

Personal Communication Systems – The Next Evolutional Step

Why Hearing Aids are the Foundation but not the Whole House

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My wife and I were out shopping the other day and stopped to get a bite to eat at a nice restaurant. There was music playing in the background and the restaurant was very busy as it was the lunch hour. While we were sitting at our table talking I noticed an older couple being seated at the table across from us. They must have been in their mid-seventies and I also noticed that he was wearing binaural digital ITE hearing aids with directional microphones. Halfway through our meal my wife made the comment that it seemed so sad that the older couple were just staring off into space while they were eating and never saying a word to each other. I started to observe them through the balance of our meal and came to the same conclusion that my wife had. They never spoke to each other. They would look at each other at times but then just start looking at the ceiling. This brought back memories of a patient I had worked with and his spouse who, when I was explaining the advantages of using a Personal Communication System (PCS) and how it could be used in a restaurant she had broken down in tears. When I asked her what the reason for crying was she said “I’m so tired of going out to eat and eating alone.” I realized that was what we had just witnessed, two people going out to eat together, but eating alone, and it left me feeling sad. I was also sad, and just a little angry, because someone who had taken on the responsibility of helping that person improve both his listening ability and his quality of life had only done half their job. One of the things I would like to help accomplish is to never have to see couples going out to eat together and ending up alone when we have the technology to allow them to enjoy each other’s company while dining out.

Defining the Problem

Today’s modern hearing aids are both sophisticated and extremely adjustable. The hearing aid can be fit to compensate for a person’s hearing loss plus meet their personal needs for sound quality to what they hear, which is a very personal perception. Good hearing aids coupled with good fitting should allow our patients, with moderate to moderately severe hearing losses, to listen to speech in a quiet environment at between twelve to fifteen feet from the source. This distance will shrink as the patient’s loss increases and/or their word recognition decreases. In a moderately noisy environment, with the patient wearing good hearing aids equipped with digital directional microphones that are fit correctly, we can reasonably expect our patient to hear at a range of five to six feet. This is because we make the assumption that the sound source our patient wants to hear is within six feet and everything beyond six feet is sound clutter in the environment. Also physics and the inverse square law start to come into play generally beginning at about six feet in a mildly sound cluttered environment. The effect of this law is to reduce the sound source we want to listen to closer to the ambient environmental noise thresholdⁱ causing a loss of speech recognition. It also must be kept in mind that ambient noise environments that our patients believe to be quiet are in reality mild to moderately noisy environments. This means that most home environments are not quiet even if the hearing aids are acting like it is. These environmental noise levels reduce both the range at which our patient can listen to conversation and the clarity speech.

How many times have we heard our patients or their spouses complain about not hearing or being heard in the home and the distances involved are between six to twenty-four feet. How many times have we heard our patients could not hear their friends or family members when they came over to the house and the distance between our patient's chair and the couch was ten to fifteen feet and the distance at the dinner table was five to ten feet. Plus, we have the complaint "my wife expect me to hear her when I'm watching the news (it's always the news, never sports) and she is talking to me from the bedroom or the kitchen (generally working at the sink with water running). And they always ask us "why don't these new, fancy, and extremely expensive digital hearing aids improve my ability to hear my spouse better than my old aids?" The answer we need to give them involves a physics lesson in sound propagation followed with the problem's solution. Or maybe the correct answer should be a physics lesson with a complete solution before we sell them that NEW, FANCY, and EXTREMELY EXPENSIVE DIGITAL HEARING AID. Maybe we need to incorporate both that expensive new hearing aid plus an integrated package of on-board and/or out-board devices designed to overcome or bypass the inverse square law and/or the acoustical physics of sound propagation that's the problem. After all, they know already that the hearing aids are going to be expense (especially with our pinnacle technology aids), why not add a few dollars more and move the price from somewhere in the neighborhood of \$6,500 to and the neighborhood of \$7,800 and supply them with a complete solution to functioning at those mid-range (six to ten feet) and far-field (fifteen to thirty feet) plus throw in the television and telephone listening in one neat little package.

Needs of Our Patient's

The needs of our patient's today are not the same as those we fit during the age of analog hearing aids. Today's patients are much more active and they are active longer. The majority of my patients in their seventies and eighties are socially active with a large number being very active. My mother was eighty-seven this year and still plays bridge three to four times a week, serves on several committees and is a member of several clubs she attends regularly. Until two years ago she did the books and worked in the gift shop at a local hospital two days a week and handled the finances for the town library on a volunteer basis. During the fall, winter and spring it is hard trying to find some free time on her schedule to work in a visit from the family. My mother-in-law is eighty-four and almost as active in her church where she teaches Sunday school, chairs an outreach committee, sings in both the choir and as a soloist. And all of their friends are as active. Moreover, a lot of my seventy and eighty year old patients plus some in their nineties still are traveling and touring as I'm sure your patient group in this age range is also. This group of people has very sophisticated listening needs in a wide variety of listening environments. Add to this the younger forty, fifty, and sixty year olds (can we say hello Baby Boomers) that are still in the workforce, either full time or part-time. I was just reading a study that says of this group of people almost half have a mild hearing loss or greater and their listening needs in both the work environment and social environment also require sophisticated solutions. We need to remember that this group of people is use to having their needs met through technology. In every case their needs breakdown to better clarity in their listening environment. Sometimes our digital hearing aids are the answer but more often than not they don't really help all that much in some of the listening environments that are really important for our patients. I just had a patient in who had called the previous week asking if we had something that would help her hear better over the phone at work her

workplace. She was working as a receptionist in a busy insurance office and was not answering the telephone quickly enough or speaking confidently enough when answering the clients questions. Her employer was concerned about her ability to do the job. An appointment was set for Saturday as she was working Monday through Friday. When she came in on Saturday she was in tears. She had lost the job on Friday. The reason they gave for letting her go was that her lack of confidence on the telephone weakened the company's image and projected a lack of trust factor. This fifty-four years old woman had not informed her employer she had a mild to moderate hearing loss. Her hearing loss was causing a psychological hesitation when she was on the telephone but her employer had interpreted her hesitation as a lack of competency on the telephone.

The Components of Personal Communication Systems

The lady, mentioned above and the listening needs of most of our patients requiring better clarity to what they are hearing is available today. Through the blending and integration of several technologies, most noticeably wireless sound collection components coupled with either onboardⁱⁱ or outboardⁱⁱⁱ components with the hearing aids can provide the improved clarity. The primary component and foundation upon which we need to build a complete communication system to provide them with the solutions they are coming to us for is going to be a good quality hearing aid. While this hearing aid does not need to be a pinnacle product it should provide the flexibility needed to truly meet our patient's hearing loss needs. As a general rule the pinnacle product lines are ideal for adding the components for a Personal communication System plus many of the pinnacle products now come with remote controls making access to the additional functions much easier for the patient.

Sound Collection

I define "Sound Collection" as a way of capturing the sound source as close to being released into the air as possible. Sometimes this can be done with a patch cord being plugged directly into what the person wants to listen to like the television or an MP3 player. Other times this means placing a microphone as close to the source as is reasonably possible. Examples of this would be attaching a microphone directly to the speaker grill on a television or using a microphone to capture a person's voice as close to their lips as possible. In either case the source^{iv} they want to listen to is captured before surrounding background noise can blend in with the source or the inverse square law can have its effect on the source.

The type microphone; omni-directional, semi-directional, full-directional or proximity will vary depending on the listening needs of the patient and could vary within the dynamic environment as the listening needs of the patient changes from minute to minute. An good example of this type of dynamic environment is a person with hearing aids that is attending a large family dinner. The table is most likely eight feet long four feet wide with three people down each side and one at each end. The overall distance from mouth to ear lengthwise would be twelve-feet and side to side would be eight-feet. The noise environment will be somewhere between +6 dB to +10 dB SNR on the average. If our patient sits in the middle of one side they will be able to hear the person on either side of them but not the people across the table or at either end. If they sit at one end of the table, again they will hear the person on either side of them but everyone else is out of range since their new digital hearing aids are working in the "speech in noise" mode. If we place an omni-directional microphone two-thirds of the way down

the table and raise it about eight inches off the table (sit an empty water glass or a vase on the table with the microphone placed on top of that) we have effectively increased his range of hearing from five feet to fifteen feet. The same idea can be used when friends come over and are sitting on the couch across the room. Our hearing aid user is sitting in their chair with their spouse sitting in a chair beside them. The spouse is about six-feet away and the friends are at a distance of twelve to sixteen feet. Even in a quiet environment with the hearing aids working in the “speech in quiet” mode the couple on the couch is out of range. If we place a semi-directional microphone on the coffee table in front of the couch this will capture the sound approximately five feet from the source and allow for an enjoyable conversation between friends. A third example would be in a car or motorhome where a proximity microphone on a small boom could be hung over the ear and allow for a good conversation without the road noise while traveling. While these examples cover just a small number of the listening environments creative microphone placement and use will help improve most difficult listening situations, while maybe still hard, into a more functional listening environment.

Hearing Aid Interface

The second half of the Personal Communication System is connecting the collected sound into the hearing aid to be processed for the user. This can be done in a number of ways. First, the FM receiver can be built directly into the hearing aid. An example of this is Phonak’s iLink hearing aid. Second, the FM receiver can be integrated directly into the hearing aid through “Direct Audio Input” (DAI). This involves using an audio-shoe or boot into which the FM receiver can plug or through the use of a special receiver that mounts onto the battery compartment and uses the DAI input connections. This second option gives the illusion the FM receiver is actually part of the hearing aid itself. These two methods provide the cleanest and best ways to input the sound source directly into the hearing aid. The third method is through the telecoil found on most behind-the-ear (BTE) hearing aids and some of the in-ear style of aids. This allows the FM receiver to be coupled through magnetic induction directly into the hearing aid. Currently this is the best option for connecting FM to in-ear hearing aids but there is a down side. In the modern world today we seem to generate a lot of Electro-Magnetic-Fields or EMF that can be picked up by telecoils as a white noise. If your patient uses electrical light rail or I have had some complaints about hybrid cars putting out an EMF that make the use of telecoils impossible. The fourth way to connect hearing aids to an FM receiver is through the use of headphones. This works well for people using Completely-in-Canal (CIC) aids. Most modern CIC aids have very good feedback control circuits and with headphones I have not found feedback to be a problem. What we do have to be careful of is overdriving the microphones on the hearing aids. When using headphones the volume must generally be kept on the lower side for best clarity.

Bringing It All Together

Soundfield research, done by this author, over the last year has shown marked improvement in speech clarity and understanding over unaided and aided with just hearing aids alone.

The average improvement in speech recognition for those people with moderate to profound hearing losses in soundfield:

60% improvement using hearing aid with FM over unaided
43% improvement using hearing aid with FM over aided with omni-directional microphones
37% Improvement using hearing aid with FM over aided with directional microphones

The average improvement for individual with normal to mild hearing losses with high-frequency hearing loss in Soundfield:

60% improvement using aided with FM over unaided
46% improvement using aided with FM over aided

Wireless technology has allowed us to provide Complete Communication Packages to meet our patients listening needs. When our patients come to us they are not looking for a hearing aid, they are looking for us to provide solutions to the hearing problems they are experiencing along with the needs they are having in the world they live in. We must step outside the box formed by a hearing aid case inclosing a microphone, receiver, electronic amplifier (or processor) and a power source that we have been operating in since the 1920's. We must look at all the technology that is available to us and then see what can be put together to meet the problems our patients are having. We need to provide complete hearing solutions not just a hearing aid.

Summery

When incorporating both quality hearing aids with FM wireless technology a much larger range of listening environments can be met. Both mid-field and far-field listening can be improved and when used in conjunction with hearing aid microphones a much greater range of hearing can be reached without the laws of physics infringing on clarity. The special needs of our patients with difficult voices (very soft or broken) or who have to hear with clarity for professional reasons at a mid-range distance (counselors, psychologists, medical doctors) or business people who have to listen in hostile listening environments (receptionist talking to people in a busy office one moment and on the phone the next, an executive who must hear on a noisy job site in the morning and at a boardroom meeting in the afternoon). And then there is our active senior who may need to hear the bids at bridge or the tone of voice used to up a raise in a poker game to just talking with a young grandchild while driving them to an event. In all of these listening needs the hearing aid is only going to work for them partly. Clarity will always be short of good enough for them, but with the addition of wireless technology and by offering these people complete communication solutions, we can meet their lifestyles and listening needs. We can move them from just short of good enough to enjoyable and profitable lifestyles which is what they are looking for.

Now is the time for us to move from the mindset of the 1920's and move into the 21st century with all that means. The 21st century is not just digital hearing aids, digital hearing aids have been around since the mid 80's. Of course that hearing aid was the size of a large suitcase and weighted about 40 pounds but it was digital and showed the way of the future. The mindset of the 21st century, in my way of thinking, is the integration of technology to help improve our patients lifestyles, activities, and especially clarity. Look at the most popular items on the market today; cars with GPS, cell phones with text messaging and video on demand, Ipods that you can watch movies on. The list goes on and on. All products that integrate diverse technologies. This is the wave of the future and the wave that we need to be riding if we truly want to provide the best possible solutions to our patients hearing problems.

ⁱ A point of reference for this article lets define a quiet noise environment as greater than +24 dB SNR, mild noise environment as a +18 dB SNR, a moderate noise environment as a +12 dB SNR, and a hostile noise environment as a +10 dB SNR or less.

ⁱⁱ Onboard, as used in this article, would be technology or equipment attached directly to the hearing aid and designed to look or act as part of the hearing aid itself.

ⁱⁱⁱ Outboard, as used in this article, will mean a device connected to the hearing aid through a non- physical connection (RF, IR or EMF).

^{iv} For the purposes of this article "Source" will mean the sound our patient wants to hear.