Telemedicine for Infant Audiology

TeleAudiology Technical Protocol

Developed by the North Dakota Center for Persons with Disabilities at Minot State University under contract for US Department of Health and Human Services, Health Resource and Services Administration, Maternal and Child Health Bureau. Neil Scharpe, MS, Project Director, Tom Froelich, MS/CCC-A, Audiologist, Steve Peterson, MT (ASCP)
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I. Scope and Content

The development of this technical protocol is directed by DHHS Health Resources and Services and is to be supplemented with the management protocol and the “tool kit” to assist in the implementation of audiology services via telemedicine technology. While the scope of this work has been done with an emphasis on rural systems, its applications could be used in a variety of areas.

It is the intent of the authors that these documents will provide the framework by which a TeleAudiology service delivery system can be established and operated. The objective of these documents is to improve the follow-up of infants identified through the Early Hearing Detection and Intervention (EHDI) program. An emphasis is placed on audiologic evaluations of infants who have been referred after failing a minimum of two hearing screening tests.

It is important to identify infants with hearing loss as early as possible and, therefore, evaluation, while not always optimal, will need to be done with children that are three months old or less. Please note that the Technical Protocol does NOT address sedation but encourages the readiness of the child prior to testing.

TeleAudiology has been shown to be an effective means of offering young children access to needed professionals while remaining closer to home. It can allow audiologists to set up testing sites in areas that have previously been void of professional services. These Spoke sites will include analytic equipment along with the computerization and internet service necessary to communicate with the audiologist at the Hub site; creating the audiologist’s virtual presence. Depending on the environment at the Spoke location, there may be several options with respect to the placement of equipment. It can be fixed or mobile; it can be permanent or temporary, etc. Examples of issues that are likely to determine this are network infrastructure, office site availability, monetary and/or resource issues, and required frequency of testing.
II. Principles

The purpose of this product is to develop a technical and management protocol that can be employed as a basis to replicate audiology testing on infants in a telemedicine environment. These protocols shall be consistent with those established by the Joint Committee on Infant Hearing (JCIH) (Hearing, 2007) and the technology validated by a recently completed North Dakota Distance Audiology Project (NDDAP) (Ribera, 2005, Towers 2005).

The method of delivering diagnostic evaluations of infants 0-6 months of age in this protocol utilized a Hub and Spoke concept with the pediatric audiologist stationed at the Hub site and a trained paraprofessional located at a Spoke site. EHDI programs across the country lose up to 50% of neonates failing the initial and follow-up hearing screening. Reasons often cited include the distance to a diagnostic pediatric hearing center from the home of the neonate.

With the development of TeleAudiology, the parents remain closer to home and the follow-up after the second screening failures could be enhanced. This TeleAudiology protocol is designed to improve the availability of diagnostic audiologic services in areas where such services are lacking. The availability of diagnostic audiologic services to all neonates/infants is of paramount importance.

III. Target Population

More than 30 babies are born every day in the U.S. with a hearing loss; making it the most common birth defect. The target population for this protocol is infant’s age 0-6 months that require audiologic diagnostic evaluation. More specifically, infants that fail their first hearing screening, usually an Otoacoustic Emission (OAE), are referred for a repeat of that qualitative analysis. This is necessary as false positive qualitative (pass/fail) results are fairly common during the first couple days of life and can be expected to be as high as 10%. It is those infants that refer after their second failed screening procedure that are the target population; those referred for a more extensive quantitative analysis and consequent diagnosis. JCIH recommends a diagnosis by three months of age as a part of a regiment to begin intervention by six months of age. This recommended schedule leaves a relatively small window of opportunity to complete critical diagnostic testing. TeleAudiology has the potential to remove some of the barriers that have prevented timely diagnosis of this target population.
IV. Assessment Instruments

Instrumentation discussed in the Technical Protocol will be those used for quantitative hearing analysis, and not specifically tied to distance technology or telemedicine. In other words, these are instruments that are commonly used in conventional pediatric audiology testing environments; but also worked well in the provision of TeleAudiology. Information on and discussion of the equipment required to provide these services via telemedicine can be found in the Management Protocol.

The analytic equipment used by the authors of this protocol is:

• Intelligent Hearing Systems Auditory Brainstem Response System
• Biologic AudX Otoacoustic Emission System
• Madsen Capella Acoustic Immittance System

These instruments offer an operating system that is compatible with the software described in the management protocol thereby giving the audiologist control of the Spoke site equipment via the telemedicine network.

V. Types of Assessments

Only those neonates/infants in need of a diagnostic audiologic evaluation would be served by this protocol. These neonates have already failed a minimum of two hearing screening administered by the birth hospital. Types of assessments which can be utilized in a teleaudiology approach include acoustic immittance for the assessment of middle ear function, distortion product otoacoustic emissions for the assessment of cochlear outer hair cell function and auditory brainstem response (ABR) for the assessment of auditory neural integrity through the brainstem. These assessment procedures meet the Joint Committee on Infant Hearing (JIHC) 2007 guidelines for the diagnostic evaluation of neonates/infants.

VI. Test Environment

Testing at the Spoke site will not generally take place in a sound treated environment. One must be aware that excessively noisy environments may result in inaccurate test data, which can consequently cause unnecessary anxiety in parents. Therefore, every precaution should be taken to insure testing is completed in the quietest environment possible. In the selection and/or preparation process, noise level measurements are recommended to insure that levels in the Spoke location are acceptable for testing. The use of insert earphones in a non-sound treated environment will serve to slightly reduce background noise reaching the neonate/infants ear canal (as well as prevent ear canal collapse common in this age group when earphones are used).
Audiologists wishing to engage in telepractice must be well versed in neonatal/infant hearing test administration and interpretation. According to the American Speech, Language and Hearing Association (ASHA) and the American Academy of Audiology (AAA) code of ethics, audiologists should not engage in any diagnostic procedures or patient management protocols for which they are not qualified by education and experience. Not all audiologists have the necessary skills to administer and interpret auditory brainstem response in neonates/infants and should refrain from doing so. This document assumes the audiologist has the skills required to diagnose hearing loss with electrophysiologic measurements.

By this stage of the assessment, the neonate/infant has failed two otoacoustic emission hearing screenings. With the goal of neonatal hearing screening programs being diagnosis of hearing loss no later than three months of age, the assessment protocol must progress to a more differentially diagnostic procedure. Auditory brainstem response (ABR) is the test of choice for this age group. ABR with neonates/infants is often time consuming and requires more than one session to complete. The following ABR protocol is offered for consideration.

In order to minimize the ABR testing time, the following test protocol was suggested by Dr. James Hall III (New Handbook of Auditory Evoked Responses, Allyn and Bacon, 2007).

1. Following the attachment of the electrodes, obtain a click evoked ABR at 80 dB nHL in both ears. If the ABR has normal wavelet (I, III, and V) and interwavelet latency values (I-III, III-V and I-V), reduce the intensity to 20 or 25 dB nHL. The click evoked ABR quickly determines (a) if hearing loss is present, (b) if hearing loss is present, whether the hearing loss is conductive, sensory or neural. Should response latencies at this intensity level be relatively normal, the audiologist could proceed to tone burst stimuli at 500 Hz and 4000 Hz in each ear. However, distortion product otoacoustic emissions (DPOAEs) can also be obtained for the frequencies of 1000 Hz through 5000 Hz instead of the tone burst ABR only when the click evoked ABR is normal. The frequency specific stimuli provide information concerning high frequency hearing that may be missed by click evoked ABR. All responses require replication.

As soon as a clear response is observed, discontinue signal averaging and move to the next step in the protocol.
2. Should the click evoked ABR be abnormal at 80 dB nHL, increase the intensity to maximum output and generate a latency intensity function in each ear. Proceed to frequency specific tone bursts and obtain responses at a minimum of 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. The midoctave frequencies may also be tested should time permit. If a conductive hearing loss is suspected, a complete bone conducted ABR should also be obtained in order to determine the size of the conductive component.

3. Distortion Product Otoacoustic Emissions (DPOAEs) are absent in neonates/infants with hearing loss and do not provide the necessary type, degree and configuration of hearing loss information required for auditory habilitation. DPOAEs, can however, be valuable in the assessment of 1000 Hz through 6000 Hz in the event the click evoked ABR is normal to 20 to 25 dB nHL. Acoustic immittance, if available, may be used at the discretion of the audiologist. The use of acoustic immittance in this age group must employ a 1000 Hz probe tone.

As previously indicated, only audiologists skilled in the electrophysiologic assessment of neonates and infants should engage in a TeleAudiology approach. Test procedures and protocols will vary by site based upon the equipment available for the assessment. Test protocols could involve acoustic immittance followed by DPOAE followed by ABR. This order of testing would alert the audiologist to the presence of a possible conductive component prior to the ABR. However, the conductive component to the hearing loss will still have to be defined by ABR air and bone conduction testing.

VIII. Results

The audiologic test results will be saved on the Spoke computer under the patient’s name, identification number or other identifier determined by the Spoke site. Identifiers will vary among the different Spoke sites and the audiologist at the Hub site will be responsible for entering the appropriate information in the patient record. The audiologist at the Hub site will have control of the computer at the Spoke site and will be able to save all test data in the patient’s file. There would be no need to save any of the audiologic test results on the Hub site computer.

The audiologist can view the test results at a later date as long as access to the Spoke site computer is granted. The audiologic report will also be saved on the Spoke site computer and then printed for the patient record or transferred to the patient electronic record at the Spoke site by the paraprofessional. Copies of the audiologic report will be sent by the Spoke site to the patient’s physician and other agencies which may be responsible for follow-up care, including the fitting of amplification. Confidentiality of patient records can be protected by keeping all records at the secure Spoke site.
IX. How Are Results Delivered?

Technical aspects of diagnosing hearing loss with Telemedicine are relatively straightforward, involving defined parameters that can lead to accurate assessment. If well designed, the audiologist can be comfortable with results. A more complex issue with distance audiology is what professionals do with the results?

The communication of audiology test results to parents is of critical importance. It must be assumed that the infant has failed two hearing screenings and that the parents may be in a heightened state of anxiety regarding the hearing status of their child. How, when and who delivers the results of diagnostics must be given serious consideration. ASHA developed a position statement addressing counseling of parents who have been identified with hearing loss in 2008 (ASHA, 2008). This statement may be used as a guideline for parent interaction, but consideration should also be given to other factors that are unique to distance audiology.

The distance factors include; no physical contact is possible between the pediatric audiologist and the parent, the skills of the paraprofessional at the Spoke site, cultural issues, the urgency of further testing in a timely manner and the consistency of the delivery method used in that community.

There are two methods of informing parents of the TeleAudiology hearing test results.

Since the audiologist is in direct audio and visual communication with the Spoke site, the audiologist can communicate the test results directly to the parents via headset or speakers. However, the emotional liability many parents display upon being informed their child has a permanent hearing loss, presents counseling difficulties.

In explaining test results, the audiologist may be unable to determine the extent of parental understanding because body language cues may be missed due to the distance factor. The audiologist may become a disembodied voice to the parent. In addition, there may be cultural or language barriers that hinder complete understanding of the hearing loss and recommendations. In this situation the paraprofessional, being face to face with the parents, would assume a greater role and they must be trained prior to being placed in this role. The parents may direct their questions/concerns to the paraprofessional once the audiologist has disconnected. This places the paraprofessional in role of primary counselor and opens the door for substantial miscommunication unless the paraprofessional has been fully trained.
Because this protocol is geared toward rural settings it is possible that the paraprofessional at the Spoke site is more familiar with the family dynamics of the situation and can be instrumental in how and when results are delivered.

Immediate notification, on the other hand may provide an opportunity for the audiologist to counsel the parent in taking immediate steps to schedule additional face to face diagnostics and begin the intervention process.

This discussion would be followed by the written report and recommendations, which include a referral to the nearest audiology center skilled in the assessment and habilitation of children. The child’s primary care physician would also receive the report and the child would be referred to the appropriate agencies involved with children with hearing loss.

The second method of communicating test results would be to include a statement in the instructions that parents receive prior to the appointment, indicating results would be communicated at a later date once test results have been thoroughly analyzed. If it is determined that results of diagnostics will be deferred until a later date, this should apply to good results as well as that of an identified loss. Parents of a particular community will inevitably find out if parents are being told that their child “passed” the hearing tests at the conclusion of the testing session and become anxious if they are not given the results in a similar timeframe. A neonate/infant identified with a permanent hearing loss will have to be referred to the nearest center skilled in the assessment and habilitation of young children. The audiology report could be forwarded to this center and be available to the audiologist when the neonate/infant attends a scheduled appointment. The audiologist at the center would then be responsible for breaking the news to the parents, planning the follow-up and referring to the appropriate agencies.

Even though providing test results to parents via videoconferencing at the time of the assessment has its drawbacks, not informing the parents at the time of assessment may have worse consequences. The parents would leave the assessment with no sense of urgency and delay scheduling an appointment with the pediatric audiology center, thereby circumventing the goals of early identification of hearing loss. It is our recommendation that the parents be informed of test results at the time of the assessment.

Another consideration is that delaying news can cause unnecessary anxiety when it is known that the child does not have a hearing loss.
X. Training Guidelines

Orientation regarding equipment purpose, measurement and function should be conducted with the personnel at the Spoke site. This should include the following:

1. Purpose and function of each piece of equipment
2. Effect of neonate/infant activity level obtained with each piece of equipment
3. Inspection of ear canal for debris
4. Selection of proper probe tip for ABR, OAE and acoustic immittance
5. Placement of probes in the ear canal
6. Placement of insert earphones for ABR
7. Preparing electrode sites for ABR
8. Checking electrode impedance and methods for impedance matching/reduction
9. Monitoring neonate/infant during the test procedure
10. Basic trouble shooting of equipment
11. Cleaning/disposal of probe tips
12. Successful completion of the UNHS Curriculum (See Tool Kit)

Since the audiologist is in direct video and audio communication with personnel at the Spoke site, the neonate/infant can be monitored and suggestions offered to the Spoke site throughout the assessment. Parents must be provided with written instructions so the neonate/infant arrives for the assessment in the proper condition for testing (sample instruction are provided in the tool kit). Sedation (chloral hydrate or mild anesthesia) is controversial in neonates/infants and will not be addressed in this document.
XI. Bibliography


ASHA. (2004). Guidelines for the Audiologic Assessment of Children from Birth to 5 Years of Age [Guidelines].


