A Survey of Canadian Audiological Practices: Immittance Measures

Pratiques en audiologie : l'immitancemétrie

Laurie MacDonald
Walter B. Green

Abstract

The purpose of this investigation was to examine current clinical practices among Canadian audiologists with respect to aural immittance measures. A survey was sent to 170 randomly selected Canadian audiologists who were members of the Canadian Association of Speech-Language Pathologists and Audiologists (CASLPA). The survey was designed to gather information on the procedures and practices of clinical audiologists when obtaining measures of middle-ear immittance which could then be compared with comparable surveys from the United States and with the current scientific literature. Of the original 170 surveys mailed out, 102 were returned (60%). The results were compiled and analysed descriptively. In general, the data suggest that audiologists are using measures of immittance for two primary purposes: (a) to detect middle ear pathology, and (b) to differentiate between cochlear and retrocochlear pathology. Typically, Canadian audiologists used low frequency /single component tympanometry with acoustic reflex elicitation. Respondents also appeared to utilize tympanic peak pressure and acoustic reflex sensation level despite research to the contrary. There was little reported usage of higher frequency probe tones and multicomponent immittance procedures.

Abrégé

La présente enquête vise à examiner les pratiques actuelles des audiologistes canadiens en milieu clinique pour l'immitancemétrie. Nous avons envoyé un sondage à 170 audiologistes canadiens membres de l'Association canadienne des orthophonistes et audiologistes (ACOA) choisis au hasard. Ce sondage a été conçu pour recueillir de l'information sur les procédures et les méthodes utilisées par les audiologistes pour l'immitancemétrie. Le sondage a été construit de sorte que les résultats puissent être comparés à ceux d'autres enquêtes menées aux États-Unis et les ouvrages scientifiques actuels. Sur les 170 sondages postés, nous avons reçu 102 réponses (60 %). Nous avons ensuite compilé et analysé les résultats de manière descriptive. En général, les données semblent indiquer que les audiologistes se servent de l'immitancemétrie pour deux raisons principales : a) détecter une pathologie de l'oreille moyenne, et b) distinguer entre une pathologie cochléaire ou rétrocochléaire. Généralement, les audiologistes canadiens ont recours à la tympanométrie en basses fréquences à composant simple avec déclenchement du réflexe acoustique. Il semble que les répondants utilisent aussi la pression tympanique de crête et le niveau de sensation du réflexe acoustique malgré les résultats de recherche qui indiquent le contraire. Peu de répondants ont indiqué se servir de méthodes utilisant les hautes fréquences ou les procédures d'immitancemétrie à multiples composantes.

Key words: immittance measures, audiological practice, clinical service, survey

Laurie MacDonald
Hospital for Sick Children
Toronto, Ontario

Walter B. Green
Dalhousie University
Halifax, Nova Scotia

Although one would expect clinical audiologists to recognize the value of providing services which are current and scientifically supported, recent surveys of American audiologists have indicated a disparity between that which is practised by audiologists and that which has been recommended in the literature (Martin & Pennington, 1971; Martin & Sides,

1985; Wiley, Stoopenbach, Feldhake, Moss, & Thordardottir, 1995). In a survey conducted by Martin and Sides (1985), the responses of 230 audiologists were examined to determine the most commonly used procedures in their clinical practice. Results of the study indicated a good deal of variability from one clinician to another, particularly for those procedures that are considered the most controversial. For example, audiologists were fairly evenly divided among masking criteria used when obtaining Speech Reception Threshold (SRT). Forty-two percent of audiologists reported masking when a 40 dB or greater difference exists between the SRT of each ear, while 48% masked when a 40 dB or greater difference exists between the SRT of the test ear and the best bone-conduction threshold of the nontest ear (Martin & Sides, 1985).

As has been shown with past audiological surveys (Martin & Pennington, 1971; Wiley et al., 1995), it would be questionable to assume that all audiologists are familiar with current research and have integrated such research findings into their clinical practice. Even if all audiologists were aware of the available literature, financial and/or time constraints may not allow the use of certain techniques in practice.

Based on the American data, it is only logical for Canadian audiologists to be concerned with the state of audiological practices in this country. Although we cannot overtly assume that the situation in Canada is similar to that in the United States, we should be concerned that Canadian audiologists provide optimum services to their patients and families. Unfortunately, information relative to audiological practices in Canada has not yet been examined.

While immittance measures have only become routine in the audiological battery of tests in the past 20 years, the clinical use of such tests dates back over a hundred years when Lucae evaluated the middle ear acoustically (Feldman & Wilber, 1976). The clinical acceptance of immittance measures, however, did not begin to develop until 1957 when studies led to the introduction of the first commercially available electroacoustic impedance instrument, the Madsen ZO61 (Feldman & Wilber, 1976). Since that time, acoustic immittance measures have become a standard part of the audiological evaluation, and in fact, have become one of the areas of assessment with the most growth in the past two to three decades. Research has indicated that more than 93% of American audiologists in 1998 routinely used immittance measures as part of a standard audiological evaluation, while only 15% used immittance measures in 1971 (Martin, Champlin, & Chambers, 1998; Martin & Sides, 1985).

Therefore, it was the purpose of the present investigation to provide information addressing common practice and research evidence by examining the status and use of aural immittance measures in Canada. This study sought to: (a) survey the procedures and practices of Canadian clinical audiologists, (b) review the current literature on limitations of selected tests and procedures, and (c) illustrate any disparities between the published scientific evidence on immittance testing and common clinical practices.

Method

Participants

Surveys were sent to 170 randomly selected Canadian audiologists who were members of the Canadian Association of Speech-Language Pathologists and Audiologists (CASLPA). Surveys were sent to all provinces with the exception of Prince Edward Island; no surveys were mailed to the Yukon or the Northwest Territories. (Nunavut was not yet created at the time of this survey.)

Materials

The survey consisted of two sections. The first section (six questions) was designed to gather data on the audiologists' workplace, experience, and training. The second portion (19 questions) gathered data specifically related to immittance testing.

Procedure

The audiologists surveyed received an introductory letter, an individually coded survey, and a self-addressed and stamped return-envelope. They were asked to complete and return the survey within four weeks of the introductory letter. A copy of the survey can be found in the Appendix.

Results

Demographics

Of the original 170 questionnaires mailed during the fall of 1998, 102 were returned resulting in a response rate of 60%. Ninety-eight percent of the respondents were certified by CASLPA or by both CASLPA and the American Speech-Language-Hearing Association (ASHA). Eighty-two percent held provincial licensure and/or registration.

Nine of the 12 provinces and territories were represented in the survey response; those not sampled were the Northwest Territories, Yukon, and Prince Edward Island. The majority of the respondents were practising in Ontario (32%) or British Columbia (26%), followed by Alberta (8%), Quebec (8%), Nova Scotia (7%),

Saskatchewan (4%), Manitoba (4%), New Brunswick (4%), and Newfoundland (3%). The data from the remaining 5% were excluded from use in this investigation because the respondents were not engaged in clinical practice.

Twenty-five percent of the audiologists sampled had been working in clinical practice for less than five years, 28% had been employed for 5 to 10 years, and 31% from 11 to 20 years. The remainder (16%) had been practising for 20 years or more.

Results indicated that the majority of respondents (71%) worked with both children and adults rather than with a discrete age group. Forty-one percent of those who responded indicated that they worked in public clinics, while 36% reported being employed in private practice settings. Fifteen percent of those surveyed indicated that their workplace varied between a public clinic, private practice, or other settings. Ninety-five percent of audiologists surveyed indicated that they routinely used aural immittance measures as apart of their audiological evaluations.

Survey Instrument

In obtaining measures of immittance, 48% of respondents reported that they 'always' used automatic recording and display of results, while 34% of respondents 'always' used manual recording and display of results. It is interesting to note that when the data were analyzed by clinical setting, 83% of respondents employed in a public clinic 'always or sometimes' used automatic recording, while only 54% of private practice audiologists used automatic recording.

The majority of respondents (46%) reported using a pump speed of 200 daPa/s. This finding, however, may have been a misinterpretation on the part of the respondents. Since most automatic immittance equipment has a default setting of 50 daPa/s (e.g., Grason-Stadler GSI-33 Version 2), one would assume that more respondents would have selected this option for pump speed. In addition, when obtaining measures of immittance with manual equipment, the speed of the pump is variable. Therefore, some respondents may have interpreted this question as inquiring to the pressure "range" measured in tympanometry (typically +200 daPa to -200 daPa; American Speech-Language-Hearing Association, 1990).

Test Battery

With respect to the battery of immittance tests used, 53% of respondents replied that they 'always' obtained measures of absolute immittance (18% replied 'sometimes'). Ninety-one percent of respondents indicated that they 'always' obtained measures of tympanometry with a 226 Hz probe tone. In contrast, 65% of respondents 'never' used a 660/678 Hz probe tone, 80% of respondents 'never' obtained measures of multicomponent tympanometry, and 70% of respondents 'never' obtained measures of multifrequency tympanometry. These trends were homogeneous when analyzed according to clinical setting and years in practice with exception of those that had less than five years in clinical practice, where only 28% of respondents routinely obtained measures of absolute immittance. Thus, a large majority of audiologists (91%) indicated that they used a low frequency probe tone when obtaining measures of immittance. On the other hand, few audiologists indicated that they ever used a 660/678 Hz probe tone, or obtained measures of multicomponent or multifrequency tympanometry.

When those surveyed were asked which acoustic reflexes were routinely elicited, 77% of respondents indicated that they routinely elicited a combination of both contralateral and ipsilateral reflexes (3% contralateral reflexes only, 14% ipsilateral reflexes only), while 5% of respondents indicated they do not elicit acoustic reflexes.

Eighty percent of respondents indicated that they 'always or sometimes' evaluated acoustic reflex decay. Since dramatic acoustic reflex decay is often observed in patients with VIIIth nerve tumors or other retrocochlear pathologies (Northern & Gabbard, 1994), one would assume that the majority of these audiologists might be using acoustic reflex decay test as a screening tool for VIIIth nerve lesions (Wiley & Fowler, 1997). Only 9% of audiologists indicated that they 'always' used reflex sensation level for detecting the presence of loudness recruitment (31% replied 'sometimes').

The survey data revealed that few audiologists routinely used sensitivity prediction procedures. Only 14% of respondents indicated that they 'sometimes' used the Sensitivity Prediction by Acoustic Reflex (SPAR) test (Jerger, Burney, Mauldin, & Crump, 1974). None of the respondents reported 'always using the test.' Seventy-three percent 'never used the test,' and none of respondents indicated that they used the Bivariate Plot (Margolis, 1983).

Referral

When asked under which conditions referrals are typically made, 65% of respondents replied that they 'always' or 'sometimes' refer to a physician in the condition of abnormal absolute immittance. Ninety-two percent of audiologists reported they 'always' or 'sometimes' refer based on abnormal tympanometry. The vast majority of respondents (77%) replied that a referral was made to a physician based on absent reflexes. Only

7% of audiologists 'always' referred based on tympanometric peak pressure outside +100 to -200 daPa range (71% replied that they 'sometimes' refer in this condition), while only 3% of audiologists 'always' referred based on reduced peak pressure gradient (59% replied 'sometimes').

Discussion

The purpose of this investigation was to provide descriptive information concerning the current practices of audiologists with respect to aural immittance measures. The specific goals of this study were to: (a) survey current clinical immittance procedures and practices, (b) compare them with information from the current literature, and (c) illustrate any disparities between current practices and scientific evidence from the published literature.

The return rate of 60% for the questionnaire was judged acceptable as was the distribution across provinces. The distribution of sampled audiologists also appeared to represent the proportional density of practitioners by region. An overview of the responses failed to show discernable regional or provincial differences for the audiological practices under study. Similarly, when compared to information from the United States (Martin et al., 1998) the data are consistent. Martin et al. reported 93% of their participants performed immittance measures, while 95% of the respondents in the present study employed these measures. Similar consistency was noted in the individual components of the immittance test battery (i.e., absolute or static immittance, tympanometry, acoustic reflex elicitation).

Most audiologists surveyed conducted low frequency probe tone, single component immittance on a routine basis. The value of such measures in the detection of middle-ear disease, especially in young children, is well documented. However, very few (almost none) of the responding practitioners reported utilization of tympanometric procedures using higher probe tone frequencies, multicomponent, or multifrequency measures. This trend was homogeneous when the data were examined according to clinical setting and years in practice. That is, the great majority of audiologists (91%) indicated that they used a low frequency probe tone when obtaining measures of immittance. On the other hand, few audiologists indicated that they ever used a 660/678 Hz probe tone, or obtained measures of multicomponent or multifrequency tympanometry. This would imply that clinicians have continued to use qualitative approaches developed in the early 1970s, which have proven satisfactory for most patients. However, advances in instrumentation, as well as a clearer understanding of middle-ear mechanics, middle-ear pathology, and tympanometry now allow for a quantitative analysis of test results. One such approach reported by Vanhuyse, Creten, and Van Camp (1975), known as the Vanhuyse Model, has been influential in expanding our understanding of tympanometric results. Hunter and Margolis (1999) suggested that the Vanhuyse model was "perhaps the most important single contribution to understanding tympanograms" (p. 90).

Theoretically, the use of a high frequency probe tone and multifrequency and multicomponent tympanometry is based on the usefulness of using probe tone frequency to distinguish between mass and stiffness disorders. Higher probe tones have been suggested to be beneficial in the detection of pathological conditions of the middle ear in which the structure of the tympano-ossicular system are significantly altered. Therefore, a high frequency probe tone may be useful in the detection of mass-dominated systems (Margolis & Shanks, 1985). For example, while a 226 Hz probe tone may be useful in detecting a classic stiffening pathology, (e.g., otitis media) it may not be useful in detecting a mass loading or decreased stiffness pathology otitis media or ossicular discontinuity (Hunter & Margolis, 1992). The audiologists sampled in the present survey appear to not be utilizing the full potential of tympanometry especially as it relates to mass-altering conditions.

With the advent of computer technology, the use of multifrequency tympanometry has been suggested as a useful method for distinguishing between mass and stiffness disorders (Hunter & Margolis, 1992). It has also been suggested that multicomponent tympanometry, which indicates the interaction between the measured conductance and susceptance components of acoustic admittance, may provide more valuable information for differentiating between high-and low-impedance abnormalities (Margolis & Shanks, 1985). Other investigations have concluded that higher frequency probe tones are of limited diagnostic value, as they are too sensitive to minor tympanic membrane aberrations (Alberti & Jerger, 1974; Liden, Harford, & Hallen, 1974). However, these past investigations relied on tympanometric shape rather than the interaction of immittance components. Anatomic differences between the infant and the adult middle-ear transmission system are one reason for using multifrequency tympanometry. An infant's ear is typically more of a mass/resistance-governed system that eventually may develop to a stiffness-dominated system as the child matures. Since high frequency probe tones are sensitive to a mass-dominated system, it is suggested that they may be more useful in detecting middle-ear pathology in the infant (Meyer, Jardine, & Deverson, 1997). Due to the large intersubject variability reported in the literature, Meyer et al. (1997)

recommended both high and conventional probe tone tympanograms be performed in infants under six months. It is clear, however, that these techniques are clinically not used at the present time by Canadian audiologists. This is presumably due to the high prevalence of stiffening pathologies in children (Shambaugh & Girgis, 1991), the poor specificity of the test, or simply the lack of clinical background as to the value of these measures. The audiologists who were in sampled in the present survey do not appear to be utilizing the full potential of tympanometry, especially as it relates to mass-altering conditions.

Only 5% of respondents indicated that they do not elicit acoustic reflexes as part of a clinical protocol. These data are encouraging for diagnostic audiology. The contralateral and ipsilateral acoustic reflexes are a powerful tool in audiological evaluation when measured in combination with other components of the immittance battery. As explained by Stach and Jerger (1991), the acoustic reflexes when viewed in isolation can be ambiguous. Analysis of both contralateral and ipsilateral patterns is a powerful tool in the differentiation between conductive, sensorineural, or retrocochlear disorders.

Eighty percent of respondents indicated that they 'always or sometimes' evaluate acoustic reflex decay. Since dramatic acoustic reflex decay is often observed with in patients with VIIIth nerve tumors (Northern & Gabbard, 1994), one would assume that the majority of these audiologists might be using acoustic reflex decay test as a screening method for VIIIth nerve lesions (Wiley & Fowler, 1997). Numerous studies (Glasscock, Jackson, & Josey, 1981; Hall, 1977; Olsen, Bauch, & Harner, 1983; Olsen, Noffsinger, & Kurdziel, 1975; Olsen, Stach, & Kurdziel, 1981) have supported acoustic reflex decay as an efficient diagnostic test in differentiating between VIIIth nerve and cochlear sites of lesion, citing both adequate sensitivity and specificity for the test.

Only 9% of audiologists indicated that they 'always' used reflex sensation level for presence of loudness recruitment (31% replied 'sometimes'). This implies that 40% of the respondents have used reflex sensation level at 'least sometimes' as an indication of the presence of loudness recruitment. Although it has been proposed that the presence of reflex threshold at a reduced sensation level is indicative of loudness recruitment, the relationship between the two is not straightforward. As described by Silman and Silverman (1991), people with mild or even moderate cochlear hearing loss often do not have reflex thresholds at reduced sensation levels; people with more severe cochlear losses often have reflex thresholds higher in dB HL than those for the normal hearing person. The diagnostic usefulness of reflex sensation level to predict loudness recruitment is limited (Hellman & Scharf, 1984). Presumably, a diagnostic impression of loudness-tolerance difficulties could have far-reaching effects with respect to (re)habilitative efforts, especially in the area of amplification. Utilization of acoustic reflex sensation level provides specious information in the specification of loudness recruitment.

The use of acoustic reflex sensitivity prediction procedures has not enjoyed widespread use in the United States (Martin et al., 1998). The audiologists sampled in the present study display this trend as well. These tests are based on the well-documented difference between acoustic reflex thresholds to pure tones versus broadband noise usually referred to as the "noise-tone difference" (Jerger et al., 1974; Margolis, 1993; Niemeyer & Sesterhenn, 1974). This difference in threshold sensitivity, along with tonal acoustic reflex results, is used to provide a prediction for the presence of a sensorineural hearing loss. Prediction of hearing sensitivity by acoustic thresholds can be valuable in evaluating children (or adults, for that matter) on whom behavioural thresholds cannot be obtained. Sensitivity prediction measures would also be useful in cases of functional hearing loss (Stach, 1998). If audiologists typically elicited acoustic reflexes, then the evaluation of such a test would require only one additional measurement — the broadband noise threshold. The data from this survey, however, indicate that very few audiologists have integrated this test into their own clinical battery. This finding simply may be a lack of exposure to the usefulness of this procedure. Nevertheless, sensitivity-prediction measures are a powerful cross-check to behavioural audiometry, especially in children (Stach & Jerger, 1991).

Referral

In regard to referrals, it was obvious that the majority of audiologists do make referrals to physicians in the situation of abnormal absolute immittance, abnormal tympanometry, and absent reflexes. The data also provide information regarding the relative value audiologists place on the basic components of the immittance test battery. For example, abnormal tympanometry had a referral rate of over 90%, while absolute immittance showed a referral rate of 65%. Further, there are a substantial number of clinicians who ' always' or 'sometimes' use the location of tympanometric peak on the air pressure axis of the tympanogram as a basis for referral. Presumably, these respondents assumed that the air pressure in the enclosed ear canal is a reliable estimation of the pressure in the middle-ear space and, therefore, a good indicator of middle-ear pathology. In fact, the location of the pressure peak has been found to be dependant on a number of variables such as the direction of the pressure sweep, location of the pressure transducer, and

changes induced in the ear canal by application of the probe (Van Camp, Margolis, Wilson, Creten, & Shanks, 1986). The use of tympanometric peak pressure as a basis for referral is not recommended (Hunter & Margolis, 1999; Silman & Silverman, 1991; Van Camp et al., 1986; Wiley & Fowler, 1997). The ASHA 1990 guidelines suggest that peak pressure should not be used as a referral criterion (Wiley & Fowler, 1997). Tympanometric gradient has not been suggested as a referral criterion for middle-ear screening. Several studies have reported that the gradient measure is highly correlated with peak admittance and provides no additional information (deJonge, 1986; Koebsell & Margolis, 1986).

Summary

The purpose of this study was neither to condone nor condemn the practices of Canadian audiologists. Rather, the intent was directed toward identifying the immittance procedures most commonly used by respondents. Several trends have emerged from the survey results. Due to the nature of the questionnaire we cannot determine the reasoning behind these trends, but can only make tentative speculations with respect to the results.

The results of the present study indicate that the increase in popularity of immittance measures over the last 20 years has not decreased. Immittance measures are indeed a standard part of audiological evaluation. This does not, however, imply that all components of the immittance battery are routinely employed, nor does it imply that interpretation of the immittance battery is consistent among audiologists. As Stach and Jerger (1991) have described, the individual components of immittance testing, specifically, absolute immittance, tympanometry, and acoustic reflexes, are relatively ineffective when viewed individually. However, in conjunction with each other, the various components of the immittance battery are a powerful tool in diagnostic audiology. Results of the current study indicate that audiologists are using immittance measures for two primary diagnostically purposes. First, it appears that audiologists are using these tests to specify middle-ear disorders, most specifically to detect stiffening pathologies of the middle ear. Audiologists are also using immittance measures for site of lesion testing to differentiate between cochlear and retrocochlear pathology. On the other hand, audiologists are not using immittance measures to detect mass loading or decreased stiffening pathologies, nor are audiologists using these tests to predict sensorineural hearing loss. Some practitioners have continued to falsely infer that reflex sensation level is conjoined with loudness tolerance problems (i.e., loudness recruitment).

In summary, the 60% response rate of the present study was impressive. The authors suggest that the response rate, as well as the national representation of respondents, indicate that these data are a reasonably accurate snapshot of current clinical practice activities in Canada. It is recommended that results from this study be used as a baseline for audiologists to compare their own practices and procedures. These results are also useful for audiological educators in their attempts to familiarize students with practices and procedures that are typical to Canadian audiologists in clinical practice.

Author Note

Please address all correspondence to Laurie MacDonald, Laurie MacDonald, Hospital for Sick Children, Department of Communication Disorders, 555 University Avenue, Toronto, ON M5G 1X8.

Acknowledgment

Dahlberg Canada and the Canadian Association of Speech-Language Pathologists and Audiologists provided support for this project.

References

American Speech-Language-Hearing Association. (1990). Guidelines for screening for hearing impairment and middle-ear disorders. *AHSA, 32* (Suppl. 2), 17-24.

Alberti, P., & Jerger, J. (1974). Probe-tone frequency and the diagnostic value of tympanometry. *Archives of Otolaryngology, 99*, 206.

deJonge, R. (1986). Normal tympanometric gradient: A comparison of three methods. *Audiology, 25*, 299-308.

Feldman, A. S., & Wilber, L. A. (1976). *Acoustic impedance & admittance: The measurement of middle ear function.* Baltimore, MD: Williams & Wilkins.

Glasscock, M. E., Jackson, C. G., & Josey, A. F. (1981). Clinical results of BERA. In J. Northern (Ed.), *Brain stem electric response audiometry.* New York: Decker.

Hall, C. M. (1977). Stapedial reflex decay in retrocochlear and cochlear lesions. *Annals of Otology, Rhinology, and Laryngology, 86*, 219-222.

Hellman, R., & Scharf, B. (1984). Acoustic reflex and loudness. In S. Silman (Ed.), *The acoustic reflex: Basic principles and clinical applications.* (pp. 469-516), Orlando, FL: Academic Press .

Hunter, L. L., & Margolis, R.H. (1992). Multifrequency tympanometry: Current clinical application. *American Journal of Audiology, 1*, 33-43.

Hunter, L. L., & Margolis, R. H. (1999). Tympanometry: Basic considerations and clinical applications. In F. E. Musiek & W. F. Rintelmann (Eds.), *Contemporary perspectives in hearing assessment* (pp. 89-130). Boston: Allyn and Bacon.

Jerger, J., Burney, P.,Mauldin, L., & Crump,B. (1974). Prediction of hearing loss from the acoustic reflex. *Journal of Speech and Hearing Disorders*, 39, 11-22.

Koebsell, K. A., & Margolis, R. H. (1986). Tympanometric gradient meassurred from normal preschool children. *Audiology, 25*, 149-157.

Liden, G., Harford, E., & Hallen, O. (1974). Tympanometry for the diagnosis of ossicular disruption. *Archives of Otolaryngology, 99*, 23-29.

Margolis, R. H. (1993). Detection of hearing impairment with the acoustic stapedius reflex. *Ear and Hearing, 14*, 3-10.

Margolis, R. H., & Shanks, J. E. (1985). Tympanometry. In Jack Katz (Ed.), *Handbook of clinical audiology*. (3rd ed., pp. 438-475). Baltimore, MD: Williams & Wilkins.

Martin, F. N., Champlin, C. A., & Chambers, J. A. (1998). Seventh survey of audiometric practices in the United States. *Journal of the American Academy of Audiology, 9*, 95-104.

Martin F. N., & Pennington, D. G. (1971). Current trends in audiometric practices. *ASHA, 13*(11), 671-677.

Martin, F. N., & Sides, D. G. (1985). Survey of current audiometric practices. *ASHA, 27*(2), 29-36.

Meyer, S. E., Jardine, C. A., & Deverson, W. (1997). Developmental changes in tympanometry: A case study. *British Journal of Audiology, 31*, 189-195.

Niemeyer, W., & Sesterhenn, G. (1974). Calculating the hearing threshold from stapedius reflex threshold for different sound stimuli. *Audiology, 13*, 420-427.

Northern, J. L., & Gabbard S. A. (1994). The acoustic reflex. In J. Katz (Ed.), *Handbook of clinical audiology* (4th ed., pp. 300-316). Baltimore, MD: Williams & Wilkins.

Olsen, W. O., Bauch, C. D., & Harner, S. G. (1983). Application of Silman and Gelfand 90th percentile levels for acoustic reflex thresholds. *Journal of Speech and Hearing Disorders, 48*, 330-332.

Olsen, W. O., Noffsinger, D., & Kurdziel, S. (1975). Acoustic reflex and reflex decay occurrence in patients with cochlear and eighth nerve lesions. *Archives of otolaryngology, 101*, 622-625.

Olsen, W. O., Stach, B. A., & Kurdziel, S. (1981). Acoustic reflex decay in 10 seconds and in 5 seconds for Meniere's disease patients and for VIIIth nerve tumor patients. *Ear and Hearing, 2*, 180-181.

Shambaugh, G. H., & Girgus, T. F. (1991). Acute otitus media and mastoiditus. In M. M. Paparella, D. A. Shumrick, J. L. Gluckman & W. L. Meyerhoff (Eds.), *Otolaryngology*, (3rd ed., pp. 1777-1787). Philadelphia, PA: W. B. Saunders.

Silman, S., & Silverman, C. A. (1991). *Auditory diagnosis: Principles and applications*. Brooklyn, NY: Academic Press.

Stach, B. A. (1998). *Clinical audiology: An introduction*. San Diego, CA: Singular.

Stach, B. A., & Jerger, J. (1991). Immittance Measures in Auditory Disorders. In J. T. Jacobson & J. L. Northern (Eds.), *Diagnostic Audiology*. Austin, TX: Pro-ed.

Vanhuyse, V. J., Creten, W. L., & Van Camp, K. J. (1975). On the w-notching of tympanograms. *Scandinavian Audiology, 4*, 45-50.

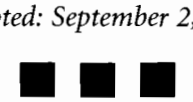
Van Camp, K. J., Margolis, R . W., Wilson, R. W., Creten, W. L., & Shanks, J. E. (1986). Principles of Tympanometry. *ASHA Monographs ,24*, 1-88.

Wiley, T. L., & Fowler, C. G. (1997). *Acoustic immittance measures in clinical audiology: A primer*. San Diego, CA: Singular.

Wiley, T. L., Stoppenbach, D. T., Feldhake, L. J., Moss, K. A., & Thordardottir, E. T. (1995). Audiologic practices: What is popular versus what is supported by evidence. *American Journal of Audiology, 4(1)*, 26-34.

Manuscript received: March 20, 2001

Accepted: September 2, 2001



Appendix A

Imittance Measures Clinical Practice Survey

School of Human Communication Disorders – Halifax, Nova Scotia

1a. Province of Employment _____

1b. Number of Years in Clinical Practice _____

1c. Clinical setting employed in:

A.	hospital/public clinic	B.	school system
C.	private practice	D.	industrial
E.	long term care	F.	other

1d. Populations served (check all that apply):

A.	0 – 5 years	B.	6 - 18 years
C.	19 – 64	D.	65+

1e. Certification status A. CASLPA B. ASHA

1f. Provincial licensing/registration: A. Yes B. No

If any of the following questions do not apply to you please move on to the next question. If you have any questions or concerns, please contact Laurie MacDonald, Dalhousie University or Dr. Walter B. Green.

EQUIPMENT

In performing the immittance battery of tests, which methodology do you employ?

		Always	Sometimes
2a.	Automatic recording and display of results	❑	❑
2b.	Manual recording and display of results	❑	❑

2c. What pump speed do you use?

A. 125 da Pa/s B. 50 da Pa/s C. 200 daPa/s D. 600/200 daPa/s

3. Test Battery

Do you routinely obtain measures of

		Always	Sometimes	Never
3a.	Absolute immittance	❑	❑	❑
3b.	Tympanometry with 226 Hz probe tone	❑	❑	❑
3c.	Tympanometry with 660 Hz probe tone	❑	❑	❑
3d.	Multipcomponent tympometry (susceptance Ba, resistance Ga)	❑	❑	❑
3e.	Multifrequency tympanometry	❑	❑	❑

Which acoustic reflexes do you routinely elicit?

3f.	Contralateral reflexes at	A. 500 Hz	B. 1000 Hz	C. 2000 Hz	D. 4000 Hz
3g.	Ipsilateral reflexes at	A. 500 Hz	B. 1000 Hz	C. 2000 Hz	D. 4000 Hz

	Do you routinely evaluate:	Always	Sometimes	Never
3h.	Acoutics Reflex Decay	❑	❑	❑

Which of the following hearing sensitivity prediction procedures do you use?

3i.	SPAR (sensitivity prediction by acoustic reflex)	❑	❑	❑
3j.	Bivariate Plot	❑	❑	❑
3k.	Other	❑	❑	❑

4. Under which of the following conditions do you routinely refer to physicians?

4a.	Abnormal Absolute Immittance	❑	❑	❑
4b.	Abnormal tympanogram (i.e., flat)	❑	❑	❑
4c.	Absent Reflex(es)	❑	❑	❑
4d.	Tympanometric peak outside +100 to –200 daPa range	❑	❑	❑
4e.	Reduced Gradient	❑	❑	❑

Thank you for taking the time to fill out this questionnaire!