HEARABLES

TODAY, CUSTOMIZABLE MEDICAL DEVICES AND COOL, GADGET-LIKE CONSUMER ELECTRONICS MERGE TO SERVE A MUCH WIDER AUDIENCE WITH CHOICES BEYOND TRADITIONAL HEARING AIDS.

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For decades, audiologists, along with hearing instrument specialists, have served as the gatekeepers of the hearing aid dispensing process. Historically, during this process the flow of information went from audiologist to patient. In essence, audiologists controlled the content of the patient-clinician dialogue and its associated treatment and remediation options, while the patient was the passive recipient of this information. Today, however, mainly due to the rise of smarter, cheaper, faster, and more portable computer processing power, the flow of information has fundamentally shifted. Patients, many of which have a strong desire to be directly involved in the entire decision-making process, now control the flow of information (Topal, 2015). As this article will demonstrate, the shifting relationship between patient and clinician has profound implications for audiologists and may lead to the distribution of new product categories, such as hearables, in our clinics. The central challenge for audiologists will be how they incorporate hearables into their clinical practice without compromising the quality of care or sustainability of their business. Propelled by Moore’s law, incrementally improving
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Computer-based technology is leading to the merging of medical devices and consumer electronics. This convergence of technologies is spawning an assortment of hybrid products that can be best classified as hearables. Several of the key attributes of medical devices, such as customizability or programmability, can be readily incorporated into off-the-shelf consumer electronics. Simultaneously, several of the qualities found in consumer electronics that make them stylish, accessible, and cool can be incorporated into the once stodgy medical device.

Although the roles in the patient-provider relationship may be shifting, it is the merging of divergent technologies, shown in Figure 1, that has the potential to expand the role of audiology. Consumers with communication difficulties are likely to demand a wider range of treatment options and express a desire to actively participate in their selection process. The opportunity to reach an untapped part of the market requires audiologists to embrace emerging technologies used to treat and manage hearing loss. As most audiologists know,
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air conduction hearing aids, classified by the Food and Drug Administration as Class I medical devices, must be dispensed through the professional channel. Several appointments are often needed to select, fit, and fine tune them. Additionally, hearing aids continue to have a stigmatizing factor that likely results in many patients avoiding them until their hearing loss is more severe and complex (Wallhagen, 2010). However, consumer electronic devices are readily available and have mass appeal because they are associated with leisure activities, such as listening to music, video gaming, or watching television. Hearables represent an opportunity for audiologists to offer their patients an alternative or complement to traditional hearing aids. To fully realize the potential of hearables without cannibalizing the existing demand for traditional hearing aids, audiologists would be wise to explore ways to expand their role in the delivery and use of hearables.

Hearables will not replace hearing aids, but have the potential to expand the market for audiology services. As shown in Figure 2, when hearing aid use is segmented by degree of hearing loss, there are two distinctly different markets. Individuals with moderately severe-to-profound hearing loss comprise approximately 25 percent of the market and more than half of this group possess hearing aids, while 75 percent of the hearing-impaired population have a mild-to-high frequency moderate hearing loss. Historically, our industry has served the top 25 percent of patients in Figure 2. These are individuals, typically older in age, often with more complex problems, usually

**FIGURE 3.** Hearing aid prevalence as a function of age (Chien and Lin, 2012).
HEARABLE OPTIONS
On the continuum between traditional hearing aids and consumer electronic devices, there are a range of products that can be classified as hearables. Each has a distinct feature set that may be beneficial and appealing to patients.

Made for iPhone Hearing Aids
Currently, Starkey and Resound make devices that integrate with the iPhone and Apple Watch, essentially turning their hearing aids into fashionable accessories. Patients can not only adjust their hearing aids with their smartphone or watch, but the smartphone can be used as a companion microphone, thus improving the performance of the hearing aids in noisy or reverberant listening situations.

Personal Sound Amplification Products
There are dozens of personal sound amplification products (PSAPs). Although there are a range of style options, some with an appearance similar to Bluetooth headsets and others looking more like large, in-the-ear hearing aids, PSAPs are essentially de-featured hearing aids. Considering their off-the-shelf availability and one-size-fits-all feature set, high quality PSAPs may serve as a “starter device” for individuals with less complex hearing loss. Sound World Solutions, SoundHawk, and Etymotic Research’s Bean appear to be three of the more high quality (smooth, broadband-frequency response) PSAPs available today, according to anecdotal reports.

Smartphone-Based Amplification Apps
Considering the stigma associated with hearing aids, PSAPs, which to the unassuming eye look an awful lot like traditional hearing aids, may suffer the same fate. After all, if it looks like a hearing aid, it must be a hearing aid. Smartphone applications, many of which can be downloaded for free, essentially turn your smartphone into a body aid when it is paired with earbuds of wireless ear phones. One study suggests that when amplification apps are fine-tuned by the audiologist, they offer some of the same performance benefits as an entry-level hearing aid (Amlani et al, 2013). Additionally, smartphone-based apps have the ability to increase patient self-confidence and reduce stigma. Recently, Amlani (2015) measured greater self-referral and hearing aid adoption in a group of older adults who completed a self-administered smartphone app-driven hearing screening, compared to a matched group who underwent a traditional face-to-face hearing screening. According to the author, this finding has the potential to halve the 6- to 12-year waiting period experienced by many individuals with hearing difficulty.

Wearable Augmented Reality
Combining amplification apps with stylish earbuds, wirelessly paired to a smartphone, wearable augmented reality devices allow individuals to customize their entire daily listening experience. Using the smartphone, individuals can reduce background noise on the street or subway, listen to their favorite music or amplify voices at the table of a crowded restaurant. True lifestyle integration seems to be goal of wearable augmented reality devices. Recently, two start-up companies Eargo ($13.6 million) and Doppler Labs ($17 million) have invested substantial sums of money into the development of ear-worn devices that provide augmented content through a smartphone.

Directed Audio Solutions
Using ultrasonic transmission to create a narrow column of sound in the air over a distance of several feet, directed audio solutions allow individuals to watch television or listen to music without the need of any ear-worn devices or accessories. One example of a directed audio system (e.g., Hypersound) uses NOAH-compatible software to program and fine tune home media audio across multiple channels. With a frequency response beyond 12,000 Hz, Hypersound may be an alternative to traditional hearing aids or used in the combination with hearing aids or PSAPs to enhance the overall television listening experience.
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requiring more time and expertise to manage. The successful outcome of the patients in the top 25 percent of FIGURE 2 is often predicated on multiple office visits over an extended period of time. However, those in the bottom 75 percent of the pyramid, where the vast majority of adults with hearing loss reside, are likely to have less complex hearing loss, and often do not require numerous appointments for hearing aid adjustments and counseling. It is this segment of the market, which does not value traditional hearing aids, and the way in which they are delivered, seemingly most open to the use of hearables.

It is not the degree of hearing loss per se, but the functional limitations of an aging auditory system that present opportunities for audiologists to intervene earlier using hearables. Many individuals with a slight hearing loss of up to 25 dB HL experience activity limitations and participation restrictions (Bess et al., 1991), yet 43 percent of patients with milder losses are given a “wait and re-test” approach (Kochkin, 2012). Furthermore, researchers are beginning to better understand the size of the population with self-reported communication difficulties, but no measurable hearing loss on the audiogram. Recently, Trembley et al (2015) reported that 12 percent of adults between the ages of 21 to 84 have hearing difficulties (HD) and normal hearing test results. Furthermore, Chai (2007) reported that 51 percent of adults 49 years of age or older report HD, with approximately half of this group having normal audiograms. Hannula et al (2011) suggested that 60 percent of adults between 54 to 66 have difficulty following conversations in noise (e.g., radio, television, restaurants) with many in this group presenting with normal hearing on the audiogram. Given the nature of self-reported communication difficulties among these groups, and their historical lack of hearing aid uptake, hearables would be a viable option for audiologists to explore when addressing the needs of this demographic.

Further opportunities for audiologists to expand their sphere of influence using hearables can be uncovered when hearing aid use is segmented by age. Chien and Lin (2012) used data from the National Health and Nutritional Examinations Surveys (NHANES), collected between 1999 and 2006, to examine the prevalence of hearing aid use among American adults aged 50 and older.

A summary of their data is shown in FIGURE 3. Chien and Lin (2012) estimated that 14.2 percent (3.8 million) individuals in the United States who are 50 years or older with hearing loss wear hearing aids. Note in FIGURE 3 that 22 percent of adults aged 80 and above with hearing loss use hearing aids, while 4.3 percent of individuals between the ages of 50 to 59 with hearing loss use them.

The data shown in FIGURE 3 reveals that the overall rate of hearing aid use is remarkably low, especially for adults younger than age 70. Younger individuals, often with milder degrees of hearing loss, are far less likely to use hearing aids even though a substantial number of them report communication challenges. According to the National Institute of Deafness and other Communication Disorders (2012), approximately 80 percent of men and 70 percent of woman have some degree of hearing loss before they reach the age of 60. This data is corroborated in a recent study by Stam et al (2014) who reported that the age group of 50 to 59 had the largest deterioration in speech recognition ability in noise over time. While attempts have been made to engage adults under the age of 60 who have hearing loss, to date, our industry has largely failed to make significant headway. Hearables may present an opportunity to address the communication needs of this population who seldom see an audiologist for services.

There are opportunities to incorporate hearables when working with the other end of the age spectrum: individuals aged 80 and older. Twenty-two percent of this group with hearing loss uses hearing aids. Even if we double the number of hearing aid users amongst the oldest cohort, we still have not managed to fit hearing aids on half of the age group that has the highest prevalence of hearing loss. When one considers all of the other co-morbidities affecting this group, such as dementia and other physical conditions that make it difficult to use hearing aids, it is easy to see the need for alternative treatment approaches, such as hearables, to more effectively meet the needs of a larger swath of patients in this age range. Salomen et al (2013) sampled 249 hearing aid users over the age of 70...
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and found that 55 percent used their hearing aids full time, 27 percent used them less than six hours per day, and 11 percent never used their hearing aids. Non-use of hearing aids increased with advancing age, as approximately 25 percent of 75- to 80-year-olds were non-users, while almost 50 percent of 85 years and older were not using their hearing aids. This finding suggests other cognitive and physical factors make the routine use of hearing aids difficult and necessitates audiologists search for alternatives to improve daily communication for this group.

Furthermore, according to data from the U.S. Bureau of Labor Statistics (2010), watching television was the most popular leisure activity among all adults aged 55 and older. Given the self-reported difficulties associated with television viewing by individuals with hearing loss (Kochkin, 2012), it is sensible for audiologists to address this common challenge by recommending hearables as an alternative for those not wanting to use traditional hearing aids.

The Evolving Role of Audiology
If consumers with hearing loss are going to demand that hearables are an option, then audiologists would be wise to adapt or modify their clinical repertoires to differentiate their professional skills and add value to the patient–provider relationship. Regardless of the technology available to individuals with hearing loss, there are at least three fundamental skills central to the provision of audiology services, as we move into a future sure to include several hearables. The ability to implement these three skills is largely predicated on our ability to engage a larger number of patients, especially individuals younger than 70 with milder hearing loss.

Personal Adjustment Counseling
Technology continues to evolve, but the underlying behaviors associated with age-related sensorineural hearing loss remain. Given the chronic nature of hearing loss of adult onset, which is often exacerbated by the aging process, the
ability to identify and move patients through the stages of change (see Laplante-Levesque, 2015, for a review) is a critical aspect of patient-centered care, regardless of the type of technology patients decide to use to remediate their handicapping condition. Motivational interviewing and personal adjustment counseling that promote behavior change need to become a core competency for all audiologists as we move into a new era of healthcare. Furthermore, the number of adults older than age 65 is expected to double over the next two decades. This phenomenon will place a premium on audiologist’s ability to sort through issues related to hearing loss, cognitive decline, and aging, and foster strong relationships with other medical sub-specialties that work with aging adults.

**Interactive Discussion and Demonstration**
As the number of treatment and remediation options expand, and as individuals with hearing loss become more knowledgeable about these options, audiologists need to use more effective communication strategies. It is possible that providing patients with a broader range of treatment and remediation options may even improve overall treatment uptake. For example, when offered options “more than half of patients” with hearing loss will choose an alternative to hearing aids (Laplante-Levesque, 2012). Thus it is imperative audiologists use things such as patient decision aids, participatory care guidelines, and patient-centered communication techniques to provide a deeper level of engagement. See Taylor and Weinstein (2015) for a summary of these skills. Additionally, as the number of hearable devices grows, audiologists may take a more active role in conducting demonstrations that allow patients to experience the potential benefits of hearables. This may require audiologists to re-evaluate their demonstration process and how they position various technology offerings. We could even see the rebirth of the antiquated assistive device center to an interactive sensory rehabilitation center.

**Quality Control and Assessment of Outcomes**
Regardless of the technology recommended to the patient, there are several essential acoustic parameters associated with use of any device that can be optimized by the audiologist. When any electro-acoustic device is coupled to a patient’s ear, audiologists have the ability to ensure the gain, output, and frequency response are meeting some established performance standards (e.g., NAL-NL2 target). This includes the ability to verify that a device is meeting an independently validated prescriptive target using probe microphone measures. Hearables, including PSAPs can be evaluated using standard verification procedures (Xu et al, 2015). Verification procedures can be used for traditional hearing aids as well as off-the-shelf hearables to ensure they are working properly. The routine and systematic assessment of outcomes related to use of hearables can also be documented by audiologists. As our profession continues to collect data on both quality control and outcomes with respect to hearables, it would be prudent for audiologists to implement standardized assessment tools, such as the APHAB and COSI, to document real-world outcomes in their practices.

**Conclusion**
Fortunately, we live in an age where the morphing of customizable medical devices and cool, gadget-like consumer electronics allow us to provide hearing-impaired people, both 50-somethings and nonagenarians, choices beyond traditional hearing aids. It’s up to forward-thinking audiologists to embrace them and understand how they fit into a clinic filled with patients who want to take a more active role in their care. This starts by carefully considering how hearables fit into the revenue-generating, bread-and-butter activities of hearing aid selection and fitting. The segmentation data clearly shows opportunities to grow the demand for our services if we can provide value to untapped markets. Putting this into action means we have to swim upstream against the inertia of traditional clinical offerings, public indifference
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References


