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Survey of Auditory Brainstem Response Referral Criteria

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Professional Research Project
Submitted to the Faculty of the University of South Florida,
Department of Communication Sciences and Disorders
In partial fulfillment of the requirements for the degree

Doctor of Audiology

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(ABSTRACT)

The primary objective of the project was to survey recognized “experts” in the field of neurodiagnostic audiology and practicing audiologists regarding their referral criteria and referral patterns for administering an auditory brainstem response test (ABR). For purposes of this study, “expert” was defined as any recognized audiologist with at least two or more publications and/or seminars in the field of auditory evoked potentials. Responses of experts and practicing audiologists were compared and contrasted to establish: a) if there was a standard referral pattern; b) what, if any, were the apparent critical components of referral patterns; and, c) whether or not current practice reflected the utilization of such critical components.

The survey was designed to establish whether the respondent was practicing, in what type of practice setting, and how often ABRs were performed. Specificity and sensitivity of ABR outcomes was also requested. The survey was administered verbally, via telephone, to 3 experts and was sent via e-mail to 178 randomly selected audiologists in the United States. Of the latter 53 returned, 38 reported conducting ABRs. Thus, data analysis was reported on 38 respondents.

The survey results did not reveal a consistent standard referral pattern. Critical components for referral were hypothesized based on the “expert” majority response. These include ABR referral based on the presence of: (1) asymmetric sensorineural hearing loss; (2) unilateral tinnitus; (3) positive reflex decay; and, (4) word recognition rollover. The majority of “non-expert” practitioners surveyed reported that these symptoms warranted consideration for referral, thus reflecting utilization of apparent critical components.

Survey of Auditory Brainstem Response Referral Criteria

It has been speculated that while the field of Audiology evolves into a doctoring profession, practicing audiologists will be presented with greater responsibility in justifying or supporting clinical diagnostic and treatment methods. One area of concern is auditory evoked potentials, particularly auditory brainstem response testing (ABR) and the appropriate practice patterns for its use as a neurodiagnostic tool with both adults and children.

While ABR testing is a useful neurodiagnostic tool, the literature fails to present a definitive description of accepted ABR referral criteria for the practicing audiologist (Gelfand, 1997; Hall, 1992; Katz, 1994; Margolis, 1997; Musiek & Rintelman, 1999). Rather, much of the literature provides a general overview of related symptoms suggestive of possible retrocochlear involvement. This includes (1) unexplained asymmetrical sensorineural hearing loss; (2) unilateral tinnitus; (3) dizziness; (4) unexplained feeling of fullness in the ear; (5) poor word recognition scores; (5) word recognition rollover; (6) inconsistent acoustic reflex thresholds; and, (7) positive reflex decay (Margolis, 1997). However, none of these suggested “red flags” are clearly defined for the audiologist as to what the criteria are for neurodiagnostic referral. For example, what is the accepted definition of asymmetric sensorineural hearing loss within our profession? Does this definition of asymmetry vary among our colleagues? If a patient only presents one of these reported symptoms or “red-flags” is an ABR referral warranted? If not, then how many of these red flags must be present to substantially justify an ABR referral?

The underlying uncertainty of answers to the aforementioned valid questions can raise concern about the consistency of audiologic practices as a whole. Furthermore, with rising legal implications for the practicing audiologist, along with payment and reimbursement issues concerning both the patient and the audiologist, justification for performing any type of clinical procedure is expected. Recently, a representative of American Speech, Language, & Hearing Association’s (ASHA) Professional Liability

Insurance group stated that “in today’s society, lawsuits have become commonplace; even ASHA professionals are subject to malpractice” (ASHA, 2000). Documented lawsuits have already come to surface within the field of audiology including improper procedures performed in the office, malpractice due to nerve testing, and most relevant, failure to properly test a patient. “Work as an audiologist puts you in contact with highly sensitive areas...regardless of your skills, situations do arise wherein professionals can be found liable for their actions” (ASHA, 2000).

Although no lawsuit has been documented to date regarding failure to refer or perform an ABR, the possibility of one occurring seems almost inevitable (ASHA, 2000). One possible way to minimize these potential cases from rising is to clearly define and standardize our clinical practice patterns across the spectrum. If formal standardization is not possible, than at least some type of “best practice” guidelines should be developed to promote consistency within our profession. “Best practice” guidelines cannot be initiated, however, without first examining the strengths and weaknesses of current practice patterns.

To date, there is no study that has investigated current practice patterns for ABR referral. Thus, the work focused on the following three questions:

1. Is there a standard referral pattern for auditory brainstem response testing as a neurodiagnostic tool?
2. What appear to be the critical components for referral?
3. Does current practice among clinical audiologists reflect the utilization of any apparent critical components?

Method

Respondents/ Sample Selection

A survey was distributed via the Internet to 178 audiologists in October and November of 2000. Recipients were quasi-randomly selected from the 1998-1999 *Member Directory* (AAA, 1998) of the American Academy of Audiology and the Veterans Health Administration of Washington Audiology and Speech Pathology Service

(VHAWASASPS) national e-mail group. In addition, a telephone survey was conducted with three selected “expert” neurodiagnostic audiologists during the month of November. For purposes of the study, “expert” was defined as any recognized audiologist with at least two or more publications and/or seminars in the field of auditory evoked potentials.

Survey

A survey was developed for the distribution via the Internet to practicing audiologists in the United States and the telephone to 3 “experts” (See Appendix A for survey). The objective of the survey was to question the designated “experts” and practicing audiologists, or “non-experts”, regarding their referral criteria and referral patterns for administering an ABR. Audiologists experienced with ABR assisted with item drafting, development, and selection. The number of questions was reduced through discussion, literature review, and compromise. The revised survey was pilot tested on audiologists and revised again based on suggestions from the experienced audiologists. Evidence of content validity was achieved by developing items that audiologists experienced in ABR agreed were the proper objectives and focus of ABR referral criteria.

The survey consisted of 12 questions which established (1) practice setting; (2) ABR experience; (3) sensitivity measures or hit rates; (4) symptom or audiologic finding classification; (5) definition of audiometric terminology; and (6) type of ABR training. Symptoms selected for inclusion within the survey were obtained from Robert Margolis’ text of *Audiology Clinical Protocols* (1997). Seven of twelve questions were written in *closed* or *restricted* form requiring “yes” or “no”, short response, or item checked answers. Respondents were asked to denote their selected responses by placing an “X” in the appropriate blank. The remaining five questions were in *open* or *unrestricted* form requiring estimates and approximations of individual clinical performance as well as two definitions of audiologic terminology. Comment sections were included at the end of each item if deemed appropriate.

Procedure

A cover letter outlining the purpose of the study, the usefulness of the data to the profession, and instructions for completion of the survey was e-mailed to each of the 178 audiologists (See Appendix A for cover letter and survey). Recipients were allotted 72 hours for completion and return. Anonymity was maintained for all participants.

The experts were initially contacted via e-mail to schedule follow-up appointments for telephone interviews. As previously mentioned, interview questions included the same 12 questions that were e-mailed to the outside practitioners and verbal responses were documented by the investigator. Expert responses were provided in greater detail in order to establish and report their suggested practice patterns for ABR referral. Again, anonymity was maintained for all “expert” respondents. Individual responses can be found in Appendix B.

Results and Discussion

Of the 178 questionnaires e-mailed, 53 were returned representing a 30% return rate. Of those 53, 15 respondents reported that they did not perform or refer ABRs for neurodiagnostic purposes and were not included in the data analysis for questions 3-13. Therefore, the data analysis performed for questions 3-13 only include responses from the remaining 38 surveys.

Responses from both the 3 “experts” and the 38 “non-experts” were reviewed and recorded into Microsoft Excel for analysis. Data provided from both groups were evaluated independently prior to making inter-subgroup comparisons. Trends were identified for both groups and comparisons were made. Descriptive analysis was utilized to examine the data. Due to the surplus of data generated by both “experts” and “non-experts”, analysis of survey results for the expert responses are presented first, followed by a synopsis of non-expert responses for each question. The following is a summary of the major findings of the survey.

Practice Setting

Reported practice settings of the “expert” respondents included (1) a hearing research lab and medical center for Expert 1; (2) a hospital practice for Expert 2; and (3) a hospital practice and community medical clinic for Expert 3. As highlighted in Figure 1, the survey respondents represented a sample of audiologists from a variety of employment settings. The most frequently indicated professional settings were Veterans’ hospitals (22.6%, $n=12$), hospital practices (18.9%, $n=10$), and university clinics (11.3%, $n=11$). No representatives from the private practice/ENT or balance center programs were included in the study. A considerable portion of respondents fell into the “other” category, including employment within the public school system, pediatric facilities, and various administrative positions.

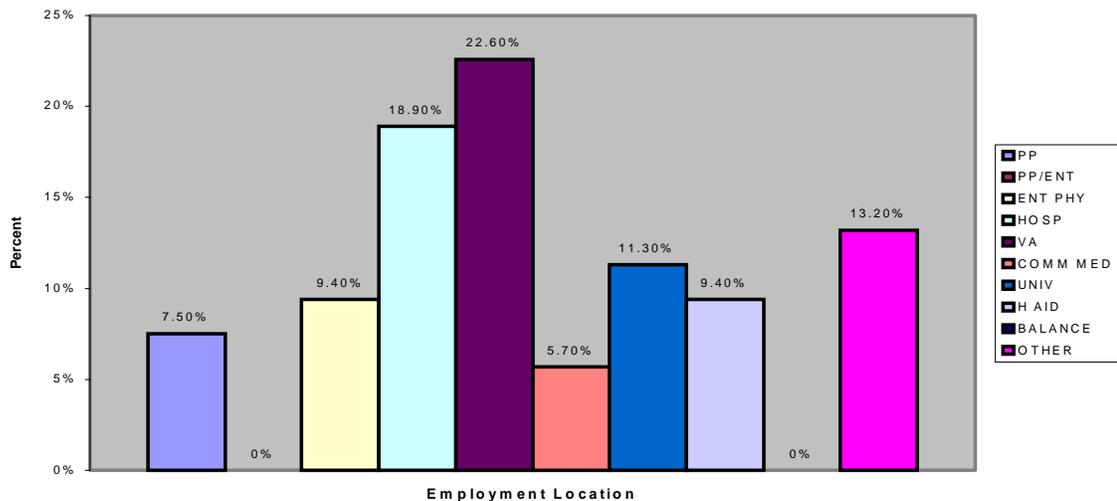


Figure 1. Practice setting for “non-expert” audiologists. (PP = Private practice, PP/ENT = Private practice/ear nose and throat, ENT/PHY = ear nose and throat physician’s office, HOSP = hospital, VA = Veteran’s hospital, COMM MED = community medical center, UNIV = University facility, H AID = hearing aid practice

Note: Some individuals responded in more than one category.

Question 1: Do you perform or refer ABRs for neurodiagnostic purposes?

All 3 of the expert respondents answered yes to this question. As previously mentioned, 15 (28.3%) of the 53 respondents answered “no” to this question and were instructed to immediately discontinue the survey and mail their responses back to the researcher. Postulated reasons for answering “no” are due, in large part, to the respondent’s reported practice setting. The majority of respondents who did not perform ABRs listed public schools, pediatric facilities, and administrative settings as their primary work environment and indicated that ABRs were not part of their practice. The remaining 38 (71.7%) respondents answered “yes” and were asked to continue completion of the survey to the best of their ability.

Question 2: Do you perform otoacoustic emissions as part of your neurodiagnostic protocol?

Both Expert 1 and Expert 2 support the use of otoacoustic emissions (OAE) as part of their neurodiagnostic protocol. Expert 1 indicated that performance of OAEs is a standard procedure within his facility. He suggests that OAEs should be performed prior to ABR referral, as a crosscheck to confirm behavioral thresholds as well as to rule out possible auditory neuropathy. The general rule of thumb is that if emissions are present, then normal behavioral thresholds should be obtained. If emissions are not present and abnormal behavioral thresholds are not obtained, then auditory neuropathy may be suspected and ABR referral is warranted. Expert 2’s responses were consistent with Expert 1. Expert 3, however, did not believe that OAEs should be conducted as part of a regular neurodiagnostic protocol. He indicated that most often the primary goal of a neurodiagnostic evaluation is to differentiate between cochlear disorder, eighth nerve disorder, or a combined disorder. The major question, in his opinion, should be whether or not there is an eighth nerve disorder. This, in his opinion, can be answered with the ABR and performance of OAEs prior to referral is unnecessary neurodiagnostically.

According to responses obtained from the practicing audiologists, this “split” amongst experts is reflected in their practice. That is, the practicing audiologists were

fairly equally divided, with 55.3% ($n=21$) reporting that they do perform OAEs as part of their neurodiagnostic protocol and the remaining 44.7% ($n=17$) reporting that they do not.

Question 3: Approximately how many ABRs do you perform monthly?

This question was designed to identify the respondent's level of experience with ABR testing. All three "experts" indicated that they are now performing fewer neurodiagnostic ABRs than they performed several years ago. The primary reason indicated for this decrease was improved diagnostic sensitivity of magnetic resonance imaging (MRI) in detecting smaller lesions sometimes missed by ABR. This suggests that in cases where there are very strong indications of possible retrocochlear pathology based on reported symptoms and audiological test results, experts may be directly referring for MRI, and only conducting ABRs in more questionable cases. Expert 1 now performs approximately 5 to 7 ABRs per month, while Expert 2 performs approximately 12. Expert 3 now performs an average of 3-4 neurodiagnostic ABRs per month.

The majority of "non-expert" respondents reported that they perform less than 10 ABRs per month (76.3%, $n=29$). Approximately 20% reported performance of 11-30 ABRs per month. Only one respondent indicated that he performed approximately 100 ABRs per month.

Question 4: How many abnormal ABRs do you identify per month?

This question was surprisingly difficult for Expert 1 to answer, in that he was unable to provide a general estimate of abnormal ABRs identified per month. Expert 2 reported an average of less than 20%, or approximately one in every five ABRs performed. Expert 3 provided an estimate of 1-2 abnormal ABRs per month, which would be equivalent to approximately 25-50%.

Similar to Expert 1, 3 (7.9%) of the "non-expert" respondents apparently experienced some difficulty in providing an estimate of abnormal ABRs identified per month as the question was unanswered. Fifteen (39.5%) of the respondents reported identification of less than one abnormal ABR per month. Almost 48% ($n=15$) reported

between 1 and 5 per month. Only two of the respondents indicated identification of more than 5 abnormal ABRs per month. Among these two, was the previously mentioned respondent that reported performing an average of 100 ABRs a month in a hospital practice setting. Nevertheless, the low estimates were expected due to the overwhelming majority of practitioners that perform less than 10 neurodiagnostic ABRs a month.

Question 5: If you have an abnormal ABR, what is your most common follow-up protocol?

All of the “experts” work in close relation with otolaryngology (ENT) clinics. Experts 1 and 3 generally send all abnormal ABR patients to ENT clinics located adjacent to or within their practice sites. Expert 3 refers most of his patients directly to ENT for MRI with gadolinium contrasts. Expert 2’s typical follow-up protocol tends to vary based on initial referral. If a patient is referred to him by a particular ENT physician, than that patient is generally referred back to that physician. If patients are referred from other outside sources, then they are typically referred to a neurotologist for MRI with gadolinium contrasts.

Approximately 48% ($n=18$) of the “non-experts” appeared to agree with the standard follow-up protocol of referring patients directly to ENT for further examination, while 39.5% ($n=15$) preferred to send patients directly for an MRI for confirmation of retrocochlear or central nervous system (CNS) abnormality. Only 2 (5.3%) respondents selected CT scan or positron emission topography (PET). The remaining 10.5% ($n=4$) utilized “other”, unspecified methods of follow-up.

Question 6: What % of abnormal ABRs identified in your clinic have been confirmed with retrocochlear pathology or CNS abnormality?

Although not specifically asked, the experts discussed this question in relation to how a lesion or abnormality was confirmed. Although both Experts 2 and 3 estimated that their “confirmation” rates were at least 75%, Expert 1 could not easily provide an estimate. In part, this is due to the “standard” by which confirmation occurs. MRI is often considered the “gold standard” for confirmation of an abnormality or lesion.

According to Expert 2, however, the MRI confirmation is dependent on the size of the lesion, with smaller lesions not being identified. Thus, surgical identification is the only true method of confirmation. Expert 3 also raised questions about the accuracy of MRI. He indicated that although MRI is generally viewed as the “gold standard” for detecting retrocochlear pathology, it only identifies structural, not functional disease. He suggested that many of the grossly abnormal ABRs that are identified and reported, may really be “grown up” auditory neuropathy patients. Auditory neuropathy is a recently described disorder in which patients demonstrate hearing loss for pure tones, impaired word recognition, absent or abnormal ABR tracings, and normal outer hair cell function as measured by OAEs and cochlear microphonics (Sininger, 1998).

A large portion (34.2%, $n=13$) did not provide an estimate for this question. One postulated reason for not providing a response may involve the lack of follow-up methods to confirm findings. Interestingly, the majority of “non-experts,” who did respond ($n=21$, 84%) reported that less than 10% of their referrals were confirmed as retrocochlear pathology, while only 8% ($n=2$) reported rates of 11-20% and 41-50%, respectively. None indicated that they had hit rates as high as 75% reported by the experts. This may indirectly be related to a higher number of neurodiagnostic ABRs with probable retrocochlear involvement that are referred to the “expert” respondents as compared to the “non-experts”.

Question 7: Do you agree that the following symptoms or audiologic findings should warrant consideration for ABR referral?

This question was designed to determine if critical components of ABR referral patterns could be identified. Respondents were asked to indicate which of several symptoms would warrant consideration for ABR referral. As previously mentioned, the listed symptoms and audiologic findings were adopted from Robert Margolis’ book of suggested clinical protocols for neurodiagnostic ABR performance (1997).

Unexplained asymmetric sensorineural (SNHL)

All three of the “experts” unanimously agreed that the presence of unexplained asymmetric sensorineural hearing loss should warrant consideration for ABR referral. Similarly, an overwhelming 92.1% ($n=35$) of “non-expert” respondents agreed with this concept. The remaining 7.9% ($n=3$) did not indicate that ABR referral is justified based on unexplained asymmetric SNHL. Of these respondents, one expressed that a patient with unexplained asymmetric SNHL should be sent directly for imaging studies rather than conducting an ABR first. Based on these findings it appears that the presence of unexplained asymmetric hearing loss is a critical component for ABR referral.

Unilateral tinnitus

Again, all “expert” respondents agreed that unilateral tinnitus should warrant consideration for ABR referral. Thirty-one (81.6%) of the “non-experts” agreed with this concept, 6 (15.8%) did not, and 1 provided no response. Thus, the presence of tinnitus also appears warranted for inclusion as a critical component of ABR referral.

Dizziness

Expert 1, indicated that dizziness, only if unexplained, should warrant consideration for ABR referral. Experts 2 and 3 did not agree with Expert 1 and indicated that dizziness should not warrant consideration. Fifty-eight percent ($n=22$) of the “non-experts” agree with Expert 1, indicating that the presence of dizziness would be considered in a decision for ABR referral, but 42.1% ($n=6$) indicated it was not. Clearly, there was no consensus on the use of dizziness as a critical component for ABR referral is questionable.

Unexplained feeling of fullness in the ear

Similar to dizziness, the “experts” were somewhat divided on the importance of a feeling of fullness in the ear as a critical component of ABR referral. While Experts 1 and 3 thought this symptom indicated consideration for referral, Expert 2 did not agree. Rather, Expert 2 indicated that he would most likely consider endolymphatic hydrops with this symptom rather than considering ABR referral. Fifty-three percent ($n=21$) of

the “non-experts” agreed with Experts 1 and 3. Forty-seven percent ($n=17$) support Expert 2’s opinion, in that, consideration for ABR should not be warranted based on the presence of fullness in the ear. Specific reasons for their responses to this question were not provided. Thus, as with dizziness, the inclusion of dizziness as a critical component for referral is not clear.

Poor word recognition scores

Expert 1 was the only specialist to agree that poor bilateral word recognition scores should warrant consideration for ABR referral. Both Experts 2 and 3 disagreed. Expert 2, however, indicated that he would first have to consider the age of the patient, period of onset, and the natural course of deterioration. Perhaps not surprisingly, given the division in the experts, the “non-experts” were also divided, with 50% indicating poor word recognition scores were criteria for ABR referral and 50% indicating not. These findings suggest that the inclusion of poor word recognition scores as a critical component for ABR referral might be questionable.

Asymmetric word recognition scores

Expert 2 reported generally not being too concerned with asymmetric word recognition as long as all other audiometric findings were not indicative of retrocochlear pathology. Experts 1 and 3, however, believed that this finding would be indicative of ABR referral. The majority (81.5%, $n=31$) of non-experts agreed with this opinion. Despite the difference in opinions amongst the “experts”, these findings appear to suggest that asymmetric word recognition scores should be included as a critical component for ABR referral.

Word recognition rollover

In general, all three “experts” agreed that word recognition rollover should warrant consideration for ABR referral. Only 37% ($n=14$) of the non-expert respondents were able to accurately answer this question due to a survey error transmitted via email. The term “word recognition rollover” only appeared on 14 of the surveys transmitted, while the term “word recognition” appeared on the remaining 24 (64%). It is important to

mention, however, that of the 14 correct surveys obtained, 71.4% ($n=10$) of the respondents agreed with the experts and indicated that ABR referral should be warranted based on the presence of word recognition rollover. Although difficult to assume what the remaining 24 respondents would have selected, it seems inappropriate to omit word recognition rollover as a critical component for ABR referral.

Inconsistent or absent acoustic reflex thresholds

Mixed responses were obtained from the “expert” respondents in terms of the importance of inconsistent or absent acoustic reflex thresholds. Expert 1 indicated that inconsistent or absent acoustic reflexes are a strong indicator of retrocochlear function and should result in consideration for referral. Expert 2, however, did not believe this to be a significant indicator. Finally, Expert 3 indicated that absent or inconsistent reflexes should be considered a critical component for ABR referral, but only ipsilateral reflexes should be examined. Fifty percent ($n=19$) of the “non-experts” agreed with Expert 2, selecting “no” to this question. 42.1% ($n=16$) said “yes,” and 7.9% ($n=3$) provided no response. Thus, the use of inconsistent or absent acoustic reflexes may not be a critical component for ABR referral.

Positive reflex decay

All three experts agreed that positive reflex decay warranted a consideration for ABR referral. Similarly, an overwhelming majority (89.5%, $n=34$) of “non-expert” respondents agreed with this decision. Four respondents (10.5%) disagreed for reasons not specified. Positive reflex decay then seems to be a critical component for ABR referral.

In addition to all of the symptoms discussed above, Expert 2 suggested that generally anything unilateral in nature, such as unilateral facial weakness or pain, should generate consideration for ABR referral. Symptoms such as ataxia and severe headaches should also be considered.

Question 8: How many of the aforementioned symptoms must be present before ABR referral is warranted?

First, Experts 1 and 3 indicated that only one symptom was necessary to warrant ABR referral. Expert 2, however, had a less conservative approach and would typically not make a referral unless three or more symptoms occurred. Fifty-five percent ($n=21$) of the surveyed respondents agreed with Experts 1 and 3. Thirty-seven percent believe that at least two symptoms should be present, while only one agreed with Expert 2 that three or more symptoms should be present. Two respondents did not complete this question.

Question 9: Which of the symptom(s), if any, warrant ABR referral based solely on the presence of one symptom?

As previously addressed in question 8, Expert 2 indicated that referral based on the presence of only one symptom was not warranted, with exception to unilateral tinnitus. Thus, all experts agreed that referral for ABR testing was warranted in the single presence of reported unilateral tinnitus. Expert 2 also indicated that referrals based on positive reflex decay (at frequencies lower than 4K Hz) were justified. Expert 1 supported the practice of ABR referral based on the single presence of any of the symptoms listed.

As reflected in Figure 2, an overwhelming 81.6% ($n=31$) of the “non-experts” agreed that the presence of unexplained asymmetric SNHL alone should automatically warrant an ABR referral. Ironically, none of the “experts” indicated that this was a strong indicator by itself, yet all three agreed it warrants ABR consideration. In agreement with Experts 2 and 3, 55.3% ($n=21$) of the respondents believed that ABR referral was indicated in the presence of positive reflex decay as a single symptom. Approximately 44.7% ($n=17$) selected asymmetric word recognition as another single symptom for immediate referral. Thirty-two percent ($n=12$) selected unilateral tinnitus as a primary indicator for referral and remaining percentages can be viewed in Figure 2. It is important to remember that complete word recognition rollover data were not available from the majority of practicing audiologists due to a problem with the use of e-mail as the medium for transmission of the survey.

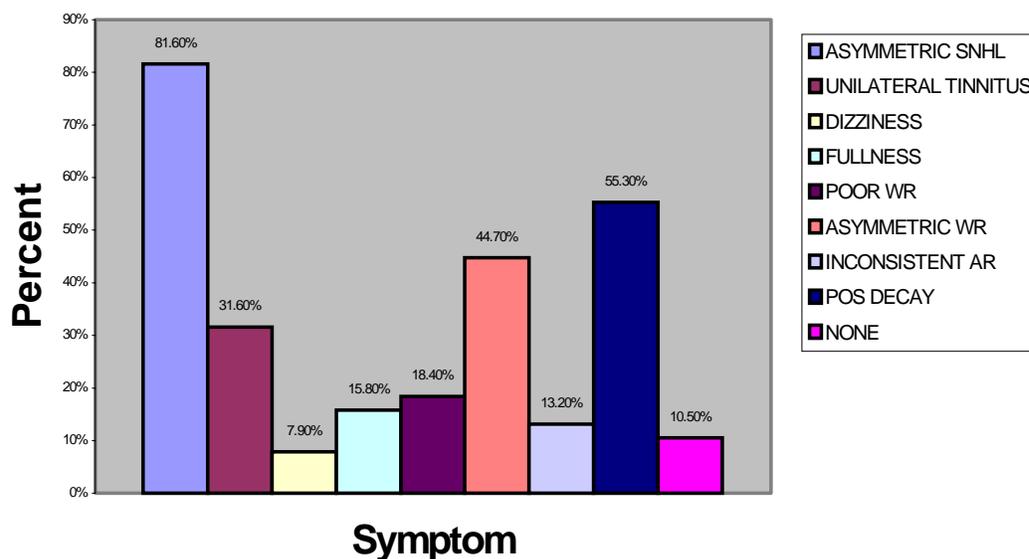


Figure 2. ABR referral based on the presence of one symptom according to “non-expert” respondents.

Note: Most respondents selected more than one item.

Question 10: What is your definition of asymmetric sensorineural hearing loss?

This question, by and large, produced the most variable and interesting responses from both groups. Expert 1 reported that he did not have a “true” definition of asymmetric SNHL, but his working definition generally centered on *a difference of 5dB at 3 adjacent frequencies or 10dB at 2 adjacent frequencies*. No reference for this definition was provided. Expert 2 generally utilizes a working definition reportedly adopted from the Academy of Otolaryngology, which includes *a difference of 10dB HL or more at 3 frequencies*; (these frequencies do not have to be consecutive). Expert 3 indicated that he does not have a clear-cut definition of asymmetric SNHL. He reported that a 15dB difference at one frequency or a 10dB difference at two or more frequencies is

a common criteria utilized. He also added that his clinical experience has helped him in determining when an “asymmetric” audiogram is truly asymmetric.

Definitions provided by the “non-experts” were just as variable. The majority of respondents were unable to provide a reference to support their postulated definitions. Several indicated that they were unaware of any such definition, and have developed their own while in practice. Common trends noted when reviewing the data included “10 dB difference at two or more frequencies,” “15 dB difference” at two or more frequencies, and “20dB difference” at one or sometime two frequencies. Some respondents added that asymmetries in the higher frequencies were of more concern.

Question 11: What is your definition of asymmetric word recognition?

Similar to the asymmetric SNHL results, definitions for asymmetric word recognition were somewhat variable. Experts 1 and 2 reported similar working definitions of a difference of 20% between ears. This figure reportedly stemmed from previous research by James Jerger, although neither expert could recall the exact references. As previously mentioned with asymmetric SNHL, Expert 3 did not have a concise definition of asymmetric word recognition. He prefers to refer to data generated by Raffin & Thornton (1980) data, which applies the binomial theorem for determining if a difference in two speech recognition scores exceeds that predicted from chance. If the difference in word recognition scores exceeds this critical value, then asymmetry is concluded.

Similar to Experts 1 and 2, 42% ($n=19$) of the “non-experts” indicated a difference of at least 20% in word recognition scores between ears was needed for concluding there was asymmetry. Many of these respondents also referred to Jerger’s work in this area. Three respondents indicated that they too, as did Expert 3, used Raffin and Thornton’s data to determine critical differences before concluding that the word recognition scores were asymmetrical. A variety of other percentage point differences were indicated by the remaining respondents, including: “12%”, “30%”, and “40%”. Rationales were not provided for these decisions.

Question 12: Where did you obtain your ABR training?

All three “experts” indicated that their ABR training, has for the most part, been a compilation of on the job training, self-taught information, and attendance at seminars. Experts 1 and 2 indicated that they started practicing in the field long before formal classes on ABR were available in graduate school. Therefore, most of their knowledge was independently obtained.

In like fashion, the “non-experts” received their training from a variety of venues. Seventy-nine percent ($n=30$) of the respondents indicated that they received ABR training while in graduate school. Sixty-eight percent ($n=26$) indicated they were trained on the job, while 36.8% ($n=14$) and 15.8% ($n=6$) learned from seminars or were self-taught respectively. Bear in mind that most of the respondents selected more than one answer to this question to reflect a combination of different forms of education.

Summary and Conclusions

The first research question was whether or not a standard referral pattern for ABR neurodiagnostic testing could be identified. Based on the findings of this study there does not appear to be a standard pattern, although several potential “critical components” for referral could be identified. Thus, in answer to the second research question, the critical components for referral appear to be the presence of: (1) unilateral tinnitus; (2) positive reflex decay; (3) word recognition rollover; and (4) asymmetric SNHL. All three experts selected these four symptoms as indicative of consideration for ABR referral. In addition, in answer to the third research question, the majority of practitioners reported that these symptoms were reasons for consideration for referral, thus reflecting utilization of apparent critical components.

Although critical components could be identified, there was not uniform agreement as to the definition of asymmetric SNHL. In addition, there was not a clear indication of how many symptoms needed to be present in order for an ABR referral by the experts, with two indicating one symptom was sufficient, and the third indicating three or more must be present. Practitioners, too, did not express clear agreement,

although the majority did indicate one symptom was sufficient. Interestingly, the “experts” who would refer based on one symptom indicated that the symptom had to be either unilateral tinnitus or reflex decay. Practitioners indicated that they would refer based on these and the singular presence of several other symptoms. Perhaps this indicates that practitioners are more concerned about possibly missing retrocochlear pathology based on audiological testing than are the experts.

Although not considered a critical component for ABR referral by all experts or the majority of practitioners, it is of interest to note that two definitions were primarily given for asymmetric word recognition testing. These were either a 20% as reportedly suggested by Jerger or the use of Raffin and Thornton’s (1980) data for determining critical differences.

Surprisingly, the experts had mixed opinions as to whether or not standardization should even exist. Expert 2 clearly indicated that he did not believe that standard guidelines should be developed for ABR referral patterns. Expert 1 also stated that he believed standardization would be too difficult to attain. He expressed concern that we, as practitioners, may lose sight of the “big picture” if we attempt to standardize our practices. Expert 3, however, looks at this issue from a different perspective and indicated that there is a need for improved consistency within our practices. He believes that efforts should be made not to “standardize”, but to develop “accepted practice guidelines” within our profession. This should be done not only for ABR referral, but other practices as well. In addition, he suggested that with the increased interest in auditory neuropathy in children, improvement in ABR referral patterns might become especially important.

Although there appeared to be some consistency in terms of practice patterns across experts and across practitioners, there were also many inconsistencies. Examples of this are the aforementioned differences in definitions for asymmetric SNHL and asymmetric word recognition. Clearly, further research may help in the development of consistent definitions and practices in order for best practice patterns to be developed.

If further research were to be conducted it would be important to increase the sample of “experts” and “non-experts.” One of the primary goals in conducting a questionnaire survey is to obtain a high return rate (Gall, Borg, & Gall, 1996). A high return rate is needed to accurately generalize from the sample’s data to the population that it is intended to represent. Most often, the target response rate is approximately 50-60%. A return rate less than 50% may, in some respect, limit the generalizability of the findings and should be interpreted with caution. Thus, in the present study, a return rate of only 30% indicates that special consideration may be warranted when interpreting the findings.

In such a study the use of Delphi methodology may be useful. The Delphi technique is a means of securing expert convergent opinion without bringing the experts together in face-to-face confrontation (Merriam & Simpson, 1995.) With this method, the opinions of experts are obtained through the use of successive questionnaires and feedback with each round of questions being designed to produce more carefully considered group opinion. This type of study may be ideal for discerning the critical components of ABR referral and may lead to the development of suggested “best practice guidelines.” If such a study were to be conducted, the results of the present investigation could be used as the initial starting point. In addition to further clinical research, the development of an interest group or task force may be helpful in establishing these guidelines.

Although the small sample size suggests that caution should be taken in generalization, the results of this study support the following conclusions.

1. There is not a standard referral pattern for auditory brainstem response testing as a neurodiagnostic tool.
2. The critical components for referral appear to be the presence of: (1) unilateral tinnitus; (2) positive reflex decay; (3) word recognition rollover; and (4) asymmetric sensorineural hearing loss.
3. “Non-expert” practitioners do appear to utilize the apparent critical components in the referral decisions for neurodiagnostic ABR.

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Appendix A: ABR Referral Survey

Date

Dear Audiologist,

As part of my doctoral studies at the University of South Florida, I am conducting a survey of practicing audiologists in the United States to identify referral patterns for **auditory brainstem response (ABR)** testing. The ultimate goal of this survey and future studies is to establish a "best practice," or standard, referral protocol for practicing audiologists and their referral sources.

Please carefully consider the following questions regarding your actual referral patterns for ordering an ABR as a *neurodiagnostic tool*. Also, I would be interested in knowing the criteria used by those who refer ABRs to you, if your referral sources are willing to share this information. After you have completed the enclosed survey, please email your responses to *snfelder@aol.com*.

The survey should only take a few minutes of your time and may yield important information for establishing standard ABR referral criteria of "best practice" standards. Your cooperation will be much appreciated. Please call me at (813) 971-0025 or email me at the previously mentioned address if you have any questions.

Respectfully,

Shannon N. Felder, M.S., CCC-A
Au.D. Candidate (4th year)
University of South Florida

INSTRUCTIONS FOR RESPONDING:

1. Scroll down to the survey
2. **Copy the survey** by highlighting the text, selecting the "**edit**" toolbar, and clicking on the word "**copy**."
3. Then click on the "**reply**" button.
4. "**Paste**" the survey onto your response email (it may do this automatically).
5. Answer questions accordingly by placing an "X" in the appropriate blanks. Once completed
6. Click on "**send**" button

ABR REFERRAL SURVEY

Please define your practice by placing an "X" by one of the following:

- | | |
|---|---|
| <input type="checkbox"/> Private practice alone | <input type="checkbox"/> Community medical clinic |
| <input type="checkbox"/> Private practice ENT physician | <input type="checkbox"/> University clinic |
| <input type="checkbox"/> Employed by ENT physician | <input type="checkbox"/> Hearing aid office |
| <input type="checkbox"/> Hospital practice | <input type="checkbox"/> Balance center |
| <input type="checkbox"/> VA Hospital | <input type="checkbox"/> Other (Please specify) |

1. Do you perform or refer ABRs for *neurodiagnostic purposes* in your practice?

Yes No

2. Do you perform otoacoustic emissions as part of your neurodiagnostic protocol?

Yes No

3. Approximately how may ABRs do you perform monthly? _____

4. On average, how many abnormal ABRS do you identify per month? _____

5. If you have an abnormal ABR, what is your most common follow-up protocol?

For example, if you obtain an abnormal ABR, how do you follow-up to assess CNS abnormality?

- | | |
|--|--|
| <input type="checkbox"/> Do not assess | <input type="checkbox"/> CT scan |
| <input type="checkbox"/> MRI | <input type="checkbox"/> PET |
| <input type="checkbox"/> ENG | <input type="checkbox"/> Other (Please list) |
| <input type="checkbox"/> ENT referral | |

Comments:

6. Based upon your findings to date, what percentage of abnormal ABRS identified in your clinic have been confirmed as retrocochlear pathology or CNS abnormality? Please provide an estimate, if possible _____ %

8. Do you agree that each of the following symptoms or audiologic findings should warrant consideration for ABR referral?

a. unexplained asymmetric sensorineural hearing loss Yes _____ No _____

b. unilateral tinnitus Yes _____ No _____

c. dizziness Yes _____ No _____

d. unexplained feeling of fullness in the ear Yes _____ No _____

e. poor word recognition Yes _____ No _____

f. asymmetric word recognition Yes _____ No _____

g. word recognition rollover Yes _____ No _____

h. inconsistent (absent) acoustic reflex thresholds Yes _____ No _____

i. positive reflex decay Yes _____ No _____

j. Other (please list) _____

9. In your opinion, how many of the aforementioned symptoms must be present before an ABR referral is warranted?

- Only one
 At least two
 Three or more

Please explain your answer:

10. Which of the symptom(s), if any, warrant ABR referral solely based on the presence of *one symptom*?

- | | |
|--|---|
| <input type="checkbox"/> unexplained asymmetric SNHL | <input type="checkbox"/> asymmetric WR scores |
| <input type="checkbox"/> unilateral tinnitus | <input type="checkbox"/> word recognition rollover |
| <input type="checkbox"/> dizziness | <input type="checkbox"/> inconsistent AR thresholds |
| <input type="checkbox"/> unexplained fullness | <input type="checkbox"/> positive reflex decay |
| <input type="checkbox"/> poor WR scores | <input type="checkbox"/> none of the above |

Comments:

10. What is your definition of asymmetric sensorineural hearing loss? (include specific threshold differences and # of frequencies if necessary) Please provide your reference for this definition if available.

11. What is your definition of asymmetric word recognition? Please provide your reference for this definition if available.

12. Where did you obtain your ABR training?

- | | |
|--|---|
| <input type="checkbox"/> Graduate school | <input type="checkbox"/> Self-taught |
| <input type="checkbox"/> On the job training | <input type="checkbox"/> Seminar/workshop |

Appendix B: Expert and Non-expert Responses / Data Analysis

Expert Responses to ABR Referral Survey

Practice setting:

Expert 1: Hearing Research Lab, Medical Center

Expert 2: Hospital practice

Expert 3: Hospital practice and community medical clinics.

Question 1: Do you perform or refer ABRs for neurodiagnostic purposes in your practice?

Expert 1: Yes

Expert 2: Yes

Expert 3: Yes

Question 2: Do you agree that OAEs should be performed as part of the neurodiagnostic protocol?

Expert 1: Yes, we perform them as a standard in our facility primarily for two reasons 1.) To learn how we could use them early on to crosscheck with behavioral audiogram (use TOAEs). If emissions are present, you should have normal behavioral thresholds. 2.) I work in a university setting and we've always been doing them

Expert 2: Yes, I recommend performing them to ruleout possible auditory neuropathy. If emissions are present, should have normal behavioral thresholds

Expert 3: OAEs do not need to be conducted as part of a neurodiagnostic protocol. It is a matter of the question you are attempting to answer. Most often it is, "is this audiometric asymmetry occurring because of a cochlear disorder, and VIIIIn disorder or a combined disorder. The major question is the VIIIIn disorder and this can be answered with the ABR. If the ABR is normal then it is assumed the asymmetry is caused by a cochlear disorder.

Question 3: How many ABRs do you perform monthly?

Expert 1: Fewer adults than we used to, approximately 5-7 per month. We see approximately 8-9 babies per month

Expert 2: Much less than before, now approximately 3-4

Expert 3: At the hospital (not the medical centers) we do approximatley 12 ABRs for neurodiagnostic purposes. 6-7 years ago we did approximately 30/month.

The difference is due to the improved diagnostic sensitivity of MRI scanning for the identification of small tumors balanced against the reported 30% false negative rate for ABR for these small tumors.

Question 4: On average, how many abnormal ABRs do you identify per month?

Expert 1: Not exactly sure and I can't give you a good estimate

Expert 2: less than 20%, about 1 in every 5

Expert 3: Estimate is 1-2 abnormal ABRs/month

Question 5: If you have an abnormal ABR, what is your most common follow-up protocol?

Expert 1: We have two working clinics which include the ENT department of our Medical School. Most of our patients are referred to ENT for follow-up.

Expert 2: If the patient was referred to us by an otolaryngologist, then abnormal ABRs are generally referred back to that physician. If the patient was referred from

another outside then they are typically referred for MRI with gadolinium by a neurotologist.

Expert 3: We work with ENT so if the ABR is abnormal patients go directly to MRI with gadolinium contrast.

Question 6: What % of abnormal ABRs identified in your clinic have been confirmed with retrocochlear involvement?

Expert 1: No idea

Expert 2: At least 75% or greater. Used to report hit rates of approximately 96% but that was probably regarding larger sized tumors. It truly depends on the size of the tumors. MRI, in my opinion, is not the gold standard for confirmation. The only true standard is surgical confirmation.

Expert 3: Estimate is 75%. Understand though, that the gold standard is MRI which identifies only structural, not functional disease. My guess is that many of the grossly abnormal ABRs we see (the other 25% with I-V IPLs of 4.8 msec and greater) may be "grown up" auditory neuropathy patients.

Question 7: Do you agree that the following symptoms or audiologic findings should warrant consideration for ABR referral?

Unexplained asymmetric sensorineural hearing loss

Expert 1: Yes

Expert 2: Yes

Expert 3: Yes

Unilateral tinnitus

Expert 1: Yes

Expert 2: Yes

Expert 3: Yes

Dizziness

Expert 1: Unexplained dizziness, Yes

Expert 2: No (only if another factor is present)

Expert 3: No

Unexplained feeling of fullness in the ear

Expert 1: Yes

Expert 2: No (would probably consider endolymphatic hydrops)

Expert 3: Yes, and also ECoChG

Poor word recognition scores

Expert 1: Yes

Expert 2: No, would have to consider age of patient, period of onset, the natural course

Expert 3: No (yes if WRS is asymmetric, testing was CD and asymmetry was evaluated against Thornton and Raffin criteria)

Asymmetric word recognition scores

Expert 1: Yes

Expert 2: No, not too concerned if other audiometric findings support it (i.e. Hunters)

Expert 3: Yes, if testing was CD and asymmetry was evaluated against Thornton and Raffin criteria.

Word recognition rollover

Expert 1: Yes

Expert 2: Yes, especially if it is unilateral

Expert 3: No for NU-6, Yes for SSI

Inconsistent or absent acoustic reflex thresholds

Expert 1: Yes, acoustic reflexes are a BIG indicator in my opinion

Expert 2: No

Expert 3: Only if unilateral

Positive reflex decay

Expert 1: Yes

Expert 2: Yes

Expert 3: Yes

Other (please list)

Expert 1: None listed

Expert 2: Generally anything unilateral, unilateral facial weakness, pain, ataxia, severe headaches.

Expert 3: None listed

Question 8: How many of the aforementioned symptoms must be present before an ABR referral is warranted?

Expert 1: Only one in general. I would, however, want to see more with unexplained fullness

Expert 2: Typically three or more. Rarely do you find only one symptom, they usually come in combination

Expert 3: Only one

Question 9: Which of the symptom(s), if any, warrant ABR referral based solely on the presence of one symptom?

Expert 1: All of them

Expert 2: Unilateral tinnitus, positive reflexes decay (for frequencies lower than 4KHz). Usually recommend monitoring and re-evaluation of patient after 6-12mos. Don't always have to refer immediately. These tumors are slow growing and generally don't cause much harm after only a short period of time.

Expert 3: absolutely unilateral tinnitus (highest positive predictor)

Question 10: What is your definition of asymmetric SNHL? Please provide your reference:

Expert 1: 5dB difference at 3 adjacent frequencies or 10dB difference at 2 adjacent frequencies. Reference is unavailable

Expert 2: Difference of 10dB HL or more at 3 frequencies (they do not have to be consecutive frequencies) This was adopted from the Academy of Otolaryngology Referral Guidelines)

Expert 3: I have no definition of asymmetric sensorineural hearing loss. It becomes "organic." In the extreme it is easy to define. Once it becomes "grey" it becomes more difficult. That is, a 15 dB difference at 1 frequency or 10 dB difference at 2 or > frequencies is a common criteria. However, the test/retest variability (on the part of the tester and testee) could explain this variability. It is a poor answer, but experience helps one decide when an "asymmetric" audiogram is truly asymmetric.

Question 11: What is your definition of asymmetric word recognition? Please provide your reference?

Expert 1: If the score falls outside of the expectations of cochlear hearing loss (in other words, is it consistent with puretone thresholds?). Depends, but 20% difference is my working start (Yowan, Jerger, Phifer?)

Expert 2: 20% or more difference (Jerger 1970's)

Expert 3: Same as answer for asymmetrical SNHL, but I would add also the mode of presentation (MLV versus, CD) has a profound effect on scores. Also, as stated above, one has to take into consideration the Thornton and Raffin data that is available for helping to determine, for a given number of words, presented by tape, how big of a difference between ears is significant.

Question 12: Where did you obtain your ABR training?

Expert 1: On the job initially, self-taught, and seminars

Expert 2: On the job and self-taught

Expert 3: Graduate school and self-taught

Additional comments:

Regarding standardization of ABR

Expert 1: Hard to standardize ABR referral protocols,....look at vestibular

rehabilitation, you encounter the same thing. If we try to standardize, we may lose sight of the big picture.

Expert 2: I'm not sure if the term "standardize" is appropriate for ABR referral. I do feel that there is plenty of room for consistency within our practices and maybe the development of "accepted practice guidelines" is more appropriate. This may especially be important for ABR practices with children in detecting auditory neuropathy. National efforts in establishing some type of panel may be necessary for developing these types of guidelines. (Not only for ABR, but other practices as well)

Expert 3: There should not be a standard referral protocol for ABR.

Regarding ABR vs.MRI:

Expert 1: It is true that ABR sometimes fails to detect small lesions, but you must consider where you are in cost. Screening MRI is only as good as the cut. ABR is less costly than MRI and could be used as a triage. Efforts are also be made to refine ABR techniques to make them more sensitive (Stacked ABR methods). Let's find improvement in our techniques and see if there's a way to make it more sensitive before we rule it out altogether.

Expert 2: Depends on the goal. Do you want to identify small tumors or large ones? Small tumors are slowly growing and often harmless. If a small tumor arrives from the auditory nerve then ABR is sensitive, if not, then it may be missed. Stacked ABR may be effective in detecting these tumors, but I'm skeptical about the cost effectiveness of that procedure. If audiologists were smart, they would develop a screening ABR that would also be cost effective for their practice. It's less expensive than MRI, takes only a few minutes and could be repeated every 6-12mos (along with behavioral audiometrics) to monitor. There is a chance that it may miss small growing tumors, but it will not miss a large one. And how many people actually come back with confirmed retrocochlear pathology identified by MRI? This would be interesting to determine.

Expert 3: This has become a real problem. When I talk about this, I place

the discussion in terms of, "If your mom/dad/sister/brother was suspected of having a benign brain tumor which test would you want them to have for purposes of diagnosis. One that would identify the tumor 70% of the time, or one that would identify the tumor 100% of the time?" The problem is that "acoustic tumors" actually are "vestibular schwannomas." That is, they begin on the vestibular division of VIII in most of the time. Because of that, ABR cannot be expected to always identify these tumors, especially the small ones. Yet, in the best centers, early identification means, early removal and the best possibility of preserving useful (functional) hearing when intraoperative monitoring is used. So, it is hard to argue with docs who refer straight to MRI.

The last point in this controversy is the criteria "we" use to determine whether an ABR is normal or abnormal. Across the USA you will find sometimes a pretty big difference. In these studies that have reported the ABR is a poor predictor, my guess is that sometimes the audiologists weren't well-skilled and that led to the ABR getting a bad reputation.

DATA ANALYSIS – Non-Expert Responses**Return Rate**

178 mailed	53 received	30%
------------	-------------	-----

Practice Setting:

Private Practice	4	7.5%
Private Practice/ENT	0	0%
ENT Physician	5	9.4%
Hospital	10	18.9%
VA	12	22.6%
Commun Med	3	5.7%
University	6	11.3%
Hearing Aid	5	9.4%
Balance	0	0%
Other	7	13.2%

Question 1

Do not refer	15	28.3%
Do refer	38	71.6%

Question 2

Perform OAEs	21	55.3%
Do not perform OAEs	17	44.7%

Question 3

0-10	29	76.3%
11-20	4	10.5%
21-30	3	10.7%
31+	1	2.6%

Question 4

Could not answer	3	7.9%
<1	15	39.5%
1-5	18	47.4%
>5	2	5.3%

Question 5

Do not assess	0	0%
MRI	15	39.5%
ENG	0	0%
ENT	18	47.4%

CT Scan	2	5.3%
PET	2	5.3%
Other	4	10.5%

Question 6

0-10%	21	55.3%
11-20%	2	5.3%
21-30%	0	0%
31-40%	0	0%
41-50%	2	5.3%
Don't know	13	34.2%

Question 7 – Asym SNHL

Yes	35	92.1%
No	3	7.9%

Unil tinnitus

Yes	31	81.6%
No	6	15.8%
No answer	1	2.6%

Dizziness

Yes	22	57.9%
No	16	42.1%

Fullness

Yes	21	55.3%
No	17	44.7%

Poor WR

Yes	19	50%
No	19	50%

Asym WR

Yes	31	81.5%
No	6	15.8%
No response	1	2.6%

Rollover

Thrown out due to typo		
Yes	10	71.4% of 14
No	4	28.6% of 14

AR

Yes	16	42.1%
No	19	50%
No response	3	7.9%

Reflex Decay

Yes	34	89.5%
No	4	10.5%

Other

Yes	18	47.4%
No	20	52.6%

Question 8

Only One	21	55.3%
At least 2	14	36.8%
3 or more	1	2.6%
Could not answer	2	5.3%

Question 9

Unexplained Asym SNHL	31	81.6%
Unil tinnitus	12	31.6%
Dizziness	3	7.9%
Unexplained fullness	6	15.8%
Poor WR	7	18.4%
Asy WR	17	44.7%
Rollover	7	18.4%
AR thresholds	5	13.2%
Pos decay	21	55.3%
None	4	10.5%

Question 12

Grad School	30	78.9%
Job	26	68.4%
Self-taught	6	15.8%
Seminar	14	36.8%

DEFINITION OF ASYMMETRIC SNHL

<u>RESPONDENT#</u>	<u>DEFINITION</u>
16	Hearing loss greater in one ear at more than 1 test frequency, unless that asymmetry is larger than 20-25 dB. If asymmetry persists at 2 test frequencies, larger than 10dB – that is an asymmetrical hearing loss.
17	15dB or greater at two adjacent frequencies
18	+ or – 5dB is generally accepted as the test/retest reliability of puretone thresholds. Threshold differences greater than 5dB are significantly different. A threshold difference between ears 10dB or greater identifies an asymmetry. When the threshold of the poorer hearing ear reaches 25dB HL, (and the middle ear function is normal) an asymmetric SNHL is present. I am unaware of simple definition of a clinically significant asymmetric SNHL.
19	A difference of 20dB at two consecutive frequencies
20	Unexplained asymmetry based on two or more consecutive whole octave frequencies.
21	A difference of 15dB or > between ears at 2 or > consecutive frequencies in the presence of a SNHL. Reference??
22	To my knowledge, there is no uniform pattern. No asymmetry in the presence of other symptoms is provocative. Any unexplained asymmetry should be suspect.
23	20dB at any one frequency unexplained by audiometric history (per Dr. Bartels suggestion)
24	20dB diff at two frequencies
25	Greater than 15dB at 2 or more frequencies
26	Greater than 15dB difference between two or more thresholds between ears. Sorry, I don't have a reference for you. I think it may be from Katz
27	–
28	15dB difference between two frequencies. Graduate school
29	10-15dB SNHL difference at two or more frequencies. Reference: ENT physician
30	At least a 15dB difference at 2 or more frequencies
31	A difference of 20dB (or greater) at any one frequency
32	An asymmetry of 20dB in the highest frequencies 4-8K is the type I would be concerned about, and evaluate carefully history and other soft signs. When the asymmetry is about 40dB in these highest frequencies, I will recommend to the physician that imaging studies be done rather than ABR
33	45dB at 1 frequency, 35-45dB at 2 frequencies, 25-35dB at 3 frequencies

- 34 1. 15dB difference between ears, at any one Hz, 2K,3K,4K, 6K, 8K Hz.
2. Any one or more Hz, but not < 1KHz (i.e. 500,250Hz etc)
No reference
- 35 When I look at it and it looks asymmetric. At least 20dB difference between ears @ adjacent frequencies
- 36 –
- 37 –
- 38 +10dB difference for more than 1 frequency typically from 1-8KHz
- 39 Any asymmetry outside the 5dB test-retest difference
- 40 It varies by physician, but they usually are interested in a 15-20dB difference in threshold.
- 41 15dB difference at 500 Hz to 2K Hz in one or both ears
- 42 15dB difference at 2 or more frequencies or greater than 15dB at one frequency (Lokenberg, 2000)
- 43 A difference of > or =15dB HL at two consecutive frequencies
- 44 Asymmetric SNHL is a difference of 20dB HL between the ears at 2 or more frequencies
- 45 Don't use specific numbers
- 46 No reference, but if I find more than 15-20dB asymmetry, primarily in the high frequencies, I would consider it asymmetrical
- 47 15dB of asymmetry at 2 octave frequencies. Professional judgement is used if this is not the case, but the patient is presenting other symptoms
- 48 –
- 49 15dB difference at one octave frequency or 10dB at 2 octave frequencies
- 50 Difference of 15dB HL or more at 2 or more frequencies
- 51 Greater than 10dB difference at 2 consecutive frequencies
- 52 25dB or more interaural difference in 1-8KHz range with at least two octave frequencies affected. Kileny, Telian, & Kemink (1991); Acoustic Neuroma Dx and Management, (IN) Dx Audiology (Jacobson & Northern, Eds.), Pro-Ed Publishers, Austin, TX
- 53 10dB difference at 2 consecutive frequencies or 15dB difference at any one frequency

DEFINITION OF ASYMMETRIC WORD RECOGNITION

<u>RESPONDENT #</u>	<u>DEFINITION</u>
16	I consider asymmetric word recognition a difference of 20% or greater.
17	16% difference or greater.
18	Significantly different scores between ears on word recognition tests, Raffin and Thornton (1980) Confidence levels for differences....JSHR
19	A difference of 30%.
20	With similar pure tone thresholds, values that exceed Thornton and Raffin binomial theory values for significant differences.
21	A difference of 20 dB or greater between ears. Reference?
22	Word recognition scores beyond +3 S.D. from AI predicted word recognition score (Virtual Audiogram)
23	8 -12 % unexplained by audiometrics (Per Dr Bartel's suggestions)
24	Greater than 20%.
25	A difference greater than 20%.
26	Greater than 20% difference between ears. (Jerger and Stach)
27	20% difference or greater between ears or positive rollover.
28	More than 10 % difference between ears.
29	This depends on the actual score. Would consider 12-15% for better recognition scores. When scores are already very poor, looking for greater than 25% difference. Before making a referral for ABR, based only on asymmetric word recognition scores, I would repeat test and make sure presentation was at MCL.
30	A difference of at least 20%.
31	20% difference.
32	Greater than Thornton and Raffin binomial distribution expected variation, assuming essentially equal sensitivity in each ear.
33	20% difference or greater.
34	16% difference between ears with roughly the same pure tone average. No reference.
35	At least 40% difference.
36	—
37	—

- 38 Greater than 20% difference between ears.
- 39 Greater than or equal to 12%. Personal communication for Chuck Berlin
- 40 20 point difference.
- 41 A difference between 40% and speech recognition scores between ears.
- 42 Don't remember the reference.
- 43 Greater than 20% difference on 50 word list.
- 44 When word recognition is worse in one ear than compared to the other, ie 100% vs. 60%, but the hearing thresholds are symmetrical. I would refer if the hearing was symmetrical but recorded word recognition is poorer than expected.
- 45 20%
- 46 No definition, but in general, if they differ by more than 20%.
- 47 Asymmetric word recognition is variable!!!! We have had many discussions with our ENTs about this. I'm sorry but I can't give you an exact number. For example, I had a patient last week with symmetrical hearing loss, traditional for VA, sloping down from 250Hz to a severe SNHL. His word recognition, though, was 88% AD and 30% AS. I consider that very significant and he was referred for an MRI, not an ABR.
- 48 -
- 49 -
- 50 More than 20% difference
- 51 Greater than or equal to 20% difference
- 52 Greater than 12% difference between ears, assessed at single presentation level
- 53 -

PRACTICE SETTING COMMENTS

<u>RESPONDENT #</u>	<u>COMMENT</u>
5	University Medical School (pediatric facility)
10	Public School
13	Health Science Administrator

QUESTION 5 COMMENTS

<u>RESPONDENT #</u>	<u>COMMENT</u>
16	(Other) Otologic referral
18	Referral for otologic evaluation
22	In our institution we use high speed High Res MRI on high suspicion cases, then ABR, for low suspicion cases, we use ABR/ENG
24	Abnormal may also reflect cochlear problem, no MRI is performed
26	Pt is referred back to the referring physician or if no referring physician they are referred to an ENT
29	By ENT report, do you mean ENT referral? Referral to ENT is most common f/u protocol and secondly if ABR is equivocal I would repeat ABR test in several months and/or monitor hearing levels

QUESTION 6 COMMENTS

<u>RESPONDENT #</u>	<u>COMMENT</u>
32	I don't get the feedback on final diagnosis. I fail to rule out retrocochlear pathology in about 10% of the ABRs done.
35	I've never had an abnormal ABR.
52	Sorry, cannot provide estimate as I'm not always aware of imaging outcome.

QUESTION 7 COMMENTS – Asym SNHL

<u>RESPONDENT #</u>	<u>COMMENT</u>
32	Send directly for imaging studies, skip ABR

QUESTION 7 COMMENTS – Dizziness

<u>RESPONDENT #</u>	<u>COMMENT</u>
29	Depends on description of dizziness
32	Depends upon either symptoms, “dizziness” is too vague a term. Would not automatically do an ABR
35	Unexplained and central findings on ENG

QUESTION 7 COMMENTS – Poor WR

<u>RESPONDENT #</u>	<u>COMMENT</u>
32	Depends what you mean by “poor”, and at what intensities

QUESTION 7 – Reflex Decay

<u>RESPONDENT #</u>	<u>COMMENT</u>
32	Depends – the entire battery of tests would determine what is the appropriate referral. This is certainly a risk factor, but I don’t know that an asymptomatic patient with reflex decay as the only finding would be referred for an ABR

QUESTION 7 COMMENTS - Other

<u>RESPONDENT #</u>	<u>COMMENT</u>
18	1. Previously normal imaging and continued concern for hearing loss; 2. Patient declines referral for imaging; 3. Family history of disease involving central auditory pathways; 4. Suspicion or history of multiple sclerosis
22	History consistent with retrocochlear or history inconsistent with other otologic condition
23	Subjective not consistent with objective
26	Abnormal acoustic reflex pattern in combination with HL, poor word recognition, etc....
29	Patient with sincere complaint of hearing problem in the absence of other abnormality on standard hearing test
33	Usually do not base on one symptom alone- depending on the symptom
34	Taste of metal in mouth, facial paralysis
38	Normal OAEs with abnormal behavioral testing results
39	Absent acoustic reflexes
44	I think all of these symptoms are important especially if they have more than one of the above

- 45 Pt reported “numbness”, “pressure”, “tingling”, or “pain” on the questionable side
- 48 Not necessarily only one the symptoms, but a combination for certain ones. We’ll do ABR for asymmetrical hearing only but would not if only has aural fullness
- 49 positive tone decay, positive PI function
- 52 Our neurodx ABR Criteria:
1. Asymmetrical hearing loss: 25dB or more interaural difference in 1-8kHz range with at least two octave frequencies affected.
 2. Tinnitus (esp unilateral after ruling out cochlear etiologies such as hydrops, noise exposure).
 3. Vertigo (not dizziness) and #1
 4. Unexplained facial weakness/numbness.
 5. Absent or elevated contralateral stapedial reflexes not justified by puretone thresholds or tympanograms
 6. Positive reflex decay- hard copy only (not visualized only)
 7. Significant uni- or bilateral reduction of speech recognition scores, partic disproportionate to puretone results
 8. Conditions associated with high risk for retrocochlear lesions such as neurofibromatosis II
- 53 A combination of two or more of these symptoms

QUESTION 8 COMMENTS

<u>RESPONDENT #</u>	<u>COMMENT</u>
16	Based upon pt hx, I believe a c/o ear fullness w/ no mention of h/o allergies, ME problems, etc, is a worthwhile diagnostic indicator for consideration of ABR testing
17	I never recommend ABR. MRI is the gold standard. ABR is virtually useless for neurodiagnostic purposes as it cannot identify small lesions
18	A decision to recommend ABR testing would not be based solely on the presence of one or more of the aforementioned symptoms. A decision to recommend ABR testing would be based on hx, physical examination, behavioral test results and what clinical questions must be answered to provide satisfactory patient care.
19	Depends on which symptom is present. For example, if a pt has unilateral tinnitus or asymmetric hearing loss, I would always refer
20	I consider these findings (or symptoms) sufficiently serious that I would rather over refer than miss a retrocochlear lesion.
22	This depends on your index of suspicion. I use the grandmother rule, “if it were my grandmother, what would I want her to get?” – most of the time this is an MRI as ABRs can miss small tumors. However, this must be weighed against cost and the probability that we could do something if a retrocochlear lesion were identified. For ex: a frail 102 yr. old with marginal symptoms is likely to

- die from other causes and is not a candidate for most treatments.
- 23 Depends on the symptom –example, unilateral tinnitus or positive decay or rollover...some of the other symptoms may need more than one such as dizziness
- 24 It really is contingent on which is abnormal.
- 25 Depends on which symptom. Unilateral tinnitus alone is enough to warrant further testing as is asymmetric hearing loss/word recognition
- 26 I would recommend ABR is only one of the above mentioned in present; however, it depends on the history. If they have an asymmetric HL, but go hunting every weekend without ear protection and the audiometric configuration is a noise notch then I may reconsider. I really look at the whole picture in order to make a determination.
- 27 If one of the above mentioned symptoms is present , a recommendation for an ABR is made to the ENT, but it is the decision of the ENT to perform an ABR or another CNS test
- 29 Only one if the symptom is new, or has previously not been evaluated. If poor word recognition scores bilaterally were the only symptom and the scores were present with severe HL, presbycusis, or other cognitive deficit, I would not refer for ABR.
- 32 It entirely depends upon which symptoms are present. This is too simplistic a “formula”
- 33 Usually do not base on 1 symptom alone – depending on the symptom
- 38 i.e. Asymmetric SNHL or positive reflex decay
- 39 There is no set protocol for referral in my opinion. Each case must be evaluated individually based on symptoms, audiologic results, and patient history
- 40 Our clinic will usually perform an ABR on any patient with unilateral hearing loss and tinnitus with no positive history of noise exposure that would account for asymmetry
- 42 Asymmetric WR and inconsistent reflexes and asymmetric HL are the three big ones for me
- 43 I suppose it depends on the duration and severity of the symptom(s). For example, if 7a (unexplained asymmetrical SNHL) has been present for 20 years because sequelae, I wouldn’t refer but would if sudden onset.
- 44 Sudden hearing loss would be the only symptom present with no other problems that I would refer. Most of the other symptoms mentioned would have to be present with another symptom.
- 45 More than one makes the case stronger, but one is enough for ABR referral
- 46 In isolation, I don’t think I would refer for any of these symptoms alone – at LEAST 2 would have to be present.

- 48 It depends on the symptom
- 49 Most of these things can occur due to high false positive rates of the testing, or patients being poor reporters of their health
- 50 I think unexplained asymmetric HL in itself is enough to warrant concern. However, in the presence of other symptoms, as listed above, I would be likely to refer if there were two or more, whether the asymmetry met my criteria or not.
- 52 Any of the above symptoms will qualify for ABR Rx

QUESTION 9 COMMENTS

<u>RESPONDENT #</u>	<u>COMMENT</u>
20	Unexplained asymmetry based on two or more consecutive whole octave frequencies
32	I don't think this fits a check box. A mild asymmetry with another symptom might warrant an ABR, but if the asymmetry is marked, imaging studies would be more appropriate. Typically we do ABRS when there is one to two soft signs
39	Unilaterally absent reflexes would also warrant a referral. Inconsistent reflexes implies to me that they are present, but that equipment and/or interpretation is not consistent
42	I really think that just one of those in isolation is not enough to warrant further testing for retrocochlear

SURVEY COMMENTS:

<u>RESPONDENT #</u>	<u>COMMENT</u>
17	I rarely perform neurodiagnostic ABRs in adults. I conduct tonal/threshold ABR I children often. I often remind referral sources that ABR is not nearly reliable as MRI.
22	Please think about the sensitivity and specificity of the ABR in detecting various types of lesions. An ABR is not very sensitive to small tumors (Ruckenstein et al, 1996). MRI is not sensitive to small vessel occlusion / CVAs in the posterior fossa. For high suspicious cases, r/u mass w/MRI, then look at function with ABR. For low suspicion cases, ABR (really to gather evidence for waiting rather than being more aggressive.) However, MRI is getting so cheap – I think go with MRI first. We owe it to the patient.
25	Our clinic sees more complicated cases than most and therefore will be doing more testing than some.
26	Patient complaints are an important part of the determination process

