Minnesota Academy of Audiology
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Feature Story

UMAC 2018: A Fruitful Conference

By Angela Mucci, Au.D.
MAA Continuing Education Committee Chair

Photo provided by Jingjing Xu, Ph.D.

The Upper Midwest Audiology Conference (UMAC), which took place February 23-24, 2018, brought together over 100 audiologists and key members of the audiology community to discuss the latest topics and challenges currently facing audiology. In addition to earning up to 12 continuing education units, members were provided with a valuable networking opportunity which set the stage for further cooperation among audiologists in Minnesota.

Opening the conference, **Brian Taylor, Au.D** highlighted the need to find a way to embrace and use over-the-counter (OTC) hearing aids and PSAPS as part of a practice model. In her presentation, **Kim Cavitt, Au.D.** highlighted the increasingly broad scope and depth that coding within audiology entails. **Shane Moodie, M.CI.Sc.** underscored the importance of using our precious time and limited resources to complete real-ear measurements.

On day two, **Devin McCaslin Ph.D.** opened the session discussing the complex world of the vestibular system while discussing how to seek better reimbursement for these services. **Jingjing Xu, Ph.D.** reviewed the need to have subjective measures to assist in the fitting process, and how this can improve patient satisfaction. **Dave Fabry, Ph.D.** discussed the transformative power of telehealth and the increasingly wide range of beneficial applications. Finally, **Rebecca Younk, Au.D.** led a panel discussion which accentuated the importance of audiology advocacy and volunteerism.

We would also like to congratulate to recipients of our annual awards, listed below.

- Excellence in Audiology: **Kristin Gravel, Au.D.**
- Honors of the Academy: **Kirsten Coverstone, Au.D.**
- Outstanding Achievement in Audiology: **Linda Murrans, M.A.**

The Continuing Education Committee thanks all our attendees, panelists, student volunteers, and especially our sponsors for another successful conference! Please email education@minnesotaaudiology.org with any comments and/or suggestions for next year's conference.

In This Issue

Third Party Payers... The Silver Bullet?

By Amit Gosalia, Au.D.
Board Certified Doctor of Audiology

The delivery of hearing aids has seen many changes over the past 60+ years. The business of hearing aids has always been between the provider and the patient. Recently this changed, when third party administrators (3PA) got involved in the process, and became an intermediary between insurance companies and the provider and/or simply offered discounted products to the public. We will dive into a little history, how 3PAs work, as well as discuss where we are headed. I will do this as objectively as possible, and will focus solely on the hearing aid relationship with 3PAs.

Raymond Carhart coined the term "audiology" in the 1940s, but it wasn't until the 1970s that the profession started to grow significantly. At that time, audiologists were forbidden to dispense hearing aids due to regulations by the American Speech-Language-Hearing Association (ASHA), audiology's sole national organization at the time. Most audiologists were employed in otolaryngology offices, testing and making hearing aid recommendations, then sending the patient to a hearing aid dealer. At the time, ASHA felt it was a conflict of interest for an audiologist to fit a hearing aid.

The relationship between the patient and the provider was essential, and hearing aid fittings were not a transactional relationship. Motivated patients did not want to purchase hearing aids, never to be seen again. Many providers felt that continual follow up was key to a successful fitting, but recurrent fees could be a barrier to patients returning for follow up care. Another concern was how to capitalize on the time it took for follow up care, since time is money. Seeing a patient for a routine clean and check takes 15-30 minutes, but the business must still account for the overhead to keep itself afloat.

Thus, the bundled hearing aid model was born. The basic formula was: Hearing aid(s) + Services + (insert additional items here [e.g., batteries, etc.]) = Total cost to patient. For many, this simplified the billing process. The business could stay profitable with a direct patient-to-business financial arrangement. Since many insurance companies did not cover hearing aids at the time, cash or check were accepted only—there were no middle-men.

Fast forward to today, with the influx of the baby-boomer generation, the number of patients seeking hearing aids has increased, as well as the demand for hearing aid coverage. Some insurance plans either fully cover or partially cover hearing aids as a benefit. Understandably, the sheer number of claims along with costs could become a financial and logistical problem for these companies. Using a single source for payments, along with consistent pricing, seemed like a good idea. Thus, third-party administrators (3PAs) in the hearing aid industry were born.

Some 3PAs started with workers' compensation claims, but, soon found their way into insurance contracts. The fundamental idea is a patient calls their insurance company, who directs them to a 3PA to utilize their benefit. The 3PA refers the patient to an in-network provider. The provider tests the patient and makes a hearing aid recommendation from a set list of options. After the hearing aid fitting, verification and follow-ups are completed, usually within 45 days, a fitting fee is issued to the provider. The provider agrees to see the patient a specific number of times during the first year, however, after that year is complete, the provider can typically charge a set fee to the patient, as directed by the 3PA.

Many providers who contracted with insurance companies felt obligated to sign up for these 3PAs, since they were contracted with the initial insurance company. Some saw it as a means to generate a steady flow of patients.

Many providers who contracted with insurance companies felt obligated to sign up for these 3PAs, since they were contracted with the initial insurance company. Some saw it as a means to generate a steady flow of patients, and reduce marketing costs of trying to acquire new patients. Others may have signed up out of fear that they would lose their business. Are these providers correct to fear 3PAs? Let's break down the financial scenario from two options. To avoid any appearances of price-fixing, we will use a hypothetical example of dental work. This patient needs two veneers. *[See Figure 1.]*

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Third Party, *cont.*

The elephant in the room is the difference in revenue. In this example, by going the 3PA route, this clinic could lose about 50% of their revenue, with every patient that ordered veneers. Essentially, they would need to see almost twice as many patients to make up the revenue loss. It's important to keep in mind that in both scenarios, overhead still needs to be accounted for. There is a great deal of discussion about whether or not to participate in 3PAs due to the lack of direct reimbursement for audiology diagnostics. Without a comprehensive hearing evaluation, we know that medical contraindications may not be detected or treated appropriately.

The idea that 3PAs are the future of hearing aid delivery remains a question. Can 3PAs continue to offer a sustainable delivery model? Will audiologists and hearing aid dispensers continue to participate in this delivery model? Will not participating in this delivery model kill private practice audiology as we know it? How will clinics compete with the low prices, or even full coverage, that 3PAs are capable of offering? Regardless of the outcome, one thing is for sure; change is imminent.

Figure 1. Comparison of 3PA vs. Private Pay

3PA

In this scenario, we will use the payment amounts from a 3PA. We will add the fitting fee, diagnostic fee, and an assumption of two visits per year for routine appointments or emergencies, for a total of five years.

Cost to patient: $3600 (no insurance reimbursement)

Evaluation: $0

Veneer fitting fee: $1300 ($650/tooth)

Cost of goods: $0

Follow ups after 12 months: $20 per visit (no matter what was performed) = $40/year

Acquisition cost = $0.00

$0 + $1350 - $0 + $160 ($40/year x 4 years (first year included in fitting fee) + 0

Total: $1510*

Private Pay

An alternative option, the bundled approach for the same set of veneers that were offered through the 3PA.

Cost to patient: $5000

Evaluation: $80 (billed $300 to insurance)

Veneer fitting fee: $5000

Cost of goods: $1400

Follow ups after 12 months: $0 (included)

Acquisition cost = $300 (for example purposes)

$80 + $5000 - $1400 + $0 - $300

Total: $3380*

**Overhead such as rent, utilities, staff, etc., must still be paid.*

Welcome New Members

Fellows

Anita Baum – anita.baum@allina.com
Mollana Carson – mcarson@oakdaleent.com
Stacey Dimond – stacey.dimond@gmail.com
Nancy Holmes – bozholmes@comcast.net
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Students

Danni Barr – barrx140@umn.edu
Maggie Houghton – hough054@umn.edu
Alix Klang – klangalix@gmail.com
Taylor Nelson – nels8434@umn.edu

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Sources: *Groth (2016), **Jespersen et al. (2016)

Clinical Validation of Pediatric Hearing Assistive Technology

By Andrea Green, Au.D.
with contributions from Kari Morgenstein, Au.D.

Disclaimer: I am not an educational audiologist, nor do I play one on TV. However, as a pediatric audiologist working in a hospital setting, I would like to share some practices that clinical audiologists may utilize to assess and support the use of hearing assistive technology (HAT) in the classroom.

Hearing assistive technology can vary from personal frequency modulation (FM) systems, adaptive digital microphones, classroom speaker systems, induction loops, Bluetooth®/ remote microphone systems, and more. The primary aim of these technologies is to improve the signal-to-noise ratio of the teacher compared to other auditory distractions of the classroom.

The Classroom Challenge

There have been several studies over the years that have examined noise levels in different classrooms. Occupied rooms can range from about 55-75 dBA with spaces like the cafeteria sometimes louder than 80 dBA – for comparison, that's the intensity of an average factory (Berg et al., 1996). With the recent popularity of "open classroom" styles, these noise levels can be even higher. Even though the American National Standards Institute (ANSI) provides recommendations about the acoustic properties of a classroom, we have to remember that these are *guidelines*, not rules that must be followed or enforced (ANSI, 2010).

To add to the difficulty of classroom listening, we know that children struggle with listening in noise as compared to adults. In fact, when we look at the Academy's HAT Clinical Practice Guidelines, it is detailed that a "growing child requires received speech levels that are at least 20 dB above those of interfering noise and reverberation (AAA, 2011)." Since children spend approximately half the time in the classroom engaged in some sort of listening activity, it is extremely important for them to have good listening conditions (Rosenberg et al., 1999). Past studies have shown us that background noise levels in classrooms are significantly related to reading scores for elementary school students, showing that the higher noise level in the classroom, the poorer the reading scores of the children (Green et al., 1982).

Although the innovation of hearing device technology can be helpful in noisy situations, the importance of consistent auditory input in the classroom has warranted the use of signal-to-noise ratio (SNR) enhancing technology for children who use all types of amplification.

Hearing Assistive Technology (HAT) Assessment

In accordance with the Academy's HAT Clinical Practice Guidelines, there is a 5-step process for selecting and fitting HAT for children:

1. Determining potential candidacy for HAT
2. Implementation
3. Device Selection
4. Fitting & Verification Procedures
5. Implementation & Validation Procedures

Though our educational audiology colleagues support the majority of this process, audiologists who work in the clinical setting play a vital role in the validation of HAT.

Clinical Validation

At the University of Miami Children's Hearing Program, we frequently utilize validation through clinical testing to show families the significant benefit of HAT. Children may sometimes be resistant to using HAT in the classroom; we frequently hear that "my teacher talks loud enough" or "I do just fine." However, children with hearing loss may not know when and if they are missing auditory information. We have found that if we can show our families and patients objective and subjective benefit, we may encourage them to use this technology more often. Additionally, we have found that having objective data about the utility of HAT has been helpful to our educational audiology colleagues when advocating for HAT use within the school system or when trying to get third party payers to cover such technology.

One way to validate performance is through the use of subjective questionnaires. While anecdotal reports by teachers and parents are useful, it's important that we follow best practices by using subjective validation tools that show quantifiable data. Therefore, HAT can be validated with functional evaluations of the child's auditory

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HAT, *cont.*

behaviors through self-assessments like the LIFE, or questionnaires like the ELF, SIFTER, CHAPS, or CHILD. Frequently, our educational colleagues will also perform observational validation through Functional Listening Evaluations as well.

Then, we also use speech in noise testing to simulate listening in difficult environments such as a classroom. This provides critical, objective validation. To compare aided versus HAT performance, we first situate the child in the middle of the soundbooth with speakers oriented at 0 and 180 degrees azimuth. Developmentally-appropriate speech material is presented at 0 degrees azimuth at 50 dB HL with noise presented at 50 dB HL at 180 degrees. This is the set-up that we use most frequently, but other potential testing conditions can be found in the AAA Clinical Practice Guidelines for HAT.

First, we see how our patients do in the unaided and aided conditions. Then, we activate the HAT and position the HAT microphone between 3-6 inches from the front speaker. Our clinic purchased a small magnet with a hook, so we can hang the HAT microphone from the ceiling on our sound booth at the appropriate distance. Next, we repeat testing in the aided + HAT configuration, which is most similar to what a student would be using in a classroom. *[See Figure 1.]*

Let's take a quick look at a case using HAT with one of our patients. J.E. is a 12-year-old patient with a bilateral, symmetrical moderate (250-500 Hz) sloping to severe (1000-8000 Hz) sensorineural hearing loss. She has always been a consistent hearing aid user, but has intermittently used her HAT system at school.

Figure 1. Use of HAT with a 12-year-old Patient

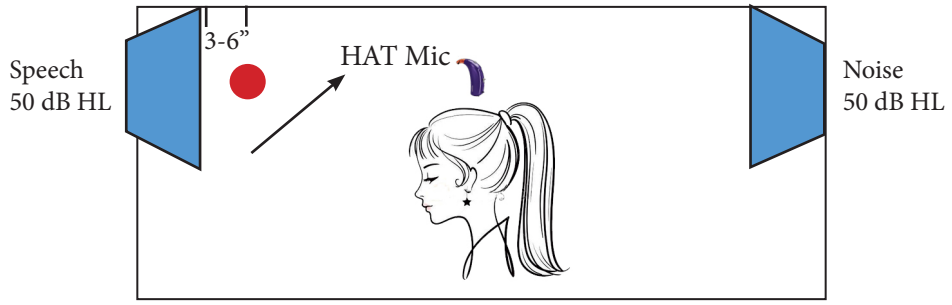

Figure 2. Comparison Results of Testing

NU-6 with +5 dB SNR

Condition	Performance
Unaided	0%
Aided	30%
Aided + HAT	90%

NU-6 with 0 dB SNR

Condition	Performance
Unaided	0%
Aided	30%
Aided + HAT	80%

NU-6 with +5 dB SNR

Condition	Performance
Unaided	23.5 dB SNR loss (severe)
Aided	1.5 dB SNR loss (WNL)
Aided + HAT	-7.5 dB SNR loss (+WNL)

We tested her unaided, aided, and in the aided + HAT conditions See Figure 2 for results.

J.E. exhibited a significant increase in her performance from unaided to aided, as we would expect. However, we can see that there's a significant increase in her aided versus aided + HAT results as well. We will frequently have the parents sit in the booth for testing, so they can get a firsthand look at the changes in their child's performance. J.E's mother even remarked, "it was amazing to see that even with the hearing aids she got many things wrong, especially when the background talkers became louder."

HAT & Beyond

Though we typically think of children with hearing loss as our primary beneficiaries of HAT, there have also been a variety of different studies looking at the use of HAT in special populations. Specifically, there is a growing body of literature that HAT is especially helpful for children with auditory processing disorder, unilateral hearing loss and minimal hearing loss (Johnston et al., 2009; Tharpe et al., 2003). Validation procedures through questionnaires and speech testing can help aid us in determining if children in these populations may also benefit from HAT.

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HAT, *cont.*

In conclusion, testing children with HAT has proven to be helpful to our pediatric patients, parents, educational audiologist colleagues, and schools in showing its benefits. Clinical test set-up is easy in a busy clinical practice and provides important information in ensuring that patients have optimal auditory access in the classroom.

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Ashley R. Hughes, Au.D., FAAA
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Message From Your President

Sharing Your Audiology Passion

By Stephanie Luepke, Au.D.

What motivates you to get out of bed each day? How do you put on a smile through adversity? How do you judge each day as a success?

Did you help someone today? Were you kind? Did you stand up for something that you believe in? Did you take a step forward towards a goal?

We are fortunate in the field of audiology that we can reflect on each day with the accomplishment of helping to meet a need. Sitting in a room full of audiologists at the annual Upper Midwest Audiology Conference (UMAC) always offers energy and excitement to advance our field. This year, we experienced practical tools to bring back to our daily work, but also discussed advocacy and initiatives to move our profession forward.

We have passion, and using that passion to promote awareness, change, and educate both patients and professionals is essential to our continued growth and success. This starts at the state level—this starts with you.

What can you offer today? Do you have ten minutes to call your state representative? Did you tell your colleagues about the excitement at the conference? Did you start making plans to come with friends next year? You might think about getting your favorite time slot at the MN State Fair, or reach out and find out about current legislation impacting audiology here in Minnesota. Do you have an idea? Email us at

administrator@minnesotaaudiology.org so that we can put your ideas in motion.

Passion put to work will make a positive difference. Thank you for sharing your audiology passion!

The Importance of Screening for Vestibular Impairment in Children

By Joshua Huppert, Au.D.

Review of the Vestibular System

The peripheral vestibular system is composed of five sensory organs housed in the inner ear – three semi-circular canals and two otolith organs. The three semi-circular canals, oriented orthogonally in the dense, petrous portion of the temporal bone of the skull, detect angular (i.e., rotational) movement of the head, while the two otolith organs, the utricle and saccule, detect gravitational pull and linear movement of the head and body in space. Collectively, these five sensory organs relay information about motion, equilibrium, and spatial orientation through the superior and inferior portions of the vestibulocochlear nerve (i.e., cranial nerve VIII) to the brain (VEDA, 2017). Although all five sensory organs are functional at birth, connections between the peripheral and central vestibular systems [required for balance] continue to develop until 12 years of age (Peterson, Christou, & Rosengren, 2006), at which point they are thought to peak in order to facilitate the development of emerging motor skills and postural control (McCaslin, 2016).

Vestibular function is achieved and maintained through complex interactions between the vestibular, vision, and proprioception systems, all of which integrate at the level of the cerebellum. Specifically, these systems collectively mediate the function of three primary reflexes (vestibulo-ocular reflex (VOR), vestibulo-colic reflex (VCR), and the vestibulo-spinal reflex (VSR)) that

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allow individuals to see clearly when moving about his/her environment, identify orientation with respect to gravity, determine direction and speed of movement, and make automatic postural adjustments to maintain posture and stability in various conditions and activities (VEDA, 2017). Therefore, it stands to reason that, should the communication and integration of any/all of these sensory systems be erroneous, some degree of impairment would ensue.

Interestingly enough, emerging audiological research and clinical practice in the areas of pediatric vestibular assessment and management has begun to expose the consequences these types of impairments may have on overall development and patient quality of life measures.

Prevalence of Vestibular Disorders in Children

Until fairly recently, very little was known about the prevalence of vestibular disorders in children. Not only do children lack the vocabulary to accurately describe hallmark presentations associated with vestibular disorders (e.g., vertigo), but many of these disorders often manifest themselves in the form of visual disturbances, headaches, clumsiness, sensory processing difficulties, delayed developmental milestones, or even learning disabilities, making the recognition and/or diagnosis of vestibular disorders challenging for both parents and professionals alike (O'Reilly et al, 2013).

Fortunately, in April of 2016, the National Institute on Deafness and Other Communication Disorders (NIDCD) funded the Child Balance Supplement (CBC) to the 2012 National Health Interview Survey (NHIS) in an effort to better determine the prevalence of, risk factors associated with, and availability of services for children with vestibular and balance impairments. The study, led by NIDCD statistician, Chuan-Ming Li, was published in *The Journal of Pediatrics*, and included data collected on nearly 11,000 children. The remarkable findings were as follows:

- The United States' nationally-weighted prevalence of vestibular disorders in children between the ages of 3 and 17 was found to be 5.3%.
- According to this data, more than 1 in 20 [nearly 3.3. million] US children may have a vestibular disorder.
- Children with hearing impairment are two times more likely to have vestibular disorders compared to children with normal hearing.

Based upon the findings presented in the NIDCD study, it would appear that vestibular disorders are actually far more common in children than we initially thought.

Screening for Vestibular Impairment in Children

According to Devin McCaslin, PhD, Director of the Vestibular/Balance Laboratory at Mayo Clinic in Rochester, MN, "One of the key indicators of a vestibular impairment is whether a child achieves their traditional milestones at appropriate times." One example provided by Dr. McCaslin regarded how typically-developing children begin to sit and crawl at approximately 5-6 months of age; however, children with underlying vestibular impairment may not begin to sit and crawl until approximately 8-18 months of age. Dr. McCaslin then goes on to say, "It can take a child with vestibular impairment 33 months to learn to walk independently versus only 12 months for an age-matched child with normal function" (McCaslin, 2016). Based upon Dr. McCaslin's advice, delayed motor milestones may be the first sign of an underlying vestibular impairment in children. Additionally, as mentioned in the NIDCD study, children with hearing impairment are two times more likely to have vestibular disorders when compared to children with normal hearing. For this reason, screening of vestibular function should also be strongly considered in ***all*** children with hearing loss.

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Table 1. Benchmarks for Developmental Motor Milestones in Children

MILESTONE	IN PLACE BY...
Response to Tilt (> than 36 months)	Should right within seconds
Head Control	4 months of age
Sitting Unassisted	9 months of age
Walking	18 months of age

STANDING ON ONE FOOT	MAINTAIN BALACE FOR...
3 years	2 seconds with eyes open
4 years	5 seconds with eyes open
5 years	8 seconds with eyes open

Screening, *cont.*

While at Vanderbilt University in Nashville, TN, Dr. McCaslin and his team utilized the following benchmarks *[See Table 1]* to screen for developmental motor milestones in children. Should screening reveal the child to be at risk, comprehensive vestibular evaluation and/or medical evaluation by the child's pediatrician and/or managing otolaryngologist may be warranted (McCaslin, 2016).

In addition to the aforementioned screening of developmental milestones, audiologists should also obtain a thorough case history including, but not limited to, risk factors for hearing loss and/or vestibular impairment associated with: birth/developmental, otologic, medical, family/genetic, and academic histories. Queries to the parents should regard whether or not there are any concerns with dizziness or balance and also, whether or not there are any concerns with vision, coordination, unsteadiness, etc. (McCaslin, 2016).

Lastly, use of self-report measures should also be considered for use in the clinic. The Pediatric Dizziness Handicap Inventory for Patient Caregivers (pDHI-PC), similar to the Dizziness Handicap Inventory (DHI) (DHI; Jacobson & Newman, 1990), was designed to be administered to the caregiver(s) of children 5-12 years of age and aims to determine the impact present symptomology associated with dizziness/imbalance may have on patient quality of life. Utilization of the DHI might be considered at the discretion of the clinician for children beyond 12 years of age, as the reliability of the patient subjective report typically improves with age/maturity. Another self-report measure, created by physical therapist, Dr. Marousa Pavlou and colleagues, is the Pediatric Vestibular Symptom Questionnaire (PVSQ) (Pavlou et al, 2016) and can be utilized for children between 6 and 17 years of age. The PVSQ aims to determine whether or not the subjective symptomology relating to dizziness/imbalance reported by the patient and/or his/her caregiver is mediating from the inner ear. The PVSQ is especially helpful in determining whether or not comprehensive vestibular evaluation is warranted and, if not, which type of specialty referral might be most appropriate based upon the presentation/report provided by the patient and his/her family. The pDHI-PC is available online through the American Speech Language and Hearing

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Association (ASHA) and the PVSQ is available online through *The Journal of Pediatrics*, as there is no copyright or license currently attached to its use, which has been confirmed by Dr. Pavlou herself.

NOTE: Should comprehensive vestibular evaluation be warranted, most of the present test battery used to assess vestibular function can be adapted for evaluation in children, as discussed explicitly in the *Manual of Pediatric Balance Disorders* by Drs. Robert O'Reilly, Thierry Morlet, and Sharon Cushing; however, site-specific normative data should be collected prior to evaluation to adequately account for maturational differences in development between children and adults. Additionally, prior to collecting data, each institution is strongly encouraged to consult with their research and development department and/or Institutional Review Board (IRB) to ensure proper execution of procedure as defined by their institution.

Centers Offering Services for the Assessment and Management of Vestibular Disorders in Children

Thankfully, a handful of pediatric institutions across the US and Canada have recognized and responded to the need for assessing, diagnosing, treating, managing, and rehabilitating children with vestibular disorders. Most of these centers utilize a multi-disciplinary approach that lend themselves well to comprehensively evaluating this complex sensory system from a multitude of different expert lenses including audiology, physical therapy, otolaryngology, neurology, optometry/ophthalmology, and gait specialists.

Current major medical centers with pediatric vestibular programs include, but are not limited to:

- Children's Hospital Colorado (Aurora)
- Nemours/A.I. duPont's Hospital for Children (Wilmington, DE)
- Boston Children's Hospital
- Hospital for Sick Children (Toronto, Ontario)
- Vanderbilt University (Nashville, TN)
- Boystown National Research Hospital (Omaha, NE)
- American Balance Institute (Largo, FL)
- Children's of Alabama (Birmingham)
- Rady Children's Hospital (San Diego, CA)
- Children's Hospital of Philadelphia

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Calorics and vHIT: Do We Really Need Both?

By Cammy Bahner, Au.D., CCC-A

With the advent of video head impulse testing (vHIT), many researchers and clinicians alike have questioned whether or not we really need to include both tests in our assessment of vestibular function. Are the long, laborious and uncomfortable caloric irrigations really necessary anymore when we have access to a much simpler, quicker tool that can assess the semicircular canals? Some have proposed that we do not need calorics anymore and that vHIT is an alternative and superior tool (MacDougall et al, 2009) to the caloric test, which has a long-standing reputation as the gold standard test for assessing loss of vestibular function.

vHIT is an exciting and relatively new tool for assessment of the vestibular system with certain advantages over caloric testing. For example, the amount of time to complete an evaluation is significantly reduced for vHIT, and the stimulus is much less likely to cause nausea for the patient. vHIT is also an effective test for evaluation of semicircular canal function in the pediatric population and may be able

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to provide information when caloric testing is contraindicated (Hamilton et al, 2015). Yet another distinct advantage of vHIT testing is that it stimulates the VOR using a more physiological high frequency stimulus than caloric testing. In spite of these advantages, caloric testing has been shown to have a high degree of sensitivity and specificity in the evaluation of unilateral vestibulopathy (Eza-Nunez et al, 2014).

Several studies have concluded that vHIT doesn't outweigh calorics, but that calorics and vHIT both provide useful information in the diagnosis of a variety of different disorders.

Advantages and disadvantages aside, the overwhelming conclusion is that calorics and vHIT do not provide redundant information regarding horizontal semicircular canal function but, instead, are complementary to one another (McCaslin et al, 2014). Although both tests do assess the vestibulo-ocular reflex (VOR), they stimulate different temporal frequencies of this reflex (Redondo-Martinez et al, 2015). The caloric response stimulates the vestibular system at a very low frequency of approximately .003 Hz, while vHIT is performed by the examiner thrusting the patient's head in a much higher frequency range up to 5 Hz. As a result, the vHIT and the caloric show different VOR responses (Redondo-Martinez et al, 2015). According to Zellhuber et al (2014), the dissociation between caloric and vHIT results may be a reflection of the temporal frequency differences, but may also be due to the differing roles of regular and irregular fibers of the vestibular nerve. The authors explain that animal studies have demonstrated some evidence that regular fibers drive the low frequency VOR, while irregular fibers drive the high frequency VOR. Several studies have concluded that vHIT doesn't outweigh calorics, but that calorics and vHIT both provide useful information in the diagnosis of a variety of different disorders affecting the vestibular system, including vestibular migraine (Yoo, et al, 2015), vestibular schwannoma (Blödow et al, 2013, Tranter-Entwistle et al, 2016)), and vestibular neuritis (Redondo-Martinez et al, 2015, Zellhuber et al, 2014). With respect to Ménière's disease, studies have shown that caloric results are more often abnormal than vHIT results (McCaslin et al, 2015). There are Ménière's disease cases where pathology will appear in vHIT, but more commonly, the vHIT is relatively normal, while the caloric responses are more sensitive in detecting the pathology. Blödow et al (2014) reported that only 37% of the Ménière's patients they studied demonstrated abnormal vHIT. In chronic vestibular pathology, caloric testing is also more sensitive than vHIT (Burston et al, 2014). This evidence provides additional support to disclaim the theory that calorics are no longer necessary.

While the reason for the differences between the two tests still remains somewhat unclear, there is plenty of evidence in the literature to suggest that the information derived from each test is important and assesses different parts of the VOR. The review of recent literature indicates that vHIT is not a replacement for caloric testing but, rather, is another tool to keep in our vestibular assessment toolbox. Both calorics and vHIT remain necessary parts of the multidimensional vestibular assessment battery.

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