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## Cochlear implants and hearing aids: Some personal and professional reflections

### INTRODUCTION

The ear, nose, and throat physician who diagnosed my hearing loss many years ago called it a “progressive hearing loss” and told me that I would eventually be going deaf. And then he went on to his next patient. It took me a long time to realize that what he meant by “deaf” was not a condition that I would ever fully experience. He apparently used the term as a medical diagnostic label and not as a functional description. I am quite sure that the potential contribution of hearing aids never figured in his diagnosis. At the time, the medical profession mainly focused on the limitations of hearing aids—when they thought of them at all (audiology as a profession was in its beginning stages). Of course, without a hearing aid, someone with a hearing loss of 60 or 70 dB was indeed functionally deaf.

Fortunately for me, this diagnostic encounter happened while I was in the service. Shortly thereafter, I was transferred to Walter Reed Army Medical Center, where I participated in the aural rehabilitation program then being offered at military hospitals. There I received my first hearing aid. I still remember my reactions when I first turned it on. I could hear my footsteps echoing down the hallway at the Forest Glen section where the aural rehabilitation program was then located. It was an exciting but rather eerie experience, and I wondered if those people with perfectly normal hearing could also hear these sounds. But of course they could; for them, it was just part of the auditory background, heard but ignored. This first hearing aid was a bit larger than a pack of cigarettes and worn in one’s shirt pocket or in a special harness under the shirt. Of course, there were lots of problems with these aids, but before we dismiss them as primitive devices from the technological Stone Age we should know that they helped many people (including me) hear and function much better than we would have without them. I shudder to think what my life would have been like without them.

Over the years, my hearing loss did indeed progress, but as it did, a parallel development with hearing aids also occurred. Hearing aids moved from the body-worn style to ear level, continually becoming more sophisticated and powerful. By this time I was an audiologist myself and able to keep up with all these new developments. Thus, I was able to switch to more appropriate hearing aids (thanks to the Veterans Administration) as my hearing thresholds worsened. These changes permitted me to continue to function quite adequately for many years. During this period, about 20 years ago, cochlear implants were developed and subsequently demonstrated to be a potentially significant prosthetic tool. The first generation of implants were single-channel devices whose advantages, while noteworthy for those who were candidates (little or no

benefit from conventional hearing aids), were limited to the improvement of vocal monitoring, environmental sound awareness, and enhanced speechreading capabilities.

As had happened with hearing aids, advances in cochlear implants also seemed to parallel my increasing hearing loss. I kept up with these developments with great interest—and a tremendous feeling of relief. I suspected that a time would come when hearing aids would no longer be enough and that a cochlear implant would have to be my next step. As a clinician, I had often seen the impact of a profound or total hearing loss on the life and well-being of an adventitiously deaf adult, and I did not want this happening to me. I was determined to maintain auditory-oral contact with my world, and I was thankful that, if necessary, cochlear implants were available that could help me realize this goal.

About 2 or 3 years ago, I thought I had reached the limits of what hearing aids could do. However, at that time, a power behind-the-ear hearing aid with an effective feedback management circuit became available. With this aid, I could realize about 10 dB more effective gain and thus could continue to communicate, albeit with difficulty, in an auditory-oral mode. But then my hearing thresholds continued to worsen, particularly in my right ear. I could no longer talk on the telephone while using just this ear, as I had been doing. Instead, I plugged a neck loop into the audio output of a cordless telephone and inductively coupled the output to both ears simultaneously. I did OK, but the fact that this was now necessary was an additional indicator of my worsening hearing status. I had seemingly reached the limits of what acoustic hearing aids could do for me. Finally, what tipped the scale regarding a cochlear implant was a visit by my New York City daughter to my rural home. As she opened the car door, the first thing she said was, “Listen to those birds; I had forgotten what they sound like up here.” What birds? I did not hear any. That did it; the next day I called the Department of Veterans Affairs to arrange for my preimplant evaluation.

## PREOPERATIVE TESTS

The initial testing took place on October 17, 2006. The audiometric and speech test results are shown in **Tables 1** and **2**, respectively.

As an audiologist, several things came to mind as I looked at my own audiometric results. I knew that they were going to be somewhere down at the bottom of the audiogram, but I did not realize just how far down they would be. What masked the full impact of these poor thresholds were my speech perception capabilities. I did well on the sentence tests in each ear and still better bilaterally. As a matter of fact, I did well enough so that questions arose as to whether or not I really was an implant candidate. However, I felt that I was and that now my next decisions had to be concerned with which specific ear I wanted implanted. Based on my history and the audiometric results, the right ear clearly seemed the most suitable. I also intended to continue to use a hearing aid in my left ear with my normal mode of listening and, at least eventually, use both devices simultaneously (more on this point later).

Insofar as the sentence tests were concerned, what was most significant to me was not how well I did on them but how poorly they reflected real-world functioning. The sentence tests in noise were administered at a +10 dB signal-to-noise level, which is not a

**Table 1.**

Preoperative air-conduction thresholds (in decibels).

Ear	Frequency (Hz)						
	250	500	1,000	2,000	3,000	4,000	8,000
Right	95	105	105	115	NR	NR	NR
Left	95	95	100	100	115	115	NR

NR = not reported.

**Table 2.**

Preoperative speech-recognition test results (percent correct).

Test	Right Ear	Left Ear	Bilateral
CUNY Sentences in Quiet	79	80	94
CUNY Sentences in Noise	59	77	90
CNC Monosyllabic Words	18	46	48
Phonemes	45	67	77
HINT Sentences in Quiet	69	75	92

CNC = consonant-nucleus-consonant, CUNY = City University of New York,

HINT = Hearing in Noise Test.

sufficiently challenging listening situation in my opinion. Also, the test scores did not include such factors as my effort during the test, my lack of confidence in many of the choices that I made, or the time I took thinking about possible alternatives before responding, all of which occur in real-world listening. In brief, I worked very hard to obtain these scores; as such, they are probably as much an indicator of my language skills as they are of my hearing status. As long as I had enough audibility—and thanks to the feedback management system on these hearing aids, I did—I was able to make some pretty accurate guesses.

The one test that I felt most accurately described my hearing status, the one that minimized (but did not eliminate) the language factor, was the monosyllabic word test. On this test, I obtained just an 18 percent score in my right ear and 48 percent bilaterally. Clearly, unlike with the sentence scores, these results were not reaching the ceiling; there was room for improvement. These scores, plus the increasing progression in hearing loss and my current age, convinced me that now was the time for the implant, if ever. Still, unlike earlier generations of implant candidates, I did have usable residual hearing in both my ears. I would likely be losing this “natural” hearing when the implant was inserted. My bet—and it was a bet—was that the benefits I received with the implant would surpass what I would lose by relinquishing my hearing aid. No guarantees existed, of course, so the period between the operation and the first activation was a time of apprehension.

## POSTOPERATIVE TESTS

Finally, activation day came. Fortunately for me, I was almost immediately able to comprehend, albeit with some difficulty, sentences spoken by the audiologist. But clearly my bet had paid off; from here on in, the situation could only improve (absent some possible complications that I did not even want to think about). Up to this point, what I knew best about implants were comparative outcome measures but not the details of their actual programming. Now being personally involved, I tried to understand the many variables involved in programming an implant

(acquiring what is called a “MAP”), with only marginal success I am afraid. Still, even without completely understanding the contribution of the various MAP parameters, I can clearly see that the nature of the MAP significantly relates to ultimate performance. This realization appears to imbue the entire cochlear implant fitting process. When someone receives an implant, the usual practice is for the recipient to be scheduled for a number of follow-up appointments. In my case, even before the implant surgery, I was scheduled for four follow-up mapping appointments. These appointments were followed by a 3-month postimplant speech testing session in which my performance could be compared with my preimplant scores. My follow-up scores are shown in **Table 3**.

As my 3-month results indicate, I performed very well. And, of course, I am very pleased with them. But a potentially serious issue is that a naïve person looking at these results could conclude that the implant had restored my hearing abilities to “normal.” This misapprehension could lead to erroneous expectations and public policy. Not to sound like an ingrate, but I think it is important to realize that these scores do not completely reflect the reality of real-world listening. While I am doing much better than I would have otherwise, I am still functionally hard of hearing. As wonderful as a cochlear implant could be, and often is, it is not a cochlea replacement.

A test of my perception of nonsense syllables would probably be the most valid predictor of my basic (analytic) acoustic/phonetic recognition skills. This test was not done with me, nor do I know of anybody that does these tests routinely with implant recipients. For my own interest, I did what I thought was the next best thing: I had myself tested with the

**Table 3.**  
Three-month follow-up speech scores (percent correct).

Condition	CUNY (Q)	CUNY (N)	CNC (Words)	Phonemes	HINT (Q)
CI Alone	100	96	96	98	100
HA Alone	92	62	22	55	88
CI + HA	100	100	98	99	98

CI = cochlear implant, CNC = consonant-nucleus-consonant, CUNY = City University of New York, HA = hearing aid, HINT = Hearing In Noise Test, N = noise, Q = quiet.

AB test lists [1]. This test consists of 10 monosyllabic word lists, for a total of 30 phonemes. Twenty tests are available, with each one composed of the same 30 phonemes. Thus, the same phonemes are included in every 10-word list, making comparisons of scores possible by using more than one list.

Over the course of the 3 months postimplant, my wife (a speech-language pathologist) administered the lists to me live-voice in a quiet room and scored the results with respect to the errors made with specific phonemes. Only nine phonemes errors are included in **Table 4**; these phonemes are the ones with which I made the most errors over the four time periods. The tests were done informally, not as a controlled research project, although we carefully administered and scored the tests. My primary intention was to develop a personalized auditory training program, which is still a possibility. What the results show is the pattern of phonemic errors I made over time as well as my changing and improved performance.

What I would like to see is for audiologists to consider such results when modifying a MAP. We know that consistent phoneme errors must reflect problems in perceiving some specific acoustic features. I personally do not know whether the processing capabilities of any of the three major implants permit the kind of modifications capable of correcting the specific type of phonemic errors displayed in **Table 4**. If not, then I would most strongly suggest that this objective be defined as a major goal for future research.

## HEARING AIDS AND IMPLANTS

For me, as an audiologist and long-term hearing aid wearer, the care with which implants are fitted and followed up is perhaps the most impressive event I have experienced so far. With implants, frequent follow-ups are assumed to be necessary in order to ensure maximal functioning. Also, the traditional area of auditory training, with a history dating from before World War II, seems to be having a rebirth since the advent of cochlear implants. While I disagree with none of this, I do feel that it is rather sad that the same degree of attention is not paid to people who use hearing aids. What they hear with the hearing aid is no less important to them than what is heard via an implant. Granted, cochlear implant candidates usually have a greater hearing loss, with many unable to function auditorily at all. But this does not or should not imply that the fitting and follow-up of hearing aids require less attention or that the communication problems that hearing aid users experience are a trivial consideration. Indeed, I can almost imagine a “discussion” between my left (hearing aid) and right (cochlear implant) ears, with the left ear complaining that it, too, wants the careful follow-up care that this “Johnny come lately” (cochlear implant ear) has been getting.

**Table 4.**  
Phoneme error matrix at four testing points during 3-month postimplant time period.

Stimulus	Response			
	1*	2†	3‡	4‡
V	F, <u>TH</u> , Z	F	<u>TH</u>	Z
M	N, B, R, omit	L, V	N	R, N
P	D, CL, PT, H	T, K	T, T, K	—
O	UH, OO, UH	UH, UH, UH, OO	AW, AW, UH	OO, OO, UH
EH	EE, I, I, I	I, I	—	—
B	D, V, W, IF, F	—	N	—
TH	ST, F, S	S, F	S, S, F, S, F, S, F	S, F, F
N	R, NT, M	V, B	R	B, M
H	—	—	K, F	K, K

\* 6 lists.

† 5 lists.

‡ 8 lists.

What adds poignancy to this situation is that, as a profession, audiology well understands what constitutes “best practices” for working with clients requiring hearing aids. These practices are given in great detail in the “Guidelines for the audiological management of adult hearing impairment” promulgated by the American Academy of Audiology [2]. These guidelines are comprehensive procedures, covering in detail the required and suggested pre- and post-hearing aid fitting procedures. I see these as a statement of our good intentions. Some examples, however, will suffice to demonstrate the gap between our good intentions and actual practices.

According to a survey published in 2006 [3], only 20 percent of the respondents (hearing aid dispensers) routinely obtained speech-in-noise measures before the hearing aid fitting. More tellingly, in my judgment, was the fact that only a minority of them regularly administered real-ear tests while fitting hearing aids. One recent survey of hearing aid dispensers revealed that while more than half the respondents possessed the necessary equipment, only about 23 percent customarily used it during the hearing aid fitting process [4].

I find the omission of real-ear tests perhaps the most revealing commentary on the status of hearing aid fittings in this country, compared with what cochlear implant recipients now ordinarily receive. A real-ear measure provides the greatest insight into the composition of the amplified acoustic signals delivered to an individual via a hearing aid. One cannot simply look at coupler responses or the responses displayed during the programming session and predict what the real-ear responses will be. We can, however, predict that they will not be the same [5]. For whatever reasons such tests are not done, and many “reasons” are forthcoming, the end result is that the care with which hearing aids are fitted and followed up lags significantly behind what now appears to be the norm for cochlear implant recipients.

As I have indicated, my intention from the very beginning of the process was to continue to use a hearing aid in my left ear. From my perspective, I had too much usable hearing in that ear to give it up. During the month I waited for the incision to heal and before the date the implant was activated, I

depended solely on the hearing aid in my left ear for verbal communication purposes. And I got along—not well, but with the use of assistive listening systems, at least functionally. I definitely was not going to give this up after receiving the implant. I knew that my normal mode of listening was going to be using both devices simultaneously. The only question I had was how I was going to foster the integration of the two types of signals arriving from each ear. Giving myself the advice I would give to others, I decided to be a bit eclectic about the process.

At first, I did want to experience only the auditory signals provided by the implant, but not all the time. For this purpose, I gave myself an auditory training program using Internet resources, television signals, and recorded books (while following with the written text). I would do perhaps an hour or two a day of this at first. But for the rest of the day, I usually listened while using both the hearing aid and the implant. I found one type of “auditory training” procedure particularly helpful. I ordinarily use a small induction loop while watching television. All this requires me to do is switch my hearing aids on the telephone (“T”) coil while listening. The implant I have also includes a built-in “T” coil. What I did, and still do on occasion, was listen with just the implant alone (C-SPAN is great) and then switch on the hearing aid as well.

I do not think that the question is whether someone with an implant should use a hearing aid in the contralateral ear—for most, I believe the answer is positive—but rather how this adjustment should be made. On the first question, we can point to research that demonstrates that, on average, people function better and prefer to listen while using both ears, either with two aids, a hearing aid in one and an implant in the other, or with two implants. On the second question—how people should adjust to the simultaneous use of a hearing aid with an implant—we can point to lots of opinion but no data that I know of. Even if we had data, that the “averages” would not apply to every individual is highly probable. In this area, as in many clinical areas, an individualized approach must be followed. My personal experiences are completely applicable to me but only instructive for someone else in the same

position. What I suggest as a clinical philosophy is that hearing aid usage be encouraged in the contralateral ear, unless contraindicated by poorer (not equal) performance during bilateral listening.

We should keep in mind that objective test results can be a deceptive indicator of the possible contribution of using a hearing aid while using an implant. For example, it would not work in my case. As one examines my test scores (**Table 3**), the addition of the hearing aid appears to offer little further advantage. I had already reached a ceiling with the cochlear implant alone, making quantification of a possible contribution by the hearing aid in bilateral listening impossible. But these scores do not reflect what I experience subjectively when I use both devices simultaneously. The auditory sensations I experience are quite similar to what I had when I used binaural hearing aids compared with just a monaural hearing aid. I have a feeling of more spaciousness and less effort in decoding speech. Auditory signals simply “sound” better. A major point for me is how my speech sounds to myself with just the implant compared with when I also use the hearing aid. With just the implant, my voice sounds very base, to the point where my own speech is very distracting and unpleasant. I do not know whether this can be corrected with a MAP variation; so far, it has not been possible in spite of several attempts. But when I add the hearing aid to the listening mix, however, vocal monitoring sounds more “normal” to me (as does others’ speech).

I am not implying that I achieve the full benefits of binaural processing when I use both devices simultaneously. For example, I cannot localize a sound source, which can be a real-world problem. But I could not do this very well when I wore binaural hearing aids either. Also, I cannot extract a single voice from a noisy background, as people with perfectly normal hearing can. These deficiencies are additional evidence that an implant does not restore normal hearing. But what it does, and has done in

my case, is restore “functional” hearing, which is an advantage I experience daily.

In brief, my decision to acquire a cochlear implant was a good one on my part. As was my decision to simultaneously use a hearing aid in my left ear. One additional point I would like to make in conclusion: people with a cochlear implant should still use all the additional devices and techniques they used (or should have used) before getting an implant. Using the telecoil, telephone enhancements of one kind or another, a television listening system, and speechreading as much as possible are all going to be helpful. As much as a cochlear implant can do for somebody, it cannot do it all.

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