I deeply appreciate the opportunity to offer a few brief comments as an endnote to this impressive conference on early amplification for infants and young children. Throughout this meeting, I found myself looking back to an earlier time—to a time when I first entered the profession of audiology as a young graduate student at Vanderbilt University. The year was 1962. From this perspective, the past two and a half days have served as a stunning reminder of the monumental progress we have made in pediatric audiology, especially in the area of early amplification for young children. When I entered graduate school at Vanderbilt University, there were less than 300 certified audiologists in the United States, and the vast majority of these audiologists were employed by VA hospitals and universities. Ken Johnson, an audiologist, had recently been named the first executive director of the American Speech and Hearing Association (ASHA), and the ASHA headquarters had just moved from Detroit to Washington, D.C. (Harford 1993). The giants of pediatric audiology were Sir Alexander and Lady Irene Ewing, Ruth Bender, Marion Downs, William Hardy, Freeman McConnell, Richard Silverman, and Eric Wedenburg. These were men and women of great vision who led pediatric audiology with passion, integrity, and a professional commitment to improve the life quality of young children with hearing impairment. These were men and women who helped to transform our profession—they were change agents, difference makers. For example, thanks to the Ewings, the concepts of early identification, parent management, and early amplification became accepted strategies in the United States for managing young children with hearing impairment. It was reasoned by the Ewings that early amplification allowed an infant to maximize the use of auditory data to trigger an innate propensity for language learning. The goal was to capitalize on that period when speech and language naturally develop. Parent-infant training programs, which emphasized early identification, early amplification, and parental involvement, were developed in numerous cities throughout the United States.

The average age of identification for hearing impairment in children was 3 to 4 years, and often there were significant delays following identification before the hearing aid fitting was completed. The hearing aids at that time were very large, unattractive, provided a limited bandwidth, an irregular response, and produced high levels of harmonic distortion (Killion 1997; Ross 1996). Receiver buttons were used to modify the response. Mark Ross reminds us that hearing aids during this period were designed for adults, not for children, and although the hearing aids may have been adequate to provide amplification to an adult with known language, it did not mean that they were capable of providing appropriate amplification for a child with severe-to-profound congenital hearing loss (Ross 1996). The upper end of the bandwidth was only about 3 kHz and of course we know that considerable linguistic information is carried by acoustic energy above this point.

Because the hearing aids were so large, Y-cords were often used to provide binaural amplification. In those instances where two body aids were recommended, the instruments were placed high up on the shoulder area in an attempt to place the microphones as close to each ear as possible.

Predictably, the fitting of a hearing aid was much different from today’s recommended fitting process. Because it was difficult for us to obtain precise thresholds, the hearing aid fitting was an ongoing process that sometimes took as long as six months to one year to finalize—thus the reason for delays in providing amplification to a child following confirmation of hearing loss. Throughout the fitting process, a Y-cord was often used...
to ensure that each ear received some amount of auditory stimulation.

The most widely accepted procedure for evaluating the hearing aid was the aided sound field audiogram using behavioral audiometry. Because of the problems associated with the effects of standing waves, warble tones—or narrow bands of noise—were usually substituted for pure-tone stimuli. The standard test procedure consisted of a comparison of unaided and aided thresholds at octave frequencies 250 to 4000 Hz. The functional gain represented the difference between aided and unaided threshold levels. Measurements were then made with several different hearing aids and/or adjustment settings such as gain, or tone control. The hearing aid and adjustment settings affording the greatest threshold improvement with the least degree of irregularity as a function of frequency was then considered the hearing aid that contributed the most toward speech understanding (Schwartz and Larson 1977). For children unable to provide a voluntary response, awareness or threshold levels using behavioral observation or visual reinforcement audiometry were obtained.

I proffer this brief historical perspective to highlight the progress we have made over the past few decades in hearing aid design and in the hearing aid fitting process, and to illustrate the unique and imposing challenges pediatric audiologists faced in those early years with limited technology and evidenced-based protocols. Looking to our past also helps us to identify those areas in which we have not made such good progress. Clearly, however, we have come a long way since the 1960s. The modern hearing aid is much smaller, more aesthetically acceptable, and contains more sophisticated circuitry that allows for the provision of a uniform and high-quality signal. Moreover, the advanced technology and clinical research that have evolved over the past 35 years have led to the development of vastly improved methods for the early identification of hearing loss, the audiologic assessment of very young children, the selection and verification of electroacoustic characteristics of hearing aids, and the validation of aided auditory function.

The Challenge

Given these many improvements, one would assume that today’s children with hearing impairment are benefiting from this newer technology and the most recent evidence-based clinical practices. Unfortunately, such is not always the case. Recent surveys concerning the practice behaviors of pediatric audiologists reveal that many clinicians do not use the available technology and evidence-based practices for the fitting of appropriate amplification to infants and young children. Hedley-Williams and coworkers (1996) demonstrated from a large survey of pediatric audiologists that no systematic procedure exists for determining and fitting hearing aids for young children. More specifically, the survey demonstrated that (1) many of the prescriptive procedures available for selecting hearing aids are not being used; (2) probe-tube measurements with children are typically not included as part of the verification strategy; in fact, aided sound field thresholds and speech measures in quiet—the same procedures used in the 1960s—appear to be the approaches of choice; and (3) programmable hearing aids are seldom, if ever, selected for use with young children. The recent amplification survey conducted at Vanderbilt offers some basis for encouragement but also illustrates a need for improvement (Tharpe 2000). About 70% of the pediatric audiologists surveyed reported using a prescriptive approach when selecting the electroacoustic characteristics of hearing aids, a substantial increase over the finding reported by Hedley-Williams and colleagues just four years ago. About 25% to 30% reported using their own personal strategy when selecting gain/frequency characteristics. Importantly, however, about 70% of the pediatric audiologists reported using objective measures (i.e., either traditional probe microphone, or RECD) to verify output limiting. On the flip side, about 30% of those surveyed continue to use behavioral measures to verify output limiting—the same approach utilized some 35 years ago.

Perhaps the most discouraging finding to date centers on the age at which a typical child with hearing impairment is fitted with amplification following the identification of hearing loss. Similar to the 1960s, a substantial lag time exists between the initial confirmation of hearing loss and the fitting of amplification. The Marion Downs National Center for Infant Hearing (Arehart et al. 1998) surveyed newborn screening programs in 16 states and noted that 45% of the newborn screening sites reported that the average initial diagnostic evaluation occurred within the first 6 months of life; 33% reported that the average age of confirmation of hearing loss was
Early Amplification: Implementing Change

An important challenge for our educational programs will be to educate students in the practice of evidence-based audiology. Evidence-based audiology deemphasizes intuition and unsystematic clinical experience as the grounds for clinical decision making, and stresses the examination of evidence from clinical research. We must resist the temptation of teaching what is popular and focus on teaching procedures that are supported by evidence. It is important for educational programs to teach students to evaluate the literature critically, continually questioning, and challenging the basis of time-honored practices, procedures, and philosophies. Students must be inspired to be creative thinkers, constantly seeking improved methodologies through innovative and imaginative investigation.

As a side note, I am concerned about the diminishing number of Ph.D.s entering our profession, especially those in academia. It is estimated that one-half of the doctoral students in communication disorders that graduate each year pursue careers in private practice or in the health care industry. Moreover, the average age of the Ph.D. in our profession is 57 to 58. Hence, in the next seven to ten years, about one-half of our Ph.D. pool in academia will retire. We thus have a dilemma: a shrinking number of Ph.D.s pursuing careers in audiology; for those who do elect a career in our profession, smaller numbers are entering academia. Who will train the next generation of pediatric audiologists? Who will develop the new knowledge and technology leading us to improved methods of prevention, identification, evaluation, habilitation, and rehabilitation in the decades to come?

Implementing Innovative Continuing Education Programs

Another form of education designed to alter practice behavior (in fact, the most common approach) is the use of lectures, skill training, dissemination of guidelines, and feedback about individual performance. Traditional continuing education programs may affect knowledge and beliefs, but they rarely result in behavior change. Changes in practice can occur with continuing education when the content is designed to change specific types of behavior. Prochaska, an internationally recognized authority on behavior change, notes that changing behavior involves progression through several stages of change: precontemplation (those who are not ready to change), contemplation (those who are seriously thinking about change), preparation (those who are intending to make a change in the near future), action (those who are making the appropriate steps to change), and mainte-
nance (those who are making efforts to avoid a relapse) (Prochaska 1995). Prochaska advocates the development of intervention strategies designed to help people progress through the stage sequence. Such an approach has realized far greater success than traditional action-oriented programs.

Clinical guidelines, another form of continuing education, can also contribute to change behavior, provided the guidelines are developed by respected clinicians, not laboratory scientists, and the guidelines are distributed to opinion leaders: men and women named by their peers as trusted sources of information. Opinion leaders then return to their communities to educate their colleagues (Greco 1993). Guidelines are of limited value unless they are embedded in a broader program that addresses the need for translation and implementation of guidelines into local communities.

**Alternatives for Changing Practice Behavior**

Other possible approaches that may help to affect change in practice behavior among pediatric audiologists include:

1. The development of programs designed to educate parents of children with hearing impairments, caring others, and the public. Knowledgeable consumers can serve as effective change agents.
2. The development of requirements for certification of pediatric specialists—boards of professional organizations and societies could incorporate guideline recommendations into membership criteria.
3. Linking evidence-based practices to third party coverage and payment. Both public and private insurers are more actively incorporating evidence on efficacy into coverage decisions.
4. The development of centers of excellence—the creation of referral centers that meet specified criteria for serving young children who have a hearing impairment under 6 months of age and their families.

**Summary**

In closing, let me reemphasize that we have made important strides in our efforts to provide appropriate amplification to young children with hearing impairment. However, much more needs to be done. We need to improve educational training for audiologists and place an emphasis on evidence-based practices. We need to develop innovative continuing education programs for practicing pediatric audiologists. We need to pursue vigorously alternative ways in which to alter practice behavior. And perhaps most important, we must create within this great profession an atmosphere for change. Indeed, all of us must be willing to respond to change. We must recognize that to respond effectively to change, we ourselves must change. We must reconceptualize who we are and why we are here in light of the changes that are occurring within our profession and our society. For many of us, change may be a complex and difficult process. We have invested considerable time and effort into specific philosophies and procedures, and we tend to be fiercely defensive about doing things in a certain way. If we truly desire to afford the best possible services to our children and their families, we must be willing to continually modify our clinical protocols as new evidence emerges. Effective clinicians produce improved techniques and constantly question and evaluate evidence, methods, and procedures, discarding the unproductive, and developing and testing the new. We simply cannot be satisfied with practicing audiology in the way that we learned in graduate school.

Similar to those pioneering pediatric audiologists who came before us, we can all do our part in moving this profession forward. We can become change agents, difference makers. To this end, let us work in our communities with a renewed commitment to provide state-of-the-art services to children with hearing impairment and their families—and a renewed commitment to change. Truly, we can afford to do no less.

I leave you with the words of one of my favorite pediatric audiologists, Mark Ross (1992): “Whatever we do, it is necessary to keep in mind that when we test and treat a young child with hearing impairment, we are also dealing with their parents, their dreams for their child, and further that what we do has an impact that transcends on time and place...it is the children and their families who must live with the consequences of our early actions.”

**References**


