A Survey of Canadian Audiological Practices: Pure Tone and Speech Audiometry

Enquête sur les pratiques en audiologie au Canada : audiométrie tonale liminaire et vocale

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Abstract

The purpose of this investigation was to survey audiologists in Canada concerning professional practice issues in the area of pure tone and speech audiometry. A survey was designed and sent to a randomly chosen group of 181 audiologists who were members of the Canadian Association of Speech-Language Pathologists and Audiologists (CASLPA). Each audiologist received a letter of explanation and a four-page survey. Results are based on 115 surveys that were returned and considered usable for determining current audiometric practices. The data were analyzed descriptively using a spreadsheet computer program. The reported pure tone and speech audiometric practices of Canadian audiologists were discussed with respect to similar surveys conducted in the United States and with respect to scholarly literature. Canadian audiologists seemed to be following supported practices in most pure tone areas. In speech recognition measures several inconsistencies were noted which could influence the value of these measures in the audiometric test battery.

Abrégé

Cette recherche avait comme objectif de sonder les audiologistes du Canada pour connaître divers aspects de la pratique professionnelle dans le domaine de l'audiométrie tonale liminaire et vocale. Une lettre explicative et un questionnaire de quatre pages ont été préparés et envoyés à un échantillon aléatoire de 181 audiologistes membres de l'Association canadienne des orthophonistes et audiologistes (ACOA). Les conclusions se fondent sur les 115 sondages retournés qui ont été jugés utilisables. Les données ont été analysées de façon descriptive à l'aide d'un tableur électronique. Les pratiques ainsi rapportées en matière d'audiométrie tonale liminaire et vocale ont été étudiées comparativement à celles révélées par des sondages semblables aux États-Unis et à la lumière de la documentation savante. Il ressort que les audiologistes canadiens semblent suivre des pratiques entérinées dans la plupart des domaines liés à l'audiométrie tonale liminaire. Par contre, plusieurs incohérences ont été remarquées au niveau des mesures de reconnaissance de la parole, ce qui pourrait avoir comme conséquence de modifier la valeur de ces mesures dans la batterie de tests audiométriques.

Key words: pure tone and speech audiometry, audiological practice, clinical service, survey

Several previous surveys concerning audiological practice issues have been reported for practitioners in the United States. The purpose of these investigations has been to establish the degree of uniformity across clinical facilities, as well as to determine whether or not audiological practices were consistent with the scientific literature. To date, there appears to have been no data reported concerning the status of audiological practice among Canadian audiologists.

Studies conducted in the United States over the last few decades have shown that despite the information in the scientific literature for audiological procedures, audiologists are not always following what has been recommended (Martin, Armstrong, & Champlin, 1994). The findings of these studies have shown that disparity exists between what procedures were supported by evidence and those that were actually being employed in clinical practice (Wiley, Stoppenbach, Feldhake, Moss, & Thordardottir, 1995). A study conducted by Martin and Sides (1985) found that the most commonly used procedures are not necessarily the most preferred, nor are they always consistent within the available research. It was also apparent that other factors might be playing a role in clinical practice.

For example, the type of equipment available in the clinic, the number of patients scheduled per day, and differences in educational experiences of one clinician to another all influence the use of particular clinical procedures (Martin & Sides, 1985).

It is not necessarily correct to assume that the data from the United States can be applied *carte blanche* to the profession of audiology in Canada. Differences in the delivery of hearing health care and perhaps a different educational system may introduce various factors not evident in the American studies. Therefore, conducting a survey similar to those reported in the United States may provide unique insight into professional practices from a strictly Canadian perspective.

The purpose of the present study was to survey Canadian audiologists to determine the clinical procedures commonly used in pure tone and speech audiometry and to determine if differences exist between those procedures and procedures supported by published research.

Methods

Participants

Surveys were sent to 181 randomly selected audiologists identified from the membership directory of the Canadian Association of Speech-Language Pathologists and Audiologists (CASLPA). The mailing took place during the Fall of 1998.

Materials

The survey consisted of two sections. The first section was designed to gather data on the audiologist's place of employment, experience, and training. The second section of the survey gathered data specifically on pure tone and speech audiometry. A copy of the survey can be found in the Appendix.

Procedure

The audiologists surveyed received an introductory letter explaining the purpose of the research, an individually coded survey, and a self-addressed stamped envelope. They were asked to complete and return the survey within four weeks of receiving it.

Results

Demographic Data

All ten provinces were represented in the survey sample. No responses were obtained from the Northwest Territories, the Yukon, or Nunavut. The breakdown of responses by respondents is presented in Figure 1.

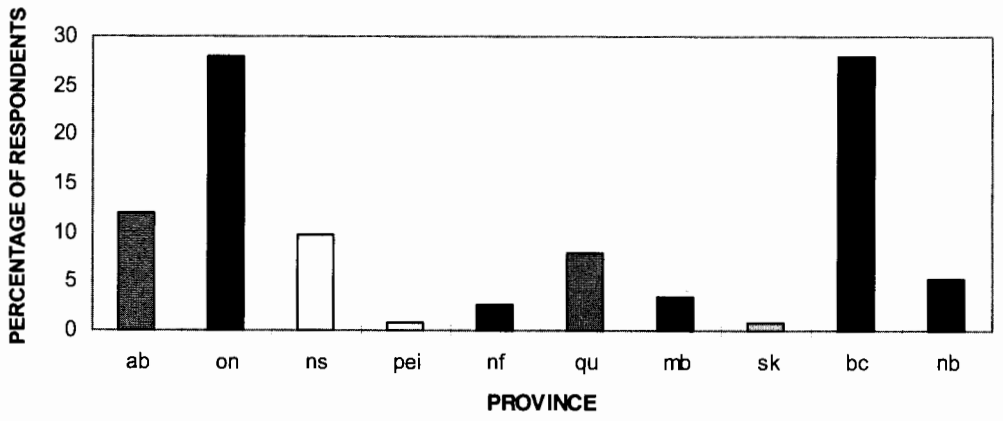
Twenty-three percent of the respondents had been working for five years or less while 22 % had been employed for six to 10 years. Respondents with 11 to 15 years of experience comprised 19 % while 27 % percent of the participants reported employment in the 16- to 20-year range; the remaining nine percent had more than 20 years of experience. With respect to type of work setting, 75 percent of respondents work with children 0 – 5 years, 82 % with children 6 - 18 years, 86 % with adults 19 – 65, and 82 % with adults older than 65 years.

Pure Tone Audiometry

Results indicated that 90 % of the audiologists surveyed either always or sometimes used supraaural earphones and 70 % either always or sometimes utilized insert transducers. Seventy-seven percent of the respondents reported that they always test the better ear first while 28 % indicated they did so sometimes. Six percent always tested the right ear first and 40 % sometimes did so. One percent tested the left initially while 29 % only sometimes.

The data showed that over 90 % of the audiologists surveyed routinely test the octave frequencies from 250 Hz to 8000 Hz. Only 2 % routinely tested 125 Hz, 18 % routinely tested 750 Hz, 21 % routinely utilized 2000 Hz, while 63 % employed 6000 Hz. Seventy percent indicated that a 20 dB threshold difference between octaves was their criteria for testing one half

Figure 1. Percentage of responses by province of employment.



octave. Eighty-six percent of respondents indicated that they routinely performed bone conduction testing. Individuals who did not routinely utilize bone conduction reported that they did so only if immittance findings were abnormal. Also, 75 % of the individuals performed bone conduction if the case history data indicated. Almost all audiologists in the sample (97 %) indicated that they routinely used mastoid placement of the bone conduction oscillator.

In the use of audiometric masking, 63 % of respondents used 40 dB difference between the air conduction thresholds of the test ear and the bone conduction results of the nontest ear. The remaining individuals used criteria of greater than 40 dB. Ninety-one percent used masking in bone conduction when there is an air-bone gap in the test ear.

Speech Audiometry

Transducer choice for speech audiometry was nearly identical to that reported for pure tone audiometry. Eighty-five percent of respondents routinely employed word recognition threshold (WRT) measures in their test battery. Almost all respondents (96 %) reported using spondee words for obtaining the WRT. Twenty-two percent always used a carrier phrase in presenting WRT stimuli, 35 % sometimes, and 43 % never.

Seventy-two percent of audiologists sampled reported they always use word recognition percentage (WRP). Eleven percent always perform performance intensity-phonetically balanced (PI-PB) functions.

A vast majority (81 %) reported either always or sometime using the CID auditory test W-22 word list while 61 % always or sometimes used the Northwestern University Test No. 6 (NU-6). Forty-six percent indicated using WRP stimuli not indicated on this survey. The modal stimulus material other than the CID W-22 and the NU-6 was the Phonetically Balanced Kindergarten Test (PBK-50). Other stimuli noted were developed specifically for Francophone populations. Most audiologists used half lists (25 words) rather than full 50 word lists. Few (17 %) of the surveys indicated that they always familiarize patients with the test stimuli prior to testing. A carrier phrase reportedly was used by a majority of participants and 89 % reported using monitored live voice as the presentation mode.

Discussion

Demographic Information

The 64 % return rate on the present questionnaire yielded what appeared to be a representative sample of audiologists currently practising in Canada. This return rate was consistent with studies of this nature done in the United States (Martin, Champlain, & Chambers, 1998; Martin et al., 1994; Martin & Sides, 1985). The distribution of responses by province was similar to the CASLPA membership breakdown across province.

It is interesting to note that 45 % of the respondents had been employed for 10 years or less. The breakdown by work setting indicated a large number of audiologists were engaged in private practice. This in all likelihood is due to the recent increase in audiologists being employed as hearing aid dispensers. The caseload information showed great overlap with respect to age indicating that most audiologists worked with a wide age range of clients.

Pure Tone Audiometry

Data from the United States (Martin et al., 1998) suggestd that about one quarter of audiologists surveyed reported using insert earphones, at least in some situations. The present data indicated a more widespread use.

The use of either supraaural or insert earphones in particular situations could not be determined from this survey. It was determined, however, that the majority of audiologists surveyed were using insert earphones in some capacity, while only 16 % of respondents never used them. Killion and Villchur (1989) suggested that the use of insert earphones offers some advantages over the use of supra-aural earphones. Supra-aural earphones have poorer reliability in the low frequencies due to air leakage resulting from unstable coupling between the earphone and the ear. Air leaks cause variable amounts of sound pressure level (SPL) loss at frequencies below 500 Hz and small, variable amounts of SPL enhancement between 500 and 1000 Hz (Zwislocki et al., 1988). At higher frequencies air leaks are less important and the critical issue becomes the SPL produced at the eardrum which is dependent on the wave properties of the earphone and external ear. These wave properties are affected by the geometry of the cavity enclosed by the earphone. This cavity can be altered depending on the positioning of the earphone and the size and shape of the pinna and ear canal (Zwislocki et al.). The positioning of the earphone varies from subject to subject and from test to test. As well, the geometry of the pinna and ear canal vary from subject to subject and can be altered by the pressure of the earphone, all resulting in intersubject and intrasubject variability (Zwislocki et al.).

Insert earphones on the other hand fit tightly into the ear canal, thereby reducing the low frequency variability caused by air leakage. They minimize some of the wave effects by eliminating the need to place the earphone over the pinna and

they maximize interaural sound attenuation (Zwislocki et al., 1988). Insert earphones also prevent the possibility of ear canal collapse during testing which typically causes a conductive hearing loss (Stach, 1998a). This is of particular concern in the elderly population and in young infants. There are age-related changes in older persons that result in tissues losing their elasticity and strength which causes the cartilaginous portion of the pinna and ear canal to become more flexible (Hinojosa & Naunton, 1980; Weinstein, 1994). This may then cause the ear canal to close or collapse when an earphone is placed on the pinna (Marshall & Gossman, 1982). In the 1980s, the American National Standards Institute (ANSI S3.6-1989) still recommended the use of supra-aural earphones in audiometry due to the lack of standard calibration procedures for insert earphones. However, the latest version of ANSI S3.6-1996 included reference equivalent threshold sound pressure levels (RETSPLs) for insert earphones. It is now recommended that insert earphones be used over supra-aural earphones except in cases where their use is contraindicated (Stach, 1998a).

Guidelines for administering pure-tone audiometry have been recommended by ASHA (1978). Most audiologists appear to follow the essentials of these guidelines. That is, most respondents reported that they test the better ear first and routinely obtain threshold data from the octave frequencies from 250 to 8000 Hz. A high percentage of audiologists make use of intra octave measurements consistent with the ASHA guideline suggestion of a 20 dB difference between octaves. The value of half–octave threshold information is important in medical diagnosis and in developing rehabilitative strategies (Yantis, 1994). It is interesting to note that much of the ASHA guideline is the result of consensus rather than actual empirical findings (Gelfand, 1997).

A high percentage of Canadian audiologists routinely perform bone-conduction audiometry, as do their colleagues in the United States. This widespread usage continues despite well-known limitations associated with bone conduction. Factors such as participation of the middle ear in bone conduction hearing, calibration problems, masking dilemmas make assumptions concerning cochlear reserve tenuous (Wilber, 1999). Before immittance measures were available, the comparison of air and bone conduction thresholds was the clinical method employed to determine if there was a conductive hearing loss caused by a middle ear disorder (Stach, 1998a). Now that immittance techniques are a standard clinical tool, it has been suggested that they be carried out before pure tone and speech audiometry in order to eliminate the need for bone-conduction testing when findings are normal. Immittance measures are more sensitive to middle ear pathology than the determination of an air-bone gap, so if *all* immittance measures are normal then whatever hearing loss exists can confidently be called sensorineural without having to do bone-conduction (Stach, 1998a). If any of the immittance findings are abnormal then bone-conduction can be used to determine if the middle ear disorder is causing a conductive hearing loss (Stach, 1998a).

Most respondents reported using the mastoid area as the site for the placement of the bone conduction oscillator despite research findings that the mid forehead site may be advantageous (Dirks, 1994; Studebaker, 1962). It has been suggested that placement on the forehead increases test-retest reliability of measurements. Observations have shown that there is less fluctuation in bone-conduction thresholds due to displacement of the vibrator when placed on the forehead as compared to the mastoid (Bekesy, as cited in Dirks, 1994). It has also been suggested that vibrator placement on the forehead reduces participation of the middle ear more effectively than when placed on the mastoid (Barany, 1938). This has been supported by studies conducted by Link and Zwislocki (as cited in Dirks, 1994) on clients who had middle ear disorders with conductive hearing loss. For example, hearing sensitivity was measured in those with otitis media when the bone oscillator was placed on the forehead and on the mastoid. Results demonstrated less hearing loss when measurements were taken from the forehead. Recently, ANSI has provided interim differences in reference equivalent threshold force levels (RETFLs) between forehead and mastoid vibrator location (ANSI S3.6-1996)

Speech Audiometry

Word recognition threshold testing (WRT), otherwise known as the speech reception or word recognition threshold, is widely used by audiologists in Canada as well as in the United States (Martin et al, 1998). Asha has published guidelines (American Speech-Language-Hearing Association, 1988) which suggested that clients should be familiarized with the stimulus items used in the testing situation. Less than half (43 %) of the respondents in this survey reported that they always allowed for familiarization. Several investigations (Conn, Dancer, & Ventry, 1975; Tillman & Jerger, 1959) have shown improvements on the order of 5 to 6 dB following a familiarization procedure. Clearly, this is an example of a clinical practice that is not being performed with respect to the research evidence.

A broader question, however, concerns the worth that the word recognition threshold brings to the audiometric battery. Wilson and Margolis (1983) reviewed the value of the

WRT and found it limited. Wilson and Margolis concluded that the WRT "may be useful under some circumstances, but the procedure probably does not deserve its current high standing among auditory tests" (p. 120).

Another word recognition measure used by most Canadian audiologists was the word recognition percentage (WRP) or speech or word discrimination test. The usefulness of this measure has been questioned from several standpoints. In terms of diagnostic predictability, both the CID W-22 and the NU-6 have been criticized for not distinguishing between types and degrees of hearing losses or differences in speech recognition abilities (Wiley et al, 1995). Wiley and colleagues conclude that "available data, then, suggest that the popular W-22 and NU-6 tests are relatively insensitive to differences in speech-recognition ability and are relatively insensitive to the presence of peripheral and central auditory disorders." (p. 28)

These measures are vulnerable to procedural variables which result in performance variability. For example, 84 % of audiologists reported using half-lists (25 words). Performance variability on tasks such as this is inversely related to the number of trials. A smaller number of items increases patient variability which results in the measure being less sensitive to detecting real differences in performance (Thornton & Raffin, 1978). The survey results also indicate that most Canadian audiologists, like their American counterparts (Martin & Morris, 1989), use monitored live voice as the presentation mode for word recognition measures. The research literature contains numerous warnings of the consequences of live voice tests. For example, it has been shown in several studies that word recognition scores from different talkers are not equivalent, nor are scores from the same talkers for identical words lists given at different times (Creelman, 1957; Mullennix, Pisoni, & Martin, 1989; Penrod, 1979; Resnick, 1962). The routine use of monitored live voice testing is not supported by the existing knowledge base. Clinicians need to be aware that the expediency gained by such practices is offset by compromised reliability and validity.

Only 11 % of the audiologists surveyed reported that they performed PI-PB functions. This finding was consistent with similar surveys reported from the United States (Martin & Morris, 1989; Martin & Sides, 1985). Utilization of PI-PB curves has been cited as one way to improve the value of WRP measures (Stach, 1998b). It has been shown in a number of studies that a single presentation level does not yield the maximum word recognition percentage (Wiley et al., 1995). The articulation function for monosyllabic words in individuals with sensorineural hearing loss often does not closely approximate the idealized function shown by normal hearing individuals. A single presentation does not necessarily provide the maximum performance (Carhart, 1965), nor does it predict the shape of the PI-PB function (Jerger & Hayes, 1977). The use of a single presentation level is another area where Canadian audiologists are engaging in a clinical practice which is inconsistent with the scientific literature.

The issue of word familiarity is also important to consider. Only 17 % of respondents always allowed for familiarization prior to testing. Several investigations (Carhart, 1965; Epstein, Giolas, & Owens, 1968; Owens, 1961) have indicated that familiarity is a critical aspect in the measurement of the WRP. Using word lists that are unfamiliar to the patient can result in poor performance independent of auditory factors which can contribute to misdiagnosis. This represents another area of scientific evidence that has not influenced the clinical situation.

In the best of situations audiologists need to be concerned about the veracity of the information provided by WRP measures currently employed. Linguistic factors such as redundancy, word knowledge, and contextual cues interact with the presence of hearing loss and influence the reliability of these measures. The accuracy, and therefore the clinical value, is further compromised by procedural variables such as half-list approaches, using monitored live voice, single presentation levels, and not providing familiarization of material. These practices should be avoided except in special circumstances or the audiologist should consider not administering word recognition measures.

Conclusions

The purpose of this study was to identify pure tone and speech audiometric procedures most commonly used by Canadian audiologists and to compare these procedures with those found by scientific research to be clinically effective. Audiologists were only asked what procedures they typically used and how they used them. The reason behind using one particular procedure over another cannot be determined from the results and any conclusions of this nature drawn from the study would only be speculative. The results suggested that in most areas of pure tone audiometry Canadian audiologists were following recommended clinical practices. However, a few findings indicated that certain procedures, especially in speech audiometry, were routinely being used (or not used) despite published evidence that questions their effectiveness.

Overall, the typical Canadian audiologist used both supraaural and insert earphones in some capacity as the trans-

ducer coupling system in pure tone and speech audiometry. S(he) tested the better ear first and tests octave frequencies from 250 to 8000 Hz and half-octave frequencies when there is a greater than 20 dB difference between thresholds. S(he) routinely performed bone-conduction testing when immittance findings are abnormal and when case history indicated use. The bone conductor was placed on the mastoid bone during testing. S(he) routinely obtained word recognition threshold testing using spondee words and word recognition percentage testing using the CID-W22 word lists. Speech materials were presented using the live voice method of presentation.

This study has provided a glimpse of the current practice activities of Canadian audiologists. It should provide an impetus for clinicians to closely examine what they are doing in certain clinical activities as well as to provide a baseline to monitor audiological practices as they change.

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APPENDIX

PURE TONE AND SPEECH AUDIOMETRY CLINICAL PRACTICE SURVEY

School of Human Communication Disorders-Dalhousie University-Halifax, Nova Scotia

1.i. Province of Employment

1.ii. Number of years in clinical practice

1.iii. Clinical setting employed in:

- a. 0 – 5 years ❑
- b. 6 – 18 years ❑
- c. 19-65 years ❑
- d. 65+ years ❑

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

- a. hospital/public clinic ❑
- b. school system ❑
- c. private practice ❑
- d. industrial ❑
- e. long term care ❑
- f. other ❑

1.v. Certification status:

- a. CASLPA ❑
- b. ASHA ❑

1.vi. Provincial licensing/registration:

- a. yes ❑
- b. no ❑

PURETONE AIR CONDUCTION TESTING:

2.i. Which transducer coupling system do you employ in puretone air conduction testing?

	Always	Sometimes	Never
a. earphones	❑	❑	❑
b. foam inserts	❑	❑	❑

2.ii. Which ear do you routinely test first?

	Always	Sometimes	Never
a. better ear	❑	❑	❑
b. right ear	❑	❑	❑
c. left ear	❑	❑	❑

2.iii. What frequencies do you routinely test?

a. 125 Hz ❑	e. 1000 Hz ❑	i. 4000 Hz ❑
b. 250 Hz ❑	f. 1500 Hz ❑	j. 6000 Hz ❑
c. 500 Hz ❑	g. 2000 Hz ❑	k. 8000 Hz ❑
d. 750 Hz ❑	h. 3000 Hz ❑	

2.iv. If you use the ½ octave frequencies (i.e., 1500 Hz) what is your criterion?

a. always ❑
b. when there is a <20 dB difference between thresholds ❑
c. when there is a >20 dB difference between thresholds ❑

2.v. Do you routinely perform bone conduction testing?

a. yes ❑
b. no ❑

2.vi. If no, under what circumstances would you perform bone conduction testing?

a. when case history information indicates ❑
b. positive lateralization on occlusion tests (i.e., Weber and Bing) ❑
c. abnormal immitance findings ❑

2.vii. Where do you routinely place the bone oscillator?

a. mastoid ❑
b. forehead ❑

When do you routinely utilize masking for air conduction testing?

Interaural attenuation = 40dB ❑
Interaural attenuation > 40dB ❑
Interaural attenuation < 40dB ❑

(between air-conduction thresholds of test ear and bone-conduction sensitivity of nontest ear)

When do you routinely utilize masking for bone conduction testing?

Always ❑
Presence of air-bone gap ❑
Cross-lateralization displayed by patients ❑
Lateralization tests indicate ❑
(i.e., Audiometric Weber and Bing)

SPEECH AUDIOMETRY:

Which transducer coupling system do you employ in speech audiometry?

	Always	Sometimes	Never
Earphones	❑	❑	❑
Foam inserts	❑	❑	❑

Do you administer Word Recognition Threshold (WRT) testing?

Always ❑ Sometimes ❑ Never ❑

What materials do you routinely use?

Spondee words ❑
Other ❑

What is your criterion for obtaining WRT?

Correct response 50% of the time	❑
Lowest level for three correct responses	❑
Lowest level for any response	❑
Other	❑

Do you routinely administer Word Recognition Percentage (WRP) testing?

Always	❑	Sometimes	❑	Never	❑

Do you utilize PI-PB functions in your audiological evaluations?

Always	❑	Sometimes	❑	Never	❑

Which word lists do you routinely use?

	Always	Sometimes	Never
CID Auditory Test W-22	❑	❑	❑
NU-6	❑	❑	❑
Other	❑	❑	❑

How many words do you routinely present to obtain Word Recognition Percentage?

50	❑
25	❑
<25	❑

When testing for SRT or Speech Recognition percentage, do you allow for familiarization or word lists prior to testing?

Always	❑	Sometimes	❑	Never	❑

When presenting word stimuli do you use a carrier phrase?

For SRT testing:

Always	❑	Sometimes	❑	Never	❑

For speech recognition percentage testing:

Always	❑	Sometimes	❑	Never	❑

What procedure for presentation of words do you routinely use?

Live voice	❑
Tape recording - commercial tape	❑
- self-recorded tape	❑
Compact disk	❑