Survey of Hearing Aid Fitting Practices for Children with Multiple Impairments

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The fitting of amplification on young children with multiple impairments in addition to hearing loss is a challenge faced regularly by audiologists. However, very little has been published on this topic in the audiological literature. The purpose of this survey was to document hearing aid fitting practices for this population within the United States. Specifically, audiologists who regularly serve children were asked to complete a series of questions on their educational preparation and their hearing aid selection, fitting, and verification practices for children with multiple impairments. For purposes of this survey, multiple impairments included vision impairment, mental retardation, physical impairment, and autism spectrum disorders. Findings from this survey suggest that children with special needs in addition to hearing loss are typically fit in the same way and with the same type of amplification as those with hearing loss only. In addition, differences were noted in hearing aid selection, fitting, and verification practices across work settings. Future directions and research needs are suggested.

Key Words: hearing aid fitting, pediatric, multiple impairments, infants

Today, more infants are surviving the tragic insults of premature delivery (birth before the 37th week), low birth weight (<2500 g), incipient infections, and inherited abnormalities than at any other time in our history. Unfortunately, many of these infants do not escape such insults unscathed. In fact, 25%–40% of children with hearing loss will exhibit additional impairments such as vision deficits, cerebral palsy, and mental retardation (Davis, Fortnum, & Bamford, 1998; Holden-Pitt & Diaz, 1998; Karchmer, 1985; Karchmer, Petersen, Allen, & Osborn, 1981; Mencher, 1983). Indeed, such multiple impairments will have a significant impact on the life quality of the child and the child’s family.

The challenges faced by pediatric audiologists when fitting hearing aids on children with multiple impairments are increasingly complex, somewhat daunting, and, at times, perplexing. There is a dearth of information on current and appropriate fitting practices for this population. Just a few of the many questions that must be answered when managing children with multiple impairments include, what is the child’s primary handicapping condition? Is the hearing loss a major or minor contributor to the child’s overall functioning level? Should children with specific additional handicapping conditions be fit differently than otherwise typically developing children? Are their listening needs different than those of typically developing children?

As a first step in beginning to address some of these pressing issues, a survey was developed to document current hearing aid selection, fitting, and verification practices for children with multiple impairments. The survey was completed by a cross section of audiologists throughout the United States who see children with some regularity in their clinical practices. Included in the report of the findings from this survey is a discussion of future directions and research needs.

Method

Respondents

The survey was mailed to 6000 audiologists across the United States. There are currently about 12,000 audiologists certified by the American Speech Hearing and Language Association (ASHA) in the United States (ASHA, personal communication, January 8, 2000); therefore, an attempt was made to survey ~50% of practicing audiologists. The respondents were asked to complete the survey anonymously. Only respondents who typically fit three or
TABLE 1. Description of impairment categories provided to survey respondents

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing loss</td>
<td>Sensorineural and at least moderate to severe in degree bilaterally</td>
</tr>
<tr>
<td>No other disabilities</td>
<td>No other disabilities except speech-language disorder</td>
</tr>
<tr>
<td>Vision impairment</td>
<td>Low vision (i.e., between 20/60 and 20/200 binocular); may wear glasses but also in need of additional assistance</td>
</tr>
<tr>
<td>Mental retardation</td>
<td>Moderate mental retardation (i.e., 50–60 IQ); will develop some language and learn to read in adolescence</td>
</tr>
<tr>
<td>Physical impairment</td>
<td>Cerebral palsy resulting in limited head control, requiring wheelchair use with head support and minimal fine motor function</td>
</tr>
<tr>
<td>Autism spectrum disorders</td>
<td>Autism with stereotypical symptoms including tactile sensitivities, receptive and expressive language disorder, marked social impairment and other behavioral concerns</td>
</tr>
</tbody>
</table>

more hearing aids in a 6-month period on children between the ages of birth and 12 years were asked to complete the survey. All respondents (those who fit children and those who do not), however, were asked to provide the demographic information reported herein.

Survey

The survey tool consisted of 31 multiple-part questions designed to extract information on educational training of the respondents and their hearing aid selection, fitting, and verification practices for children between the ages of birth and 12 years with hearing loss alone or multiple impairments. Age ranges were grouped as follows: (a) birth to 6 months, (b) 7 to 12 months, (c) 13 months to 2 years, (d) 3 to 5 years, and (e) 6 to 12 years. In addition to children with hearing loss and no other impairments, respondents were asked to reveal hearing aid selection, fitting, and verification practices for children who have hearing loss and vision impairments, mental retardation, physical impairments, or autism spectrum disorders. These categories of impairments were chosen because they are representative of those typically seen in audiology clinics. Table 1 lists the descriptions of these impairments provided to the respondents for purposes of answering the survey questions. These categories are mutually exclusive.

Results

Response Rate

The survey return rate was 27% or 1599 surveys, the distribution of which was wide and evenly dispersed across the United States. The respondents appear to reflect accurately the profile of the targeted audiologists, that is, most respondents had master’s degrees (84%) and worked full time (79%) performing clinical duties the majority (95%) of their time. Additionally, the primary work site of the respondents was an urban (80%) private practice setting (64%). This profile is consistent with that reported by ASHA (ASHA, personal communication, January 8, 2000), suggesting that a representative sample of audiologists was surveyed. Twenty-seven percent (N = 425) of the responding audiologists indicated that they qualified to complete the entire questionnaire (i.e., ≥3 pediatric hearing aid fittings in a 6-month period). The demographic profile of this subgroup of respondents completing the entire survey was equivalent to that of the total pool of respondents. The remainder of this report reflects the responses of the subgroup of respondents.

Experience and Training

Seven multiple-part questions were directed toward eliciting information on the educational and experiential background of the respondents qualifying to complete the entire survey. Results revealed that 82% of all respondents had taken a course in pediatric audiology in graduate school; however, only ~32% received at least one full lecture in graduate school on the impairments under consideration in this survey. Only a small number of the respondents (18%) had taken a course in pediatric amplification in graduate school. The respondents were also asked if they received any type of instruction on hearing aid fitting practices for children with the four types of additional impairments addressed in this survey. Approximately 19% of the respondents had received such instruction through such avenues as graduate school practicum, conferences, and workshops.

Respondents reported having more experience with older school age children than with neonates or preschoolers. Specifically, they reported an average of approximately 8 years’ experience fitting amplification on children between the ages of birth to 6 months and approximately 12 years’ experience with 6- to 12-year-old children. In addition, respondents reported fitting amplification approximately five times more often on school-age children than neonates or preschoolers.

Preselection Considerations

When asked, “Do you require that children . . . be a certain chronological or developmental age before being fit with a hearing aid?”, approximately 97% of the respondents reported that they do not. Figure 1 depicts the average age of children, as reported by the respondents, when fit with their initial amplification. As noted, the majority of the respondents indicated that, on average, they fit amplification on children at ≥13 months old. Children with hearing loss and visual deficits were reported to be fit at younger ages overall than those with other impairments. Those with hearing loss and autism, however, were fit at 3 to 5 years or older the majority of the time. This may be explained by the difficulties inherent in evaluating hearing status in children with autism (Tharpe et al., 2001). Further, no differences were noted in age of initial amplification fitting across those respondents who
work primarily (i.e., >50% of their time) in private practice, hospital, or university settings.

Respondents were asked their opinions about how children with hearing loss and the four additional handicapping conditions typically benefit from amplification compared with children with hearing loss alone. Respondents most frequently indicated that children with both hearing loss and visual impairment were likely to receive more hearing aid benefit, children with hearing loss and physical impairments would receive equal benefit, and children with hearing loss and mental retardation would receive equal benefit, and most respondents did not know what to expect regarding benefit of amplification for children with hearing loss and autism compared with children with hearing loss alone.

When asked to indicate the hearing aid style, configuration, and microphone type typically fit on children of all ages with the various handicapping conditions, respondents overwhelmingly reported the use of binaural (>95%), behind-the-ear (BTE; >90%) devices. Less than 10% of respondents chose body style and less than 5% chose in-the-ear (ITE) devices regardless of additional impairments. Slightly more respondents (a total of approximately 15%) recommended ITE devices for children in the 6- to 12-year age group. There were no differences, however, in hearing aid style recommendations across handicapping conditions.

An interesting trend across age in the selection of microphone type was noted. As shown in Figure 2, a majority of respondents chose omnidirectional microphones for infants and preschoolers; however, as age increased, more respondents chose directional microphones. Approximately 10% of the respondents in each age category did not know what type of microphone they typically order.

In addition, respondents were asked to select the type of primary amplification typically fit on children with the various handicapping conditions. Options included programmable, programmable/digital, nonprogrammable, and nonprogrammable/digital devices. Respondents (35%–45%) most often selected nonprogrammable devices for children followed by programmable/nondigital devices (20%–25% of respondents) regardless of age or additional handicapping condition. Only ~15% of respondents indicated that they recommended digital devices for children across the age range.

A relatively large number of respondents (15%–30%) reported that some form of frequency modulated (FM) system (either personal FM or FM/BTE combination) is their choice for primary amplification for children. These results are summarized in Figure 3. For purposes of clarity, results were collapsed across handicapping conditions because no differences were noted. A noticeable increase in the number of respondents recommending FM/BTE devices as primary amplification can be observed as the age of children increases.

**Selection Practices**

Respondents were asked a series of questions about hearing aid circuitries and selection methodologies typically used for children with hearing loss and additional handicapping conditions. Specifically, they were asked to indicate the hearing aid circuitry they typically select for children with the various handicapping conditions. Options included linear with peak clipping, linear with compression limiting (output compression), and input compression including wide dynamic range compression. Recall that the hearing loss description provided to the

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**FIGURE 1.** Response to the question, “On average, how old are children . . . when you fit their initial amplification?” (N = 425); HL, hearing loss; MR, mental retardation (adapted from Tharpe, 2001).

**FIGURE 2.** Response to the statement, “. . . select the microphone type that you typically fit” as a function of age (N = 425).

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**FIGURE 2.** Response to the statement, “. . . select the microphone type that you typically fit” as a function of age (N = 425).
respondents was “sensorineural and at least moderate to severe in degree bilaterally.” Consistently, with no noted differences across age or handicapping condition, greater than 50% of all respondents reported selecting input compression, including wide dynamic range compression. In addition, approximately 35% typically selected linear circuitry with compression limiting, ~15% selected linear with peak clipping, and 7% of respondents did not know the type of circuitry ordered. Respondents in different work settings differed in their circuitry recommendations. As illustrated in Figure 4, respondents working primarily (>50% of their time) in school settings more often selected linear peak clipping circuitry and less often selected input compression than their colleagues in private practice, university, or hospital settings.

Respondents were asked to indicate the method they most often use in selecting gain/frequency specifications for children in the various age groups and with each of the handicapping conditions. For purposes of clarity, results were collapsed across the various handicapping conditions and age categories because no differences were noted. Approximately 50% of all respondents selected the desired sensation level (DSL) approach (Seewald et al., 1996) as the method of choice for determining gain/frequency specifications for children. Differences were noted, however, in selection methodology among those respondents working primarily (>50% of their time) in private practice, university, school, and hospital settings. As seen in Figure 5, although the majority of respondents in university, school, and hospital settings use the DSL approach for selecting gain/frequency specifications for children, fewer respondents in private practice settings do so. In fact, those in private practice settings more often selected the use of a personal strategy (i.e., informal prescriptive approach) for selecting hearing aid gain/frequency specifications for children than those in the other work settings.

Similarly, respondents were asked to indicate the method typically used to select output-limiting characteristics. Again, results were collapsed across the various handicapping conditions because no differences were noted. Approximately 18% of the respondents indicated that they use 2-cc coupler levels with a self-determined (i.e., informal prescriptive) value to select output limiting, 27% use 2-cc coupler levels predicted from puretone test results using formal prescriptive formulas, 31% use 2-cc coupler levels using average (age appropriate) real-ear-to-coupler difference values (RECD), 19% use 2-cc coupler levels and measured coupler values.
levels using measured RECDs, and 5% did not know what method they use to select output limiting. The only age-related changes noted were an increase in the use of a measured RECD accompanied by a decrease in the use of an age-average RECD between ages 2 and 3 years (see Figure 6).

Again, we were particularly interested in determining whether respondents from different clinical settings were using different methods for selecting output-limiting characteristics. Interestingly, differences were noted among respondents who practiced primarily in private practice, university, school settings, and hospital settings. As depicted in Figure 7, fewer respondents in university settings use self-determined 2-cc coupler levels to select output-limiting characteristics than respondents from other work settings. As described in Figure 7, fewer respondents in university settings use self-determined 2-cc coupler levels to select output-limiting characteristics than respondents from other work settings. In addition, those in all work settings reported a reduction in the reliance on age-average RECD values at about age 2 to 3 years, and all except those in private practice reported an increase in measured RECDs at that time. Finally, ~75% of those using self-determined 2-cc coupler levels (output limiting) reported values of no greater than 120 dB.

Verification Practices

Although previous questions were concerned with hearing aid selection criteria, we were also interested in verification practices of pediatric audiologists. Respondents were asked to indicate the method most typically used to verify gain/frequency specifications. Their options included a variety of behavioral (i.e., sound field-aided thresholds, aided speech reception thresholds [SRT] or speech awareness thresholds [SAT], and aided word recognition testing) and probe microphone measures. Preferred verification method varied as a function of age but not by handicapping condition. Therefore, for purposes of clarity, results were collapsed across handicapping conditions. As observed in Figure 8, an approximately equal number of respondents reported a preference for using some type of real-ear probe microphone measure or behavioral measures. It is of interest to note that, again, the use of 2-cc measures using the RECD decreased across age, whereas traditional real-ear probe microphone measures increased across age. This inverse relationship appears to begin between ages 12 months and 2 years. Behavioral measures, especially sound field–aided thresholds, remained a popular technique for verifying gain/frequency specifications across all age ranges.

An examination of gain/frequency verification practices

**FIGURE 7. Response to the statement, “. . . select the method you typically use to select output-limiting characteristics” as a function of primary work setting (>50% time). Work settings included private practice (N = 158), university (N = 36), school (N = 35), and hospital (N = 91). “Self-determined 2cc” refers to 2-cc coupler levels determined by the respondent, “Predicted 2cc” refers to 2-cc coupler levels predicted from pure-tone test results using prescriptive formulas, “Average RECD” refers to 2-cc coupler levels using average (age-appropriate) RECD, and “Measured RECD” refers to 2-cc coupler levels using measured RECD. * = 0% response.**

**FIGURE 8. Response to the statement, “. . . select the method you typically use to verify your gain/frequency specifications as a function of age” (N = 425). “Behavioral Measures” includes sound field–aided thresholds, aided speech reception thresholds or speech awareness thresholds, and aided word recognition testing (adapted from Tharpe et al., 2001).**
of respondents in specific work settings yielded some interesting results. Note in Figure 9 that although behavioral measures remain popular for verification of gain/frequency across all work settings, they are clearly the methodology of choice for those respondents in private practice, school, and hospital settings.

Finally, respondents were queried about their preferred method for verifying output-limiting specifications. Their options were the same as those for verification of gain/frequency specifications. Again, although no differences in methodology preference based on handicapping condition were noted, age differences were observed (Figure 10). As expected, respondents indicated that the use of the RECD was highest with younger children. Use of 2-cc coupler measures using the RECD decreased with increasing age, whereas use of traditional real-ear probe microphone measures increased with age. A distinctive difference in validation methodology preferred for gain/frequency specifications versus output-limiting specifications was observed. Recall that the respondents were split in their preference for probe microphone versus behavioral measures for verifying gain/frequency specifications. For output-limiting verification, however, respondents clearly preferred a probe microphone method (i.e., traditional probe microphone measure or RECD).

As illustrated in Figure 11, primary work setting again appeared to influence the preferred methodology for verification of output limiting. Less than 5% of respondents in university settings used any type of behavioral measure to verify output limiting, whereas 30% to 40% of respondents in private practice, 30% to 55% of those in schools, and 20% to 25% of those in hospital settings typically used behavioral measures for verification.

Discussion

The purpose of conducting this survey was to examine hearing aid selection, fitting, and verification practices for children with multiple impairments. An improved understanding of current practice in this area can assist in determining future directions and research needs. Perhaps the most striking feature of these data is the consistency of hearing aid selection and fitting practices for children with the various handicapping conditions, that is, selection and fitting practices do not appear to be any different for children with multiple impairments than for children with hearing loss and no additional impairments. This is an interesting finding because children with impairments in addition to hearing loss are likely to participate in activities that are distinctly different from those without such impairments. Consider this example. Children with multiple handicaps are frequently involved in activities that may make the use of the most commonly recommended hearing aid style for children, the BTE aid, problematic. Recall that the description of the physical impairment provided to the survey respondents stated that the child under consideration had “cerebral palsy resulting in limited head control, requiring wheelchair use with head support.” A BTE device could result in excessive feedback as a result of positioning for physical therapy activities, the use of head and neck braces, and general postural concerns with children having poor head control. Body-style hearing aids, although not commonly used in today’s high-technology market, may be an appropriate option for some of these children. Yet, fewer than 5% of respondents indicated that they would recommend a body aid for a child fitting this profile.

In addition to potential differences needed in the selection of hearing aid types and physical characteristics, the
actual fitting process may need to be different for children with multiple impairments than for the otherwise typically developing child. As discussed in detail by McCracken and Bamford (1995), despite the ease and efficiency of RECD measures, some children with multiple impairments may strongly resist such measures by means of excess movement and tactile defensiveness. As such, average RECD values might be used, thus ignoring individual variability. This certainly appeared to be true for the respondents to our survey. Recall that the respondents preferred the use of age-average RECDs over measured RECDs especially before age 1 to 2 years. The ear canal volumes in children with craniofacial abnormalities (not an impairment specifically addressed in this survey), however, will often be unusually small for their chronological age and will differ considerably from age-average RECDs. The age-average RECD, therefore, may greatly underestimate the actual RECD (McCracken & Bamford, 1995).

**Practice Settings**

Differences in hearing aid selection, fitting, and verification strategies were apparent across practice settings. Recall that those practitioners in private practice reported using DSL for selecting gain/frequency specifications less often than those in university, school, or hospital settings. Further, those in school settings recommended peak clipping instruments for output limiting more than twice as often as those in private practice, university, or hospital settings and were much more likely to use behavioral measures to verify hearing aid output than those in other settings.

It is interesting to consider the factors that may have contributed to these findings. For example, it is reasonable to suspect that third-party reimbursement may influence some hearing aid recommendation practices. Practitioners, by necessity, may be influenced by reimbursement rates for specific technologies, and this influence may be greater or lesser depending on the employer’s dependency on such support. Similarly, certain work settings may be more amenable to continuing education opportunities than others. Audiologists in some
work settings may not have access to funds that support their attempts to update their fitting practices by attendance at professional workshops or conferences. Finally, audiologists in some work settings may not have access to current fitting technology such as probe microphone equipment and computerized hearing aid fitting programs.

Age of Initial Hearing Aid Fitting

Respondents reported that they typically fit initial amplification on children ≥12 months old. These results are consistent with a previous report on survey results of newborn hearing screening programs in 16 states in the United States and are particularly disturbing when one considers evidence that infants with hearing loss are being identified at younger ages than ever before (Arehart, Yoshinaga-Itano, Thomson, Gabbard, & Brown, 1998). Unfortunately, this survey did not probe into the causes for what appears to be a delay between identification of hearing loss and hearing aid fitting. It is reasonable to speculate, however, that such a delay could be the result of continued verification of a hearing loss (i.e., repeated testing or attempts to obtain additional data), parental delay (i.e., searches for additional opinions or denial of the hearing loss), financial delay (i.e., lack of funding for hearing aids or insurance processing), or a combination of events. It is also possible that audiologists have not yet gained sufficient experience with the procedures used to fit amplification on very young infants and children.

Experience and Training

Approximately 82% of the respondents to this survey reported having had at least one course in graduate school in pediatric audiology. However, only 18% had taken a course in pediatric amplification, and only 19% had received any type of instruction (i.e., lectures, workshops, etc.) on hearing aid fitting practices for children with additional handicapping conditions. Clearly, a need exists to provide audiologists with additional training in this specialized area of pediatric hearing aid fitting. As the survival rate of premature and high-risk infants improves, the accompanying morbidity rate also increases. Thus, the need for such training continues to grow.

Selection and Verification Procedures

The method chosen most often by survey respondents for selecting gain/frequency characteristics for children with the profiles specified in this survey was the DSL approach (Seewald et al., 1996). Less than 10% of respondents to a 1995 survey reported using the DSL, whereas 50% of our current respondents reported doing so (Hedley-Williams, Tharpe, & Bess, 1996). In addition, the results of this survey suggest that the use of probe microphone technology with children has increased over the last several years. Only 15% to 40% of respondents to our 1995 survey reported always using probe microphone measures (Hedley-Williams, Tharpe, & Bess, 1996), whereas the current survey revealed that 50% to 75% of respondents typically use probe microphone measures for verification purposes. It should be noted that the 1995 survey did not inquire specifically about selection and verification practices for children with multiple impairments.

The results of this survey suggest that there is still a large number of pediatric audiologists who use behavioral measures for verification of their hearing aid fittings.

Numerous investigators have clearly articulated the limitations of using sound field aided thresholds or aided speech measures to select or verify hearing aid fittings or to make comparisons across aids (Hawkins, Montgomery, Prosek, & Walden, 1987; Humes & Kirn, 1990; Macrae, 1982; Mueller & Grimes, 1983; Seewald, Moodie, Sinclair, & Cornelisse, 1996; Shore, Bilger, & Hirsh, 1960; Walden, Schwartz, Williams, Holum-Hardegen, & Crowley, 1983). The most obvious limitation of these measures with young and multiply involved children is that a reliable behavioral response is required. Given the varying levels of responsiveness that are expected from children with multiple handicapping conditions, particularly mental retardation and autism, such measures are not recommended.

Conclusion and Future Directions

Overall, the results of this survey suggest that pediatric audiologists have made considerable progress in the fitting of amplification on infants and young children over the past several years. The use of prescriptive approaches designed specifically for use with infants and children is on the rise. Probe microphone technology is more widespread for selection and verification purposes than indicated in our last survey of 1995 (Hedley-Williams, Tharpe, & Bess, 1996). There is, however, room for improvement. It is alarming that ~50% of respondents still use behavioral measures for verification of gain/frequency specifications and ~30% use behavioral measures for verification of hearing aid output. In addition, it appears that hearing aid fitting strategies do not take into account the variety of functional needs that those with multiple impairments may have. It is apparent that our students need additional training in the unique characteristics and amplification needs of children with handicapping conditions in addition to hearing loss.

Interpretation of these data should be made with caution in view of the study limitations. The respondent sample sizes, when broken down into work setting categories, are relatively small. Although a reasonable number of clinicians in private practice and hospital settings responded to this survey, the number of respondents from school and university settings was relatively small. Generalization of these findings to other school and university settings, therefore, may not be appropriate. In addition, one should keep in mind that respondents were provided with specific patient descriptions on which to base their answers. Under different circumstances (e.g., different degree or configuration of hearing loss), the respondents...
may have made different recommendations. Nevertheless, these data suggest some areas of needed change.

The results of this study do highlight the need for systematic research in this area. We, as a profession, need to continue our exploration into appropriate hearing aid fitting practices with this special population. A few of the many questions that remain unanswered include:

- What are the optimal frequency-shaping characteristics for individuals with vision and hearing impairments for enhancement of speech perception as well as orientation and mobility?
- How do compression characteristics affect distance estimation ability for those with vision and hearing impairments?
- Given the apparent sensitivity to sound and other sensory input demonstrated by individuals with autism, are there special considerations to be made during the fitting process with this population?
- Are there tools that can be developed to validate hearing aid fittings in special populations who are unable to communicate adequately for traditional validation measures?
- Although directional microphone use has demonstrated benefit for some school-age children with hearing loss listening in noisy environments, limited information exists about the benefits of directional microphone use in younger children. Three of every five preschoolers are currently in day care settings that are certainly as noisy as classroom settings (Children’s Defense Fund, 2000). Can we assume that directional microphone use is advantageous for this young population as well?

**Author Note**

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**References**


