Programming Cochlear Implants: Interview with Jace Wolfe, PhD

Douglas L. Beck, AuD, speaks with Dr. Wolfe about his co-authored book, *Programming Cochlear Implants*, FM and Bluetooth, binaural hearing, bilateral cochlear implants, adult and pediatric criteria, and more.

Academy: Hi, Jace. Thanks for your time today. Before we jump into the book, I'd like to get a little background information. I know you work for the Hearts for Hearing Foundation in Oklahoma City. What sort of a group are they?

Wolfe: Hearts for Hearing is a not-for-profit organization. In fact, the mission of the Hearts for Hearing Foundation is to maximize spoken language opportunities for children and adults with hearing loss. We serve people of all ages with all types and degrees of hearing loss. Our specialty is the promotion of listening and spoken language skills for children. However, the services we provide are so diverse that I might see a baby who failed a hearing screening at age one or two weeks in the morning; and then in the afternoon, I might program a 92-year-old cochlear implant recipient, as I did last week.

Academy: That's great. What about your co-author? Where does she work?

Wolfe: Erin is an assistant professor in the Department of Speech and Hearing Sciences at the University of North Texas. She's already accomplished so much in her career. Her primary research areas are cochlear implants and FM technology and she has a prolific publication record in those areas. She also is an excellent teacher and has an impressive record of service within our profession.

Academy: Excellent. When you mentioned FM, do you actually mean traditional FM systems, or do you include all manner of wireless, such as FM and Bluetooth systems, as used with hearing aids and cochlear implants?

Wolfe: Great question…historically, we've kept to the stricter meaning such as dedicated FM systems. However, we're just now starting a new study in which we're looking at a wide variety of wireless systems to see how they work with cochlear implants. We'll be looking at personal FM, Bluetooth, and, of course, monaural and binaural presentations.

Doug, as you know, in years past, children in the classroom depended on the teacher speaking into a microphone and that signal was transferred to the child's hearing aid or cochlear implant via FM. Now, with SmartBoard technology, most of the lesson and the audio signal may come from a computerized presentation board at the front of the classroom and that system interfaces with the child's hearing system, so the technology and the opportunities are changing rapidly and it all has to sync-up correctly.

Academy: Right! The vast improvements in portability and ease-of-sync have made tremendous differences. Even for people wearing hearing aids, the fact that Bluetooth connectivity allows the phone (and other) signal(s) to go to both ears simultaneously is an order of magnitude better than listening with only one ear. Even with relatively normal hearing, I struggle using cell phones monaurally with regard to loudness, clarity, background noise, signal-to-noise ratio, sound quality. It's a wonder cell phones ever caught on! But when I add the second ear, the difference is night and day. I can see the need and the application for advanced wireless technology for adults and children with cochlear implants.

Wolfe: You brought up some really important points. I think the manufacturers should really receive our thanks and gratitude for these recent developments and applications of these technologies to hearing aids and cochlear implants. I know I shouldn't name names here, but pairing personal amplification systems with virtually any telephone and virtually any television and having it stream wirelessly into both ears has made an enormous difference with respect to the quality of life of our patients who use these technologies.

Academy: And this is for me, a soap-box issue. The difference in monaural versus binaural hearing with respect to cell phones, telephones, television, and other audio sources is enormous. The key is, you've got to get the patients to try it. Once they try it, done deal. Of course, the children are ready to try it immediately, but many older patients start with resistance. They'll say, "Oh no, I don't need that…" or they're reluctant because they're scared of new and unfamiliar technology, or they're concerned about hooking it up at home. But it really is "plug 'n play," and once they try it, they wonder how they ever got along without it.

When you apply those technologies to hearing impaired and deaf children in the classroom and it's a no-brainer. Of course, the signal must be audible and the signal-to-noise ratio has to be maximal and ideally, whenever possible, it should go to both ears, two hearing aids, two cochlear implants, or a bi-modal presentation such as one cochlear implant (CI) and one hearing aid. We've known how important binaural presentation is for decades and now we have the technical prowess to make it affordable, efficient and practical in hearing aids and cochlear implants.

Wolfe: Exactly, and we do expect great things when we apply additional wireless technologies to cochlear implants. My hearing is normal, but frankly, when the heater or AC kicks on and the background noise level in my living room increases, I would really benefit from these technologies. I think wireless is a huge deal. It's very affordable and we're excited to see how it'll pan out in our upcoming studies with cochlear implants because CI patients have more difficulty in noise and other challenging listening situations than do hearing aid wearers.

Academy: Right, they do. And, getting back to your book, which is very likely the most pragmatic guide to CIs and CI programming in 2010, I believe you stated the typical CI recipient has a dynamic range of about 20 dB? Wolfe: Yes, and so we're dealing with a very limited dynamic range and this means we have to maximize auditory information so as to transfer the most acoustic information. And in addition to connectivity issues with FM and Bluetooth, there are many CI-specific factors to be considered, such as threshold, upper

level of stimulation, signal amplitude and pulse width, electrical dynamic range, input dynamic range, sensitivity, channel gain and of course, volume.

Similar to hearing aids, we have compression and the various parameters associated with that. Contemporary sound processors possess sophisticated input processing schemes to provide a wide range of acoustic signals that may be beneficial to the CI user with a narrow electrical dynamic range.

Academy: Okay, and that's a good lead-in to the three commercially available CI manufacturers and their latest models that intend to do that, maximize the transfer of acoustic information to the CI recipient. Can you give me a brief thumbnail overview of the three?

Wolfe: Sure. Advanced Bionics has the HiRes 90K cochlear implant and the Harmony Sound Processor, which allows use of HiResolution Fidelity 120 signal coding strategy. Cochlear offers the Nucleus 5 systems with the CI 512 internal device and the CP810 sound processor. Cochlear uses the Advanced Combination Encoder (ACE) and ACE(RE) strategies as contemporary signal coding strategies. MED-EL offers the SONATA $_{TI}^{100}$ with the OPUS 2 sound processor, which allows for use of the Fine Structure Processing (FSP) signal coding strategy. .

Academy: And to really get to know the details and to get comfortable with these devices, your book reviews each in detail and offers some side-by-side comparisons and step-by-step protocols. Of course, the reader can go to the manufacturer's Web sites, too. Are there clear differences across these three devices or are they all pretty similar?

Wolfe: Well, that could take a few hours to answer…There are similarities and differences, just like with the major hearing aid manufacturers. So I'll mention a few comparison points…For example, Advanced Bionics and Cochlear offer removable magnets for MRI up to 1.5 Tesla, whereas Med-El is "MRI safe" up to 0.2 Telsa. The Advanced Bionic system has 16 intracochlear electrodes and 2 extracochlear electrodes, Cochlear has 22 intracochlear and 2 extracochlear electrodes and Med-El has 24 intracochlear electrodes, which are electrically coupled to provide 12 independent stimulation sites. Each of the manufacturers has at multiple signal coding strategies that can be programmed for the recipient. All CIs are available now as BTE models and some can connect with remote controls to increase functionality and ease-of-use.

Academy: Okay, and as far as quantities of channels and electrodes, it seems once we get beyond the bare minimum, the actual number of channels and electrodes is of little consequence. That is, with monopolar and bipolar coupling, common ground coupling, virtual and inter-electrode coupling…there are so many sequential and simultaneous stimulation opportunities, that the key concept is fitting flexibility, rather than hardware constraints. Is that correct?

Wolfe: We're still learning about the ideal channel and electrode combinations and numbers to optimize an individual's performance. In fact, the literature shows that 4 to 6 channels is likely all you need to maximally transmit speech in quiet and perhaps 10 to 12 to get good speech understanding in noise. Then again, one cannot access what has not been built into the system. Fortunately, each of the manufacturers offers such wide fitting parameters that the choices are vast and they overlap across manufacturers, and they each go way past the minimum requirements. In the end, what is ideal likely varies on a patient-by-patient basis.

Academy: What about retroactive compatibility? I recall one manufacturer committing years ago that every new generation of external components would accommodate previous internal components.

Wolfe: Yes, well, that is the intention and I believe they all try to do that, but CIs have been FDA approved for almost 30 years and it seems coupling the newest software and external hardware to the newest cochlear implants will almost always produce a better result than coupling new external components to previous internal components.

We have, however, seen improvements in performance when a recipient with an early model cochlear implant is upgraded to a contemporary external sound processor. Of course, as external hardware, signal coding strategies, and programming software improve it becomes more challenging to interface early systems to newer technology.

Academy: Jace, what about the current guidelines for CI eligibility? Your book covers this in some detail and I thought it was very interesting. Perhaps you can give me a brief overview?

Wolfe: Sure. I think what you're referring to is surprising to most people. That is, the implant criteria are actually "manufacturer specific." So each of the three manufacturers has labeling for their own device and they must receive approval from the FDA for their device and their wording, and so the three criteria vary slightly. For instance, Cochlear has the most liberal candidacy criteria for adults. They state that the adult candidate must have a moderate hearing loss in the low frequencies and a severe-to-profound hearing loss in the high frequencies—and it's pretty loose with regard to the exact definition of "low" versus "high" frequencies and the definitions of "moderate, and severe and profound" hearing loss.

Additionally, the specific open-set word recognition criteria vary from manufacturer to manufacturer, too. For children, the criteria appear a little too strict, in my opinion. In other words, children have to do very, very poorly with hearing aids to qualify for CIs according to the FDA criteria. For instance, the child has to score between 20-30 percent or poorer with respect to pediatric word recognition tasks, in the best aided condition. Therefore, the child really has to do poorly with hearing aids to be considered a CI candidate. And so playing devil's advocate, the flip side of that is to say that according to the FDA, if a child has 32 percent word recognition with hearing aids, that's fine. Of course, the FDA does not really say that, but that's more-or-less the reality of their eligibility criteria.

Academy: That's a great point. I guess if I were to personalize it, and if I had a 6-year-old child, with a 70 dB hearing loss and 44 percent word recognition scores. I would absolutely endorse a CI.

Wolfe: Yes, in that scenario, I think most of us who deal with CIs, and see the results daily would agree with you. Again, our goal here at Hearts for Hearing Foundation is to help the child or adult meet and fulfill their goals, and nobody can really do that when they understand less than half the words spoken to them!

In fact, I'm very comfortable saying that more than 90 percent of the people implanted in 2010 (and after this date) will have open set

speech discrimination in quiet and on the telephone which is darn near 100 percent, and then when you add in connectivity technology for more challenging situations—the sky is the limit.

Academy: Jace, I know we can jabber on for hours, but I have to let you go. Let me state clearly that I am very impressed with the book and I think it's likely one of the two most important books on CIs available in 2010. I highly recommend it for anyone (professional or patient) who wants a quick read to get up-to-speed on the advances, expectations and protocols for CIs, and I think every audiology student should read this book. Thanks for your time.

Wolfe: Thanks, Doug. I appreciate your time, interest and endorsement.

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