

# Hearing Aid Use for Children With Hearing Loss: A Literature Review

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## **Abstract**

*Purpose: The purpose of this study was to complete a comprehensive literature review related to hearing aid use during early childhood.*

*Method: A rapid evidence assessment was completed to provide a summary of information published or presented between 1980 and 2012. A qualitative assessment was completed for all eligible material, emergent themes related to hearing aid use were synthesized, and a narrative summary was generated.*

*Results: Eight publications, one conference proceeding, and one presentation were identified. Three themes emerged from the review: hours of hearing aid use, factors influencing use, and suggestions about how to increase use from parents and professionals.*

*Conclusion: Minimal research has been done related to hearing aid use for young children with hearing loss. Further research is needed to address influences such as quality of fit, parent factors, multiple disabilities, and cultural differences and to investigate effective strategies for increasing hearing aid use.*

Early identification of hearing loss and effective management are critical to optimize outcomes for spoken language development. Almost 95% of children with hearing loss are born to hearing parents (Mitchell & Karchmer, 2004). Most of these parents choose to communicate with their children using listening and spoken language, which requires consistent and effective use of amplification (White, 2007). As a result of newborn hearing screening, many children with hearing loss are being identified, fitted with hearing aids, and receiving early intervention services before 6 months of age (Center for Disease Control and Prevention [CDC], 2011; White, Forsman, Eichwald, & Muñoz, 2010).

Consistent access to appropriately amplified sounds is essential for speech and language development. During an infant's first year of life, the auditory system continues to develop from the auditory input received, laying a foundation for speech and language development (Sininger, Doyle, & Moore, 1999). However, when hearing loss is diagnosed in early childhood, parents are faced with learning new information and skills and must learn how to integrate new habits into their daily lives. Young children are dependent on their parents to manage hearing aid use during early years critical to their development. Consequently, parent ability to effectively integrate recommendations for managing their child's amplification in daily life is foundational for intervention success.

Best practice guidelines indicate children should be fitted with hearing aids within 1 month of diagnosis (Joint Committee on Infant Hearing [JCIH], 2007) and studies have found that

children in the United States are being fitted at younger ages; however, there is a wide variability in the age when children are first fitted with hearing aids (Holte et al., 2012; Muñoz, Blaiser, & Barwick, 2013). During the hearing aid fitting process, parents are provided with an orientation to support learning of new information and skills (American Academy of Audiology [AAA], 2013). However, practice guidelines only provide general information about how parent training and support for hearing aid use should occur, leaving ample room for significant variability in how services are provided. For example, the AAA 2013 Pediatric Amplification Guideline suggests parents be given information in a variety of formats (e.g., discussed, written, demonstrated) over several appointments, based on parental ability to perform skills. A suggested list of topics to include is provided along with the importance of recognizing that this is an ongoing process. Because of a paucity of research related to parent education and support for hearing aid management, there is a distinct lack of specific details about the process, such as challenges parents encounter and evidence-based strategies audiologists can use to help parents achieve effective hearing aid management. Given the importance of effective hearing aid use, the purpose of this study was to complete a comprehensive review of the literature related to hearing aid use during early childhood to identify areas where further research is needed.

## **Methods**

A review of the literature was completed to provide a summary of information published or presented on hearing device use for young children between 1980 and 2012. A comprehensive review can provide a map of the evidence on a topic to guide future research.

### **Procedure**

Two reviewers independently completed each stage of the literature review process. The reviewers conferred at the completion of each stage and when discrepancies occurred, the sources deemed relevant by only one of the reviewers were included in the full text review. Sources of information included journal articles and conference presentations.

For publications, the search included peer-reviewed and non-peer-reviewed articles from 1980 to June of 2012 from 12 databases (PubMed; CINAHL; PsychINFO; ERIC; Academic Search Premier; PsychARTICLES; Social Sciences Citation Index; Psychology and behavioral Science Collection; Health Source: Nursing Academic; Cochrane Library; EMBASE; ASHA Compendium of guidelines and systematic reviews). A list of key words were used to identify articles that included information about children, hearing loss, hearing aids or cochlear implants, and compliance, use, or management. Articles for full text review were identified through a title and abstract review of articles found from the search strategy. Additional relevant references were identified through a review of the reference lists for articles meeting the criteria for a full-text review. The archives for four conferences were reviewed (i.e., Early Hearing Detection and Intervention, Alexander Graham Bell, Investing in Family Support, and Phonak Sound Foundation), including conference proceedings when available from 2002 to June of 2012.

**Inclusion criteria.** The sources of information were included if they were: (a) studies, non-peer-reviewed articles, or presentations that addressed hearing device use as a component of the article or presentation (i.e. traditional hearing aids, bone conduction hearing aids, cochlear implants); (b) for children birth to 6 years of age with permanent bilateral hearing loss; (c) written in English; and (d) completed between 1980 and 2012 for published studies, and between 2002 and 2012 for presentations.

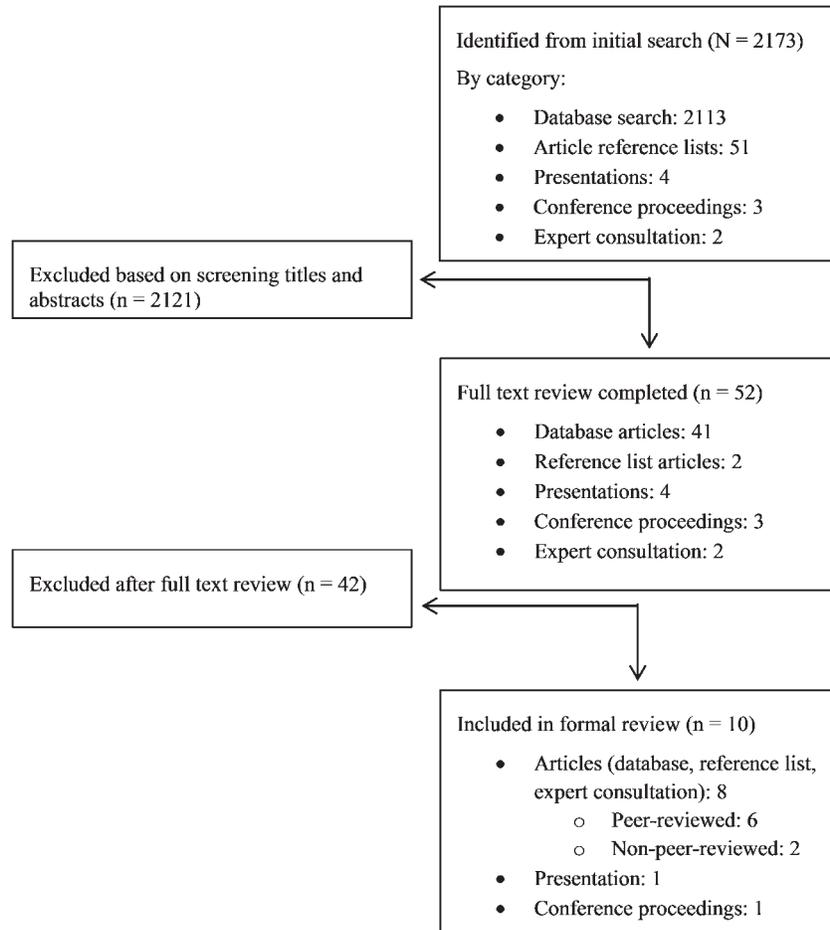
**Analysis.** Published research studies, non-peer-reviewed articles, and presentations were reviewed and relevant sources of information were included, regardless of the level of quality (e.g., randomized study, case report). A qualitative assessment was completed for all eligible material, emergent themes related to hearing aid use were synthesized, and a narrative summary was generated.

## Results

### Relevant Sources of Information

The search resulted in the identification of 8 articles (6 peer-reviewed and 2 non-peer-reviewed), 1 presentation, and 1 conference proceeding. A flow chart depicting the process for identifying the 10 resources is provided in Figure 1. All 10 of these resources addressed use of traditional air conduction hearing aids.

Figure 1. Search Flowchart



Three themes emerged from the analysis of the 10 identified sources of information on hearing aid use for young children: (1) hours of hearing aid use, (2) factors influencing hearing aid use, and (3) suggestions for improving hearing aid use (see Table 1 for a list of the sources of information). Some of the sources of information addressed more than one theme, and for many, hearing aid use represented only a small component of the topics addressed within the study, professional article, or presentation. The broader purpose is briefly described the first time each source is mentioned, followed by the findings specific to hearing aid use.

Table 1. List of Sources Included in Review

Author	Year	Theme(s) Addressed	Mechanism for Dissemination
Fitzpatrick et al.	2010	Hours of use	Publication (peer-reviewed)
Hoffman & Beauchaine	2007	Suggestions for improving use	Publication
Jones & Launer	2010	Hours of use	Conference Proceeding
Martin & Stroud	2005	Suggestions for improving use	Presentation
McCracken et al.	2008	Factors influencing use	Publication (peer-reviewed)
Moeller et al.	2009	Hours of use Factors influencing use Suggestions for improving use	Publication (peer-reviewed)
Moeller	2011	Factors influencing use Suggestions for improving use	Publication (peer-reviewed)
Muñoz et al.	2012	Hours of use	Publication (peer-reviewed)
Muñoz et al.	2013	Hours of use	Publication (peer-reviewed)
Walker et al.	2013	Hours of use Factors influencing use	Publication (peer-reviewed)

### Hours of Hearing Aid Use

From the literature review, five publications and once conference proceeding were identified that addressed hours of hearing aid use for young children (see Table 2). Four addressed hearing aid use based on parent report, one used data logging as the basis to explore hearing aid use, and one included both parent report and data logging.

Table 2. Summary of Findings for Hours of Hearing Aid Use for Children Birth to 6 Years of Age

Study	N	Age	Hearing Aid Use Determined by	Average Hours of Daily Hearing Aid Use
Fitzpatrick et al. (2010)	225	Not Specified	Parent report	N/A
Jones & Launer (2010)	5000 (0-19 yrs)	0-4 years	Data logging	5 hours
Moeller et al. (2009)	7	9-13 months (study entry)	Parent report	N/A
Muñoz et al. (2013)	110	0-62 months	Parent report	N/A
Muñoz et al. (2012)	35	0-36 months	Parent report	N/A
Walker et al. (2013)	272	5 months to 7.3 years	Data logging Parent Report	8.2 hours 10.84 hours

**Parent report of hearing aid use.** Two of the studies were parent questionnaires designed to better understand parent hearing aid experiences related to access, timeliness of services, and challenges (Muñoz, Roberts, Mullings, & Harward, 2012; Muñoz et al., 2013). One study was a prospective longitudinal study that investigated hearing aid use during the second year of life, factors that influenced use with each family, environmental aspects, challenges encountered, benefit, and adjustment to the hearing aids (Moeller, Hoover, Peterson, & Stelmachowicz, 2009). One study was a retrospective study that investigated prevalence of congenital mild bilateral or unilateral hearing loss, clinical amplification recommendations, and use for children (Fitzpatrick, Durieux-Smith, & Whittingham, 2010).

The Muñoz et al. (2012) pilot study ( $N=35$ ), investigated parent experiences of young children (0–3 years) with hearing loss in Utah using an anonymous questionnaire. Parent report of typical hearing aid use indicated 37% of children used hearing aids 10 hours or more per day, while 31% reported 6 hours or less of hearing aid use per day. This pilot study led to a national study ( $N=333$ ; Muñoz, et al., 2013) and based on parent report, hearing aid use less than all waking hours was reported by: 38% of parents of children birth to 18 months ( $n=29$ ), 43% of parents of children 19 to 36 months of age ( $n=30$ ), and 29% of parents of children 3 to 6 years of age ( $n=51$ ).

Moeller et al. (2009) conducted a prospective longitudinal study, and hearing aid use was explored using a structured interview format. The mothers of 7 infants between the ages of 9 to 13 months, at the beginning of the study, with hearing loss ranging from mild to moderately severe were interviewed three or four times (when their child was 10.5–12, 16.5, 22.5, and 28.5 months of age). Parents responded to questions related to hearing aid use across eight situations using a descriptive scale (i.e., always, frequently, occasionally, rarely, never). Findings revealed that three families achieved full-time hearing aid use by 16.5 months of age and were able to maintain consistent use; consistency of use fluctuated for two families; and use was frequent, but not full-time across most ages and situations for two families. The authors concluded that consistency of use increased over the second year of life, and some families achieved optimal use (all waking hours). The study revealed that even highly motivated and persistent parents encountered challenges.

A retrospective study completed by Fitzpatrick et al. (2010) examined the charts of children who were identified with hearing loss between the years of 1990 and 2006. From the chart review, they identified children with mild bilateral ( $n=178$ ), high frequency bilateral ( $n=31$ ), and unilateral ( $n=46$ ) hearing loss with a mean identification age of 51.1 months, 56.9 months, and 60.4 months respectively. They reported that for all of the children in their sample ( $N=255$ ), consistent hearing aid use was reported for 51.8% of the children at home, with another 23 charts indicating consistent use at school. They also found that 36.7% of the charts reported inconsistent or no hearing aid use. The ages of the children at time of reported use was not specified.

**Data logging.** One study addressed hearing aid use with data logging alone (Jones & Launer, 2010). The purpose of the study was to better understand various aspects of the fitting and use of hearing aids for children birth to 19 years of age, to learn more about how to improve the fitting process, and to learn how to enhance performance. Average hours of hearing aid use was collected from Phonak iPFG fitting files over a 9-month period from 60 different clinics in the United States ( $N=5000$  children). For children ages 0–4 years (number of children in this age range was not specified), data logging revealed average hours of hearing aid use was 5 hours per day, with 40% using their aids for 4 hours or less per day. Only 10% of the children were considered as using their hearing aids full-time (12 hours per day).

**Parent report and data logging.** One study addressed hearing aid use with parent report and data logging (Walker et al., 2013). This article included results from a longitudinal study that investigated predictors of hearing aid use, barriers to hearing aid use, and reliability of parent report of hearing aid use for children ages 5 months to 7.3 years with mild-to-severe hearing loss ( $N=272$ ). Two studies were included: In the first study, parent interviews were used to investigate

parent reported average hours of hearing aid use during the week and on weekends, and consistency of use across eight different environments (adapted from the Moeller et al., 2009 study). The second study, a sub-set of the participants in the first ( $n=133$ ), investigated hours of hearing aid use based on data logging measurements and compared data logging to parent reported hours to investigate accuracy of parent report of hearing aid use. Results related to hours of hearing aid use are reported in this section, and factors predicating hearing aid use and factors influencing hearing aid use are described in the next section.

Findings specific to hearing aid use time revealed discrepancies between parent report of hearing aid use and the average hours of daily hearing aid use collected from data logging. A correlation was found between parent report and data logging, for every 1-hour increase in use reported by the parent there was a 0.95 hour increase in data logging ( $r=.76, p < .0001$ ). It was found that 84% of parents overestimated hearing aid use time by 2.6 hours ( $SD=2.52$ ) and 16% underestimated use time when compared with the information obtained via data-logging. The differences between underestimation and overestimation ranged between 2 hours of underestimation to 10 hours of overestimation. The amount that use was over-estimated by parents decreased by .03 hours with each year increase in the child's age

### Factors Influencing Hearing Aid Use

From the literature review, four publications were identified that addressed factors influencing hearing aid use (see Table 3). From these sources, three categories of factors were identified: a) situational, b) child, and c) parent, covered to varying extents in each resource.

Table 3. Summary of Findings of Situational, Child, and Parent Factors Impacting Hearing Aid Use

Study	N	Age	Factors Influencing Hearing Aid Use
Walker et al. (2013)	272	5 months to 7.3 years	Situational (e.g., unsupervised); child state (e.g., illness); chronological age; degree of hearing loss; maternal education level
Moeller et al. (2009)	7	9-13 months	Situational (car, outdoor play, outings); child state or temperament; child age
Moeller (2011)		N/A	Factors discussed: temperament; developmental changes; attention seeking behavior; parent understanding
McCracken et al. (2008)	27	N/A	Clearly established routine; perseverance; access to written information

**Situational, child, and parent factors.** The Walker et al. (2013) study, described earlier, investigated situational, child, and parent factors that influenced hearing aid use and were reported based on age ranges (i.e., 0–2 years; 3–4 years; 5–6 years). Situational factors were found to influence hours of hearing aid use such as unsupervised situations (e.g., riding in the car). Only 35% of parents of children 0–2 years reported that their child always used hearing aids in the car, compared to 78% of parents in the other two age groups. It was found that use time improved for unsupervised situations after 12 months of age. Hearing aid use was better in supervised situations (e.g., in public places) and also increased with age with 50% of parents of 12-month-old children to 81% of school-age children reporting consistent use. Hearing aid use was also influenced by placement in a day care setting with 58% of parents of children 0–2 years reporting hearing aids are always used. Breaks in the routine were also found to influence hearing aid use (e.g., change in care provider, after bath). Parents reported greater hours of hearing aid use during the week compared to on the weekend. Other adverse situations influenced hearing aid use, such as loud events (e.g., movie theatre) and equipment issues (e.g., hearing aid feedback).

Child and parent factors found to influence hearing aid use included child state (e.g., mood, illness, fatigue, and temperament), degree of hearing loss, and maternal education. Challenges related to child state decreased with age with 39% of parents reported challenges for children ages 0–2 years, 28% for 3–4 year-olds, and 11% for school-aged children. Child state was most problematic for children 12 and 18 months of age (50 and 54%, respectively). Degree of hearing loss was found to predict hearing aid use. Children with poorer hearing thresholds were found to use hearing aids more than children with more mild degrees of hearing loss. Mothers who were college graduates had children who wore their hearing aids more consistently than mothers who had other educational backgrounds. The greatest difference was observed between mothers with a college degree and mothers with a high school diploma or less (1.9 hours).

**Situational factors.** The Moeller et al. (2009) study, described earlier, identified setting specific and activity-based issues that influenced hearing aid use. The most challenging settings identified by parents included riding in the car, outdoor play, and outings. These settings were challenging because of concern for the safety of an unsupervised child, or the possible damage to or loss of the hearing aids. Other challenges found to influence hearing aid use were transitional times (e.g., naps), child state or temperament (e.g., tantrum, illness), and activities (e.g., rolling on the floor, playing alone, dancing). Mothers reported that hearing aid use was easier in situations where the parents or caregivers could closely monitor the child and his or her hearing aids. With close supervision, consistent use was reported by 16.5 months of age. Results showed that regular use (rated as either frequent or always) in all settings was achieved by most of the families by the age of 28.5 months.

**Child and parent factors.** A commentary by Moeller (2011) discussed insights from research on language development that can guide audiological practices with young children. Specifically, three key premises were explored: developmental advantages for children and families that can be derived from early intervention, benchmarks audiologists can use to monitor outcomes, and influences from device use and access to incidental learning for language learning. Discussion specific to device use addressed issues learned from the Moeller et al. (2009) study, described earlier. Insights that emerged included recognition that adjusting to hearing aid use went well for some families and not for others. The article suggested that audiologists should shape interactions based on family and child specific characteristics. For example, child temperament (e.g., cooperative, persistent) may influence how the parent manages reseating the device when the child repeatedly unseats the device. Issues addressed also included how developmental changes can cause fluctuations in consistent use for children at different ages, as well as cognitive discoveries, increased independence/mobility, intentional seeking of attention, and curiosity combined with increased fine motor skills. These can all result in increased challenges for maintaining consistent use, especially for children within the age range of 12 to 16 months of age. Regarding parent factors, Moeller (2011) also found that the parents' knowledge and understanding of the impact of their child's hearing loss and the importance of their child's amplification affected consistent use.

**Parent factors.** A qualitative study by McCracken, Young, and Tattersall (2008) investigated parent experiences with screening and early audiological management. Parents of children with bilateral hearing loss of a moderate degree or worse were interviewed ( $N=27$ ) using an open-ended format without pre-determined questions. Parent responses related to hearing aid use included issues about the importance of having a clearly established routine with their child to facilitate consistent hearing aid use, while other parents suggested that perseverance was key in achieving consistent use. Additionally, parents reported receiving conflicting information from different professionals with regards to consistent use, which left parents confused and frustrated. Parents found having written information on retention of hearing aids to be helpful and felt having written information on other topics (e.g., managing transition times) from professionals would also be helpful.

## **Suggestions for Improving Hearing Aid Use**

From the literature review, three publications and one presentation were identified that contained suggestions for improving consistency of hearing aid use. Information provided was based on parent reported strategies and advice from professionals.

**Parent reported strategies.** Moeller et al. (2009), described earlier, asked parents what strategies they used to improve hearing aid use time. For one family, their child removed his aids to get attention and suggestions provided included acting neutrally when he removed them, and reinserting his hearing aids after a few minutes. Other parents suggested hearing aid retention devices (i.e., critter clips, bonnets, toupee tape). These devices were reported to be especially helpful between the ages of 12 to 16 months. In addition, parents reported that commitment was important in achieving consistent use.

A presentation by Martin, Stroud, and Nicholson (2005) discussed responses from a parent survey ( $N=28$ ) that explored technical issues, social emotional concerns, parent advice to other parents, and how information from the study shaped their practice. Parent responses regarding hearing aid use indicated the need for parents to be determined to achieve consistent use so the child becomes accustomed to using the hearing aids. Additional advice included aspects of emotional support (e.g., finding someone to talk to, perseverance) and aspects related to care and use (e.g., wear hearing aids all the time). From this study, the researchers indicated they learned parents of younger children had different needs than parents of older children including the need for more reassurance and information.

**Advice from professionals.** Hoffman & Beauchaine (2007) provided an overview of steps for effective intervention, including having a partnership with the medical home, appropriately fitted amplification, and parent orientation to the hearing aids. Information specific to hearing aid use addressed the importance of not only providing information to parents regarding the proper care and benefit of amplification, but also including demonstrations for device maintenance and performing listening checks. The importance of providing written information was also emphasized.

The Moeller (2011) article, described earlier, recommended audiologists need to anticipate that barriers for consistent use will change over time due to child development, and audiologists need to be aware of typical age-specific barriers. The author indicated that by being aware of these challenges, audiologists can help prepare parents and help brainstorm with parents when challenges arise.

## **Discussion**

Early identification of hearing loss provides an opportunity for intervention to begin within the first few months of life. For spoken language development, experience with auditory input through early access to amplification is an essential component of the intervention process. In addition to the critical technical components of amplification selection and fitting to achieve appropriate programming for audibility (AAA, 2013), consistent use of hearing aids is needed. This literature review focused on research that addressed hearing aid use for young children, and found a scarcity of evidence-based information on this topic. From the available research there is information related to hours of hearing aid use, factors affecting hearing aid use, and suggestions from both parents and professionals about increasing hearing aid use.

### **Hearing Aid Use**

The four studies that addressed hours of hearing aid use found variability in how often young children were wearing their hearing aids. For three of these studies, hearing aid use was based on parent report and most parents reported children typically were not wearing their hearing aids during all waking hours. This is a concern because consistent auditory input is a foundational component for development of spoken language. In addition, Walker et al. (2013) found that parents of young children frequently over-estimated hearing aid use. This may

suggest hearing aid use may have been less in studies that used parent report data to determine consistency of use.

There is no evidence that provides specific recommendations for how many hours of use is adequate; however, we know that children with hearing loss, regardless of the degree, are at risk for developmental consequences as a result of their hearing loss. Therefore, use of hearing aids during most waking hours is a recommendation that is more likely to result in benefits for children with hearing loss. Further research is needed to better understand the link between hearing aid use and communication milestones. Even though data logging has shed light on the issue of hearing aid use and is an important objective measure for monitoring hearing aid use, problems such as a malfunctioning hearing aid or a dead battery can also contribute to lower hours of use that would not accurately reflect how much the child wore their hearing aids. Further research is needed to explore the factors that interfere with children's ability to access appropriately amplified speech.

None of the studies that reported hearing aid use data included information about the quality of the hearing aid fitting or the impact it had on hearing aid use. Even if hearing aids are worn full time, benefit will be compromised if the auditory input is not appropriately verified to ensure prescribed targets are achieved (e.g., Desired Sensation Level [DSL]; Bagatto et al., 2005). It should not be assumed that hearing aid settings are being appropriately verified. For example, a recent study (McCreery, Bentler, & Roush, 2013) that is part of the larger longitudinal study reported by Walker et al. (2013) found that over half of the children were wearing hearing aids with programmed settings that were greater or less than the prescribed targets by 5 dB, and that this was not correlated with degree of hearing loss. This is an important consideration as a child may be reluctant to wear a hearing aid that is either under- or over-amplifying.

### **Factors**

Four studies discussed factors affecting hearing aid use, including situational, child, and parent factors, as well as factors that predicted hearing aid use. Factors predictive of hearing aid use identified by Walker et al. (2013) could be considered fixed, to a certain extent (i.e., degree of hearing loss, socio-economic status, maternal education), raising red flags for children that may be at greater risk for sub-optimal use. Other factors parents experienced with hearing aid use (e.g., Moeller et al., 2009; Walker et al., 2013) may be responsive to strategies to manage related challenges (e.g., child behavior, activities). However, currently there are no studies that provide information about effective strategies and/or counseling approaches that result in increased hearing aid use as determined by an objective measure (i.e., data logging).

Additionally, there are no studies that address hearing aid use for children with multiple disabilities. Given that approximately 40% of children in programs for children who are deaf and hard of hearing also have other disabilities (Gallaudet Research Institute, 2003a, 2003b), a better understanding of factors specific to this population is needed. Furthermore, studies to date have not included diverse populations; therefore, factors that may be influenced by cultural or linguistic differences have not been explored.

### **Suggestions From Parents and Professionals**

Four publications provided suggestions about addressing hearing aid use; however, this information is primarily anecdotal in nature. Evidence for actual improvement in hearing aid use based on these suggestions is lacking. The important role of parent-to-parent support in coping with the challenges of hearing aid management, both by giving and receiving advice, was revealed (e.g., Martin, Stroud, & Nicholson, 2005). However, while, professional guidelines indicate the importance of hearing aid use and offering parent-to-parent support (American Academy of Audiology, 2013), no specific guidance is provided to audiologists in how that may be achieved due to lack of research on these topics.

## Conclusion

Children need to wear their hearing aids consistently, during all waking hours, to support age-appropriate development of speech and language skills. This comprehensive literature review found a paucity of research on hearing aid use for young children. Based on this literature review, there is a need for research in the following areas:

- Challenges parents of infants experience with daily management
- Parent perceptions, concerns, and beliefs about their children's hearing needs
- Audiology practices related to hearing aid orientation and parent support
- Factors that impact hearing aid use as determined by data logging results
- Effective strategies to increase hearing aid use
- Relationship between quality of hearing aid fitting and hearing aid use
- Factors influencing hearing aid use in children with multiple disabilities
- Factors influencing hearing use for culturally diverse populations
- Effective strategies for collaboration among professionals and parents

Further research on hearing aid use has the potential to influence how audiologists support parents in achieving consistent hearing aid use for their young children with hearing loss, ultimately improving child outcomes.

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