **http://business.queensu.ca/qcbv/sme.**

www.unitronhearing.com

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Auditory Training Software Programs for Adults

By Brian Taylor, AuD

About the Author

Brian Taylor, Au.D, is currently the Professional Development Manager for Unitron Hearing in Plymouth, MN. He is a regular Contributing Editor for AudiologyOnline *on a variety of topics including evidence-based practice and amplification. Dr. Taylor has 17 years of clinical management and teaching experience in the field of Audiology.*

I'm looking for auditory training software programs designed for use with hearing-impaired adults (and less importantly children). Could you give me the names of companies that offer such programs?

If we focus only on computer-assisted auditory training programs for adults, there are five programs available clinically. All of them are designed to take advantage of the plasticity of the auditory system. Even though none of these computer based programs may be routinely used by most dispensing professionals, I know of at least one systematic evidence-based review published in a special issue of JAAA a few years ago concluding that adult auditory training is effective (Sweetow & Palmer, 2005). Additionally, there are several anecdotal reports and a couple of studies from non-refereed publications showing that the consistent use of an auditory training program can lower returns for credit.

Although lower returns for credit don't necessarily equate to improved patient satisfaction, all of us can agree that lower returns are a good thing. Considering the clinical evidence of effectiveness for auditory training and its underutilization in most practices, it's obvious that the majority of audiologists are overlooking the value of computer-based auditory training programs.

1. Computer-Assisted Speech Perception Testing and Training at the Sentence Level, or CASPERSent. CASPERSent is a multimedia program designed by Dr. Arthur Boothroyd. The primary training target is perceptual skill. The program consists of 60 sets of CUNY sentences representing 12 topics and 3 sentence types. Sentences are presented by lipreading only, hearing only and a combination of the two. Patients are required to hear and/or see a spoken sentence, repeat as much as possible, view the text, click on the words correctly identified, see/hear the sentence again, and move on to the next sentence. The CASPERSent can be self-administered or administered with the aid of another person. For more information, visit: www.rohan.sdsu.edu/~aboothro/files/CASPERSENT/CasperSent_preprint.pdf
2. Computer Assisted Tracking Simulation and Computer Assisted Speech Training (CATS). The CATS program, which was developed at the Central Institute for the Deaf in St. Louis and subsequently updated by Dr. Harry Levitt, allows the patient and another person to interact. It works the following way: the talker says a sentence or phrase, and the listener repeats verbatim the sentence or phrase. If the sentence is correct, the talker goes on to another sentence or phrase. If it is incorrect, the talker repeats some variation of the utterance until the listener correctly repeats it. The computer-based tracking program makes it easier to score the results of each session and monitor progress. I do know some clinicians that offer tracking exercises as part of a more comprehensive aural rehabilitation program for their hearing aid wearers.
3. Computer-Assisted Speech Training (CAST). Like the previous auditory training programs mentioned, CAST was originally designed for adults with cochlear implants, but, like the other two, it can be adapt-

ed for use with adult hearing aid wearers. CAST uses more than 1000 novel words spoken by four different talkers. The CAST program is adaptive in that the level of difficulty is automatically adjusted according to the patients performance. To learn more about CAST, visit www.tigerspeech.com/tst_cast.html

4. Listening & Communication Enhancement (LACE). In my opinion, the LACE program is the most user-friendly computer-based program for both patients and clinicians. Patients are required to complete a series of short exercises that are intended to boost their auditory memory and speed of processing. LACE can be completed on any home computer and results can be tabulated and shared with the clinician using the Internet. Recently, Neurotone, the creators of LACE, introduced a DVD version to make it even more accessible. LACE was originally designed to be completed at home by the patient, however, I do know that many clinics around the country are seeing increased patient compliance when at least some of the exercises are completed in the clinic. For more information, visit www.neurotone.com
5. Siemens recently introduced a computer-based auditory training program called eARena. This training program is similar to LACE in that the level of difficulty of the exercises is automatically adjusted based on the skill level of the patient. Speech in noise perception and auditory memory are two of the skills eARena is designed to enhance. Also included in the eARena software is a basic hearing aid orientation, which helps reinforce the individual orientation the audiologist provides each patient during the fitting appointment. Although the data is unpublished, Siemens has presented data at conferences indicating that eARena contributes to better real world outcomes. For more information, visit www.hearing-siemens.com

Historically, auditory training programs have been viewed by some as largely academic exercises that are conducted in a university clinic. With the evolution of computer technology and the Internet over the past decade or so, audiologists need to reconsider the use of computer-based auditory training. Although an array of questions remain unresolved (e.g. which program is most effective for different adult populations), there is evidence supporting the efficacy of computer-based auditory training programs. Given the relatively steady in-the drawer and return for credit rates plaguing our industry, it is imperative that audiologists embrace computer-based auditory training programs. Without a doubt, computer-based auditory training needs to be part of a more comprehensive aural rehabilitation program that we offer our patients.

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Charles I. Berlin

In conversation with Marshall Chasin, Editor-in-Chief

Charles I. Berlin, PhD, retired in 2002 as professor of otorhinolaryngology, head and neck surgery, and physiology, and director of the world-renowned Kresge Hearing Research Laboratory at LSU Medical School in New Orleans. He was also a practicing licensed audiologist who saw patients weekly in the audiology clinic he directed which was selected by *Family Circle* magazine in 1987 as the Best Place in the United States for Hearing Problems. He has been called the "Teacher's Teacher" and succeeds in making complicated auditory concepts accessible to parents, teachers, hearing aid specialists, as well as his audiology and physician students.

He is the recipient of the American Academy of Otolaryngology, Head and Neck Surgery's highest award, the Presidential Citation; the recipient of the Honors of the Association, as well as the Frank J. Kleffner Award for Lifetime Clinical Achievement from the American Speech Language and Hearing Association; and the recipient of the Lifetime Career Research Award from the American Academy of Audiology as well as the 2002 Wernick Award from the Academy of Dispensing Audiologists.

He was a founding member of the advisory board to the National Institute of Deafness and Other Communication Disorders, and the recipient of the James P. Snow MD Award from SHHH, and the prestigious Robert J. Ruben MD Award from the Society of Ear Nose and Throat Advances in Children.

Marshall Chasin (MC): If I recall correctly, you started your life studying meteorology and english. What drew you from there to audiology?

Chuck Berlin (CB): Polio – the metereology was a bone I threw to my mother and father who wanted me to have a college degree. I was planning on being a musician and to run off with a real georgeous lady and live happily ever after on music and love. Then I got polio in the fall of 1952 – my senior year in college. I had to give up piano playing and I realized that I wouldn't be a professional piano player any more – I was wrong, but that's another story. I decided to pick another field and my father was a speech pathologist. I went to Wisconsin and Pittsburgh and finished a PhD in speech pathology and I said, "is this all there is?" When I was practicing speech pathology at the VA in San Francisco, I had a chance to go to Johns Hopkins for a post-doc that lasted seven years. That led me to a career in hearing sciences, with one foot in speech pathology and the other foot in hearing sciences.

MC: You have been called the "teacher's teacher." Whenever you open up a journal there is something from, or based on, the work of, Charles I. Berlin. You have published numerous textbooks ranging on topics from the efferent to the afferent, from biology and genetics to earmold acoustics and hearing aids. You have even written programmed guides to the decibel and understanding electronics. One of my favourite articles was with Mead Killion and Linda Hood on the K-BASS earhook. How did that bizarre concept come to be?

CB: We had a whole bunch of patients back in the 1970s with ultra-audiometric hearing – very poor (70–80 dB HL) hearing losses up through 8000 Hz, but normal high frequency hearing above that (10–14 kHz). We built them a hearing aid that shifted sound from the normal range up into the high frequency range – a transposer hearing aid. And once we got that information in the literature, people started to send us all kinds of reverse slope hearing loss patients. One of the things that we learned was that when a full shell occluding earmold was used, it

blocked out all of the high frequency (normal) hearing that these people had. They needed a non-occluding earmold that would allow them to still be able to hear unamplified sound in regions of normal hearing, in addition to the amplification they did need. This was counterintuitive since a non-occluding earmold was for people with high frequency hearing losses and were designed to let the low frequencies in. We had to develop an earmold/earhook configuration that would let the high frequencies through but allow the lower frequencies to be transmitted to the ear. Mead, Linda and I developed this and did the math and came out with something called the K-BASS (or Low Pass) earhook. (available from www.etymotic.com). Its essentially a big muffler for the high frequency sounds. I understand that it is still used quite successfully for those people with low frequency conductive hearing losses who cannot tolerate an occluding earmold, and it is an alternative in some cases to a BAHA (Bone Anchored Hearing Aid).

MC: The concept of auditory neuropathy (or auditory dyssynchrony) is synonymous with Charles Berlin and the Kresge Hearing Research Laboratory. How did your work on this begin?

CB: I started that work also because of the ultra-audiometric story. We got a reputation as a centre of last resort – people would send us all of their unusual patients and cases. On the surface, we were a laboratory that tried to figure out why something that was sent to us worked the way it did. In this case, we were giving courses in ABR and one of our graduates of the course called us up and said "Chuck: I have this 12-year-old patient with a normal audiogram but absent ABR. Have you ever heard of such a thing?" I said "No, you must have made a mistake." So, this 12-year-old comes in to my lab and we run him on three separate machines and we couldn't get an ABR on any of the machines. We did reflexes and they were absent which shouldn't have been the case with normal hearing. Ultimately I said, "I don't know what this is, but I am not going to forget it," and I put it on my shelf for future consideration. About that time, a couple of papers came out, such as those by Worthington and Peters questioning whether an absent ABR means you're deaf. They came to the same conclusion that they didn't really know what was happening. Ultimately as we learned more, it became apparent that this was a timing issue of the firing of the inner hair cells – a dyssynchrony. We called this kid back in and he also had auditory dyssynchrony. Arnie Starr, myself, Linda Hood, Yvonne Sininger, and Terry Picton wrote an important paper at about that time. The patients were examined by Arnie Starr and Terry Picton and found to have peripheral neuropathy, so we labelled it "auditory neuropathy." We started to read some papers and we found that Spondlin discovered that the inner hair cells were the real driving force in speech understanding. Another paper came out by Anatuzzi et al. (at Harvard) that showed that premature babies who suffered from anoxia, had no inner hair cells, and once you have no inner hair cells, you have no way of firing the VIII nerve. So, inner hair cell loss is the same as neuropathy. This is what led to my paper where we relabelled auditory neuropathy as auditory dyssynchrony.

MC: Let's turn our attention to an academic chair called the Charles I. Berlin Chair in Molecular and Genetic Hearing Sciences. Has it been filled yet and do you feel that audiology students should know more about genetics than they did 25 years ago?

CB: The chair is being filled by Dr. Bronya Keats – a geneticist. She was one of the geneticists who discovered the genetic basis for Usher's syndrome. She has also been involved with locating the gene for a form of ataxia. And I feel that the future of audiology should be more in the realm of genetics. Thanks to Dr. Keats, I actually take a genetic pedigree of my patients. There are genes (e.g., otoferlin) that express themselves in the inner hair cells initially (and later spreads to the outer hair cells). Other genes (e.g., pejvakin) affect the VIIIth nerve. So one gene can give you real neuropathy and another can give something else.

MC: Speaking of genes, Erik Borg has suggested that one of the main reasons for the individual susceptibilites of people to loud noise was the differential function of the stapedial reflex – some people's reflexes are at lower levels and are more active than others, and that this difference was a genetic one.

CB: The stapedial reflex is not protection for noise exposure, regardless of what the textbooks say. When you stiffen the middle ear, you increase the elastic reactance and that basically cuts out low frequencies below 1000 Hz but the damage is done above 1000 Hz. I think that Borg was right about the variability, but this has to come from the inner hair cell function. If you don't have inner hair cell function, you don't have a stapedial reflex. If the inner hair cells are compromised then there is no muscular contraction, and we know this is the case with auditory neuropathy. However, these people are not more susceptible to noise exposure than anyone else, so it follows that the role of the stapedial reflex (even if it is genetically conditioned) is not a factor in the protection from noise. Furthermore, nature gave that reflex to most mammals, without any con-

cern for protection from industrial noise etc. It is a reflex that PRECEDES vocalization in humans, probably protects them from the 110 dB or more sound power just inside the mouth, and is used by many animals to control and coordinate vocal output along with reflective echolocation.

MC: We can't talk to Charles Berlin without talking about the effects of Katrina on New Orleans. How is New Orleans now?

CB: This interview is being done as I am back home in New Orleans at Jazzfest and I am at Preservation Hall – you can hear the music in the background. I will be joining them as soon as we are finished talking. I have sadness and absolute fury. Sadness because I lost virtually every material possession I had in my house – my papers, articles, and a magnificent piano …. Saved a few pictures of the kids. My wife and I were on vacation at the time and on TV we watched our house floating away. That was in August of 2005 – we didn't come back until October of the same year. The good part was that none of our children listened to us and settled anywhere near New Orleans, and they were all safe.

MC: Here we have a gentleman who has been "retired" for about five years now, but is busier than the vast majority of audiologists who are still working. What is your secret?

CB: Lots of exercise, vitamins, and I love my work. Also, my wife doesn't want me in the house. She said that "I married you for better or for worse, but not for lunch."

Part I: The State of Statements – Balance Sheets, Income Statements, and Statements of Cash Flow

By Robert M. Traynor EdD, MBA and Robert G. Glaser, PhD

About the Authors

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For most audiologists the patient is foremost as we provide hearing care services. Successful practitioners know that when their practice is centred on their patient's welfare, success will usually follow. Probably the greatest responsibility of the patient-centric practitioner is to be in business next year when the patient needs things that are warranty items, or other services that may be of benefit to them.

There are many stories of highly successful patient-centric practices that did not survive for one reason or another caused by difficulties on the business management of the practice, not patient care.

Generally, educational programs that prepare audiologists for the clinical world do not adequately prepare clinicians for survival within the business community as there is much information that must be assimilated in the clinical treatment of our patients, thus, minimal or no time to prepare perspective clinicians in business management. When entering into private practice, audiologists must realize that they become part of the cold hard business world and survival depends upon making a profit. Although suppliers, creditors, employees, and others care about the patients we serve, the business of audiology is like any other business requiring much attention and monitoring to succeed. Thus, to be a good manager, clinicians must have the capability to digest information about the financial performance of the practice and develop the background to translate that

information into decisions that move the practice toward profitability. Although it is not necessary to obtain an MBA to know how to run your practice or an audiology profit center within a hospital, educational, or other institutional setting, courses in accounting and finance are substantially beneficial and readily available at most local community colleges. These courses offer the practitioner greater insight into the management their practice and give them the power to interpret the relevant business variables. The following discussion is an attempt to orient clinicians to the basics of the Balance Sheet, Income Statement and, probably most important, the Statement of Cash Flows.

Financial Statements

Most of us use the services of an accountant to prepare reports and assist us in the interpretation of the information they contain. Traynor (2008) suggests that practitioners should have knowledge of the vocabulary and language of accounting to effectively communicate with the accounting (and bookkeeping) professionals who manage their practice and protect their assets. Although it is the bookkeepers that enter the day-to-day data, it is the accountant that prepares reports that assist practitioners in making evidence-based decisions regarding the success or failure of daily operations, conducting a specific clinical procedure, or a new market offering. These reports are fundamental to understanding the reasons for positive or negative changes in the bottom-line performance of the practice. Such accounting reports are prepared according to internationally accepted accounting rules called the Generally Accepted Accounting Principles (GAAP), a universal method of valuing profit and measuring assets and liabilities. Although they vary slightly from one country to another, GAAP rules are used to conduct accounting in all businesses. GAAP describes how transactions for costs, profit, inventory, sales, and other business specifics are recorded and facilitates the comparison of one business to another since businesses all use these same procedures for accounting. While the role of an accountant in the practice will vary from one practice to another, the professional assistance of these practitioners is essential to success.

There are two primary objectives of every business, including audiology practices; profitability and solvency. Unless a practice can produce satisfactory earnings and pay its obligations in a timely manner, all other objectives will never be realized because the practice will not survive. Financial statements that reflect a practice's solvency (the Balance Sheet), its profitability (the Income Statement) and a view of its financial health (the Statement of Cash Flows) provide the practitioner substantive information upon which to make well informed decisions about the operations of the practice. These financial statements are so important that bankers and other lenders depend on them to support their decisions to grant credit opportunities. Bankers and lenders know that financial statements are the basis of the calculations for business ratios that offer important, informative metrics about activity, liquidity, and leverage (debt) of the practice.

Balance Sheet

The Balance Sheet contains the elemental fiscal components of the practice; information about assets, liabilities and owner's equity. It presents a snapshot of the financial condition of the practice at a specific moment in time, usually at the close of an accounting period such as the end of the month, quarter, or year (Brealey et al 2002). Businesstown.com (2003a) indicates that the purpose of the balance sheet is to quickly review view the financial strength and capabilities of the business as well as answer important questions such as:

- Is the business in a position to expand?
- Can the business easily withstand the normal financial ebbs and flows of revenues and expenses?
- Or should the business take immediate steps to strengthen cash reserves?

The balance sheet gets its name from the fact that the two sides of the statement must numerically balance, as presented in the classic formula presented below:

Assets = (Liabilities + Owner's Equity) + (Revenue – Expenses)

Assets are recorded on left side of the Balance Sheet and Liabilities and Owner's (stockholders) Equity are recorded on the right side of the Balance Sheet, as presented in Table 1. On many balance sheets, Total Assets are set to equal 100%, with all other assets listed as a percentage of the total assets. On the right side of the Balance

Sheet, Total Liabilities and Equity may also set equal to 100%. Entries of all liabilities and owner's (stockholders) equity accounts are represented as the appropriate percent of the Total Liabilities and Owner's (stockholders) Equity. The Balance Sheet must contain all of the practice's financial accounts and should be generated at least once a month. Monthly review of the balance sheet provides a comprehensive overview of the practice's overall financial position at that specific point in time.

Assets listed on the Balance Sheet

Audiology Associates, Inc.
Balance Sheet
December 31, 2006

Assets		Liabilities & Owners' Equity	
Current Assets:		Current Liabilities:	
Cash	34,000	Short Term Debt	20,000
Accounts Receivable	80,000	Accounts Payable	35,000
Merchandise Inventory	170,000	Other Accrued Liabilities	12,000
Total Current Assets	284,000	Total Current Liabilities	67,000
Property, Plant and Equipment (Fixed Assets):		Long Term Debt	50,000
Equipment	40,000	Total Liabilities	117,000
Less Accumulated Depreciation	(4,000)	Owners' Equity	203,000
Total Assets	320,000	Total liabilities and Owners' Equity	320,000

Table 1

are items of value that represent the financial resources of the practice. Accounts listed on the Balance Sheet are placed in order of their relative degree of liquidity (ease of convertibility to cash) therefore; Cash is always listed first since it does not require an action or an agent to convert cash into cash. Accounts Receivable is listed second since it represents Cash but must be "converted" into cash by collection. Assets are commonly differentiated into two classes; Current Assets and Fixed or Long-term Assets (see Table 1). Current Assets are short-lived and are expected to be converted into cash or to be used up in the operations of the practice within a short period of time, usually within a fiscal year. Current Assets include cash, accounts receivable, product inventory (hearing instrument and assistive listening device inventory, batteries, etc.) and prepaid expenses, such as insurance.

Next are the Long-term or Fixed Assets that will not be turned into cash within the practice's fiscal year. Examples of Long-term or Fixed Assets may include (but are not limited to) audiometric and other equipment used in the practice, office equipment and computers, purchased vehicles, purchased buildings, leasehold or tenant improvements, telephone systems. These assets are found in the balance sheet (Table 1) listed as "Property, Plant and Equipment" or as "Fixed Assets." To best conceptualize Long-term or Fixed Assets, consider that most fixed assets are purchased over time and must be in place over a long period of time to foster the day-to-day clinical and business operations of the practice. As equipment ages, it is said to depreciate. This depreciation of the equipment is an expense and can be claimed as a tax deduction. The accountant for the practice will evaluate the appropriate method for calculation and the extent of deductions available for every fixed asset listed on the balance sheet.

Liabilities include all obligations the practice has acquired through daily operations of the practice. Liabilities include Accounts Payable (ex. hearing instrument and ALD acquisition costs), Accrued Business Expenses, Interest Owed on Loans, and other obligations incurred from daily operations. Owner's or shareholder's equity includes financial investment by the owner or shareholders and the earned profits that are retained in the business. Current liabilities are listed as amounts owed to lenders and suppliers and are usually separated by those that are due in the short term and long term. As with the asset categories, current liabilities are delineated into subcategories such as short term debt, accounts payable and accrued liabilities. These are referred to as current liabilities since they are due to be paid in a short period of time, usually within the fiscal year. A separate category is retained for long term debt, such as bank or other loans payable over a much longer period, usually longer than the fiscal year. All current and long term liability amounts are then totalled collectively to reflect the total liability of the practice (see Table 1). Owner's (shareholder) Equity represents funds that were initially invested by the owner as well as the profit that was earned and retained in the practice. If the practice were to liquidate, the owners (stockholders) would be an expense requiring payment, thus it is listed on the liability side of the balance sheet as a financial obligation that must be repaid at some point in time.

Income Statement

The Income Statement is sometimes called a profit and loss statement or "P and L" statements and depicts the status of overall profit within the business. McNamara (2007) indicates that income statements simply include how much money has been earned (revenue), subtracts how much money has been spent (expenses) that results in how much money has been made (profits) or lost (deficits). Basically, the statement includes total sales minus total expenses. It presents the nature of the practice's overall profit and loss over a specified period of time. Therefore, the Income Statement gives a practitioner a sense for how efficiently the business is operating.

In accounting, the practice's profitability is measured by comparing the revenues generated in a given period with the expenses incurred to produce those revenues. The difference between the revenue generated and

the expenses created during the generation of the revenue is the profit (or loss) of the practice. In an audiology practice, revenues are defined as the inflow of revenue from providing patient care or the dispensing of products. Expenses can be considered the sacrifices made or the costs incurred to produce these revenues. If revenues exceed expenses, net earnings result while if expenses exceed net revenue, a loss is recorded.

As with other financial statements, the Income Statement, presented in Table 2, may be prepared for any financial reporting period and is used to track revenues and expenses for the evaluation of the operating performance of the practice. Businesstown.com (2003b) suggests that managers can use income statements to find areas of the practice that are over budget or under budget and identify those areas that cause unexpected expenditures. Additionally, the Income Statement tracks the increase or decrease in product returns; cost of goods sold as a percentage of sales and presents some indication of the extent of the practices' income tax liability. Since it is very important to format an Income Statement appropriate to the type of business being conducted, the structure of income statements may vary from one business or practice to another. In audiology the format may depend upon the mix of business conducted in diagnostics, hearing products, and rehabilitative services.

Audiology Associates, INC.
Income Statement
Year the Ended December 31, 2006

Net sales	1,200,000.
Costs of goods Sold	850,000.
Net profit	350,000.
Selling, general and administrative expenses	311,000.
Income from operations (EBIT)	39,000.
Interest expense	9,000.
Income before taxes (EBT)	30,000.
Income taxes	12,000.
Net Income	18,000.

Table 2

Net Sales on the Income Statement consist of sales figures representing the actual revenue generated by the business. Marshall (2004) states that the Net Sales entry on the Income Statement represents the total amount of all sales less product returns and sales discounts. Directly below the Net Sales in Table 2, is the Cost of Goods Sold (COGS). COGS are costs directly associated with making and/or acquiring the products that are sold by the practice. These costs include the acquisition of products, such as hearing aids or assistive devices provided by outside suppliers. If hearing instruments are repaired or manufactured by the practice, COGS could also be materials, parts, and internal expenses related to the manufacturing or repair process, such as faceplates, shells, microphones, receivers, and components. Net Profit, sometimes called Gross Profit, is derived by subtracting the Cost of Goods Sold from Net Sales. This Net Profit, however, does not include any operating, interest, or income tax expenses. Just below the Net Profit entry in Table 2 is a category for Selling and General Administrative Expenses. This subcategory is described by Tracy (2001) and Marshall (2004) as a broad "catch-all" category for all expenses except those reported elsewhere in the Income Statement. Examples of Selling and General Administrative Expenses that may be recorded here are legal expenses, the owner's salary, advertising, travel and entertainment, and other similar costs. The actual income from operations, sometimes called Earnings before Interest and Taxes (EBIT) and is the result of deducting the Selling and General Administrative Expenses from the Net Profit. The Earnings before Interest and Taxes (EBIT) is the net revenue generated by the practice but there are still interest expenses and taxes that must be recorded. At this point, the Interest Expense is deducted and then the tax amounts are subtracted to arrive at the Net Income (or Loss).

Statement of Cash Flows

Successful practitioners know that profit and cash flow can be two totally different things, but they are intimately related. A practice can be highly profitable yet on the verge of bankruptcy if the profits are sequestered, for example in the Accounts Receivable – *high profit, low cash flow*. This situation results in limited cash to pay the practitioner, employees, taxes, and/or to service the accounts payable. Conversely, if there is substantial cash inflow to a practice but excessive overhead costs that are strangling profitability, financial difficulties will ensue – *low profit, high cash flow*. This is a situation where in the practice owner has overextended available resources with ill-conceived equipment purchases, exceptional leasehold costs, or extraneous staff salaries and other ques-

tionable business decisions.

The Statement of Cash Flows reflects the cash position of the practice as well as the sources and uses of cash in the practice during a specified business cycle. It presents how cash flows in and out of the practice. While, monthly cash flow statements are useful, quarterly cash statements of cash flow are essential to provide a look at trends that might be developing in the overall cash flow picture of the business. To illustrate how cash flows in and out of the practice, Marshall (2004) indicates that the Statement of Cash Flows is used to identify the sources and uses of cash over time and can be compared to the current period for analysis. In Table 3, the Statement of Cash Flows is divided into three general sections, Cash Flow from Operating Activities, Cash Flow.

From Investment Activities and Cash Flow From Financing Activities. The Operating Activity section begins with the Net Income (taken from the Income Statement, Table 2) and includes all transactions and events that are normally entered to determine the operating income. These entries include cash receipts from selling goods or providing services, as well as income earned as interest and dividends, if the practice has investments. Cash Flow from Operating Activities also includes additions or deductions of items that affect cash such as depreciation, increase (or decrease) in accounts receivable, merchandise inventory and liabilities, resulting in the Net Cash used by Operating Activities. The Net Amount of Cash Provided (or used) by practice operating activities is the key figure on a Statement of Cash Flows. The Operations Section is of the most interest since it presents the specific areas of the practice where cash was consumed by the running of the practice.

The second section of a Statement of Cash Flows reviews Income generated from investing activities. This section includes transactions and events involving the purchase and sale of equipment, securities, land, buildings, and other assets not generally held in the practice for resale. This area of the statement also covers the making and collecting of loans, if the practice internally finances products and services these loans to consumers internally. Investing Activities are not classified as operating activities since they have an indirect relationship to the central, ongoing operation of the practice. Transactions within the third section record Cash Flows from Financing Activities and deals with the flow of cash between the practice, the owners (stockholders), and creditors as well as the cash proceeds from issuing capital stock or bonds if applicable. For example, if there was a need to transfer profit from the practice to the owners or from the owners (or creditors) into the practice, it would be reflected in the Cash Flows from Financing Activities section. Careful review of the Statement of Cash Flows can offer valuable information to the practitioner as to where the cash generated actually goes and presents an invaluable opportunity to make adjustments in practice operations for management purposes.

Audiology Associates, INC.
Statement of Cash Flows
Year the Ended December 31, 2006

Cash Flows from Operating Activities:	
Net income	$ 18,000.
Add (deduct) items not affecting cash:	
Depreciation expense	4,000.
Increase in accounts receivable	(80,000.)
Increase in merchandise inventory	(170,000.)
Increase in current liabilities	67,000
Net cash used by operating activities	$(161,000.)
Cash Flows from Investment Activities:	
Cash paid for equipment	$ (40,000.)
Cash Flows from Financing Activities:	
Cash received from issues of long term debt	$ 50,000.
Cash received from sale of common stock	190,000.
Net cash provided by financing activities	$ 240,000.
Net cash increase for the year	$ 39,000.

Table 3

Epilogue

Although these statements are extremely useful, Freeman (2000) indicates that these data are a record of practice performance. Until the data is calculated into the various ratios that unlock the valuable information within the Balance Sheet, Income Statement, and the Statement of Cash Flows the totals are just numbers. The real information in these statements are the calculations that determine the practice's liquidity, activity and leverage (debt) ratio simple calculations. Although calculations can be conducted on all of the statements, the ratios of primary importance are conducted on the balance sheet and income statement data. These financial accounting ratios can give the practitioner information as to if there are enough funds to pay the bills, how long it takes to turn the accounts

receivable, or inventory and even give information as to the debt of the practice. The next part of this series will discuss the calculation of some important ratios that can influence the management of the practice as they are tracked from month to month, quarter to quarter, and year to year.

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Part II: Analyzing the Practice for Success

By Robert M. Traynor EdD, MBA and Robert G. Glaser, PhD

Freeman et al (2000) describes two forms of financial analysis ratio comparisons, cross sectional and a time series analysis.

A cross sectional analysis, refers to the comparison of the practice's performance to that of an industry standard for similar practices in size, scope and geographical area. Though probably more appropriate recent years, is still difficult to determine an industry standard as there are not good data reported by private audiology practices as to their performance. Since performance comparisons between practices or to an industry standard are difficult to conduct, it is the time series analysis that becomes the most important. The time series comparison looks at the practice performance to itself, or over periods of time, usually month to month or year to year. Data, such as financial statements are compared from one period to another to determine if the practice's performance is better or worse. These time-series comparisons of financial statements and the data they contain are essential to making informed, data based management decisions about the practice and its operations.

Where is the Data?

Financial statements are full of numbers that, by themselves, simply present how the practice performed at a particular point in time and do not have too much significance in isolation. Since the financial statements alone do not provide information on the efficiency or profitability of the practice, they require analysis and a time series comparison to generate real information. When these numbers in the current statements are compared to financial statements conducted at other times (monthly or yearly) they come alive with informative data that paints a true picture of how success or failure has developed. Financial statements with the correct calculations and comparisons can reveal a wealth of information to the stockholders (or the practice owner) about earnings over time, soaring or stagnated sales, and even the practice's capability to pay back a loan to the bank. Within the same practice comparing financial statement totals to others taken at the some point in time is very helpful, for example, comparing the first quarter 2004 with the first quarter or 2005 or the whole year of 2004 with 2005, or last year at this time to this year at this time. Marshall et al (2004) indicate that these calculations assist in the determination of a practice's financial position and the result of their operations by reporting on liquidity, activity, and debt and profitability analysis of income statements. It is the calculation of various ratios for balance sheets and income statements that facilitate the comparison of one practice with another, no matter what the size of the operation. Although there are many of these and a wise practice manager should consult with their accountant as to those that are the most beneficial for the practice, these relatively simple measures can be calculated and tracked. The data can then be transferred to a spreadsheet and reviewed over time to demonstrate the health of practice, for obtaining loans or supplier credit, reviewing success and failure for management decisions, to set budgets, or simply general information.

The Calculations

Financial statements provide information regarding the capability of the practice to meet obligations to suppliers, employee salaries, product returns, loans, leases, and other expenses. Managers use liquidity, activity, and leverage ratios to analyze the balance sheet to demonstrate the strengths and weaknesses of the practice. Liquidity ratios are used to measure the short-term ability of practice to generate cash to pay currently maturing obligations while activity ratios measure how effectively the organization is using its assets, analyzing how quickly some assets can be turned into cash. Debt or leverage ratios reflect the long term solvency or overall liquidity of the practice and are of interest to the investors and/or the bankers that have loaned money.

Liquidity Ratios

A common liquidity ratio is the Current Ratio (CR). The CR is sometimes called a Working Capital Ratio as it is a calculation of how many

times the practice's current assets cover its current liabilities and specifically looks at if the practice has sufficient resources to meet current liabilities. Put another way, the Current Ratio asks the questions, can the practice pay its bills or not? The Current Ratio is figured on the Balance Sheet as follows:

$$\text{Current Ratio} = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

If the result of a CR calculation is less than 1, the practice will not be able to meet its current liabilities and if the CR is 2 or more, the practice can pay its bills and have money left over. Usually bankers and practice managers like to see this ratio at least between 1 and 2. Since the CR calculation includes prepaid expenses (such as insurance, etc.) and the inventory, in some situations it may offer a cloudy view of the real picture. Particularly these days when audiology practices may have a stock of open fit or RITE hearing instruments, many audiology practices now have some inventory. Thus, a very common modification of the CR is the Quick Ratio (QR), commonly known as the Acid Test Ratio (ATR). The ATR evaluates the practice's liquidity without considering the inventory and prepaid expenses and, in doing so, often presents a more accurate indication of the liquidity of an audiology practice. The ATR is figured from the information on the balance sheet as follows:

$$\text{Acid Test Ratio} = \frac{\text{Cash} + \text{Marketable Securities} + \text{Accounts Receivable}}{\text{Current Liabilities}}$$

As with the CR, Acid Test Ratio values less than 1 demonstrate that the practice has serious difficulty meeting everyday expenses.

Just as plans are made to meet personal obligations in tough times, wise practice managers keep an emergency fund in the case that business drops off or ceases. These can be from natural disasters, major construction projects proximal to the clinic, or simply a downturn in the economy. In accounting, emergency funds are called Defensive Assets (DA) or those assets that can be turned into cash within three months or less, such as cash (savings), marketable securities, or accounts receivable. A calculation that determines the amount of Defensive Assets (RA) necessary to ward off disaster is the Defensive Interval Measure (DIM). To figure the DIM, it is first necessary to know the Projected Daily Operating Expenses (PDOE) or how much it costs to keep the practice open each day. To find the PDOE, simply look at the income statement and determine the cost of goods sold in a year (listed as the selling and administrative expenses) in a year and other ordinary cash expenses for the year then divide by 365:

$$\text{Projected Daily Operating Expenses} = \frac{\text{Total yearly Expenses}}{365}$$

Once the daily operating expenses (PDOE) are known, the DIM is found by dividing the DA by the PDOE:

$$\text{Defensive Interval Measure} = \frac{\text{Defensive Assets}}{\text{Projected Daily Operating Expenses}}$$

The DIM calculation gives the manager of the practice knowledge of the length of time the business could survive if revenue was substantially reduced or absent as present.

Activity Ratios

Activity Ratios are calculations that allow the practice manager to review how efficiently the practice uses its assets to generate cash. Although there are a number of Activity Ratios that can present the efficiency of the practice, the Accounts Receivable Turnover Ratio (ART), The Inventory Turnover Ratio (ITR), and the Total Assets Turnover Ratio (TAT) are useful to managers.

It is a good policy for all patients to pay when products and/or services are delivered and most practices have a sign to that effect in the waiting room, collecting as much revenue as possible on the date of delivery. Reality is, however, that insurance companies pay slowly; sometimes 60-120 days after the services are rendered and may often not even pay the first time the claim is submitted. Some patients need time to pay for goods and services require credit to facilitate the sales of hearing aids, batteries, and other goods or services. Although credit given to patients is another topic, the receivable account should be closely monitored to determine how much is due to the practice and how long, on the average, it takes to collect for these credit sales. The Accounts Receivable Turnover Ratio (ART) looks at how many times the receivable account is turned into cash each year. To obtain the ART ratio it is necessary to first find the average amount that is due the practice from the receivable account at any one time or the Average Accounts Receivable (AAR) balance. This is obtained by adding the accounts receivable balance at the end of last year and balance of the accounts receivable at the end of the current year and dividing it by 2:

$$\text{Average Accounts Receivable} = \frac{\text{AR (Year 1)} + \text{AR (Year 2)}}{2}$$

Once the AAR is computed, the time it takes to convert this account

into cash or the ART ratio is conducted by taking the Net Sales (Income Statement) and dividing by the average accounts receivable balance:

$$\text{Accounts Receivable Turnover Ratio} = \frac{\text{Net Sales}}{\text{Average Accounts Receivable}}$$

Once known, the ART present the manager with how long it takes, on the average, to collect the amounts that in the accounts receivable, thus, the higher the ratio the better. For example, if the ART ratio is = 5.3, the practice turns over the accounts receivable 5.3 times per year or every 2.26 months. To obtain more detail, the calculation of the number of days it takes to turn the accounts receivable can be obtained by simply dividing the average accounts receivable into 365.

As indicated earlier, audiology practices are now stocking more inventory than ever before and it is beneficial to understand how fast the inventory sold so that stock can be ordered routinely. The Inventory Turnover Ratio (ITR) is the calculation that measures how fast the inventory is sold, or "turned." To arrive at the ITR it is necessary to obtain the average value of the inventory in the practice. The Average Inventory (AI) is found by reviewing the balance sheet and taking the beginning inventory for the year and the ending inventory of the previous year and dividing by 2.

$$\text{Average Inventory} = \frac{\text{Beginning Inventory} + \text{Ending Inventory}}{2}$$

Once the AI is known, the ITR can be computed by dividing the cost of the goods sold (Income Statement) by the average inventory. If the ITR was 5.9 this indicates that the inventory will turn almost 6 times each year. As with other activity ratios, the turning of the inventory can be further delineated to reflect how long it takes the inventory to sell out in days by simply dividing 365 by the ITR.

$$\text{Inventory Turnover Ratio} = \frac{\text{Cost of Goods Sold}}{\text{Average Inventory}}$$

In this example, if the inventory turns about 6 times per year then it takes about 61 days for the inventory to sell out. These data assist the manager in taking advantage of discounts for more efficient ordering of products, free demonstration product offers and insures that there is always a sufficient supply of products on hand for sale.

The Total Assets Turnover ratio presents how many times the practice assets turns over per year and is an indication of how efficiently assets are turned into cash. The TAT calculation looks at the sales for goods and services (income statement) and divides by the total assets (balance sheet) to arrive at how many times the practices' assets turnover per year.

$$\text{Total Asset Turnover Ratio} = \frac{\text{Sales}}{\text{Total Assets}}$$

Of course, the higher the ratio the better as this is an indication that the assets turn over more times per year, suggestive of an efficient practice that uses it assets efficiently to generate cash.

Leverage or Debt Ratios

There are two beneficial ratios that provide the practice manager with information as to the debt of the practice. The Debt to Assets Ratio (DAR) and the Times Interest Earned (TIE) ratio present the capability of the practice to support debt for the addition of equipment, to open another location, or other activities.

The DAR presents how much liability the practice has for every dollar of assets and offers creditors information about the ability of the practice to withstand losses. Specifically, the creditors are interested in how much of a loss the practice can sustain without impairing its capability to repay loans with interest. The DAR is simply the Total Liabilities divided by the Total Assets (balance sheet):

$$\text{Debt to Assets Ratio} = \frac{\text{Total Liabilities}}{\text{Total Assets}}$$

A desirable DAR is a low number since the higher the number indicates that the practice is more dependent on borrowed money to sustain itself. If the DAR is high it suggests that small changes in cash flow may cause serious difficulties in the capability to repay their debt.

The Times Interest Earned (TIE) ratio is an indication of how many times the practice earns the amount of interest that it is charged on the money that it has borrowed. The TIE is computed by taking the practices' earnings before interest and taxes and dividing it by the interest charged (income statement).

$$\text{Times Interest Earned Ratio} = \frac{\text{Earnings Before Interest and Taxes}}{\text{Interest Charges}}$$

In an audiology practice the TIE should be somewhere between three and five as it indicates that the earnings are at least three to five times greater than the interest payments. A TIE ratio that is less than 1 indicates that the practice cannot pay its interest commitments.

Sometimes the ratios that often tell the most about a practice are the profitability ratios that are conducted on the income statement. These profitability ratios are clues to how well the company performed and looks at if the company's net income is adequate, the rate of return achieved and profit margin as a percentage of sales.

Useful ratios that reflect performance of the practice considered are the Profit Margin on Sales (PMOS) and the Asset Turnover Ratio (ATR) calculated from information presented in both the income statement and the balance sheet.

The Profit Margin on Sales (PMOS) presents the profit margin achieved after all expenses are subtracted and presents how much of every dollar of sales are profit. To compute the PMOS, net profit (income statement) is divided by sales (income statement).

$$\text{Profit Margin On Sales} = \frac{\text{Net profit}}{\text{Sales}}$$

PMOS results are presented in a percentage that reflects the amount of each dollar that is profit. For example, if the calculation yields 20% then $0.20 cents of every dollar collected is profit. These values can be tracked to determine if there are changes in profitability that require attention.

Summary

Although ratios can be very helpful in the evaluation of a practice, Glaser and Traynor (2008) offer some cautions on the use of ratio analysis. They indicate that the best information about a company's health is determined from comparison and analysis of a group of ratios, not a single ratio and that these comparisons need to be made from like times of the year to arrive at accurate data on the practice's performance. Additionally, they also indicate that these ratios may be distorted somewhat due to the reimbursement policies of insurance companies.

This has been a basic orientation to the use of ratio analysis to evaluate the audiology practice. There are many other ratios that can unlock specific performance information that are not presented in this discussion. The development of a set ratio assessment calculations to track various components of your particular practice should be developed with the help of a certified public accountant or other trained business professional. Once set up these calculations can be tracked over time using a spreadsheet to facilitate a basis for decisions based actual practice performance.

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A Tutorial on Ear Impressions, Hearing Aid Shells and Earmolds

By Chester Z. Pirzanski, BSc

About the Author

Chester Pirzanski is senior supervisor for shell and earmold manufacturing with Oticon Canada. He is also involved in new earmold research with Oticon A/S in Denmark. Correspondence can be addressed to cp@oticon.ca.

Custom earmolds and earshells are individually manufactured earpieces. The process of their fabrication is based on duplication of an earmold impression, which is a negative plastic model of the patient's ear. The earmold impression is obtained through injection of an impression material, commonly silicone, into the patient's ear.

Custom earmolds and earshells are supposed to fit accurately and securely in the individual's ear because the otoplastic is crafted for that particular person. Unfortunately, some otoplastics fall short of expectations; they are uncomfortable, work out from the ear, and allow for acoustic feedback. This may help to explain why some hearing health care professionals feel that the earmold laboratory is responsible for poor results, while the earmold laboratories may suspect that clinicians take inadequate earmold impressions on occasion.

In this author's opinion, a good hearing aid or earmold fit is the result of the actions of the clinician and the earmold laboratory. The clinician must

- possess adequate knowledge of the ear anatomy,
- take an anatomically accurate ear impression, and
- properly select the shell/earmold style, material and acoustic options.

The earmold laboratory must

- skilfully shape the impression and
- manufacture the earmold under controllable conditions.

This article explains the relationship between these factors.

The Human Ear

The human external ear consists of the pinna, ear canal, and eardrum. The canal has two bends, with the eardrum located beyond the second bend, except in cases such as surgical patients and those with developmental abnormalities or malformations (e.g., atresia, stenosis, etc.). These bends, observed in the transverse view of the ear, give the canal a unique but consistent pattern of parallel lines (Figure 1). The tragus line tends to be parallel to the line of the canal medial end, and the two bends have approximately the same angle.[1]

Anatomically, the section between the ear's first and second bend is made up of cartilage. This cartilage is soft, pliant, and it is often lined with earwax produced by sebaceous and cerumenous glands situated deeper in the canal. The canal cartilage can be stretched by the earmold and still remain within comfort limits. The cartilage is also subject to shifting resulting from jaw movements. The jaw's downward movement commonly stretches the anterior ear wall and increases the volume of the ear canal.

Beyond the second bend of the ear canal, the cartilage thins and eventually disappears, and the ear wall becomes more rigid. The underlying tissue of the bony area has no subcutaneous layer, is quite thin, highly vascular, and quite sensitive.

The Ear Impression

Research data[2–6] indicate that hearing aid shells and earmolds have a greater chance of being feedback free and comfortable if ear impressions used to make them:

- have no under-filled areas such as gaps, weld marks or air pockets,
- illustrate the two bends of the auditory passage in full,
- have high after-cure dimensional

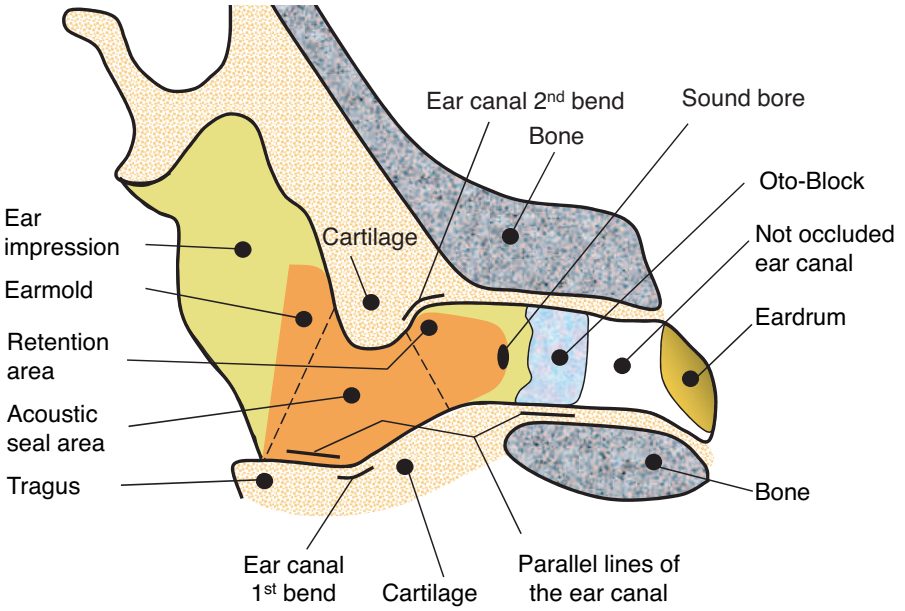

Figure 1. The transverse view of the human ear shown with an ear impression taken past the canal second bend and an earmold crafted from the impression.

stability,

- adequately reflect the softness of the cartilaginous tissue of the ear (this is done by selecting impression material with the proper viscosity), and
- demonstrate the increase in ear canal diameter resulting from the jaw's downward movement (this is done through the impression taking technique).

Viscosity of an impression material is defined as a measure of the material consistency before polymerization. Viscous means having a thick consistency. A silicone impression material can be of low, medium, or higher viscosity. A low viscosity silicone has a soft consistency; a higher viscosity silicone is denser (putty like). Although the consistency of currently available impression materials significantly varies from one material to another, manufacturers generally do not provide a description of viscosity.

Silicones offered in a rectangular-flange 48-mL cartridge are all low viscosity. Silicones in the newer rounded-flange S50 cartridge are either low or medium viscosity. There are no higher viscosity silicones in cartridges. Hand-mixed silicones are either medium or higher viscosity.

Assessing impression material viscosity by its colour or brand name can be misleading. Manufacturers of impression materials sell their product in a variety of shades to various distributors. This means that a blue silicone being sold under one brand name may be a different viscosity than another blue silicone being sold under another brand name. On the other hand, a pink silicone provided by different distributors, often under different prices, may share the same viscosity.

The shore value of a silicone impression material does not relate to its flow characteristics before hardening. In fact, the shore value refers to the finished impression hardness. The lower the value, the softer the finished impression. Figure 2 shows the viscosity and shore values of silicone impression materials made by Egger.[7] As provided, some low viscosity silicones are firm after curing (high shore value), whereas some higher viscosity silicones are soft after curing (lower shore value). Therefore, the shore value is practically irrelevant to the clinician and should not be used as a guideline for assessing the consistency of a silicone.

The viscosity (consistency) of the impression material may affect the fitting of the resulting earmold. Research shows that approximately 20% of ear canals are moderately soft and 10% are very soft.[8] The rest of the ears are firm. If a low viscosity (soft) silicone is used to take an impression from a soft cartilage ear, the cartilage will not stretch and the resulting shell or earmold may fit loosely, be susceptible to acoustic feedback, and work out from the ear. The 10% of the very soft ears are the most difficult to fit. As a result of the excessively loose fit and lack of retention, the earshell or earmold may require frequent pushing back in to the ear and cause the ear tissue soreness and discomfort. This is typically, but incorrectly understood as a symptom of a tight fit. For ears with firm canal cartilage, the viscosity of the silicone does not matter; these ears will show no stretching or only minor stretching with the use of any silicone.

Silicones with a higher viscosity (more putty-like) are better for taking all ear impressions. Since higher viscosity impression materials are made only for hand mixing, they can only be used with a syringe. Therefore, the syringe should be the tool of choice. There are no higher viscosity silicones available for guns (pistol injectors).

The impression taking technique is the second critical factor in obtaining a good ear impression. The opening of the patient's mouth may result in the ear canal widening. This widening is

quite severe in about 10% of the population.[8] These ears are a nightmare for the clinician; acoustic feedback, poor retention, and discomfort may not be resolved through subsequent remakes. In addition, in some patients, the reoccurring widening of the ear canal affects the sound pressure at the eardrum. As a result, the hearing aid will sound weaker and then louder giving the patient and the clinician the false perception that the sound bore is hitting the ear wall.

A significant number of earmold and earshell fitting problems can be avoided if the ear impression is taken with the patient's mouth wide open, supported with a mouth prop between the molars (see Figure 3).

Many clinicians share that they can accurately assess the softness of the ear tissue and the magnitude of mandibular movements, and select the impression material and technique accordingly. When a group of audiologists was asked to evaluate ear canal dynamics and then verify their observations with measurements taken from ear impressions, they found that the accuracy of their predictions was only in the range of 30%.[8]

Combining the use of a higher viscosity silicone and the open mouth impression is the best approach in making ear impressions that are most suitable for manufacturing best fitting hearing aid shells and earmolds.

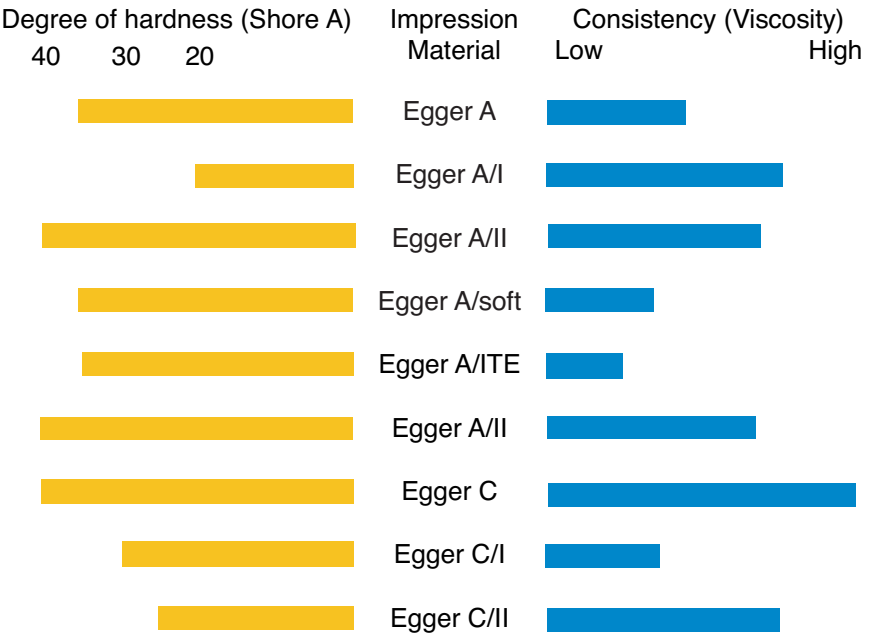

Figure 2. Viscosity and shore values of silicone impression materials made by Egger. Adapted from Egger Otoplastik & Labortechnik GmbH Product Catalog.

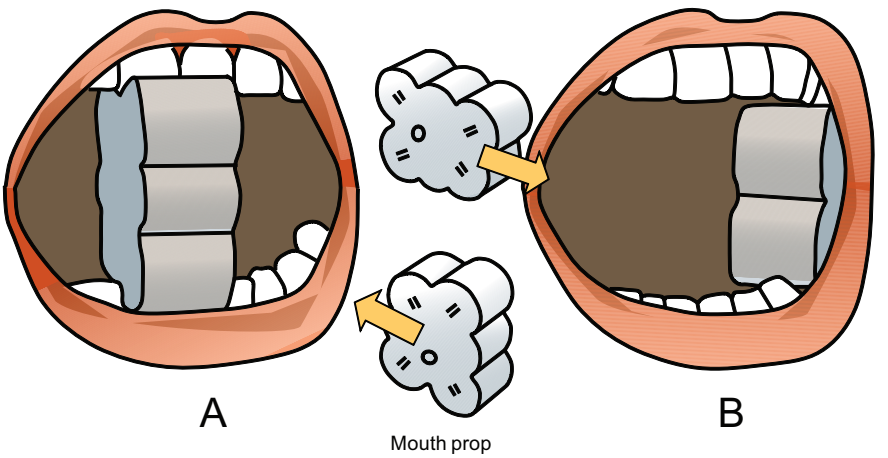

Figure 3. Options in using the mouth prop for taking an open mouth impression.

Ear Impression Evaluation

Prior to selecting the earshell/earmold style and material for the patient, the ear impression should be carefully evaluated. This evaluation can yield valuable information for the likely success of the fitting. When evaluating the impression, answer the following questions;

Is the concha of the ear large enough to accommodate the hearing aid faceplate?

The concha can be narrow or have a deep antitragus. This may limit the space available for certain faceplate configurations, typically the 13 size battery, volume control, and directional microphones.

Is the canal large enough to accommodate the receiver and the required size of the vent?

Power hearing aids and some extended bandwidth hearing aids require a larger receiver. Vents can be as big as 3 mm. If the canal in the impression is small and a larger receiver or vent is needed, consider a larger shell style that will accommodate the receiver in the concha area. Ordering the smallest aid possible may lead to annoying discomfort and

feedback problems.

Does the shape of the impression offer adequate in-ear retention for the resulting shell?

Retention for an earmold or earshell is created by any area on the impression that is larger than the area located more laterally. Typical areas of retention include the antitragus, the helix, the canal aperture, and any hour-glass shaped area on the ear canal. Figure 4 shows the most common retention areas on ear impressions.

Will the hearing aid be easy to insert for the patient?

Consider that excessively large retention areas can make the aid difficult to insert. This pertains to both the retention areas at the concha and canal. Ears that have a sharp first canal bend or a significant widening deeper in the canal may require a shell with a shorter and/or aggressively tapered canal.[9]

If the ear concha shows signs of deformity or irregularity, mark the horizontal plane required for the directional microphone. Mark the impression with the patient's initials and send to the lab.

The Earshell and Earmold

It is a common belief that the closer the shape of an earmold or hearing aid shell resembles the impression, the better the fit of the instrument. While this may be true in some fittings, in general, fewer fitting problems occur if the impression is skilfully trimmed by the technician.[10] This relates to the fact that the ear canal wall is supported by different anatomical structures such as muscles, cartilage, fat, and bone, all possessing different softness and sensitivity. These factors must be accounted for in impression processing if the earmold or hearing aid shell is to fit comfortably and seal the ear adequately.

The selection of custom earshells includes the full concha in-the-ear (ITE), in-the-canal (ITC), and the completely-in-the-canal (CIC). Submodels such as half-shell and mostly-in-the-canal (MIC) are also available.

With the recent advancements in the shell-making technology, new shell and earmold materials are available. The old Lucite, beige and brownish UV shells are gone. The new materials include pink, beige, cocoa, brown, red, blue, clear, and white laser-cured acrylic resins. These new resins are resistant to any biological and chemical agents and demonstrate excellent impact strength, dimensional stability, chemical and scratch resistance, biocompatibility, and clarity. They rate 0 on a 0–4 standard cytotoxicity scale, meaning they are completely non-toxic.[11] The computer aided design and manufacturing (CAD/CAM) technology is used to produce shells and earmolds from these new materials.[12,13]

Virtually Modeled and Digitally Printed Earshells and Earmolds

The CAD/CAM method of shell manufacturing includes three stages: impression scanning, virtual modeling, and shell printing. The three stages are linked to a computer server that integrates the data from each stage to create the final hearing aid

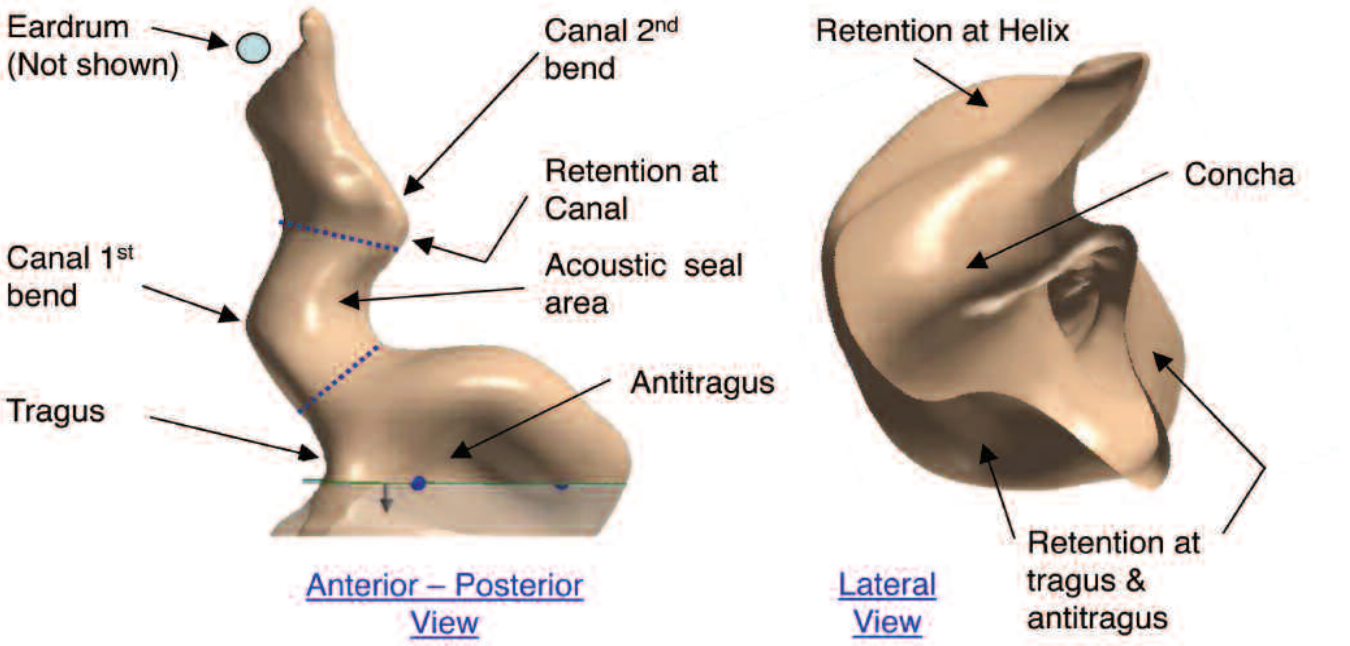

Figure 4 The most common retention areas on ear impression. Images created with 3Shape software.[14]

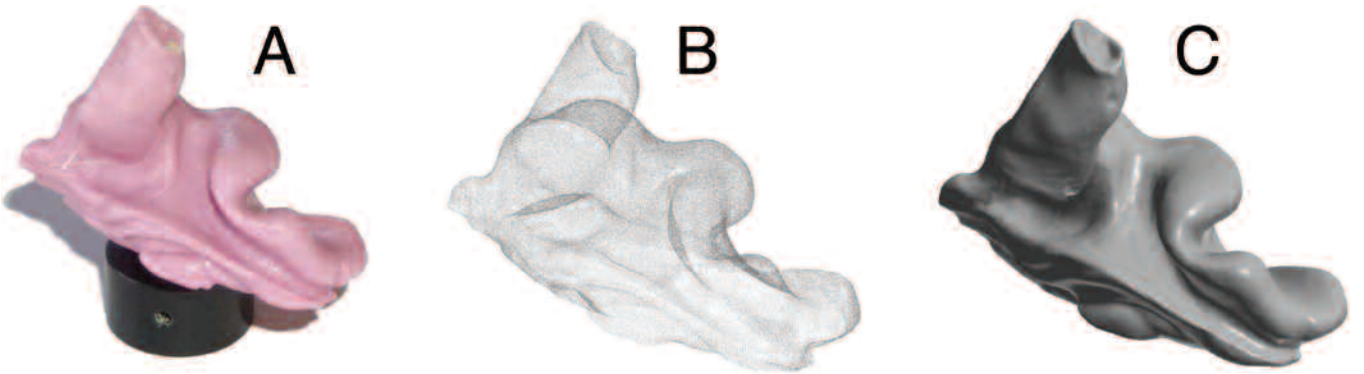

Figure 5. Stages in obtaining the virtual impression: (A) the physical impression ready for scanning; (B) "point cloud" or the "wire frame"; (C) virtual impression ready for modeling. Courtesy of 3Shape.com.

shell.

During scanning, the ear impression is photographed by several digital cameras. As the laser beam scans across the impression, a "point cloud" (or a "wire-frame") of the impression is generated. The computer interpolates the data and creates a virtual model of the impression (Figure 5). Impression scanning can be performed at the earmold lab or in the clinician's office. Scanning does not improve the quality of the ear impression; a poor physical impression will yield a poor virtual image.

Shell modeling (shaping) is the process where the technician (or modeller) modifies the virtual impression with 3D modeling software and creates a virtual hearing aid shell. Parts of the virtual impression that are not necessary for the shell are removed. Afterwards, the technician experiments with the size of the shell and different placements of the virtual components (to include IC chip, receiver, microphone, faceplate, vent, receiver tubing, wax guard, etc.) into the virtual shell until the best possible placement is achieved (see Figure 6). The image of the virtual impression is used throughout the modeling as a virtual control mold to allow the modeller see the anticipated fit of the hearing aid in the patient's ear. All changes to the virtual impression are reversible until the modeller approves his/her design.

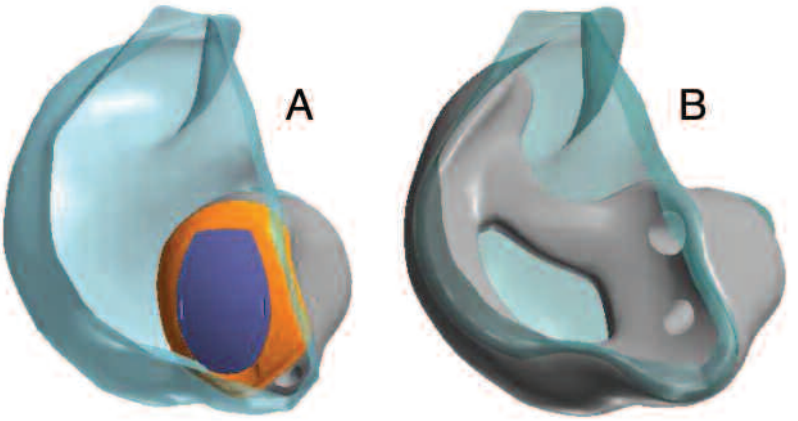

Figure 6. A computer modeled ITC hearing aid (A) and BTE #13 tube skeleton earmold (B). The image of the impression is used throughout the modeling as a virtual control mold. Images created with 3Shape software.

Printing is the term used for the actual production of the shell or earmold. The most common are stereo lithographic apparatus (SLA) and digital light processing (DLP). During the printing process, the printer uses a laser to harden the photosensitive resin into shells that was modeled during the modeling stage. The shells are printed in a pool of light-sensitive liquid acrylic along with the receiver bore and vent. Thin layers of the acrylic (1/10 mm thickness) are hardened to form the shell. For example, a CIC shell that is 20 mm in total length requires 200 layers.

Finished SLA and DLP shells look similar to the shells made with the older manual UV technology. This poses a challenge for some clinicians. Since they do not know what technology was used to make the shell, they assume that it could be the old UV technology and they send new impressions for hearing aid remakes. With the new digital shell technologies, the modeling files, including the impression, are stored in the computer and can be retrieved anytime for remodelling or reprinting. This is a convenient approach for remakes for lost and damaged hearing aids, for changing the shell style, increasing or decreasing the vent size, and minor canal lengthening or shortening. If the clinician wants the new impression be

used for the remake, this should be mentioned in the order form.

BTE earmolds with the standard #13 tubing can be made as a full-shell, skeleton, half-shell, canal, and canal-lock style. Most earmold labs offer the following materials for standard BTE earmolds: (1) hard acrylic (Lucite); (2) medical grade silicone; (3) vinyl; and (4) polyethylene.

The selection of earmold styles has increased in recent years. This is the result of the development of new BTEs that work with thin-tube and the RITE receiver (receiver-in-the-ear, also known as thin-wire).

BTE hearing aids with thin-tube and thin-wire are commonly fitted with a soft dome. For more severe hearing losses, or when a better acoustic seal or retention are needed, custom earmolds can be ordered. In the traditional earmold lab, these earmolds can be made from all materials used for standard earmolds, except polyethylene. However, an increasing number of earmold labs offer now hard clear and beige earmolds made with the SLA/DLP technology. The most common styles include the deeply fitted micromold, canal lock and skeleton earmolds, available for both thin-tube and thin-wire earmolds. Figure 7 provides samples of virtually modeled BTE earmolds. Micromolds made from soft silicone or vinyl are also popular.

Challenges in Thin-Tube and Thin-Wire Earmold Selection and Fitting

For patients with bigger and medium size ears the selection of a hard or soft material will not make a difference in the quality and accuracy of the micromold fit. For patients with smaller and angled canals, micromolds are more challenging to fit. This relates to the fact that the patient's finger may be too big to push the micromold deeply in to the ear canal. If this happens, the partially inserted micromold can be reported by the patient as too short, or too long, or too loose, or too tight, depending on the patient's perception of the problem. In addition, the thin-wire micromold has to accommodate the RITE receiver within the length of the mold in a straight channel with the red or blue adapter glued to the medial end of the mold to which the receiver snaps in. Some ear canals do not offer enough space for this. For these ears silicone micromolds are recommended. In silicone micromolds the RITE receiver has a friction fit which does not require the red/blue adapter and the receiver does not have to be inserted to the end of the micromold. This gives the lab technician more flexibility in shaping the micromold and obtaining a deeper and more secure fit with better cosmetics.

For very small ear canals, or when enhanced retention is needed, soft skeleton earmolds are best. The skeleton style can also be used for open-canal (non-occluding) fittings for both thin-tube and thin-wire BTEs and for patients with dexterity problems who cannot handle the small micromold.

The most recent development are power RITE BTEs. Since the power receiver is bigger than the standard RITE receiver, mini-canal hard and soft RITE earmolds have been developed. Due to the size of the receiver, power earmolds do not fit as deeply as micromolds.

Soft earmolds for #13 tube, thin-wire, and thin-tube BTEs are still manufactured manually. The SLA/DLP technology cannot print soft earmolds from the resins available today. If it is important for the clinician that the digital technology be used to model, print and store the file, a hard earmold should be considered.

Conclusions

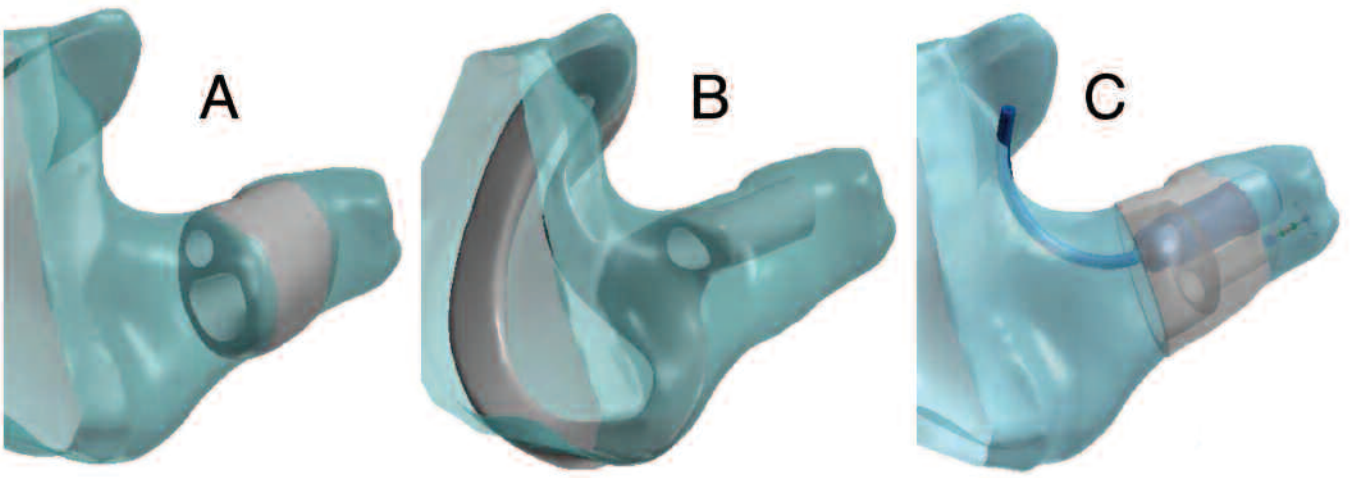

Figure 7. Thin-tube open-vent (A), non-occluding (B), and thin-wire (C) virtually modeled BTE earmolds. Images created with 3Shape software.

With the broadened variety of hearing instrument styles and options, understanding how the impression technique and the earmold style and material affect the fit of the resulting earmold has become more critical than ever. Taking a good open-mouth impression with a putty-like silicone and a mouth prop starts the process. A careful evaluation of the finished impression will provide the necessary clues for the earmold style and material selection. If in doubt, do not hesitate to call the earmold laboratory for their guidance and recommendations.

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Silencers in a Nutshell

By Tim Kelsall

Almost every noise regulation around the world, including Ontario's, has some variation of the words "The employer shall protect workers from exposure to a sound level greater than the limit without requiring them to use and wear personal protective equipment."

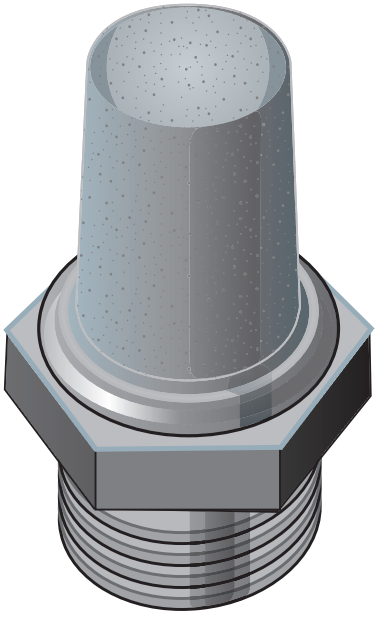
Unfortunately in practice too many workplaces only rely on hearing protection (or nothing at all), even when there are clearly practical noise control measures available. This is one reason why over 1 million Canadians report having a hearing disability.

One of the most common noise controls is the silencer, which come in all sizes and can handle almost any noise caused by movement of air or gas. This article will highlight a few of the more common types.

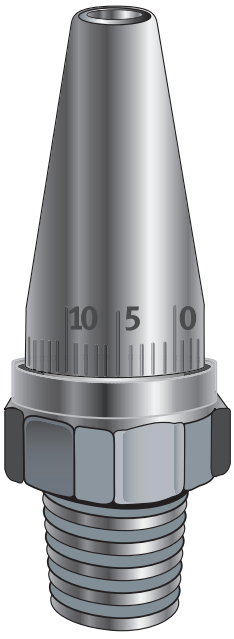
Gas Exhaust Silencers

The gas exhaust or snubber silencer can quiet almost any pneumatic or steam exhaust. It simply screws into any air exhaust and spreads the air exhaust over a much larger area, thus slowing the air and quieting the air exhaust. They come in all sizes, from simple silencers that screw into a 1/4″ NPT pipe nipple to steam exhaust silencers large enough to handle the blow-down from a large boiler.

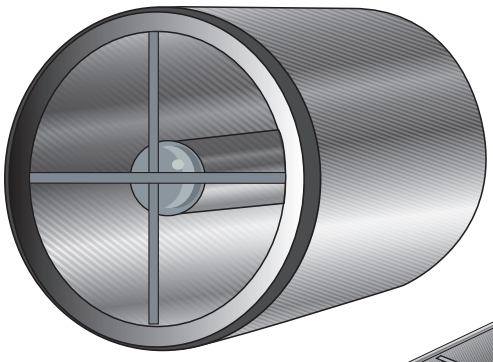
Two items are of concern: the gas exhausting should be relatively clean so the silencer does not plug, and the gas should be dry since expanding gas cools and there is the potential for the silencer to become plugged with ice. Otherwise they are rugged and dependable.



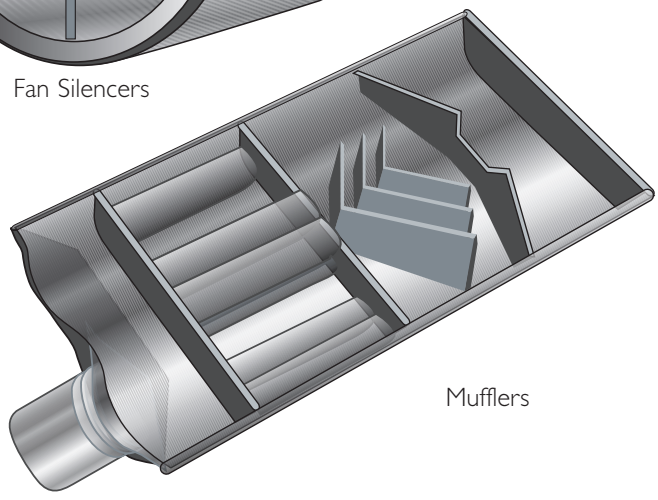
Gas Exhaust Silencers



Air Jet Silencers



Fan Silencers



Mufflers

Air Jet Silencers

Probably the most cost effective noise control available, the air jet silencer operates by entraining outside air into the air jet, turning a small high-speed jet into a large slow moving jet. The interesting thing is that the larger jet actually has better momentum transfer than the original jet, meaning it can be used to clean, push objects, dry, or to perform any other application of air jets even more effectively than a standard compressed air nozzle while saving considerable compressed air. This allows these silencers to pay for themselves very quickly. They come in a wide variety of configurations to handle almost any application which used to be done by compressed air jets, efficiently, quietly and cost effectively. Again, clean dry air is important. They also effectively prevent air embolism by making it impossible for a compressed air jet to puncture the skin.

Fan Silencers

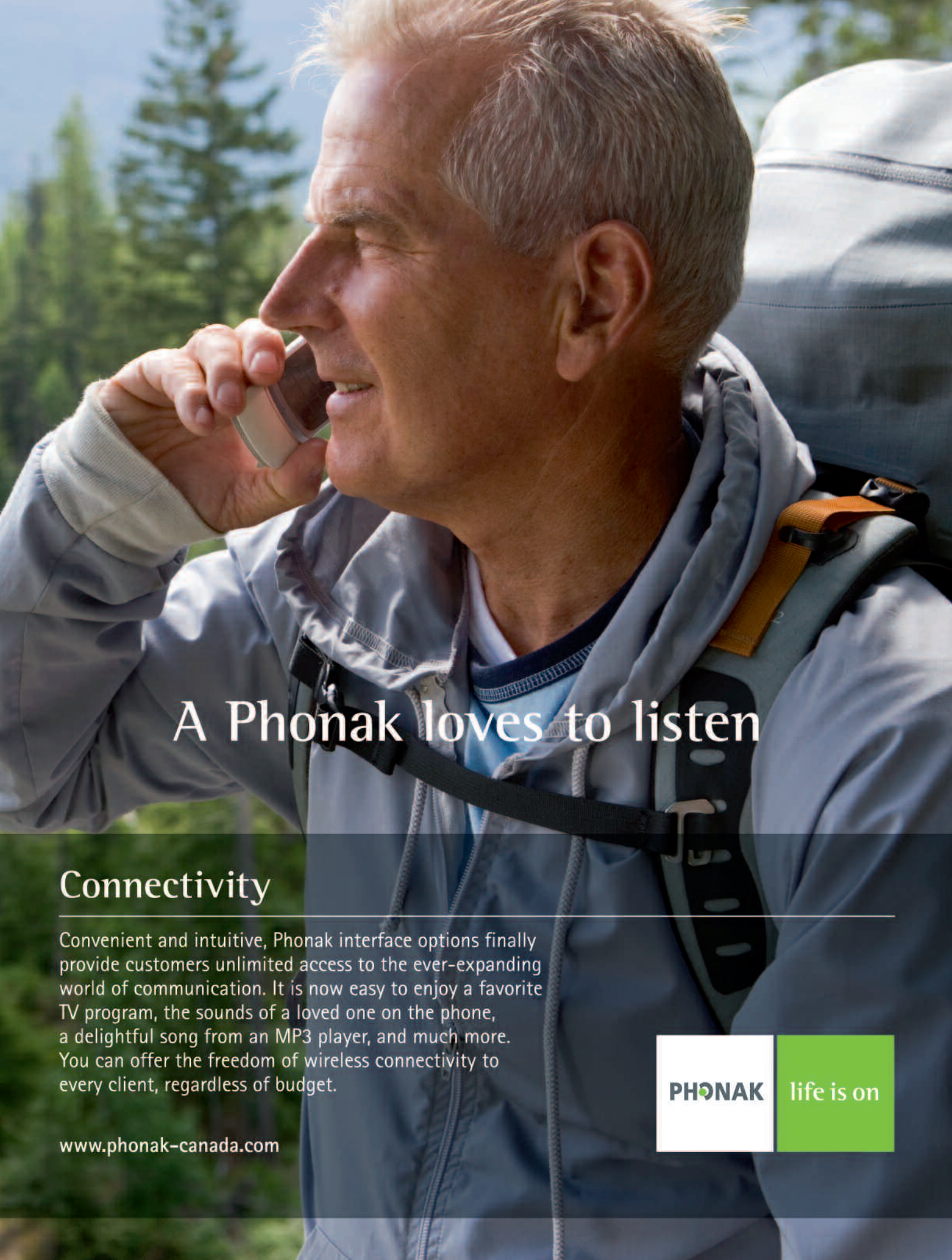
The most common type of silencer in industry would be the fan silencer. They come in both rectangular and circular configurations to match the ductwork and should be on the inlet and outlet of almost every industrial fan. A fan silencer, which comes in a wide variety of configurations, is really nothing more than a duct lined with sound absorbing material. They can be designed to add very little additional pressure drop to a system. Unfortunately there are still fans being installed in industry without silencers and they are almost invariably a cause of excessive noise exposure. Worse, if the ductwork is not designed with silencers in mind they may be difficult (but often not impossible) to retrofit. As fan manufacturers can predict the noise from their fans quite accurately, there is no need to guess as to the size or performance required.

Mufflers

Reactive silencers or mufflers are familiar as seen on cars and are used on almost all engines and compressors. They operate using the wave properties of sound to cancel other waves and, as we all know from our cards, they are very effective (until they get a hole in them). Again they come in a variety of configurations and materials to suit almost any application.

Basically, if sound or a noisy gas flow is coming out of an opening there is a silencer available to quiet it down. There is no reason why such noise sources should be allowed to over expose employees in industry, mining, construction, or any other area. The more employees, work and safety committees, engineers, and safety professionals know about these simple approaches to noise control in industry, the sooner these common offenders will be done away with.

Tim Kelsall is director of noise and vibration, Hatch, Mississauga, ON and can be reached at tkelsall@hatch.ca



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