

Date published/posted: August 20, 2009

Audiologic management for children with permanent unilateral sensorineural hearing loss

Clinical Question

- Population/Problem:** In school-age children with either severe to profound unilateral sensorineural hearing loss (SNHL) or mild to moderately severe unilateral SNHL
- Intervention:** does amplification (i.e. digital hearing aid (HA), Frequency Modulation (FM) system, contralateral routing of signal (CROS) link aid, etc)
- Comparison:** compared to no amplification
- Outcome:** improve educational or functional performance?

Target Population

Inclusion: School-age children with any degree of unilateral SNHL

Exclusion: Children with conductive hearing loss

Recommendations

In all children with unilateral SNHL:

1. It is recommended managing providers discuss the potential impact of unilateral hearing loss (UHL) with the child and family to help them understand potential gains, realistic goals, costs, and physical requirements of amplification so they can make an educated decision regarding interventions (*Kenworthy 1990 [3b], McKay 2002 [4b], Updike 1994 [4b], Local Consensus [5]*). See Appendix 1: Tips for Children with Unilateral Hearing Loss.
Note 1: Be cognizant of cost, which can be an issue in providing a HA or FM system. Most insurance companies do not cover HAs or other amplification devices, nor do they pay for FM systems as covered benefits and many schools do not uniformly provide FM systems for children with UHL (*Local Consensus [5]*). The Bureau with Medical Handicaps covers hearing aids for UHL so if families qualify for Ohio's Bureau of Children with Medical Handicaps (Title V funding), this program will provide coverage for hearing aids for unilateral hearing loss (*Local Consensus [5]*).
Note 2: Cincinnati Children's Hospital Medical Center (CCHMC) Division of Audiology has a loaner bank for hearing aids and FM systems. Families can borrow a hearing aid or FM system for a period of time (*McKay 2005 [5b]*). The Ohio School for the Deaf has an FM loaner bank for school use. This is directly accessed by schools and the equipment can be borrowed for a 3 month period. These systems can provide an opportunity to have a trial period of amplification/FM system prior to paying for the technology outright (*Local Consensus [5]*).
2. It is recommended, whether or not amplification is provided, that the child and care team (family, health care professionals, clinicians and school personnel) consider monitoring the impact on functional, educational, and behavioral performance as well as academic performance and behavior (family selected outcomes) in the classroom to guide care decisions (*Lieu 2004 [1a], McKay 2008 [5], Local Consensus [5], McKay 2005 [5b]*).

In children with severe to profound unilateral SNHL:

3. It is recommended that school-aged children with severe to profound unilateral sensorineural hearing loss (USNHL) be fit with an FM system as the first line of amplification technology (*Kenworthy 1990 [3b], Updike 1994 [4b]*). Select an FM system with the most open fit to decrease occlusion in the good ear (*Kopun 1992 [4b]*).

4. It is recommended that provision of a HA in children with severe-profound UHL be on a case-by-case basis (*Kiese-Himmel 2002 [4b], McKay 2002 [4b]*).

Note 1: Evaluating speech discrimination and speech in noise can provide additional information to guide decision-making (*Updike 1994 [4b], McKay 2005 [5b]*).

Note 2: If a child has not had success with other amplification interventions, the CROS hearing aid may be considered, though its use has not been wide-spread (*Kenworthy 1990 [3b], Shapiro 1977 [4b]*).

Mild to Moderate Sensorineural UHL:

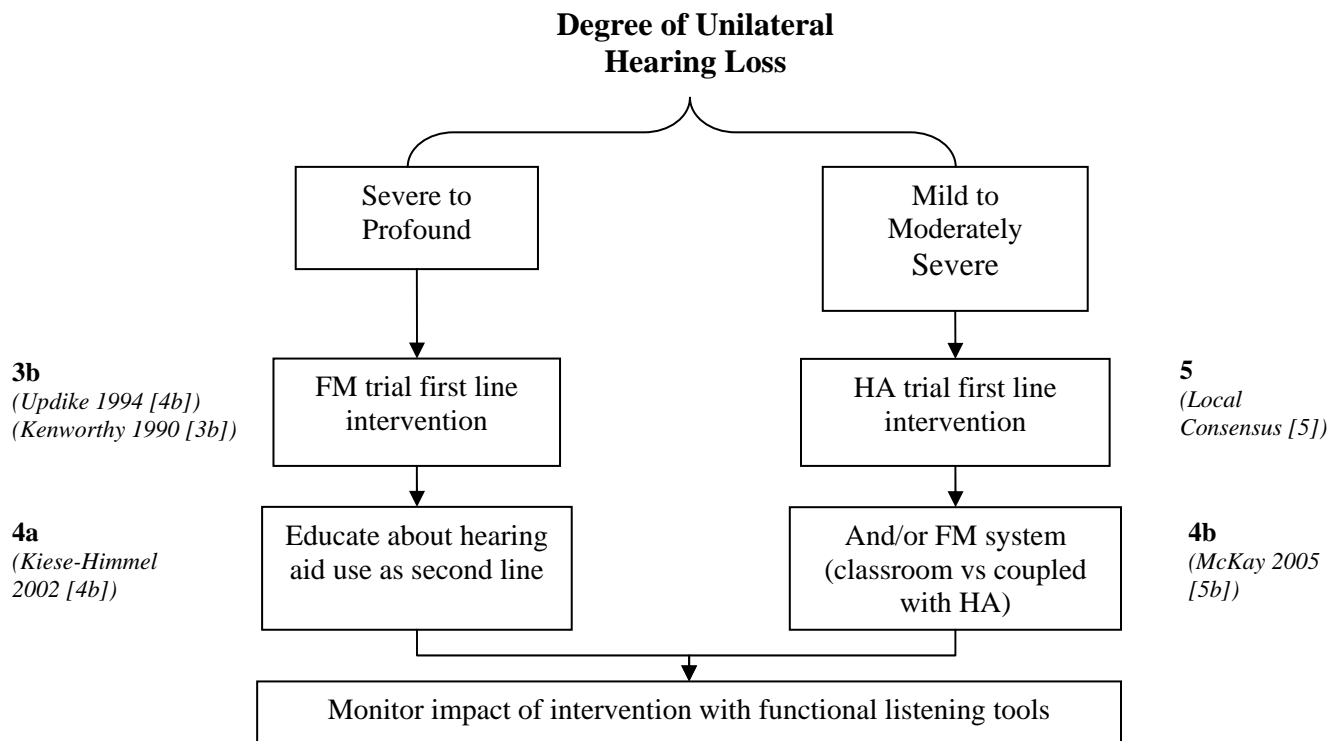
5. It is recommended that children with mild to moderate sensorineural UHL be fit with a hearing aid (FM ready) as the first line intervention (*Kenworthy 1990 [3b], McKay 2002 [4b], Shapiro 1977 [4b], McKay 2005 [5b]*).

Note 1: There may be theoretical harm in noise-induced hearing loss with amplification in the fitting and monitoring of a HA (*McKay 2008 [5]*).

Note 2: A non-FM ready smaller HA might be appropriate for a child who does not want a visible HA (*McKay 2008 [5]*).

6. It is recommended provision of an FM system with or without a hearing aid be discussed with the family (*McKay 2002 [4b], Local Consensus [5]*).

Note: A theoretical risk of an FM system is the loss of access to incidental information and learning. An FM system is most appropriate for use in an educational setting (*Lieu 2004 [1a]*).



FM = frequency modulation system; HA = hearing aid

Discussion/summary of evidence

The quality of the body of evidence regarding school age children with unilateral hearing loss is moderate and limited in guiding interventions and evaluating performance because of the small number of studies, the sample sizes within those studies and the varying amplification systems. See Appendix 2. None of the studies evaluated the impact of amplification on educational or functional outcomes. Therefore, recommendations are based primarily on local clinicians who have come to consensus, but also limited studies describing difficulties children with unilateral hearing loss experience, studies which use clinical settings simulating real life situations such as classrooms with background noise, and survey results from families of patients who have accepted amplification and noted changes in day to day


functioning. It is important to monitor both the effectiveness and potential problems associated with children who choose amplification and children who do not decide to pursue amplification and/or FM systems (Lieu 2004 [1a], Palmer 2005 [1b], Kenworthy 1990 [3b], Kiese-Himmel 2002 [4b], McKay 2002 [4b], Updike 1994 [4b], Kopun 1992 [4b], Shapiro 1977 [4b], Local Consensus [5], McKay 2005 [5b]).

Health Benefits, Side Effects and Risks

The primary risk of amplification is in the potential for over-amplification and subsequent damage to existing hair cell function, causing a progression of hearing loss. Basing amplification decisions on behavioral audiometry, having a child who is cooperative and results that are of high reliability will decrease the likelihood of over amplification. Current hearing aid technologies are equipped with loudness controls which help prevent over amplification (McKay 2008 [5]).

Negative effects of amplification and/or FM systems include time and effort to manage the hearing devices, cost to the family and potential embarrassment for the child by having attention drawn to their disability. Some children are bothered by wearing a device that makes them look different and therefore may not “buy in” to consistently wearing the amplification device. When using an FM system, although the child can hear what the person using the microphone is saying more clearly, discussion and incidental information from those not using the microphone may be missed, misunderstood or misheard (Kopun 1992 [4b], Stein 1983 [4b]).

References/citations (evidence grade in []; see Table of Evidence Levels following references)

Note: When using the electronic version of this document,  indicates a hyperlink to the PubMed abstract. A hyperlink following this symbol goes to the article PDF when the user is within the CCHMC network.

1. **Bess, F. H.; Dodd-Murphy, J.; and Parker, R. A.:** Children with minimal sensorineural hearing loss: prevalence, educational performance, and functional status. *Ear & Hearing*, 19(5): 339-54, 1998, [4a] [_____](#) .
2. **Bess, F. H., and Tharpe, A. M.:** Unilateral hearing impairment in children. *Pediatrics*, 74(2): 206-16, 1984, [4b] [_____](#) .
3. **Bess, F. H.; Tharpe, A. M.; and Gibler, A. M.:** Auditory performance of children with unilateral sensorineural hearing loss. *Ear Hear*, 7(1): 20-6, 1986, [4b] [_____](#)  [_____](#).
4. **Bovo, R.; Martini, A.; Agnoletto, M.; Beghi, A.; Carmignoto, D.; Milani, M.; and Zangaglia, A. M.:** Auditory and academic performance of children with unilateral hearing loss. *Scand Audiol Suppl*, 30: 71-4, 1988, [4a] [_____](#)  [_____](#).
5. **CDC:** Annual Early Hearing Detection & Intervention (EHDI) Program Data, 2006. Accessed Mar 2, 2009 from [_____](#) and [_____](#)  [5].
6. **Culbertson, J. L., and Gilbert, L. E.:** Children with unilateral sensorineural hearing loss: cognitive, academic, and social development. *Ear Hear*, 7(1): 38-42, 1986, [4b] [_____](#)  [_____](#).
7. **English, K., and Church, G.:** Unilateral Hearing Loss in Children: An Update for the 1990s. *Lang Speech Hear Serv Sch* 30(1): 26-30, 1999, [4a] [_____](#)  [_____](#).
8. **Flexer, C.; Richards, C.; Buie, C.; and Brandy, W.:** Making the grade with amplification in classrooms. *Hearing Instruments*, 45: 24-26, 1994, [3b]  [_____](#).
9. **Hartvig Jensen, J.; Johansen, P. A.; and Borre, S.:** Unilateral sensorineural hearing loss in children and auditory performance with respect to right/left ear differences. *British Journal of Audiology*, 23(3): 207-13, 1989, [4b]  [_____](#).
10. **Keller, W. D., and Bundy, R. S.:** Effects of unilateral hearing loss upon educational achievement. *Child Care Health Dev*, 6(2): 93-100, 1980, [4a] [_____](#)  [_____](#).
11. **Kenworthy, O. T.; Klee, T.; and Tharpe, A. M.:** Speech recognition ability of children with unilateral sensorineural hearing loss as a function of amplification, speech stimuli and listening condition. *Ear Hear*, 11(4): 264-70, 1990, [3b] [_____](#)  [_____](#).
12. **Kiese-Himmel, C.:** Unilateral sensorineural hearing impairment in childhood: analysis of 31 consecutive cases. *Int J Audiol*, 41(1): 57-63, 2002, [4b] [_____](#)  [_____](#).
13. **Kopun, J. G.; Stelmachowicz, P. G.; Carney, E.; and Schulte, L.:** Coupling of FM systems to individuals with unilateral hearing loss. *J Speech Hear Res*, 35(1): 201-7, 1992, [4b] [_____](#) .
14. **Lieu, J. E.:** Speech-language and educational consequences of unilateral hearing loss in children. *Arch Otolaryngol Head Neck Surg*, 130(5): 524-30, 2004, [1a] [_____](#)  [_____](#).
15. **Local Consensus:** During BESt development timeframe. [5] .
16. **McKay, S.:** To Aid or Not to Aid: Children with Unilateral Hearing Loss. _____ 2002, [4b] [_____](#)  [_____](#).

17. **McKay, S.; Gravel, J. S.; and Tharpe, A. M.:** Amplification considerations for children with minimal or mild bilateral hearing loss and unilateral hearing loss. *Trends Amplif*, 12(1): 43-54, 2008, [5] _____
18. **McKay, S., and Iyer, A.:** Management guidelines for children with unilateral hearing loss. *ASHA Leader*, 10(7): 4, 2005, [5b] _____
19. **Neary, W.; Kent, S.; Yeong, C. C.; and Coyne, L.:** The role of audiological testing and computed tomography in the aetiological investigation of children with permanent unilateral hearing loss. *Audiological Medicine*, 1(4): 215-223, 2003, [4b] _____
20. **Niedzielski, A.; Humeniuk, E.; Blaziak, P.; and Gwizda, G.:** Intellectual efficiency of children with unilateral hearing loss. *Int J Pediatr Otorhinolaryngol*, 70(9): 1529-32, 2006, [4b] _____
21. **Niskar, A. S.; Kieszak, S. M.; Holmes, A.; Esteban, E.; Rubin, C.; and Brody, D. J.:** Prevalence of hearing loss among children 6 to 19 years of age: the Third National Health and Nutrition Examination Survey.[see comment]. *JAMA*, 279(14): 1071-5, 1998, [4a] _____
22. **Nober, L. W., and Nober, E. H.:** Auditory Discrimination of Learning Disabled Children in Quiet and Classroom Noise. *Journal of Learning Disabilities*, 8(10), 1975, [2b] _____
23. **Oyler, R. F.; Oyler, A. L.; and Matkin, N. D.:** Unilateral hearing loss: demographics and educational impact. *Language Speech & Hearing Services in the Schools*, 19(2): 201-210, 1988, [4a] _____
24. **Palmer, C. V., and Grimes, A. M.:** Effectiveness of signal processing strategies for the pediatric population: a systematic review of the evidence. *J Am Acad Audiol*, 16(7): 505-14, 2005, [1b] _____
25. **Pipp-Siegel, S.; Sedey, A. L.; and Yoshinaga-Itano, C.:** Predictors of parental stress in mothers of young children with hearing loss. *J Deaf Stud Deaf Educ*, 7(1): 1-17, 2002, [4a] _____
26. **Schmithorst, V. J.; Holland, S. K.; Ret, J.; Duggins, A.; Arjmand, E.; and Greinwald, J.:** Cortical reorganization in children with unilateral sensorineural hearing loss. *National Institutes of Health Public Access Author Manuscript*, 16(5): 463-467, 2005, [3b] _____
27. **Shapiro, I.:** Children's use of CROS hearing aids. *Arch Otolaryngol*, 103(12): 712-6, 1977, [4b] _____
28. **Stein, D. M.:** Psychosocial characteristics of school-age children with unilateral hearing loss. *Journal of the Academy of Rehabilitative Audiology*, 6: 12-22, 1983, [4b] _____
29. **Tharpe, A. M.:** Unilateral and mild bilateral hearing loss in children: past and current perspectives. *Trends in Amplification*, 12(1): 7-15, 2008, [5] _____
30. **Urdike, C. D.:** Comparison of FM auditory trainers, CROS aids, and personal amplification in unilaterally hearing impaired children. *J Am Acad Audiol*, 5(3): 204-9, 1994, [4b] _____
31. **Vartiainen, E., and Karjalainen, S.:** Prevalence and etiology of unilateral sensorineural hearing impairment in a Finnish childhood population. *Int J Pediatr Otorhinolaryngol*, 43(3): 253-9, 1998, [4b] _____
32. **Yoshinaga-Itano, C., and Thomson, V.:** The work of the Village: creating a new world for children with hearing loss and their families. *International Journal of Audiology*, 47 Suppl 1: S14-22, 2008, [5] _____

Note: Full tables of evidence grading system available in separate document:

- [Table of Evidence Levels of Individual Studies by Domain, Study Design, & Quality](#) (abbreviated table below)
- [Grading a Body of Evidence to Answer a Clinical Question](#)
- [Judging the Strength of a Recommendation](#) (abbreviated table below)

Table of Evidence Levels (see note above)

<i>Quality level</i>	<i>Definition</i>
1a† or 1b†	Systematic review, meta-analysis, or meta-synthesis of multiple studies
2a or 2b	Best study design for domain
3a or 3b	Fair study design for domain
4a or 4b	Weak study design for domain
5	Other: General review, expert opinion, case report, consensus report, or guideline

†a = good quality study; b = lesser quality study

Table of Recommendation Strength (see note above)

Strength	Definition
“Strongly recommended”	There is consensus that benefits clearly outweigh risks and burdens (or visa-versa for negative recommendations).
“Recommended”	There is consensus that benefits are closely balanced with risks and burdens.
No recommendation made	There is lack of consensus to direct development of a recommendation.

Dimensions: In determining the strength of a recommendation, the development group makes a considered judgment in a consensus process that incorporates critically appraised evidence, clinical experience, and other dimensions as listed below.

1. Grade of the Body of Evidence (see note above)
2. Safety / Harm
3. Health benefit to patient (*direct benefit*)
4. Burden to patient of adherence to recommendation (*cost, hassle, discomfort, pain, motivation, ability to adhere, time*)
5. Cost-effectiveness to healthcare system (*balance of cost / savings of resources, staff time, and supplies based on published studies or onsite analysis*)
6. Directness (*the extent to which the body of evidence directly answers the clinical question [population/problem, intervention, comparison, outcome]*)
7. Impact on morbidity/mortality or quality of life

Supporting information

Introductory/background information

The prevalence of unilateral permanent hearing loss in school age children ranges from 0.3-5.6% (Bess 1998 [4a], Niskar 1998 [4a]). A population study in UK indicated a prevalence of USNHL ≥ 40 decibels (dB) of 9 per 10,000 population (Neary 2003 [4b]), while in Finland, a rate of 1.2 per 1000 population in the 1980's was reported by Vartiainen (Vartiainen 1998 [4b]). See Table 1.

Table 1: Prevalence Studies (Bess 1998 [4a], Niskar 1998 [4a], Neary 2003 [4b], Vartiainen 1998 [4b], Bess 1984 [4b])

Study	Prevalence Rate (per 1000 population)
(Bess 1984 [4b])	3 (> 45 dB) 13 (including milder forms of HL)
(Vartiainen 1998 [4b])	1.2
(Neary 2003 [4b])	0.9 (≥ 40 dB) 1.15 (including milder forms of HL)
(Bess 1998 [4a], Niskar 1998 [4a]) (school age)	3 to 5.6

dB = decibels, HL = hearing loss

In a survey of educational audiologists (English 1999 [4a]), there was a slight predominance for left-sided hearing loss (53% left vs 47% right), however, the population cohort from UK had a slight predominance for right-sided hearing loss (54% right vs 46% left) (Neary 2003 [4b]). In the educational survey, the degrees of hearing loss were as follows: 18% mild, 17% moderate, 22% moderate to severe, 12% severe, and 29% profound. Additionally, there were co-existing conditions in a subset of children, including 13% with learning disorders, 4% with mental retardation, 3% with significant vision impairment, 2% with attention deficit hyperactivity disorder (ADHD), and 0.2% with autism.

Summary statistics from the Directors of Speech and Hearing Programs in State Health and Welfare Agencies survey from 2006 indicated 22.4% (1147/5127) of children identified with Hearing Loss through State Early Hearing Detection and Intervention programs had UHL. Among the 665 with sensorineural UHL, 22% had mild UHL, 30.5% had moderate UHL, 23% had severe UHL, 22% had profound UHL, and 2.5% had an unknown degree of UHL (CDC 2006 [5]).

There are a number of reasons children with USNHL may be at a disadvantage in a classroom setting. A child may have difficulty hearing or understanding speech when the speaker is on the side of the child's poor hearing ear (monaural indirect condition), particularly when the good ear is near competing speech or noise. Even in quiet environments, when hearing with two normal ears, word recognition scores are almost 20% better than if only hearing with one ear (*Lieu 2004 [1a]*). This concept is described as binaural summation. This phenomenon is also enhanced by the squelch effect, whereby two ears can suppress background noise to allow the listener to hear the primary signal or information (*Keller 1980 [4a]*).

Children with UHL have difficulty localizing sound. Since the ears are on opposite sides of the head, the distance from the sound source to each ear helps the listener figure out where the sound originated. This is due to the head-shadow effect.

Many classroom settings can be quite noisy. In fact, Nober and Nober (*Nober 1975 [2b]*) reported the average intensity of 4 elementary classrooms at 65 dB. This is important if the loudness of the speaker's voice does not supercede the noise level in the classroom. The signal-to-noise ratio is a way to describe the relative differences between the speaker's volume and the background noise volume. In general, children with mild SNHL require at least 20 to 30 dB advantage of the speaker over the background noise (or a signal to noise ratio of +20 or +30 dB). Noise in the classroom can also reverberate off the walls. This further impacts the listening environment for children who are struggling auditorally to listen to instructions and teaching.

These factors have been shown to be important in studies comparing children with USNHL to hearing children. The children with USNHL had poorer performance in localizing sounds and speech recognition in noisy conditions (*Bess 1986 [4b]*). These findings also were noted to be worse as the degree of hearing loss increased. Children who had failed a grade had more difficulties understanding speech that was presented directly in front of them as compared to children with USNHL who did not fail a grade.

Children with USNHL have not been found to differ from hearing peers in cognitive measures (*Culbertson 1986 [4b]*) and speech/language measures (*Stein 1983 [4b]*). However, school age children with USNHL have shown a higher rate of difficulties with school performance, with grade retention ranging from 22-36% and requiring special assistance from 12-41% (*Pipp-Siegel 2002 [4a]*, *Bovo 1988 [4a]*, *Oyler 1988 [4a]*, *Bess 1984 [4b]*). Subtle differences in cognitive subtests on IQ measures have been identified in children with UHL (*Niedzielski 2006 [4b]*). Children with right sided unilateral sensorineural hearing loss may be more likely to have academic difficulties (*Oyler 1988 [4a]*, *Hartvig Jensen 1989 [4b]*, *Bess 1984 [4b]*). Bess et. al. 1986 found academic difficulties associated with children having UHL (*Bess 1986 [4b]*). See Table 2.

Table 2: Academic Difficulties (*Pipp-Siegel 2002 [4a]*, *Bovo 1988 [4a]*, *Oyler 1988 [4a]*, *Bess 1986 [4b]*)

Study	Grade retention	Additional Resource Supports
Bess and Tharpe 1986	35%	13%
Bovo 1988	22%	12%
Oyler 1988	24%	41%
Pipp-Siegel 2002	Not reported	36%

Unilateral hearing loss can be associated with structural problems with the ear, syndromes, and congenital cytomegalovirus (CMV). Therefore, children with unilateral hearing loss warrant etiologic work-ups and medical care similar to that among children with bilateral hearing loss (*Lieu 2004 [1a]*).

Prior to universal newborn hearing screening (UNHS), children with unilateral hearing loss were identified at school age. The literature primarily focuses on this group of children. With the implementation of UNHS, the age of identification of unilateral hearing loss may decrease for many children. However there is no evidence regarding the management of unilateral hearing loss in the very young child. Based on data from Colorado's early intervention (*Yoshinaga-Itano 2008 [5]*) and the findings of functional MRI (fMRI) data on cortical reorganization on side of hearing loss (*Schmithorst 2005 [3b]*) this will be an important area for clinical research.

Appendix 1: Tips for Children with Unilateral Hearing Loss

What is unilateral hearing loss (UHL)?

Your child has been diagnosed with a unilateral hearing loss. UHL means there is a normal hearing loss in one ear and a hearing loss in the other. It can range from mild to total hearing loss. Hearing loss affects everyone differently. Here is some information to help you understand more about UHL and tips on how you can help your child listen better.

What are some common side effects of UHL?

- Having trouble figuring out where a sound is coming from
- Difficulty hearing the soft sounds of speech and language
- Some children may be a little slow to meet some speech and language milestones on time
- Not understanding what people are saying when you are in noisy places
- Unable to pay attention for a long period of time, trouble keeping focused, because they have to work harder to listen
- Having a hard time following directions that include more than one piece of information
- May become tired more easily (from listening with only one normal hearing ear)
- May develop subtle speech, language, or learning difficulties

How can I help develop my child's speech and language?

Here are some things you can do to help your child develop his speech and language skills

- Go down to child's level, get the child's attention, make eye contact, and follow child's eyes
- Position yourself near the good ear and speak clearly
- Keep background noise down to a minimum (turn down the TV, radio, etc)
- Talk about what is happening now, the activities that the child is engaged in, and daily routines
- Talk about what you are doing (e.g. "I am washing the table, so we can eat lunch.")
- Imitate and expand your child's statements by a word or a phrase to help build language skills (e.g. child, "milk" then parent, "More milk? Here is more milk.")
- When giving the child a direction, speak a little slower and pause between the parts of the direction (e.g. "Please find your shoes...then get your coat.")
- Ask the child to repeat what you have said to check that all of the direction was understood (e.g. "What do you need to do after you find your shoes?")
- To encourage vocabulary growth, talk about and describe objects and actions in different ways and provide a lot of experiences with books (e.g. child, "pretty flower." Parent, "Yes that is a pretty flower. That flower is a daisy.")
- Observe your child's reactions to know if information is understood, especially in noisy environments. Ask questions to make sure your child understood
- Help your child turn the good ear to the speaker or stand close to others so that peers can be heard during play.
- Have your child's speech and language development checked on a regular basis as recommended or if there are concerns.

How can I develop my child's listening skills?

Here are some things you can do to help your child develop his listening skills:

- Position yourself in front of your child's face – to teach use of visual cues at an early age.
- Have your child look at the person who is speaking to him.
- Place your infant/child's car seat in a position that makes the speaker's voice closest to the better hearing ear – if you are the passenger, sit in the back seat next to your child, while still following car seat regulations
- Have your child look at the person who is speaking to him.
- Limit the amount of background noise and visual distractions (e.g., turn off the TV, radio)
- Read books and talk on the side of the better hearing ear.
- Teach your child to find the best spots to listen and learn!
- Educate caregivers/teachers about the degree of hearing loss and what they can do to better help your child listen and learn.

Here are some things you can do to help make a better listening environment for your child:

- Become aware of the noises that are in your child's environment and limit the amount of background noise. Some common noise sources are: TVs, radios, open windows, fans, dishwashers, microwave, running water and a hair dryer.
- Evaluate the listening environment and make any changes that would most benefit your infant/child. Some examples are:
 - **restaurant** – ask for a seat away from the kitchen door – place the infant/child w/ better hearing ear towards the primary speaker -if possible, have your child's back to the wall and ensure good lighting
 - **auditorium or large room** – have your child sit near the middle, at the front of the room (good visual position) and away from other sound sources
 - **classroom** – ask that tennis balls placed on feet of desks/chairs, add area rugs or curtains to absorb sound. Identify competing sound sources (air conditioner, fans, pencil sharpeners, computer terminals, etc) and make sure child is not seated near them.
- Openly talk about where you are placing your child so the child learns how to make these decisions for himself. (e.g. "Let's think about the best place to sit in the restaurant" or "That radio is too loud. Let's turn it off so we can talk.")
- Use earplugs to protect against loud sounds (fireworks, lawnmowers, music, etc).

Check with the Ears, Nose, Throat doctor (ENT, or otolaryngologist) and/or audiologist

- When you feel additional support is needed, like amplification (hearing aids) or FM devices.
- To have your infant/child's hearing tested more frequently to watch for possible changes.
- Whenever your child has an ear infection.

Appendix 2: Summary of Evidence

Study Citation	Study Type/ Design	N	Setting	Patients	Intervention	Comparison	Outcomes
<i>(Kenworthy 1990 [3b])</i>	Prospective cohort Repeated measures design with self as control	6	Simulated sound in regular classroom	8 to 12 year olds with 56 to 120 dB UHL	No amplification vs FM system vs CROS aid	Self as own control Speech recognition in monaural indirect, monaural direct, mid-line signal/omni-directional noise	5 of 6 children <ul style="list-style-type: none"> severe to profound UHL showed significant gains in speech recognition scores with FM system likely to be academically unsuccessful 6 th child <ul style="list-style-type: none"> milder UHL better able to cope under adverse listening conditions generalization of conclusion is limited
<i>(Updike 1994 [4b])</i>	Prospective cohort self as own control	6	Regular classroom	Children with mild to profound UHL 5 to 12 year olds Equal distribution of side of HL	FM vs CROS aid vs HA	Self as own control Listening in quiet environments & those with background noise +6dB S/N ratio	<ul style="list-style-type: none"> All experienced significant difficulty with word recognition in typical classroom environment. With FM showed improved word recognition in background noise environment compared to CROS aid and HA which offered no improvement, actually showed detrimental effect.
<i>(Flexer 1994 [3b])</i>	Prospective Cohort	282	12 regular classrooms (6 regular Kindergarten and 6 regular first grade)	None of the students were diagnosed with hearing impairment	FM sound field amplification systems – high fidelity public address self-contained wireless systems contained in single classroom 13 question parent questionnaire	3 classrooms of each grade were amplified 3 kindergarten classrooms amplified compared to 3 non-amplified and 3 first grade classrooms amplified compared to 3 non-amplified classrooms	<ul style="list-style-type: none"> Based on questionnaire – 75% of 93 of the 282 children reported having had 6 or more ear infections, leaving them with fluid in their middle ear placing them at significant risk for academic failure 25% of the entire 282 had extensive & continuous history of ear & hearing problems 25% to 33% of the typical kindergartener or first grader were not hearing clearly word sound distinctions <ul style="list-style-type: none"> 33% failed the fall screening 36% failed the 1st winter screening 34% failed the 2nd winter screening 27% failed the spring screening
<i>(Kopun 1992 [4b])</i>	Prospective cohort study	15	Experiment conditions	5 to 13 year olds with UHL (degree of HL not defined)	Effects of various occlusions by FM system	Calculation of attenuation characteristics of delivery systems	<ul style="list-style-type: none"> Occlude \leq 30% of the ear canal. Best fit for FM system - most open fit. Tube fitting - only option that is non-occlusive. Lightweight headphones produce \leq 5dB of attenuation through 4000Hz.
<i>(Shapiro 1977 [4b])</i>	Longitudinal case series	10	Clinical setting	7 to 17 year olds, Most profound UHL	CROS Aid	Questionnaire after 1 month of use No comparison group	<ul style="list-style-type: none"> 7 of 10 were “successful users” Defined as reported regular use Improvement in academic performance as rated by the teachers

Study Citation	Study Type/ Design	N	Setting	Patients	Intervention	Comparison	Outcomes
<i>(Kiese-Himmel 2002 [4b])</i>	Descriptive Case series Retrospective chart review to identify parents for survey	31	Hospital based	Parents of 1 to 10 year olds with > 30dB UHL (majority severe to profound)	Survey determining acceptance of amplification (HA)	No comparison group	<ul style="list-style-type: none"> • 80% of children accepted HA, • Those with severe to profound UHL were less likely to accept the HA
<i>(McKay 2002 [4b])</i>	Case series	28	Hospital based	Parents of children 2 to 17 year olds with mild-moderately severe UHL	Survey determining benefit of HA	No comparison group	<p>72% reported benefits, specifically improvements in:</p> <ul style="list-style-type: none"> • hearing, • social settings and • academic settings
<i>(McKay 2005 [5b])</i>	Non Peer-reviewed Management Guideline	N/A	ASHA guidelines	Clinical experience at Children's Hospital of Philadelphia audiology, based on literature review	HA, FM	N/A	<p>Candidates for amplification:</p> <ul style="list-style-type: none"> • Mild to moderately severe (25 to 65 dB HL) sensory or permanent conductive HL in one ear • 3 ≥ or < 3 if frequency-specific threshold information is available <p>FM systems for all with</p> <ul style="list-style-type: none"> • UHL including those with severe to profound HL or • poor word recognition abilities <p>Bone conduction and CROS systems not standard recommendation, but based on a case-by-case if appropriate</p>
<i>(Tharpe 2008 [5])</i>	Systematic review	N/A	Clinical populations	Children with UHL	HA, FM	N/A	<ul style="list-style-type: none"> • Make sure HA does not interfere with speech perception related to unaided condition • Amplify at HL of 65dB or less • Consider FM candidacy when: <ul style="list-style-type: none"> ○ demonstrates poorer than expected performance on speech-in-noise tasks ○ poorer than expected academic performance in the classroom, ○ increased listening fatigue and/or ○ decreased listening ability in difficult acoustic environments. • Consider in decision: <ul style="list-style-type: none"> ○ environment in which device will be used, ○ age of child, ○ degree and configuration of HL & use of HA.

Study Citation	Study Type/ Design	N	Setting	Patients	Intervention	Comparison	Outcomes
(Lieu 2004 [1a])	Systematic Review	N/A	N/A	Children with UHL	HA, FM	N/A	<p>Risk factors for educational problems:</p> <ul style="list-style-type: none"> • early age of UHL onset, • perinatal and/or • post-natal complications, • severe to profound SNHL, • right UHL <p>Interventions in children with UHL:</p> <ul style="list-style-type: none"> • Preferential classroom placement, • parental education, • child education, • teacher education, • screening for speech and language delays/ difficulties/ amplification <p>Consider amplification, FM systems, HA, CROS aids, or bone conduction aids if any signs of:</p> <ul style="list-style-type: none"> • speech-language delay, • struggling in school or • struggling in social interactions. <p>Tailor device to the needs of the individual child.</p> <p>Screen school-age children for educational problems at routine intervals</p> <p>Follow-up audiograms at least annually to monitor for progression of hearing loss; repeat audiograms if any change in hearing is suspected</p>

ASHA – American Speech -Language - Hearing Association, CROS – contralateral routing of signal, dB – decibel, FM – frequency modulation, HA – hearing aid, HL – hearing loss, Hz – hertz, N/A – not applicable, UHL – unilateral hearing loss

Group/team members

Group/Team Leader: Susan Wiley, M.D. Developmental and Behavioral Pediatrics

Other group/team members

Ellis Arjmand, MD PhD Otolaryngology
David Brown, PhD Audiology
Lori Garland, Audiology
Barbara Johnson, library sciences
Jareen Meinzen-Derr, PhD Epidemiology
Charlotte Ruder, Speech pathology

Clinical Effectiveness Support:

Eloise Clark, MPH, MBA, Guidelines Program Administrator
Karen Vonderhaar, MS, RN, Methodologist

Search strategy

Database: Ovid MEDLINE (R), 1996 to January Week 2 2008

- 1 child/or school aged children.mp (376492)
- 2 ex hearing loss/ or exp hearing loss, unilateral/ (15898)
- 3 amplifiers/ (294)
- 4 (outcomes or educational performance or school performance or functional outcomes\$.mp. [mp=title, original title, abstract, name of substance word, subject hearing word] (251435)
- 5 (#1 and #2 and #3 and #4).mp. [mp=title, original title, abstract, name of substance word, subject heading word] (251435)
- 6 1 and 2 and 3 and 4 (0)
- 7 (amplifiers or digital hearing aids or fm system\$ or baha or cros link aid).mp. (792)
- 8 1 and 3 and 4 and 7 (3)
- 9 Hearing loss/or hearing loss unilateral/ (2519)
- 10 (Hearing Loss or unilateral or hearing disorder\$.mp. [mp=title, original title, abstract, name of substance word, subject heading word] (47371)
- 11 1 and 3 and 4 and 7 and 10 (0)
- 12 4 and 7 and 10 (12)
- 13 1 and 12 (6)
- 14 From 13 keep 1-6 (6)

Limits: Humans, English, Child: 6-12 years

Amplification OR digital hearing aid OR fm system OR baha OR cros link aid (2648)

Unilateral hearing loss (63)

(Educational OR school) AND (outcomes OR performance) (5144)

(Educational OR School) AND (outcomes OR performance) AND unilateral hearing loss AND (amplification OR digital aid OR FM system OR baha OR Cros link aid) (1)

(unilateral hearing loss) AND systematic[sb] (6)

Known conflicts of interest

Conflicts of interest were declared and none were found.

Applicability issues

Outcome measures to be monitored include:

1. Access to sound (categories of fair, good or excellent based on real ear and sound field audibility measures)
2. Auditory Perception and Skills (rated by the Auditory Skills Checklist © or other functional measure)
3. Improvement in Everyday Listening Skills (rated by the Meaningful Auditory Integration Scale)
4. Patient Independence (Questionnaire filled out by child or parent)
5. Care Plan Adherence (report adhering to care plan to at follow-up visit)
6. Parental Stress Index-Short Form
7. Quality of Life (Peds QL)

Copyright Statement

Copies of this Best Evidence Statement (BESt) are available online and may be distributed by any organization for the global purpose of improving child health outcomes. Website address: <http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/ev-based/default.htm>.

Examples of approved uses of the BESt include the following:

- copies may be provided to anyone involved in the organization's process for developing and implementing evidence based care;
- hyperlinks to the CCHMC website may be placed on the organization's website;
- the BESt may be adopted or adapted for use within the organization, provided that CCHMC receives appropriate attribution on all written or electronic documents; and
- copies may be provided to patients and the clinicians who manage their care.

Notification of CCHMC at HPCEInfo@cchmc.org for any BESt adopted, adapted, implemented or hyperlinked by the organization is appreciated.

For more information about CCHMC Best Evidence Statements and the development process, contact the Health Policy & Clinical Effectiveness office at: 513-636-2501 or HPCEInfo@chmcc.org.

Note

This Best Evidence Statement addresses only key points of care for the target population; it is not intended to be a comprehensive practice guideline. These recommendations result from review of literature and practices current at the time of their formulation. This Best Evidence Statement does not preclude using care modalities proven efficacious in studies published subsequent to the current revision of this document. This document is not intended to impose standards of care preventing selective variances from the recommendations to meet the specific and unique requirements of individual patients. Adherence to this Statement is voluntary. The clinician in light of the individual circumstances presented by the patient must make the ultimate judgment regarding the priority of any specific procedure.

Reviewed by: Clinical Effectiveness