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An Exploration of Audiologists' Readiness to Adopt Connected Hearing Healthcare for Remote Hearing Aid Fitting

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Abstract

Background: Globally, the increasing prevalence of hearing loss and need for improved access to hearing healthcare services, highlights the growing need for alternative service delivery models. A Connected Health model emerges as a solution for this need, focusing on the use of telecommunication technologies. This model, extended to audiology, can help to better 'connect' a patient to their own care process and to their provider during audiological diagnostics, treatment, and management services, at a distance and in an effective and timely manner. The strong capacity for and underutilization of Connected Audiology within current aural (re)habilitation service models have led to research around the "readiness" factors that are contributing to a low uptake of remote services within Canada.

Objective: This survey-based study aimed to describe audiologists' readiness to adopt Connected Audiology for remote hearing aid fitting using a modified framework for eHealth readiness.

Methods: An analytic, cross-sectional quantitative survey called the Connected Audiology Readiness Evaluation (C.A.R.E.) was conducted using online data collection methods. Practicing audiologists, across Canada, were recruited via professional networks/associations to identify the main factors associated with clinician readiness to adopt remote hearing aid fitting services into clinical practice.

Results: Reported readiness levels around the implementation of Connected Audiology displayed across the 8 CARE dimensions are as follows. High readiness levels are reported for the following dimensions: practice context, social capital, patient-provider relationship, organizational support and attitude; average readiness levels are reported for the access and aptitude dimensions; and low readiness for the standards dimension with a high need for the development and implementation of guidance documents to support implementation.

Conclusion: Findings from this survey will inform researchers, clinicians and policymakers of the main areas needing support for the uptake of Connected Audiology, guiding future planning, development, and implementation efforts. In addition, findings from this study

can help guide Canadian audiologists in the integration of remote hearing aid fitting services into routine clinical practices.

Key words: Connected audiology, readiness, uptake, remote service delivery, hearing aid fitting.

Summary for Lay Audience

With the number of people world-wide affected by hearing loss, the knowledge that this number will increase in coming years, and with limited availability of professionals in the field of audiology, there is a need for alternative models of service delivery in clinical practice. Connected Audiology emerges as a solution to offer coverage for those who have limited contact with qualified professionals in audiology (e.g. geographical barriers). The aim of this study is to identify the factors associated with readiness to adopt Connected Audiology, including the identification of barriers and facilitators to its use, from audiologists' perspective. Overall the findings indicate; high readiness levels when considering practice context, patient-provider relationship, organizational support and attitude; average readiness levels for the access, social capital and aptitude dimensions; and low readiness levels when considering the standards dimension with a high need for development and implementation of guidance documents to support implementation. Findings from this study help inform researchers, audiologists, and policymakers around the readiness levels of audiologists in Canada to uptake Connected Audiology and remote hearing aid fittings services.

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Chapter 1

1. Introduction

The number of people with hearing loss is increasing rapidly around the world, generating a global need to manage, diagnose, and treat this health condition. The World Health Organization reported that 466 million people live with a hearing impairment; of these, 93% are adults and seven percent are children. Although these numbers already seem substantial, the scenario will worsen as the projected population of people with hearing loss grows to 630 million by 2030 (World Health Organization, 2019). In both developed and developing countries, the number of available audiologists per person is affecting the access to audiological services. A 2019 report from Speech & Audiology Canada indicates approximately 5 audiologists for every 100,000 people in the province of Ontario; this ratio is estimated to be 0:100,000 in remote northern areas of Canada (Statistics Canada, 2019). Furthermore, the world is facing a need for rapid change in the delivery of health services, including audiological services, due to the recent declaration of the coronavirus (COVID-19) pandemic made by the World Health Organization (World Health Organization, 2020). An alternative model of service delivery could focus on the provision of care at a distance, and therefore, has the potential to alleviate the demands placed on the health care system by increasing access to services. Based on this information, there is a growing opportunity to adopt new practices, which may allow for a greater number of people to be connected to qualified professionals when time, mobility, social distancing, or distance-related issues restrict access to audiological services.

One important factor in the successful implementation of a "new" clinical practice is the readiness levels of all involved stakeholders. For this thesis, the clinical practice of interest refers to remote service delivery centered on the provision of hearing aid support services (this is defined further below). This thesis will therefore focus on assessing readiness as it relates to the provider: an audiologist. Readiness is defined as one's state of preparedness including their willingness (motivation) and ability (capacity) to engage in a specific act (Domlyn & Wandersman, 2019a). When it comes to the implementation of remote service delivery, readiness includes both the delivery system, as well as the support system (Domlyn & Wandersman, 2019a). The delivery system includes, but is not limited to, the healthcare provider, clients/patients, significant others, and/or facilitators; whereas, the support system is represented by researchers, policymakers, and support staff who can assist in reaching outcomes

for their clients/patients. Considering the reported high percentage (> 70%) of failure in the implementation of eHealth solutions (Lorenzi, 2003), it is crucial to assess readiness at all levels. A comprehensive assessment would consider readiness at the level of the broader health context, the public (e.g., patients/clients and all support personnel) and healthcare provider. This thesis will therefore assess the provider's hearing healthcare readiness, within a complex system of stakeholders, including providers, organizational leaders, clients/patients, and support personnel. Support personnel can include family members, caregivers, trained facilitators, and other people that aid in facilitating the care process in the remote location.

A comprehensive readiness assessment can inform important barriers and facilitators to implementation, and ultimately help determine whether the key stakeholders are ready for practice change. Determining how prepared stakeholders are for an anticipated change in a service provision delivery method (e.g., a shift from in-person to remote delivery of services) is an important first step for success in the implementation of Connected Audiology (Jennett et al., 2003). Furthermore, understanding stakeholders' preparedness can assist in the identification of areas of readiness that may require intervention or further support to increase implementation rates/success (Mauco et al., 2018). The overall aim of the readiness assessment included in this thesis is to better understand the barriers and facilitators with which remote audiological services are provided in Canada. More specifically, this thesis will analyse readiness levels from the provider's perspective (the audiologist), with a focus on facilitating the delivery of remote hearing aid fitting services. The readiness evaluation is centered on the provision of remote follow-up hearing aid fitting services, which is described as the provision of audiological services at a distance using technology to connect the audiologist to the client/patient in order to manage and/or facilitate programming adjustments to their hearing aid(s). As such, the concept of readiness, as it relates to remote service delivery, encompasses not only technological factors but also motivational, organizational, training, and acceptance factors that are considered key components of this concept (Yusif et al., 2017).

1.1 The Evolution of Terms Related to Remote Service Delivery

The provision of remote services has evolved since the 1900s, when an initial approach to this service delivery modality included physicians reading electrocardiograms using telephone lines, and ship radios to link physicians to sailors to attend to emergencies at sea (Gunsch, 2011).

To date, the provision of remote services has included a plethora of terms that fall under the umbrella term "Connected Health" (Figure 1.1); and has also expanded to include multiple clinical applications in the field of audiology (e.g. screening, diagnosis, and/or intervention). "Connected Health", has been defined by several authors, however a commonly cited definition is proposed by Caulfield & Donnelly (2013):

> "Connected Health" encompasses terms such as wireless, digital, electronic, mobile, and telehealth. It refers to a conceptual model for health management where devices, services or interventions are designed around the client's/patient's needs. And health related data is shared, in such a way that the client/patient can receive care in the most proactive and efficient manner possible. All stakeholders in the process are 'connected' by means of timely sharing and presentation of accurate and pertinent information regarding patient status through smarter use of data, devices, communication platforms and people (p. 704).

Telemedicine, one of the first terms used to describe an alternate service model to in-person care, encompasses the delivery of remote medical care in a curative model. Due to telemedicine's focus on the medical model of care, researchers started looking for a more inclusive term, thus, the concept telehealth emerged to describe "health care" related services, provided at a distance, extending the scope of service provision (Van Dyk, 2014). Around 2014, the American Speech-Language-Hearing Association (ASHA) incorporated the term telepractice into their clinical guidance documents, to reduce the misperceptions that this practice only related to medicine or medical-based settings. According to ASHA, telepractice is the "application of telecommunications technology to the delivery of speech language pathology and audiology professional services at a distance by linking clinician to client or clinician to clinician for assessment, intervention, and/or consultation" (American Speech-Language-Hearing Association, n.d.). Simultaneously, the term tele-audiology emerged to describe the first audiological test executed through the internet by Dr. Gregg Givens, and nine years later, the first transatlantic tele-audiology test (Nemes, 2010). Tele-audiology has been defined as "the utilization of telehealth to deliver audiological diagnostic treatment and management services" (Rushbrooke & Houston, 2016, p. 30).

Across many professions, telepractice is emerging as a solution to offer improved equity of access to services by extending provider capacity. For the purpose of this study, the

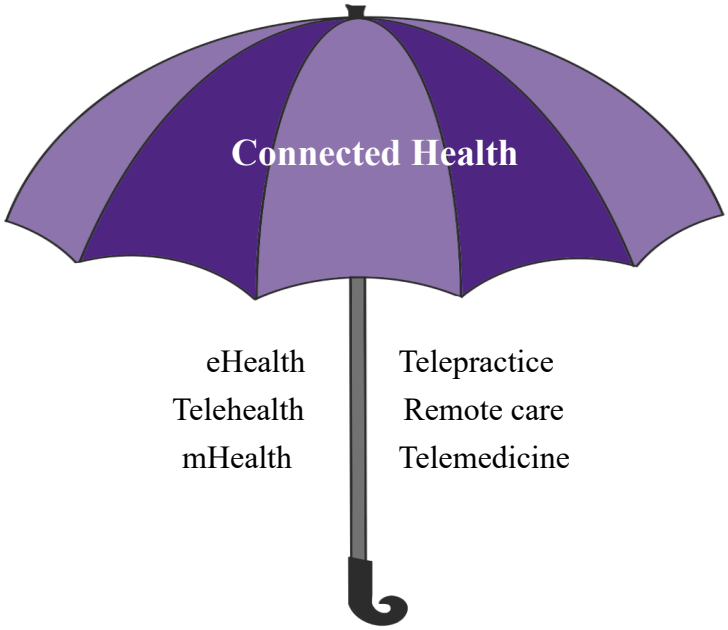
term Connected Audiology, a branch of Connected Health, will be used to replace the terms discussed above. Connected Audiology is specific to the field of audiology and is defined as a patient-centered model of care that uses information and communication technology to connect all stakeholders in the audiological care process, with the needs of the client/patient in mind, including client/patient-clinician interaction during audiological diagnostic, treatment and management services at a distance (Perez et al., 2020). One application of Connected Audiology is remote hearing aid fitting; this application will be the focus of this thesis.

Remote hearing aid fitting services should be delivered following the same best-practice protocols and guidelines as indicated for the provision of face-to-face hearing aid fitting services. It is the service delivery model that is modified in a remote encounter, allowing for service to be delivered at a distance, or remotely. Hearing aid fitting practices include various steps, which may include device selection, fitting, verification, fine-tuning, validation, troubleshooting, and counselling. Due to technological limitations and a lack of best-practice evidence, not all of these steps can be or are recommended to be used remotely during all types of remote service delivery appointments. For example, hearing aid verification, requiring real ear measurements, has been used during initial appointments with the addition of a facilitator and socialized equipment (Campos & Ferrari, 2012). For the purpose of this thesis, remote hearing aid fitting was explored in the context of follow-up appointments that did not require the addition of a trained facilitator or specialized measurement equipment. The addition of supporting people, such as parents and caregivers, were considered as they are often and integral part of the hearing aid fitting process, such as in pediatric scenarios.

With the knowledge that a patient-centered eHealth management model has the potential to respond to patients' needs (Chouvarda et al., 2015), Connected Audiology emerges to provide audiological support to the right person at the right time. For example, Connected Audiology has the potential to enable timelier and/or more frequent follow-up appointments in situations where families live in rural communities, at a distance to their audiology clinic, and/or cannot attend to audiology clinics due to pandemic matters or health conditions, for example. Connected Audiology could also be considered an option for families that are unable to easily travel to the audiology clinic due to mobility issues or child-care needs (Rushbrooke & Houston, 2016).

Figure 1.1

Connected Health Umbrella Term



Note. An illustration of the plethora of terms falling under the umbrella term “Connected Health”.

1.2 Models of Service Delivery

There are three main paths of service delivery related to Connected Health that enable clinician-to-patient or clinician-to-clinician connections: 1) synchronous, 2) asynchronous, and 3) a hybrid model. The synchronous model allows real-time interaction and can use many different types of communication technologies such as telephone communication, videoconferencing, and remote programming software, for example (Gladden et al., 2015). In contrast, the asynchronous model stores the information at a remote site and then forwards the information to be analysed and later interpreted (e.g. email, electronic medical records) (Saunders & Chisolm, 2015). Finally, hybrid service delivery occurs when both models are employed or when a combination of in-person and remote service delivery is used to deliver services. All the above-mentioned models enable service delivery across many different practice contexts, including schools, community health centers, or clients' homes.

1.3 Evidence for the Provision of Remote Hearing Aid Fitting

Researchers around the world have reported the successful use of remote hearing aid support services in the field of audiology (Campos & Ferrari, 2012; Ferrari & Bernardez-Braga, 2009; Fletcher et al., 2019; Swanepoel & Hall, 2010). For this thesis, the interest is focused on remote follow-up hearing aid fitting services; this could include different models of service delivery such as asynchronous, synchronous, or hybrid. Limited literature related to this topic exists. Overall, the literature discusses the use of remote care to facilitate hearing aid fitting management for both adult and pediatric populations at a distance; much of the early literature focused on evaluating the feasibility and/or the validity of such services. Findings from a study conducted by Angley et al., (2017) conclude that when Information Technology (IT) was utilized (e.g. web camera) for remote hearing aid follow-up appointments, patients and audiologist both perceived that this option of service delivery successfully maintained rapport among the patient-audiologist relationship. When patients with hearing loss begin using hearing aids, many questions and challenges can arise during the first stage of the adaption and acclimatization process. Laplante-Levesque et al., (2009) have shown the feasibility of an internet-based audiological counselling program in providing support to those who are new hearing aid users. Results from this study suggest that the remote provision of services to new hearing aid users, such as informational and emotional counselling, were also beneficial in adequately addressing

patients' needs and concerns. Remote hearing aid support services have also been used with pediatric patients. Munoz et al. (2017) explored the use of remote fitting in a pediatric population, showing that remote fitting allows flexible and timely intervention, while being able to include family members during the session.

Considering best-practice requirements to complete hearing aid fitting processes, the hearing aid verification step is integral and ensures that a fitting is verified against and validated hearing aid prescription. Literature suggests that verification can be performed remotely with the use of a facilitator(s) and specialized equipment, when in-person encounters cannot be conducted (Campos & Ferrari, 2012). To-date, remote hearing aid verification has only been demonstrated using specialized equipment and support personnel in the form of facilitators; further research is needed to develop and validate verification procedures that are effective in the absence of additional equipment/people and that can be used in follow-up remote fitting appointments. Even though there is growing interest in the field of Connected Health and knowledge around the feasibility of providing remote audiological services, under-use is still reported, thus warranting more research related to the clinical uptake of evidence-based applications (Meyer et al., 2019; Paglialonga et al., 2018).

1.4 Barriers and Facilitators to Clinical Adoption of Connected Audiology

A comprehensive assessment of the barriers and facilitators related to the uptake of remote services in audiology will ultimately identify the areas of practice needing support. Barriers can operate at different levels and can be divided into intrinsic and extrinsic factors. Barriers to implementation can be related to structural barriers, organizational barriers, technological barriers, and can also be related to clinicians, researchers or patients (Meyer et al., 2019). Barriers that are identified should be managed and treated to enhance adherence to evidence-based practice (Kruse et al., 2018). The following stakeholders factors are felt to influence Connected Audiology: age, attitude, training level, motivation, culture, and level of cognition could interfere with adoption (Rushbrooke & Houston, 2016). From the provider's perspective; Glista et al., (2020) identified six factors that are thought to influence clinical uptake of remote hearing aid fitting. These factors include technology and infrastructure, audiologists-centered considerations, client-centered considerations, hearing healthcare regulations, clinical implementation considerations, and financial considerations; within these concepts are subfactors

related to attitudes and aptitudes, for example. One of the major barriers to uptake of a new practice is the lack of knowledge – this can refer to knowledge about what telepractice is and how telepractice is implemented (World Health Organization, 2011). According to Montano et al. (2018) there are three main factors that restrict the adoption of Connected Audiology: 1) professionals may have feelings of uncertainty, 2) patients may experience a lack of confidence or fear around the use of technology, and 3) fear of disruption of personal connection (relationships). Other researchers state that the lack of uptake is related to a lack of evidence, financial implications, organizational approaches, and the absence of clear implementation guidelines (Rushbrooke & Houston, 2016).

There are many factors reported in the literature that can be considered facilitators to the implementation of Connected Audiology. For example, the lack of knowledge in the field of Connected Audiology can be managed with the provision of training, with professional development and training identified as key facilitators to remote service delivery. Training can better equip audiologists with the required knowledge to implement Connected Audiology and therefore, facilitate implementation (Moodie et al., 2011). Moodie and colleagues (2011) identify a list of implementation facilitators specific to audiological practices, which can be applied to Connected Audiology. This list includes mention of hands-on training, timely feedback from experts, support from colleagues and/or managers/administrators, and personal commitment, as factors that assist with implementation and/or utilization of a new tool.

It is crucial to identify facilitators and barriers when implementing a new service (e.g. the adoption of remote hearing aid fitting) prior to its implementation in clinical practice, as they assist in recognizing strengths and weaknesses within the healthcare context, thus helping facilitate the transition into clinical practices. Differing needs and priorities exist among patients and audiologists. Thus, tailoring the evidence according to individual needs and determining potential users and the context in which the knowledge is going to be used are activities that will guide preparation and implementation (Graham et al., 2006).

One method of implementing Connected Audiology and preparing for the change is to follow a structured plan. Patient candidacy, clinician education and training, technology infrastructure, and regulatory environments are aspects that have been identified as necessary to implement Connected Audiology (Montano et al., 2018). This information suggest that readiness is also determined by availability of regulatory revisions, guidance documents, training manuals,

and the creation and dissemination of protocols that offer the potential to increase the readiness levels of health care providers (Davies-Venn & Glista, 2019). As such, a comprehensive readiness assessment has the potential to offer guidance and support to key stakeholders during implementation practices.

Numerous surveys have been conducted on attitudes towards telepractice (Eikelboom & Swanepoel, 2016; Singh et al., 2014). A recent study by Eikelboom & Swanepoel (2016) indicated that audiology practitioners generally have a positive attitude towards telepractice and are willing to be involved in this new model of service delivery. Findings from a study conducted by Singh et al., describe some reluctance when considering specific clinical tasks such as remote hearing aid programming for first-time hearing aid wearers and diagnostics (Singh et al., 2014). In general, the attitude towards Connected Audiology could be considered a barrier or facilitator depending on the practice context in which it is being applied. The application of remote hearing aid fitting in follow-up appointments, versus initial, may therefore be considered more of facilitator than a barrier. Eikelboom and Swanepoel (2016) identified that only 25% of the 269 clinicians surveyed (internationally) reported having used Connected Audiology (Eikelboom & Swanepoel, 2016). Information obtained from the telepractice survey conducted by Special Interest Group (SIG) 18 (American Speech-Language-Hearing Association, 2016) included clinicians who identified themselves as experts in tele-audiology. The results of this survey indicated that almost 64% of 569 clinicians surveyed in the United States and Canada have provided services through telepractice. As such, these surveys suggest that there is a general interest in Connected Audiology and that there have been some experiences in its implementation, but that implementation is not widespread.

Although there is evidence available to suggest that conducting audiological procedures remotely is feasible, some barriers, such as the lack of evidence gathered from randomized controlled clinical trials and meta-analyses, restricts the adoption of an alternative model of service delivery such as Connected Audiology (Tao et al., 2018). A lack of strong evidence to support the validity and reliability of remote audiological services, compared to in-person care, can therefore act as a barrier to implementation; this may relate to the need to understand the value added by services such as Connected Audiology, prior to investing in implementation.

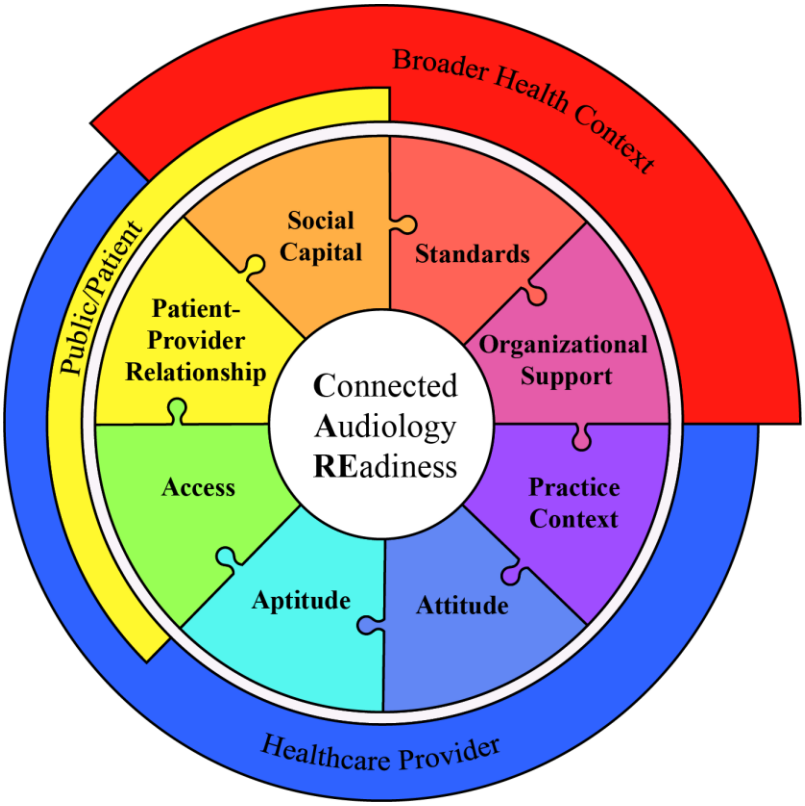
1.5 Development of the Connected Audiology Readiness Framework

Having a clear understanding of all relevant requirements to adopt remote hearing aid fitting will aid in its success during implementation. Nonetheless, researchers have identified a paucity of reliable assessment tools or frameworks to guide readiness assessment amongst health care providers (Mauco et al., 2018; Maunder et al., 2018; Yusif et al., 2017). In response to this gap, a readiness framework was developed to inform the development of this survey work and all underlying questions: The Connected Audiology Readiness (CARE) Framework. The CARE framework, developed at the National Centre for Audiology, Western University, by Glista, Moodie, Scollie and Perez, builds on an existing eHealth readiness framework entitled the "Framework for eHealth Readiness of Dieticians (FeRD)" (Maunder et al., 2018). The FeRD provides a conceptual model for developing eHealth readiness evaluation tools to examine, measure, and drive strategies to better prepare dietitian professionals for eHealth. In addition to incorporating relevant components from the FeRD, the CARE framework (Figure 1.2) has incorporated existing theories from two bodies of work within the field of audiology: 1) a conceptual model of the factors influencing clinician adoption of remote hearing aid support (Glista et al., 2020) and 2) a framework of the characteristics influencing the use of knowledge and evidence in clinical practice (Moodie et al., 2011). The resulting CARE framework is therefore grounded in knowledge around eHealth readiness, remote service delivery in audiology, and integrated knowledge translation. It includes three broad readiness categories outlining key stakeholders: 1) broader health context, 2) public/patient and 3) healthcare provider; and eight underlying dimensions related to readiness in the uptake of Connected Audiology: a) practice context: the key factors in the context of audiological care that determine the setting in which the practice takes place (e.g., physical conditions such as light, noise, privacy and space orientation, as well as the non-physical set-up relating to scheduling); b) access: the ability to practice Connected Audiology based on access to technological and/or support requirements; c) social capital: the effective functioning of included social groups (e.g., clients/patients and/or support personnel) through relationships and shared understandings or values; d) standards: this referred to practice guideline, protocol and best-practice documents required to support implementation; e) organizational support: the degree to which the audiologist believes that their organization supports the use of Connected Audiology (e.g., managers, co-workers, company leaders); f) aptitude: the knowledge and skills required to

provide Connected Audiology, g) attitude: the audiologists feeling, opinions, beliefs including and influencing motivation and perceived added value to Connected Audiology; and h) patient-provider relationship: the perceived relationship that exists between the audiologist and the client/patient.

Figure 1.1

Connected Audiology REadiness (CARE) Framework



1.6 The Potential of Connected Audiology in Assessing Readiness

Considering the number of people world-wide with hearing impairments, knowledge that this number will increase in coming years, and the limited availability of professionals in the field of audiology, the uptake of Connected Audiology emerges as a solution to offer services in many different delivery contexts. Connected Audiology has great potential to improve access to services, especially when limited access to qualified audiologists (providers) and/or restricted access to services are present. For example, Connected Audiology has the potential to benefit patients situated in rural centers, based on geographical limitations, but also those in urban centers or in school-based settings, due to challenges related to lack of child-care, mobility issues or health conditions, and when living under pandemic circumstances that may restrict physical contact. To ensure that this potential solution is implemented successfully in a country like Canada, it is pertinent to assess the factors that could influence the uptake of Connected Audiology. One approach that could facilitate the researchers' understanding is to identify strengths and weaknesses of key stakeholders such as; broader health context, healthcare provider, and public/patient, that might be impacting readiness to adopt and/or implement change in clinical practice. This information could then be used in early implementation planning to ensure that factors associated with readiness are appropriately addressed as we move Connected Hearing Healthcare forward. The demand of an alternative model of service delivery and the importance of determining whether Canadian audiologists are ready to adopt a change has motivated this research.

The primary research objective of this study is to explore and describe audiologists' readiness to adopt Connected Audiology for remote hearing aid fitting using a modified eHealth readiness framework. Readiness for remote hearing aid fitting was explored in the context of follow-up fitting appointments. A secondary research objective is to establish whether readiness levels differ according to the sub populations of audiologists determine by the self-identification of previous experience with remote hearing aid fitting services in clinical practice (hence, self-identified as 'ready').

Chapter 2

2. Methods

This descriptive, cross-sectional study included the development and dissemination of a four-part survey in a single electronic file embedded in a survey link. This survey was designed using findings from a study conducted by Glista et al., (2020), which has guided the development of the CARE survey questions. This study identified the main factors perceived to influence the clinical uptake of remote hearing aid support services, in a study with Canadian audiologists (Glista et al., 2020). These factors were then used to inform the eight dimensions of the CARE framework, as well as the CARE questions. The four parts of the survey include: 1) informed consent; 2) participant inclusion criteria (4 questions); 3) participant demographics (9 questions); and 4) the main body of the survey (18 umbrella questions and sub-questions). A total of six sub-questions for the practice context dimension were included, 14 for the access dimension, four for social capital, three for organizational support, 12 for standards, nine for aptitude, 20 for attitude and seven for the patient-provider relationship dimension. This study was reviewed and approved by the Western University Health Science Research Ethics Board (HSREB). The survey data was collected and compiled using Qualtrics® (Qualtrics, Provo, UT) and then exported into an Excel document to facilitate analyses. The survey development included input from two clinician-researcher experts in the field of audiology, and one expert from physical therapy sciences with expertise in questionnaire development. Prior to wide-scale distribution, a pilot test of the electronic survey was completed by two experienced audiologists. Comments and suggestions collected during this pilot phase were incorporated into the final version of the study. These included suggestions regarding the wording of the questions, the structure of the survey, general feasibility, and completion time, for example.

2.1 Participants

A purposive sampling of practicing audiologists was completed to recruit participants from across Canada. Recruitment efforts focused on the participants' knowledge, experience, availability, and willingness to participate in this study, using inclusion criteria to guide participant selection (Etikan, 2016). Audiologists were invited to participate using the following strategies: 1) email distribution of a recruitment script and poster via the Canadian Academy of

Audiology's (CAA) online newsletter, with three distribution attempts; 2) distribution of a recruitment poster via other professional networks including the College of Audiologists and Speech-language Pathologists of Manitoba and the Quebec Association of Speech Language Pathologists and Audiologists. All associations of audiologists and speech-language pathologists across Canada were contacted, however, 22.22% agreed to participate in participant recruitment to this study; 3) in-person recruitment at the CAA annual conference (October, 2019) using recruitment posters and a sign-up sheet, and 4) individual contact within co-authors' professional networks by email to invite colleagues to complete and/or share the survey. CAA is a Canadian association for audiologists dedicated to enhancing the role of audiologists as primary hearing health care providers through advocacy, education, and research. Members of CAA include hearing health care professionals practicing across Canada.

2.2 Informed Consent and Inclusion Criteria

The two initial sections of the survey provided participants with a copy of the letter of information (LOI), outlining a description of the study, potential risks and harms, confidentiality, and contact information. Following review of the LOI, the following statement for consent to participate was provided: "By submitting your survey responses at the end of the survey, you are consenting to voluntary participation in this study. You understand that you can withdraw from the study at any time, without any penalty or consequences". Review of this consent statement and progression to the next section of the survey indicated the acceptance of consent to participate in the study. Prior to progressing to the inclusion criteria questions, the participants were asked to watch an animated information video (4 minutes long), available at http://care.nca.uwo.ca/, with specific information related to Connected Audiology and the application of remote hearing aid fitting. The complete survey and information video were available in both English and French languages. Materials were translated into French from English and then reverse translated to ensure accuracy. A translation certificate was provided for this work. The information video also included the use of captioning (which was also translated). Of the participants that completed the survey, 94.5% completed the survey in English and 5.5% in French.

Sixty-eight participants completed the informed consent process and advanced to the section of the survey containing inclusion criteria questions. Participants were required to meet

the following criteria, according to their professional practice at the time they filled out the survey, to be included in this study:

1. Practice clinical audiology in some capacity (full-time or part-time);
2. Provide face-to-face hearing aid fitting services;
3. Live in Canada;
4. Practice audiology in Canada.

Audiologists who were not working as a registered audiologist in Canada were excluded from this study.

A total of 89.71% (n/N = 61/68) of audiologists in this study reported practicing audiology in some capacity, 82.35% (n/N = 56/68) were providing face-to-face hearing aid services, and the majority (n/N = 36/68) lived and practiced in Ontario, as shown in Figures 2.1 and 2.2. A total of 55 audiologists met the study inclusion criteria and progressed to the demographic section of the survey.

Figure 2.1

Respondents' Provincial Residence

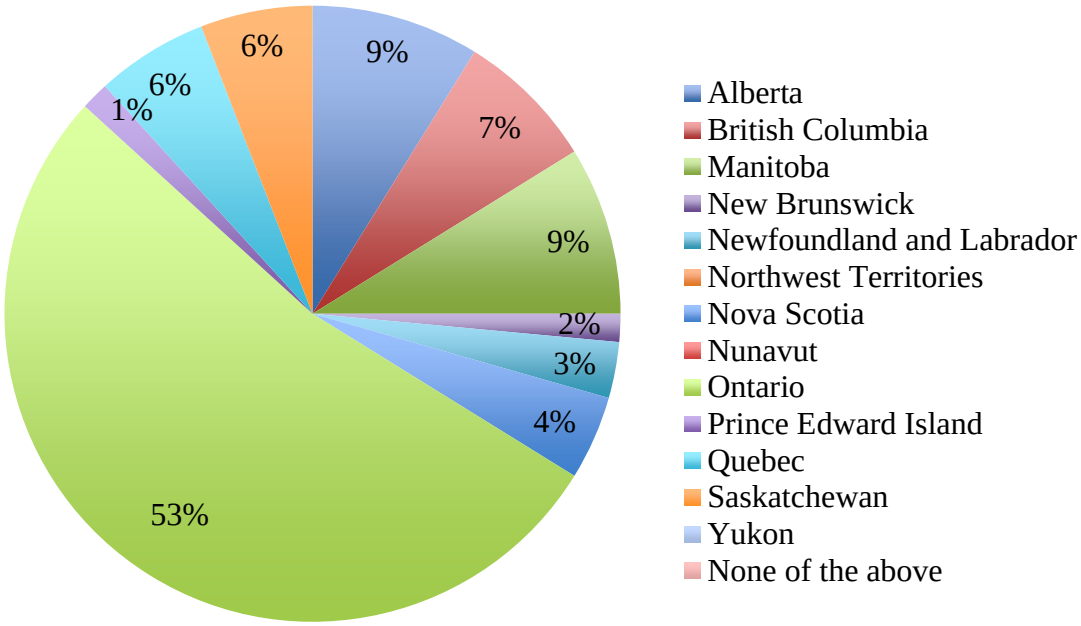
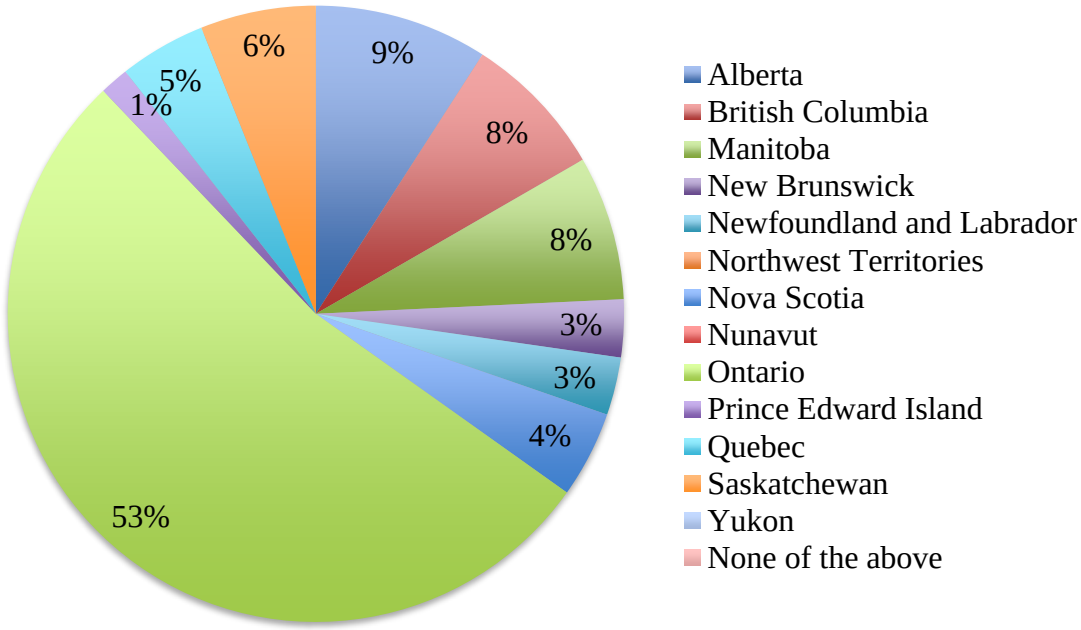


Figure 2.2

Respondents' Practice Context



2.3 Description of Demographic and Main Survey Questions

The remaining two sections of the survey included a series of demographic questions that led into the main body of the survey. In summary, the demographic questions provided information regarding the participants' sex, age, audiology-related degrees earned, practice experience, practice context, description of population center in which they live and practice audiology, and previous experience level in offering general Connected Audiology services and/or remote hearing aid support services in clinical practice. The responses to the demographic question concerning prior experience with remote hearing aid fitting (refer to question 11, Table A2) constituted the dependent variable in the exploratory bivariate analysis described below. In addition to the question exploring the percentage of audiologists with experience in the delivery of Connected Audiology services, audiologists in this study were asked to describe the type of services that they previously provided in an open-ended question text-based response format. Answers for this open-ended question were grouped into 10 categories: assessment, counselling, identification, treatment, prevention, education, habilitation and rehabilitation, early hearing detection and intervention, research, and administration. Population centers and rural areas were classified according to Statistics Canada as follows: small urban centers include a population between 1,000 and 29,999; medium urban centers include a population of between 30,000 and 99,999; large urban centers include a population of 100,000 and above; and rural centers include a population below 1,000 (Statistics Canada, 2016). Survey data related to the participants' internet speed (when completing CARE survey) was collected using Speedtest® by Ookla, 2006.

The main body of the survey included 18 umbrella questions and 75 sub-questions. All umbrella questions and corresponding response formats are outlined in Table 2.1, according to the survey dimension that they fell under (refer to appendix A for a copy of the entire survey).

Table 2.1

List of Statements per Dimension and Corresponding Response Choice

Dimension	Umbrella question	Response type
Practice context	We are interested in learning more about your current practice context. Please indicate if you have access to the following in your place of practice (Check all that apply).	Multiple-choice
	Please indicate the time of day that you currently offer client/patient services specific to hearing aid fitting.	Multiple-choice
Access	Please indicate the time of the day that your support staff is currently available to assist you with patient/clinic services specific to hearing aid fitting.	Multiple-choice
	Please indicate if the following resources are (Yes) or are not (No) currently available in your place of practice.	Multiple-choice
	Please use the following URL to complete an internet speed test and press the back button to return to the survey (you can copy and paste the URL to your browser search engine): https://www.speedtest.net/	Text entry
Social capital	Please provide an estimate of how many of your clients/patients would:	Multiple-choice
Organizational support	Please indicate to what extent you agree or disagree with the following statements related to your current place of practice.	Word scale
Standards	Please indicate if organizational guidelines (policy/ procedure/ protocol/ recommendation documents) are implemented or not in your current place of practice.	Word scale
Aptitude	Please rate your comfort level around the following situations.	Word scale
	Please rate your comfort level in using each of the following technologies.	Word scale
	Please rate your comfort level in downloading applications (a.k.a. “apps”).	Word scale
Attitude	Please rate the level to which remote delivery of the following hearing aid fitting services will add value to your routine practice.	Word scale
	Please indicate how much effect Connected Audiology will have on the different aspects of your routine practice.	Word scale
	Please indicate your level of agreement with the following statements.	Word scale
Patient-provider relationship	We would like to know how you feel the provision of remote hearing aid fitting services will influence	Word scale

Dimension	Umbrella question	Response type
	the patient-provider relationship. Please indicate your level of agreement with the following statements.	

2.4 Description of Analyses

Data analyses include descriptive analyses and bivariate analyses. Descriptive statistics were used to summarize group-level findings according to each survey question and the CARE framework dimensions. Descriptors included absolute frequency (number of responses), relative frequency (percentage), and central tendency measures. These were calculated for responses collected in both multiple-choice and word scale response formats.

2.4.1 Bivariate Analyses

Providing a cross-sectional assessment, this dissertation aimed to explore the statistical association between audiologists' previous experience providing remote hearing aid fitting services (dependent variable; question 11, Table A2), and how this can be predicted by the results from individual survey questions (independent variables). This specific dependent variable was selected based on the reported number of practicing audiologists who self-indicated already having provided remote hearing aid services in clinical practice, and therefore, are considered to be in a current state of readiness to provide remote services. All other questions were coded as dichotomous independent variables, or variables potentially associated with the adoption of remote hearing aid fitting services.

Previous studies in the health sciences have used Odds Ratio (*OR*) to analyse surveys results, determining the associated factors to different health conditions (Bosetti et al., 2000; Das Gupta et al., 2020; Pant et al., 2017) and the determinants factors of health professionals' readiness (Biruk et al., 2014). Others studies have supported the use of *ORs* for cross-sectional studies (Bertani et al., 2018; Grimes & Schulz, 2002).

An *OR* quantifies the expected ratio between the odds of a positive outcome (i.e., in the context of this thesis, a positive response to Question 11 on prior remote hearing aid fitting experience) given a positive value (response) on a particular predictor variable and those odds given a negative value on that same predictor variable; thus, the ORs reflects the odds (likelihood) that an outcome will occur given a specific exposure (Szumilas, 2010). An *OR* close to 1 suggests that the odds does not depend on the predictor variable, whereas an *OR* significantly larger than 1 suggests a positive association between the two variables.

For this study *ORs* and their 95% Confidence Intervals (CI) were calculated to determine the likelihood of participant readiness to adopt remote hearing aid fitting services. This

measurement of association between exposure (independent variables) and outcome (dependent variable) has the potential to expose the strength and the odds of chance occurrence (Grimes & Schulz, 2002).

Bivariate analyses were conducted using the Stata statistics package (v.12) and Excel. For this study *ORs* were obtained through a logistic regression to establish which key variables have a statistically significant association to the dependent variable of interest.

Literature around the use of category collapsing suggests both pros and cons, as it relates to data analysis and reporting. For example, pros to collapsing categories include easier reporting of results and reduction of outlier influence, whereas cons include, reduced accuracy and power, in some cases (DeCoster et al., 2009; Rutkowski et al., 2019). To complete the bivariate analyses included in this study, responses containing more than 2 categories (per question), were collapsed to dichotomous scales; this included data based on word scales and multiple-choice formats. Category collapsing was completed as follows:

1. Word scales containing 5-points were removed from the bivariate analyses, due to the presence of neutral categories that could not be categorized logically into a valence category. The valence categories could not be analysed on their own (after removal of neutral categories) due to insufficient data points. A total of 2 umbrella-questions and 11 sub-questions were removed from the analyses for this reason.
2. Word scales containing 4-point scales were collapsed into a 2-point scale by pairing adjacent categories at either end of the scale. Considering one sample aptitude related question, *Novice* and *Average* categories were collapsed as well as *Above-average* and *Expert* categories. This resulted in a dichotomous set of responses relating to less versus more aptitude to uptake Connected Audiology.
3. Three-point scales were collapsed using clinical decision-making logic. No 3-point scales included a neutral category. Considering the 3-point scales used in the standards dimension, *Not implemented* was kept in its own category as a clinical barrier to readiness, whereas *Partially implemented* and *Fully implemented* were collapsed together to create a new category thought to facilitate clinical readiness. When collapsing scales related to perceived effect in the attitude dimension, the same criteria was followed; *No added value* responses were grouped in a category as perceived

barriers, and responses from a *Small added value* and a *Large added value* were grouped together into one category as perceived to act as facilitators to readiness.

4. Multiple-choice questions containing more than two response options were collapsed to two options by removing responses relating to *Unsure* and *None* and collapsing those including *Both* with the response option that logically fit. In the case that zero responses were gathered for a multiple-choice category, the category was removed from the analysis. For example, for the practice context dimension participants were asked to indicate the time of the day when they offer services specific to hearing aid fitting. This question included multiple-choice response format, where during business hours, outside of regular business hours and both, regular business hours and outside of business hours were the options. The categories *Outside* and *Both* were collapsed, whereas the category *During regular business hours* was kept in its own creating two categories: *Regular* versus *Flexible* hours. For this question, the category *Outside* had zero responses and was thus removed from the analyses.
5. Two multiple-choice questions were removed from the bivariate analyses as they did not inform the participants' state of readiness. These questions were included in the survey to help interpret the information gathered around internet speed.

Table 2.2 states the original categories along with the collapsed categories used in all statistically significant bivariate analyses.

Table 2.2
List of the Original and Dichotomous Scales

Original Scale	Collapsed Scale
Practice context	
During regular business hours	During regular business hours
Outside business hours	Outside business hours and both regular business hours and outside of business hours
Both, regular business hours and outside of business hours	
Access	
Business hours	Business hours
Outside of business hours	Outside business hours and both
Both	
None	
Organizational support	
Strongly disagree	Somewhat disagree to strongly disagree
Somewhat disagree	Somewhat agree to strongly agree
Somewhat agree	
Strongly agree	
Standards	
Not implemented	Not implemented
Partially implemented	Partially to fully implemented
Fully implemented	
Aptitude	
Novice	Novice to average
Average	Above-average to expert
Above-average	
Expert	
Attitude	
No added value	No added value
A small added value	Small added value to A large added value
A large added value	
Patient-provider relationship	
Strongly disagree	Somewhat disagree to strongly disagree
Somewhat disagree	Somewhat agree to strongly agree
Somewhat agree	
Strongly agree	

Note. This table outlines the collapsing of categories for the Bivariate Analyses.

Chapter 3

3. Results

This section includes all results from the demographic section and from all questions from the main body of the survey. For the main survey, results are reported according to the eight framework dimensions. A total of 68 audiologists started the survey, 55 met the inclusion criteria and 47 completed the entire survey, resulting in a completion rate of 69.11%. The average completion time was 20.41 minutes (*IQR* = 14.56 – 37.22 minutes). A high mean completion time of 702.05 minutes was reported; this is most likely due to outliers and may not be indicative of the average completion time. Data from partially completed surveys were included in the analyses.

3.1 Demographics

Demographics including sex, age, previous education, and years of experience were collected as part of the survey to obtain a general overview of participating audiologists. The data allowed a description of the participant sample for comparison between different groups. Table 3.1 summarizes the demographic responses collected in the CARE survey. Questions were formatted to include dichotomous questions (e.g., yes/no) and multiple-choice questions.

Table 3.1

Total Group Demographic Responses

Demographics	n/N	%
Gender		
Female	43/55	78.18
Male	12/55	21.82
Age (years)		
18-29	7/54	12.97
30-49	32/54	59.26
50-64	13/54	24.07
65 +	2/54	3.70
Educational level*		
Clinical Master's degree (e.g., MCISc)	40/54	74.07
Research-based Master's degree (e.g., MSc)	13/54	24.07
Clinical Doctoral degree (e.g., AuD)	11/54	20.37
Thesis-based Doctoral degree (PhD)	6/54	11.11
Years of experience		
Less than 1	1/54	1.85
1 to 5	10/54	18.52
6 to 10	12/54	22.22
More than 10	31/54	57.41
Description of community of practice		
Small urban population centre	6/54	11.11
Medium urban population centre	12/54	22.22
Large urban population centre	36/54	66.67
Rural area	0/54	0.00
Provision of general Connected Audiology services		
Yes	24/54	44.44
No	30/54	55.56
Provision of remote hearing aid fitting		
Yes	12/53	22.64
No	41/53	77.36

Note. Table is displayed in number of responses per category (n), total responses (N), and corresponding percentages. * Percentages exceed 100% for this category due to the allowance of multiple responses from respondents.

3.2 Practice Context Dimension

When asked to describe various aspects of current clinical practice contexts that are thought to relate to the feasibility and/or practicality of remote service delivery, 98.11% (n/N = 52/53) of respondents indicated having both a quiet space to deliver services, and adequate lighting. Regarding the spaces available for the provision of audiological services, 96.23% of respondents (n/N = 51/53) had a space that provided privacy to deliver client/patient specific services; 62.26% of respondents (n/N = 33/53) had a space that was separated from traditional practice areas used in face-to-face delivery of service; and 47.17% percent (n/N = 25/53) indicated having a space available outside of regular business hours. Regular business hours were defined as those hours worked during a typical "daytime" schedule (e.g., 8.00 AM to 5.00 PM). When asked about the time of day that services were usually offered, 85.19% of respondents indicated that they offered client/patient services specific to hearing aid fitting during business hours only (n/N = 46/54), while the remaining 14.81% offered services both during regular business hours and outside regular business hours.

3.2 Access Dimension

Audiologists in this study provided information about their access to technology and the existing technological infrastructure in their place of work, relating to delivery of remote audiological services. Table 3.2 summarizes the resources available at the respondents' place of practice. Overall, greater access to technological resources is thought to relate positively to readiness to uptake Connected Audiology.

Table 3.2

Access to Technology and Infrastructure

Resources	n/N	%
Internet connection	54/54	100.00
Laptop or desktop	54/54	100.00
A tablet or smartphone that can be made available to client/patient	19/51	37.25
Microphone	44/54	81.48
Video camera	33/54	61.11
Software to convert speech to text	7/51	13.73
Access to a language interpreter	19/51	37.25
On-demand IT support	20/52	38.46
Scheduled (less frequent) IT support	38/51	74.51

Note. Table is displayed in number of responses per category (n), total responses (N), and corresponding percentages.

Based on their current place of practice, the majority of respondents indicated having access to support staff during business hours (86.79%, n/N = 46/53), very few indicated having access to support staff at all hours of the day (9.43%, n/N = 5/53), a small percentage indicated having no access to support staff (3.77%, n/N = 2/53), and none of the respondents reported having access to support staff outside of business hours.

Audiologists in this study were asked about the type of internet connection used; results indicated that 59% of respondents (n/N = 32/54) had access to a desktop or laptop computer with hearing aid fitting software with a wired internet connection, 33.33% (n/N = 18/54) had access to a wireless connection, and 7.41% (n/N = 4/54) were unsure of the type of internet connection available in their workplace. Most respondents completed the survey using a laptop computer (46.30%, n/N = 25/54), 38.89% (n/N = 21/54) used a desktop computer, and 14.81% (n/N = 8/54) used a mobile device. The majority of respondents indicated completing the survey at their place of practice (51.85%, n/N = 28/54), fewer indicated completing the survey out at home (42.59%, n/N = 23/54), and very few (5.56%, n/N = 3/54) completed the survey at another location.

Using the Speedtest®, audiologists were asked to test the speed of their internet connection and record the upload and download speeds. The following information includes responses from respondents who completed the survey at their place of practice (n/N = 28/54). The mean, median, and *IQR* are as follows:

- The median upload speed: 23.31 Mbps (*IQR* = 10.4 - 78.09);
- The median download speed: 51.81 Mbps (*IQR* = 29.15 - 84.07); and
- Mean values of 40.93 Mbps for upload speed and 99.26 Mbps for download speed.

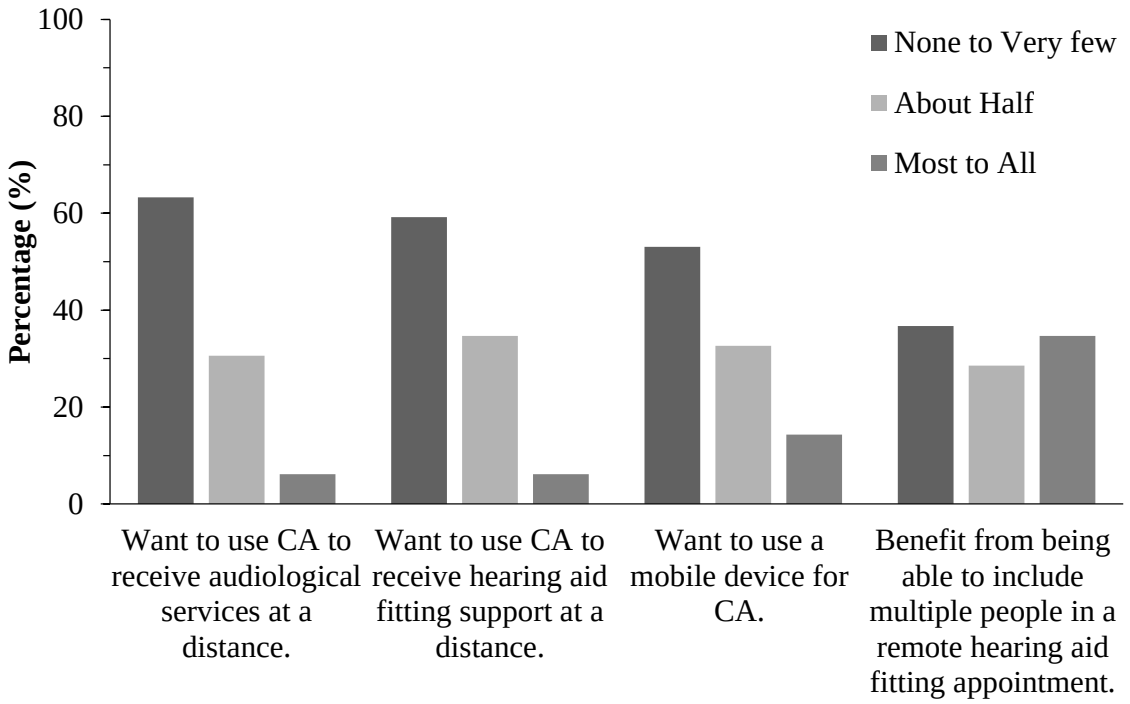
3.3 Social Capital Dimension

In this section audiologists in this study were asked to estimate, based on their perspective, if their clients/patients would be willing to engage in Connected Audiology. Overall, the highest number of responses indicated a feeling that *None* or *Very few* of their clients/patients would want to use or would be able to use remote service delivery and/or the various technologies required to facilitate Connected Audiology as reported in Figure 3.1. Participants were asked to complete ratings on a 5-point Likert scale; which were collapsed into a 3-point scale for reporting purposes. The categories *None* and *Very few* were combined into the category

None to very few, and *Most* and *All* were collapsed into the category *Most to all*. *About half* was retained as the third option.

Figure 3.1

Percentage of Clients/Patients Willing to Use Connected Audiology



Note. Willingness is reported from respondents' perspective. CA= Connected Audiology.

3.4 Standards Dimension

Audiologists in this study were asked to report on the current implementation status of organizational guidelines in their place of practice, including policies, procedures, protocols, and recommendation documents which underpin the provision of remote hearing aid fitting services. As shown in Table 3.3, results indicated that most respondents did not have access to guidance documents within their organization to guide the implementation of Connected Audiology in clinical practice.

Table 3.3

Organizational Guidelines Implemented at Respondents' Workplace

Guidelines	Implementation (%)		
	None	Partially	Fully
To promote CA	80.85	14.89	4.26
Outlining evidence-based best practice in CA	85.11	14.89	0.00
On the security of client data obtained during CA	72.34	14.89	12.77
On the storage/maintenance of client/patient records related to CA	70.21	17.02	12.77
On obtaining consent for the purpose of delivering CA	72.34	21.28	6.38
On obtaining consent to include other health care professionals in CA appointments	76.60	19.15	4.26
On client/patient candidacy for CA	82.98	12.77	4.26
On scheduling CA appointments	78.72	14.89	6.38
On reimbursement for services delivered via CA	91.49	8.51	0.00
On licensure to practice CA	82.98	17.02	0.00
On maintaining client confidentiality when offering remote service delivery	67.39	19.57	13.04
On insurance requirements specific to the delivery of remote services	82.98	14.89	2.13

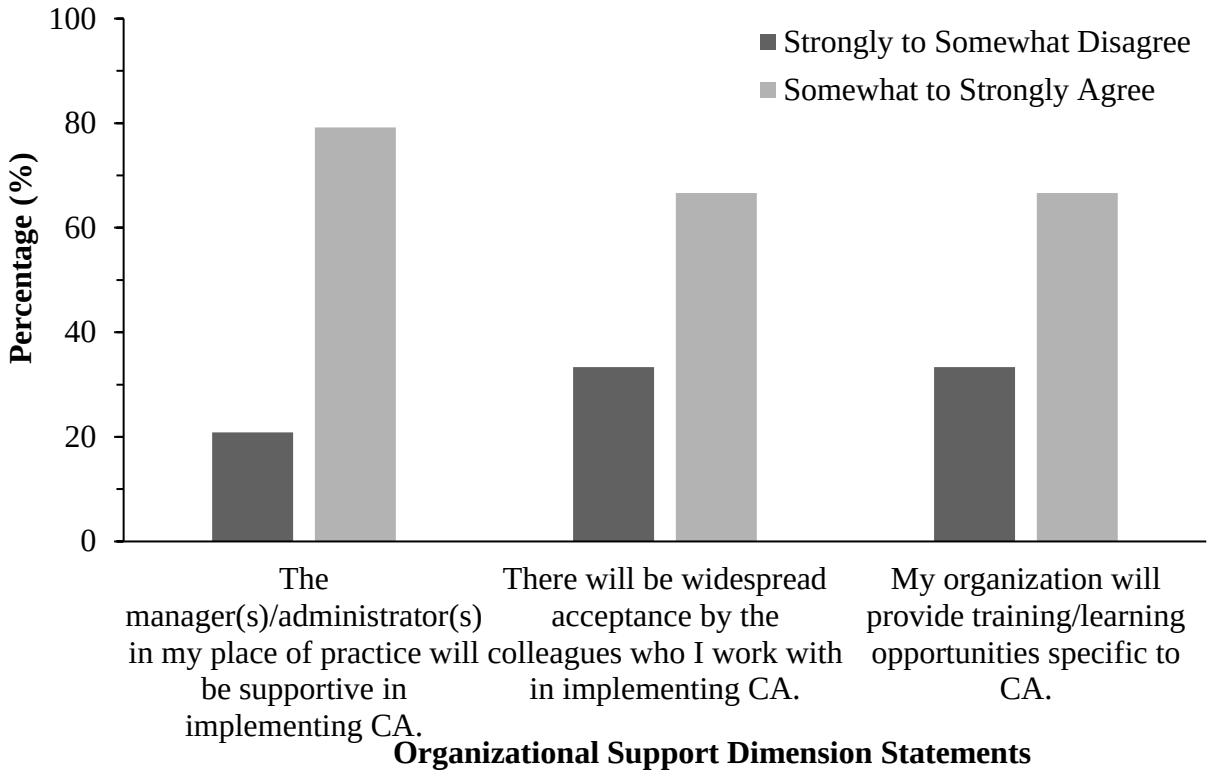
Note. The wording of the sub-questions listed in Table 3.3 have been modified from the original survey to improve readability (refer to Appendix A for the original sub-questions). All responses refer to the percentages of guidelines implemented at audiologists' workplace. CA = Connected Audiology.

3.5 Organizational Support Dimension

Organizational support was measured by surveying respondents' perceptions around different forms of organizational support, including support from colleagues, managers, and administrators, to better understand the respondents' needs and the "buy-in" perceived within the organization. Rating categories have been collapsed from a 4-point scale to a 2-point scale to increase readability by combining the *Strongly disagree* and S*omewhat disagree* categories into the category *Strongly to somewhat disagree* and the *Somewhat agree* and the *Strongly agree* categories were combined into *Somewhat to strongly agree*. In general, audiologists in this study indicated perceived their organization to be supportive of Connected Audiology, peers to be accepting and indicated access to professional development opportunities (Figure 3.2).

Figure 3.2

Percentage of Respondents-Perceived Organizational Support



3.6 Aptitude Dimension

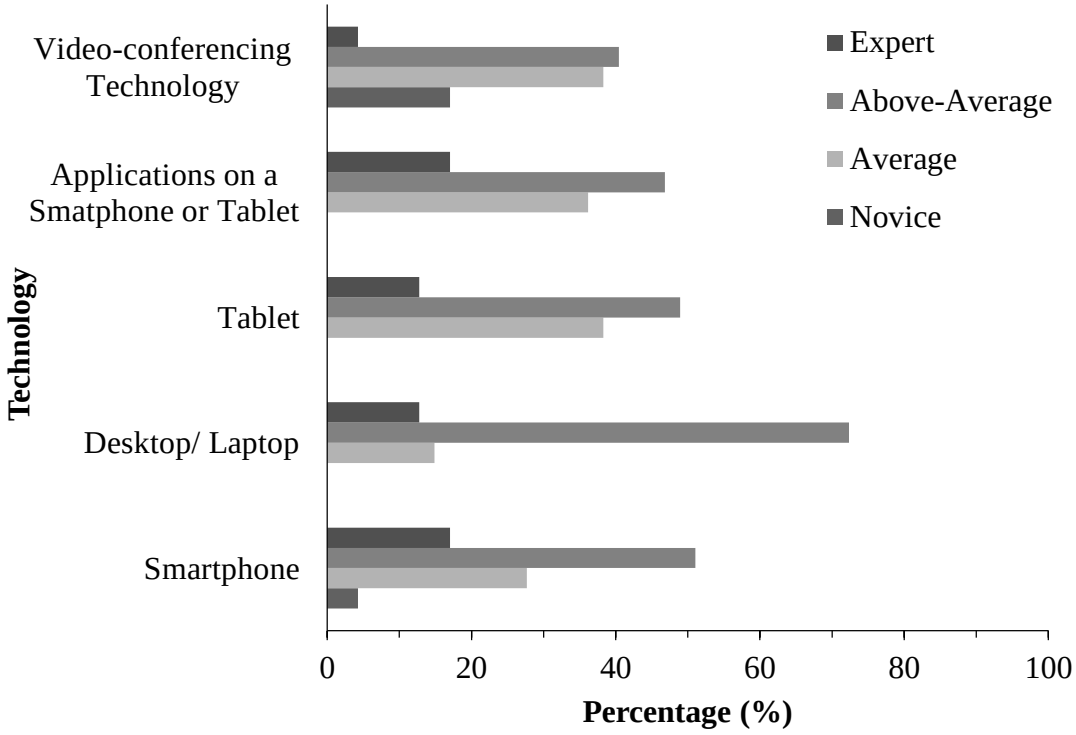
Audiologists in this study were asked to rate their skill-level/abilities around the provision of Connected Audiology, including that related to specific technologies. Using a 4-point scale (*Novice, Average, Above-average*, and *Expert*), most respondents reported an *Average* ability to identify when clients/patients were candidates for remote hearing aid fitting services (53.19%, n/N = 25/47), whereas 23.40% indicated a *Novice* ability (n/N = 11/47), and 23.40% indicated an *Above-average* ability (n/N = 11/47). No respondents considered themselves to be "*experts*" on identifying patient candidacy around remote hearing aid fitting support. Using video conferencing to communicate with clients/patients, 44.68% (n/N = 21/47) of audiologists in this study indicated that they had an *Average* ability to use it, 31.91% (n/N = 15/47) indicated a *Novice* ability, 19.15% (n/N = 9/47) an *Above-average* ability, and 4.26% (n/N = 2/47) an *Expert* ability.

Participants were also asked to rate their ability to recognize body-language and/or emotional cues during video conferencing; 42% (n/N = 20/47) of respondents rated their ability as *Average*; 23.40% (n/N = 11/47) as *Novice*, 31.91% (n/N = 15/47) rated as *Above-average*, and 2.13% (n = 1/47) considered themselves as *Expert*.

When rating comfort level for downloading applications, 44.68% percent (n/N = 21/47) of respondents reported themselves as having an *Above-average* aptitude, 29.79% (n/N = 14/47) indicated an *Average* aptitude, 23.40% (n/N = 11/47) an *Expert* aptitude, and 2.13% (n/N = 1/47) rated themselves as *Novice*. Most audiologists in this study reported having *Average* or *Above-average* aptitudes for using technologies required to facilitate remote hearing aid fitting appointments (Figure 3.3).

Figure 3.3

Respondents' Comfort Level Using Technologies



3.7 Attitude Dimension

This dimension evaluated respondents' attitudes around the provision of remote hearing aid fitting, including the potential for Connected Audiology to add value to their routine clinical practice, as well as the perceived need to adopt or learn new practices (e.g., motivational factors). Results are presented across Tables 3.4 and 3.5. Table 3.4 shows the perceived added value around the remote provision of specific audiological procedures of importance to the hearing aid fitting process. Audiologists in this study generally felt that Connected Audiology would add value to their clinical practice.

Table 3.4

Perceived Added Values

Audiological Procedures	None		Small		Large	
	(n)	%	(n)	%	(n)	%
Monitoring hearing aid use remotely	2	4.26	26	55.32	19	40.42
Adjusting the level of hearing aid gain remotely	1	2.13	24	51.06	22	46.81
Activating or deactivating hearing aid settings remotely	0	0.00	23	48.94	24	51.06
Verification of the hearing aid output following changes made remotely	3	6.38	23	48.94	21	44.68
Managing feedback concerns remotely	1	2.13	23	48.94	23	48.94
Providing counselling for care/use of a device remotely	0	0.00	17	36.17	30	63.87

Note. Table is displayed in number of responses per category (n) and corresponding percentages. Responses are according to audiological procedures related to the provision of remote hearing aid fitting (n/N = 47/68)

Audiologists in this study were asked to estimate how much effect they felt Connected Audiology would have on different aspects of their routine practice. Categories were reduced from a 5-point scale to a 3-point scale for reporting purposes (*Large negative effect* and a *Small negative effect* were combined into a category *Small to a Large negative effect* and a *Small positive effect* with a *Large positive effect* were combined into *Small to a large positive effect*). Of the 47 audiologists that completed this sub-question, 40.43% (n/N = 19/47) considered Connected Audiology to have a positive effect on accommodating appointments outside of typical business hours, 38.30% (n/N = 18/47) a negative effect, and the remaining 21.28% (n/N = 10/47) indicated it would have *No effect*. All of the respondents (100%, n/N = 47/47) felt that giving access to remote service delivery for clients/patients with travel-related constraints (e.g. remote areas, mobility concerns, high traffic, child-care, medically-fragile, special needs) would have a *positive effect* on their routine practice.

Using the same 3-point scale as above, when evaluating respondents' attitudes towards various factors influencing clinical uptake, 97.87% (n/N = 46/47) of the audiologists in this study indicated that reducing travel time for clients/patients would have a *Small to large positive effect*, and 2.13% (n/N = 1/47) of the respondents felt that there would be *No effect*. In contrast to the feelings around client-related travel time, over half of the respondents (55.32%, n/N = 26/47) felt that Connected Audiology would not have any effect on reducing their own travel time to work, and slightly fewer (44.68%, n/N = 21/47) felt that this factor would have a *Small to large positive effect*.

When asked about their ability to attend to client concerns sooner than waiting for a face-to-face appointment, 94% (n/N = 44/47) of respondents indicated that remote service delivery would have a *Small to large positive effect* on their routine practice, 4.26% (n/N = 2/47) reported that there would be *No effect*, and only one participant (2.13%, n/N = 1/47) indicated there would be a *large to small negative effect*. Respondents' perceptions around whether remote services would improve their ability to accommodate appointments that included multiple caregivers and/or health care professions resulted in 87.23% of audiologists in this study (n/N = 41/47) feeling that it would have a *Small or large positive effect*, and 12.77% (n/N = 6/47) feeling that there would be *No effect*.

When considering how much effect Connected Audiology will have on reducing the number of missed/late appointments due to travel-related constraints, 91.49% (n/N = 43/47) of

respondents agreed that Connected Audiology would have a *Small to large positive effect*, 6.38% (n/N = 3/47) indicated it would not have an effect, and only one participant (2.13%, n/N = 1/47) indicated that this factor would have a *Small to large negative effect* on their routine practice.

Results collected for the following questions used a 4-point scale; this was reduced to a 2-point scale for reporting purposes as follows: *Strongly disagree* was reported with *Somewhat disagree* and *Somewhat agree* with *Strongly agree* to report whether respondents *Agreed* or *Disagreed* with each of the statements included in Table 3.5. These results speak to the agreement levels around habits, training, costs, and motivation pertaining to Connected Audiology and suggest mainly positive attitudes towards Connected Audiology in general and around remote hearing aid fitting service provision.

Table 3.5

Factors Influencing Connected Audiology Uptake

Statements	*Strongly to somewhat disagree*		*Strongly to somewhat agree*	
	n	%	n	%
Habits and doing what I have always done will limit my use of remote hearing aid fitting service	23	48.94	24	51.06
If implemented, the cost of purchasing a license to practice CA will limit my ability to provide remote hearing aid fitting services	25	53.19	22	46.81
Time to familiarize myself with set-up new technologies will limit my ability to provide remote hearing aid fitting services	32	68.09	15	31.91
I am motivated to keep up with new technologies specific to CA	6	12.77	38	87.23
I am familiar with research related to remote hearing aid fitting	21	44.68	26	55.32
The provision of remote hearing aid fitting services will influence hearing aid adoption/return rates	14	29.79	33	70.21
I am motivated to pursue training/learning opportunities specific to remote hearing fitting	6	12.77	41	87.23

Note. Table is displayed in number of responses per category (n) and corresponding percentages according to levels of agreement (n/N = 47/68). CA= Connected Audiology.

3.8 Patient-Provider Relationship

Audiologists in this study were asked to what extent the provision of remote hearing aid fitting services would influence their patient-provider relationship. Responses were collected using a 4-point scale (*Strongly disagree*, *Slightly disagree*, *Slightly agree* and *Strongly agree*). Rating categories were reduced from 4 to 2-point scale for analyses purposes: *Strongly disagree* with *Somewhat disagree* and *Somewhat agree* with *Strongly agree*. Results are shown in Table 3.6. Overall, respondents reported that the provision of Connected Audiology services would not have a negative influence on their patient-provider relationship.

Table 3.6

Perceived Influence of Remote Service Provision on Patient-Provider Relationship

Statements	*Strongly to somewhat disagree*		*Strongly to somewhat agree*	
	n	%	n	%
I will more easily connect with difficult-to-reach clients and caregivers with remotes services	7	14.98	40	85.11
My clients will have realistic expectations around how often I should be available to deliver remote services	24	51.06	23	48.94
Most of my clients will prefer face-to-face service delivery over CA	6	12.77	41	87.23
I will maintain a good patient-provider relationship with my clients via CA	4	4.26	45	95.74
When incorporating other professionals into a remote appointment, I feel I will maintain good collaborative relationships	4	4.26	45	95.74
The clients will perceive remote services delivery as adding value to their care	3	6.38	44	93.62
Having access to multiple communication options to use in CA will help maintaining good patient-provider relationship	2	4.26	45	95.74

Note. Table is displayed in number of responses per category (n) and corresponding percentages (n/N = 47/68). CA = Connected Audiology.

3.9 Bivariate Analyses

Readiness factors that are related to the implementation of Connected Audiology were explored. Bivariate analyses were conducted using results from the following question as the dependent variable: “Have you ever offered remote hearing aid fitting services using Connected Audiology?”. Results pertaining to all other questions have been used as predictor variables to assess the level with which these factors were associated with prior experience in providing remote hearing aid fitting services. As shown in Table 3.7, two out of 19 demographic variables, and 14 out of 75 variables from the main body of the survey are significantly associated with experience in providing remote hearing aid fitting services. Overall, results from these analyses reflect practice areas in which there is a strong association between readiness and the facets required to facilitate remote hearing aid fitting.

Table 3.7

Significant Bivariate Analyses Results

Variable	*z*	95% CI	*OR*	*p*
Demographic				
Previous experience using CA				
No	-	-	-	-
Yes	2.36	[1.34, 24.84]	5.78	.02
Access				
Access to a video camera				
No	-	-	-	-
Yes	2.06	[1.12, 80.51]	9.49	.04
Standards				
To promote CA				
Not implemented	-	-	-	-
Partially to fully implemented	2.52	[1.58, 40.33]	8.00	.01
Outlining evidence-based best practices in CA				
Not implemented	-	-	-	-
Partially to fully implemented	2.26	[1.29, 41.42]	7.33	.02
On the storage/maintenance of client/patient records related to CA				
Not implemented	-	-	-	-
Partially to fully implemented	2.18	[1.18, 23.27]	5.25	.03
Guidelines on obtaining consent for the purpose of delivering CA				
Not implemented	-	-	-	-
Partially to fully implemented	2.37	[1.37, 28.14]	6.21	.02
On client/patient candidacy for CA				
Not implemented	-	-	-	-
Partially to fully implemented	2.74	[1.98, 60.98]	11.00	.00
On scheduling CA appointments				
Not implemented	-	-	-	-
Partially to fully implemented	2.29	[1.30, 29.46]	6.20	.02
On licensure to practice CA				
Not implemented	-	-	-	-
Partially to fully implemented	2.00	[1.03, 27.42]	5.33	.04
On maintaining client/patient confidentiality when offering remote service delivery				
Not implemented	-	-	-	-
Partially to fully implemented	1.95	[0.99, 18.94]	4.33	.05
Aptitude				
Identifying when clients/patients are candidates for remote hearing aid fitting services				

Variable	*z*	95% CI	*OR*	*p*
Novice to average	-	-	-	-
Above-average to expert	2.08	[1.09, 22.82]	5.00	.04
Attitude				
I am familiar with the research related to remote hearing aid fitting				
Strongly to somewhat disagree	-	-	-	-
Somewhat agree to strongly agree	2.09	[1.15, 87.84]	10.05	.04

Note. Bivariate analyses were conducted on all demographic and main survey questions. CA = Connected Audiology.

Chapter 4

4. General Discussion

The purpose of this study was to describe Canadian audiologists' readiness to adopt Connected Audiology to facilitate the delivery of remote hearing aid fitting. As such, the Connected Audiology Readiness Evaluation (CARE) was developed to assess readiness across the eight dimensions recognized in the CARE framework to influence the clinical uptake of remote hearing aid fitting services: access, aptitude, attitude, practice contact, organizational support, standards, social capital and patient-provider relationship. Connected Audiology, and the provision of remote services, have emerged as new models of care in response to the need for timely and efficient solutions to both pediatric and adult populations. Even though there is a paucity of literature related to the remote hearing aid fitting services, the available evidence suggests that service providers (e.g., audiologists) perceive added value when offering remote services (Brännström et al., 2016). Moreover, studies related to the provision of remote hearing aid treatment and intervention (e.g., hearing aid fitting and verification), suggest efficient and timely delivery methods that are comparable to in-person encounters (Campos & Ferrari, 2012), with a focus on family-centered care and the inclusion of multiple people in the care process (Muñoz et al., 2017). Furthermore, the literature describes remote follow-up hearing aid fittings appointments to be feasible and to improve the user's fitting experience, especially in the first stage of hearing aids use (Angley et al., 2017). As more evidence is required to warrant the broad use of Connected Audiology, it is important to explore and identify what readiness factors are restricting the adoption of remote audiological services in general, and those specific to hearing aid fitting.

Readiness is an important factor when determining a stakeholder's likelihood of using remote services. This study focused on assessing readiness at the level of the provider, specific to registered audiologists practising across Canada. The results of a readiness assessment can inform stakeholders of the barriers and facilitators around the uptake of a new practice (Domlyn & Wandersman, 2019b). Moreover, having a clear understanding of the current context in which a new option of service delivery is going to be implemented will help to tailor the interventions in response to stakeholders' needs.

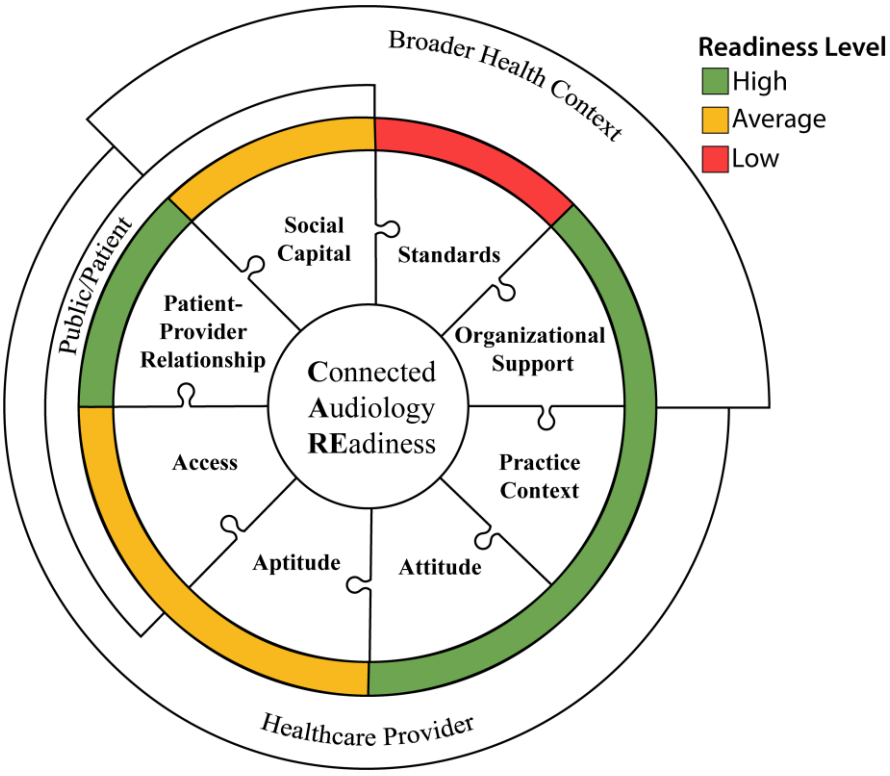
Most audiologists included in this study were women (78%), aged 30 – 49 years of age who held a clinical degree in Audiology (MClSc). These findings are not surprising as the field

of Audiology generally attracts more women than men into training programs that are mainly structured around clinical training opportunities. These demographic finding are also consistent with those previously reported by Singh et al. (2014) in a survey of the attitudes of practitioners toward tele-audiology including mostly female respondents (74%) and with a mean age of 39.3 years (Singh et al., 2014). Although experience level was sampled using slightly different categories, both this study and that by Singh and colleagues reported most respondents having many years of clinical experience (i.e., greater than 10 years for this study).

When considering the respondents' description of their practice communities, most reported practicing in large urban populations centres (67%), with fewer reporting their community of practice to be in a small or medium urban centre, and none reporting a rural population centre. The findings from this study therefore generally reflect readiness as it pertains to urban centre practices and therefore may underestimate technological barriers that may exist in rural practice communities. Less than half of the respondents indicated providing some form of Connected Audiology services in clinical practice (44%), and few reported providing services specific to remote hearing aid fitting (23%), this is consistent with the low reported use patterns (25%) from an international survey of audiologists' attitudes towards telehealth (Eikelboom & Swanepoel, 2016). Overall, the findings from this study suggest that the readiness levels of Canadian audiologists in this study vary considerably across the eight dimensions evaluated by the CARE survey, with a reported high state of readiness when considering practice context, patient-provider relationship, organizational support and attitude, an average state of readiness when considering access, social capital and aptitude and a low state of readiness when considering the standards dimension (refer to Figure 4.1). Findings are summarized below, across dimensions, to yield a better understanding of the different clinical factors acting as barriers and facilitators when it comes to Connected Audiology readiness.

Figure 4.1

Summary of Audiologists' Readiness Levels to Adopt Connected Audiology



The practice context dimension included factors related to the set-up of the physical space, in addition to current routines and practices used in the delivery of in-person care and the requirements for modifications to facilitate remote service delivery. Factors related to the physical space available in the delivery of remote services are reported as important when designing and/or preparing to use remote service delivery (Krupinski, 2014). Overall, audiologists in this study reported having access to a place of practice suited for remote service delivery. These places were equipped with adequate lighting and provided a space that was private and quiet. Although, most of the respondents had access to a space that they felt was suitable to deliver remote services, almost half had access to a practice space outside of regular business hours, and most (85%) provided services only during regular business hours. These results indicate that Canadian audiologists in this study may need to modify how they schedule appointments to accommodate remote delivery of services outside of regular business hours. Offering services outside of regular business hours has the potential to provide services clients/patients with challenges attending appointments due to work demands, mobility issues or parents with small children (Rushbrooke & Houston, 2016).

The evidence suggests that the availability of technological resources at the audiologists' workplaces, which makes connecting with their clients/patients at a distance more feasible, lessens geographical barriers and improves access to care (Krupinski, 2015). Based on the findings of Glista et al., (2020), audiologists considered "access" to technology to be a highly important factor in the uptake of remote service delivery. Results from the access dimension suggest that most audiologists in this study have access to the basic equipment required to conduct remote follow-up hearing fitting appointments. These resources included: an internet connection, laptop or desktop computer, microphone, video camera and IT support by appointment. Conversely, respondents indicated a need for additional resources when it came to those tailored to hearing impaired patient/clients (e.g., software to convert speech to text and access to a language interpreter). Less than 40% of audiologists in this study indicated access to on-demand IT support, and a tablet or smartphone that could be made available to a client/patient in need. These findings suggest the need to improve resource availability to better provide services to clients/patients, especially those with severe to profound hearing loss that may experience challenges communication over virtual appointments. The factors pertaining to the

access dimension refers not just to equipment, but also to a need for improved access to IT support that can assist at time of appointment.

To successfully conduct remote appointments, another important component is a robust connection; this is typically judged by the internet speed and bandwidth. Gladden (2017) suggests a minimum of 0.4 Mbps (megabits per second) to conduct a synchronous clinical encounter, whereas a minimum of 1 Mbps for basic videoconferencing is recommended in the literature (Abrams & Gaiser, 2017). However, as the speed might be affected by the bandwidth (how much data can be downloaded or uploaded), the bandwidth should be considered for the adequate transmission of data, specifically for running applications required during remote hearing aids fitting. Hearing aid manufacturers have suggested that an internet speed of no less than 5 Mbps for upload and 5 Mbps for download is required, especially when adding a shared video source (Phonak AG, n.d). Most audiologists in this study possessed the minimum speed required to support remote encounters (5 Mbps for upload and download speed) and therefore likely had access to a stable internet connection with good quality video, and audio clarity, particularly in synchronous (real-time) encounters. This may relate to the practice communities reported and the fact that many respondents reported practising in large urban centers. In general, most Canadians have access to internet speeds of 50 Mbps for download and 10 Mbps for upload, but those in rural and remote areas still have limited access and may require further support (Government of Canada, 2019). The respondents included in this study have access to internet resources of a similar quality and rigor to the average Canadian citizen.

When assessing social capital, audiologists in this study reported on their perceptions, therefore limiting the ability to generalize findings outside of this group of participants. Overall, less than 40% of audiologists believe that their clients/patients would want to embrace Connected Audiology to receive general audiological services at a distance or those specific to hearing aid fitting support. The use of Connected Audiology has multiple benefits; one of them is the possibility to include other professionals, caregivers, and family members in the remote follow-up appointments (Rushbrooke & Houston, 2016). Audiologists in this study recognized the benefit to including multiple people in a remote hearing aid appointment and the benefit that might bring to their client/patient. Feelings of uncertainty related to patients' willingness to engage in Connected Audiology were also reported. These results may be interpreted with

caution as those feelings were captured through the audiologists' perspective instead of clients/patients' perspective.

In Canada, there are guiding associations and colleges in the field of Audiology such as the Speech-Language & Audiology Canada (SAC), Canadian Academy of Audiology (CAA), and College of Audiologists and Speech-Language Pathologists of Ontario (CASLPO), which are dedicated to supporting and protecting the audiologists and speech-language pathologists delivering care, as well as the patients/clients receiving care. Although some standards documents related to the provision of virtual/remote care in audiology have been issued by such regulatory bodies, this study suggests an extremely low implementation rate of such policies, procedures, protocols and/or guidance documents into clinical practice. Ross et al. (2016) suggest key factors for effective implementation of eHealth in a healthcare setting to include dimensions related to the outer context, in particular, the need for supportive legislation, and recognised standards (Ross et al., 2016). Within Canada, there appears to be a great need for the development and implementation of guidance documents to support and increase the adoption of Connected Audiology; this is consistent with a low state of readiness in the standards dimension.

In contrast to the above, high states of readiness were reported by audiologists in this study in the organizational support dimension. According to Tao et al., (2018) different non-medical barriers such as the acceptance of support staff in the field of Connected Audiology are restricting its adoption. Nonetheless, results in this study suggest that there is general support from colleagues, managers and administrators perceived by the respondents. More than 60% of audiologists indicated working in a supportive place of practice, when considering the provision of training and learning opportunities specific to Connected Audiology. As reported by Moodie et al. (2011), perceived organizational support is a facilitator when implementing or utilizing new tools.

The CARE survey explored aptitudes and technological skills considered to be relevant during the implementation of remote audiological services. In a recent study conducted by Glista et al. (2020), knowledge and/or expertise around the use of technological resources was identified as a key component in the uptake of remote service delivery specific to hearing aid fittings. There is an evident digital transformation in healthcare that is creating the need to master the user's skills and to improve the user's interaction with technology (Kayser et al., 2019). Knowing how to use the technological resources required to deliver services virtually may help

providers (audiologists) to learn and trust in new options of service delivery (Parasuraman & Colby, 2015). Furthermore, the World Health Organization (2011) states that the lack of knowledge around the applications of Connected Health is acting as a barrier when implementing remote services. Results of this study indicate that most respondents possess the competence, knowledge and skills required to appropriately utilize the technology to provide Connected Audiology services, but that they may require additional support on training around virtual etiquette. Overall, having the technological skills and aptitudes to use the technology, could decrease implementation failure, due to lack of readiness to use it (Mauco et al., 2018).

When attitude is a barrier, it can affect performance and implementation of Connected Audiology into clinical practice (Krupinski, 2015). Ultimately, both the aptitude and attitude dimensions should work together to influence successful uptake of remote services. Researchers in the field of tele-audiology and Connected Health report that most healthcare providers possess a positive attitude and a willingness to uptake a new model to connect with clients/patients at a distance (Ravi et al., 2018; Singh et al., 2014). Eikelboom & Swanepoel (2016) report that audiology practitioners around the world generally have a positive attitude towards Connected Audiology and are willing to be involved in the provision of remote services. However, a limited group of audiologists possess actual experience in implementing Connected Audiology. Overall, results obtained from the attitude dimension demonstrate high states of readiness, as audiologists' attitudes remain positive. Many respondents (64%) agreed that counselling for care/use of a device remotely would be beneficial to their clients/patients; and most (94%) considered that attending to their patients concerns in a timely manner would have positive effect in their clinical practice. Audiologists in this study possess a strong motivation to pursue training opportunities and felt that Connected Audiology could add value to their clinical practice, by positively affecting access to services, reducing travel time, and influencing overall hearing aid adoption.

Many challenges may arise during remote encounters; one of those is the communication and how effectively can be manage to warrant successful interventions (Bulik, 2008). For the patient-provider relationship dimension, the results reflect an important lesson about how the provision of Connected Audiology services can provide a trusted and supportive relationship. These findings are represented by most audiologists in this study who felt that a good relationship could be maintained in remote appointments with their clients/patients and

colleagues. However, some support may be required as audiologists indicated feelings of uncertainty around the frequency with which they should be delivering remote services and are unclear if patients/clients will have realistic expectations around this topic. Caldwell et al., (2017) reported that increasing the implementation rates of remote services has the potential to increase patients confidence when using remote services and could positively affect patient-provider relationships (Caldwell et al., 2017). Overall, audiologists in this study reported that the provision of remote services would not have a negative influence on their patient-provider relationship. Nonetheless, readiness should be assessed more routinely in clinical practice as audiologists' perceptions are evolving and may change with adoption and use of Connected Audiology (Demiris et al., 2010).

4.1 Conclusions From the Bivariate Analyses

The bivariate analyses included in this study were exploratory and aimed to assess whether there was a relationship between the dependent variable (previous experience providing remote hearing aid fitting services) and all other independent variables (the responses to all survey questions). These analyses could not be performed for all survey questions due to methodological limitations discussed below. Therefore, a subset of bivariate analyses (including all or partial responses for all eight dimensions) provides a general overview of the study findings with respect to the respondents' current state of readiness. Statistically significant findings are reported for four of the eight dimensions as well as for one demographic consideration.

Results from the demographic section suggest that respondents with previous experience in the general provision of Connected Audiology are nearly six times more likely to be ready to adopt remote hearing aid fitting than those without it. Results pertaining to the access dimension suggest that participants with access to a video camera in their place of practice are nine times more likely to be ready to adopt remote hearing aid fitting. Results from the standards dimension indicate that audiologists in this study working in places where guidelines are partially or fully implemented are at least five times more likely to be ready to implement remote hearing aid fitting. Reponses from the aptitude dimension suggest that respondents who self-rated their comfort level as *Above-average* to expert when identifying patient's candidacy for remote hearing aid fitting services are five times more likely to be ready to implement remote hearing

aid fitting than those who self-rated as *Novice to average* in identifying a patient's candidacy. With regards to the attitude dimension, respondents who reported familiarity with the research related to remote hearing aid fitting, are 10 times more likely to be ready to implement Connected Audiology than those who indicated disagreement. In summary, the results from these analyses suggest specific areas in which audiologists may require support to successfully implement Connected Audiology into their clinical practice. As such, a high need exists for development and implementation of guidance documents to support implementation of Connected Audiology.

4.2 Limitations

One limitation of this study is its sample size. The relatively small, reported sample size may be related to an extensive survey with numerous questions and sub-questions, lack of incentives and/or lack of mixed-mode approach in collecting survey responses (mail, phone or in-person). This small sample size may restrict the generalizability of results within Canada. Even though results of this study include audiologists across Canada, more than half of participants (53%) were living and practicing in Ontario. In addition, the findings of this study are specific to Canadian audiologists living and practicing in small-to-large urban population centres; thus, responses are not necessarily applicable to audiologists' practising in rural centres or in another provinces in Canada with cultural and socioeconomic differences.

Questions including 5-point scales were removed from the bivariate analyses due the presence of a neutral category and the inability to collapse the responses in a straightforward way. Furthermore, removing the neutral categories and re-running analyses based on responses for the valent categories was not possible due to the small sample size and the distribution of responses for some questions. Thus, future studies including bivariate analyses should consider using even categories when surveying participants to facilitate bivariate analyses.

4.3 Future Research

Further research is needed to assess readiness levels (according to the CARE framework) across a broader range of stakeholders. For example, readiness can be assessed according to client/patient perception and at the organizational level to name a couple. Incorporating readiness data across many key stakeholders will allow for a more comprehensive evaluation of the

barriers and facilitators to the implementation of Connected Audiology and with regards to remote hearing aids fitting.

This study was conducted prior to the COVID-19 pandemic, thus future research should consider assessing provider readiness to uptake remote services during and post the pandemic. Although the pandemic has leveraged a rapid change in the implementation of alternative models of services delivery, such as Connected Audiology, there may still be some areas of practice needing support prior to successful implementation. According to the Canadian audiologists in this study, the dimensions needing support include access, aptitude, and standards dimensions. This highlights the idea that readiness is not equal across all dimensions of interest to Connected Audiology and remote hearing aid support services, and therefore the dimensions needing support before COVID-19 may have changed during the pandemic.

Moreover, recirculating the survey to obtain a larger sample size across all Canadian provinces would help to improve the generalizability of the findings. Future research including international audiologists would help to generalize results outside Canada, and hence will help address facilitators and barriers to the uptake of service delivery via Connected Audiology worldwide. Although this study included participants across Canada, all of them were living and practicing in urban centres. Future research efforts could focus on the readiness of audiologists in remote communities to identify areas that may need support and hence move forward the implementation of Connected Audiology for patients/clients that have limited access to audiological services due to distance/geographical challenges.

In summary, findings from this study help inform researchers, audiologists, and policymakers around the readiness levels of audiologists in Canada to uptake Connected Audiology and remote hearing aid fittings services. The findings have identified factors across the eight CARE dimensions that might be acting as facilitators or barriers during implementation practices of remote hearing aid fitting services. By identifying areas where readiness states are low, we can start to understand the how best to tailor implementation and support efforts in response to stakeholders' needs.

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Appendices

Appendix A: Connected Audiology Readiness Evaluation (C.A.R.E.)

Letter of Information and Consent

Study Title:	The Connected Audiology Readiness Evaluation (C.A.R.E.) for remote hearing aid fitting.
Principal Investigator:	Danielle Glista, PhD, The National Centre for Audiology and Communication Science & Disorders, Western University, London, ON.
Co-Investigators	Sheila Moodie, PhD, The National Centre for Audiology and School of Communication Sciences & Disorders, Western University, London, ON. Susan Scollie, PhD, The National Centre for Audiology and Communication Science & Disorders, Western University, London, ON. Luisa Natalia Perez, MSc, student, Health and Rehabilitation Sciences and The National Centre for Audiology, Western University, London, ON.
Sponsor/Funder Information:	Funds for this study will come from a Research Grant Agreement between Sonova AG and The University of Western Ontario.
Conflicts of Interest:	There are no conflicts of interest to declare related to this study.

Introduction

Dear study participant;

You are being invited to participate in a research study conducted by researchers at the National Centre for Audiology on the topic of Connected Audiology to deliver remote hearing aid fitting services in clinical practice. Connected Audiology refers to the use of telecommunication technology to connect the client to the clinician during audiological diagnostic, treatment and management services at a distance. For example, conducting remote hearing aid fitting processes. We are inviting you to participate is this study as an Audiologist that sees clients/patients in a Canadian practice context. Participation in this study will include completion of an online survey called the Connected Audiology Readiness Evaluation (C.A.R.E.). This survey will help us learn more about the main factors that will influence Canadian Audiologists in adopting remote hearing aid fitting services in their current practice context at the time of follow-up appointment (not during initial hearing aid fitting appointments). Findings will help guide the planning, development and clinical implementation efforts related to remote hearing aid fitting services.

Why is this study being done?

The purpose of the C.A.R.E. survey is to learn more about Connected Audiology in a Canadian practice context. C.A.R.E. questions relate to readiness factors such as available resources, attitudes, and current practice contexts, to name a few examples. We hope to learn what factors may act as barriers or facilitators when implementing remote hearing aid fitting technology into Canadian practice contexts.

How many people will take part in the study?

We are inviting members of the Canadian Academy of Audiology to participate in the survey. You are eligible to participate if you are currently practicing Audiology in Canada, offering hearing aid fitting services in some capacity and providing face-to-face hearing aid fitting services. The anticipated total number of people that will enroll is unknown at this time.

What will happen during this study?

The C.A.R.E. survey will take approximately 25 minutes to complete. As part of the survey, you will be asked to watch a short animated information video that can be accessed via the URL link

provided in the survey. The information you provide when answering the survey is for research purposes only. You can choose not to answer questions if you wish.

Voluntary Participation

Your participation in this study is completely voluntary. You may refuse to answer any questions that you do not want to answer. Responses from partially completed surveys will be saved automatically. Once you complete the survey and submit your survey responses, your data will be included in the study and cannot be withdrawn.

What are the risks and harms of participating in this study?

There are no known or anticipated risks or discomforts associated to participation in this research. You may not receive direct benefit from being in this study. The information collected will contribute to the literature pertaining to e-health implementation in Audiology. You may benefit from furthering your knowledge around the factors related to clinical implementation of remote hearing aid fitting services.

How will participant's information be kept confidential?

Your survey responses will remain anonymous. We will use the information collected from the survey for scientific purposes and any publications resulting from the findings will remain anonymous. We will not be collecting personal identifiers as part of the survey. The survey will be delivered through a web-based survey tool called Qualtrics®. The University of Western Ontario has a license to use Qualtrics® and has negotiated with Qualtrics® to store collected electronic data on a server located in Ireland. The data collected is subject to different laws and regulations. Data collected will be transferred to the study investigators, located at The University of Western Ontario, upon study completion.

What if you have questions about the Study?

If you require any further information regarding this study, please contact Luisa Natalia Perez. If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Human Research Ethics (519) 661-3036, 1-844-720-9816, email: ethics@uwo.ca. The REB is a group of people who oversee the ethical conduct of research studies. The HSREB is not part of the study team. Everything that you discuss will be kept confidential.

By submitting your survey responses at the end of the survey, you are consenting to voluntary participation in this study. You understand that you can withdraw from the study at any time, without any penalty or consequences.

Thank you for your participation in this study.

Please, prior to filling out the survey click on the link below to watch a short video related to Connected Audiology.
Once you finish watching the video, please press the back button in your browser to return to the survey.

http://care.nca.uwo.ca/

C.A.R.E is a survey designed to identify factors related to readiness to use Connected Health Technologies in Audiology specific to remote hearing aid fitting services. Please answer the survey questions using your own opinions and experiences. There are no right or wrong answers. All responses will be kept confidential and your survey will remain anonymous.

Thank you for your participation

Key concepts:

- Regular business hours: Hours worked during a typical "daytime" schedule (e.g., 8:00 am to 5:00 pm).
- Mobile device: A portable computing device such as a smartphone or tablet computer.
- Face-to-face service delivery: Services delivered in the direct physical presence of all involved parties and not including telecommunication technologies.
- Remote service delivery: Services delivered at a distance in which the recipient is remote from the service provider and telecommunication technologies are used interactively.
- Connected Audiology: The use of technology to facilitate a connection between clients/patients and an audiologist, in the delivery of audiological services such as remote hearing aid fitting.

Table A1

Inclusion Criteria Section

Inclusion Criteria Questions
1 Are you currently practicing clinical audiology in some capacity? (e.g. full time, part time) o Yes o No
2 Do you currently provide face-to-face hearing aid fitting services? o Yes o No
3 In which province are you currently living? o Alberta o British Columbia o Manitoba o New Brunswick o Newfoundland and Labrador o Northwest Territories o Nova Scotia o Nunavut o Ontario o Prince Edward Island o Quebec o Saskatchewan o Yukon o None of the above
4 In which province do you currently practice audiology? o Alberta o British Columbia o Manitoba o New Brunswick o Newfoundland and Labrador o Northwest Territories o Nova Scotia o Nunavut o Ontario o Prince Edward Island o Quebec o Saskatchewan o Yukon o None of the above

Table A2

Demographic Section

Demographic Questions
5 How do you describe yourself? (Check one) o Female o Male o Transgender o Do not identify as female, male or transgender
6 Please indicate your age by category o 18 – 29 years o 30 – 49 years o 50 – 64 years o 65 years and over
7 Please indicate which degree you have received (Check all that apply) o A clinical Master's degree (e.g., MCISc) o A research-based Master's degree (e.g., MSc) o A clinical Doctoral degree (e.g., AuD) o A thesis-based Doctoral degree (PhD) o HIS (Hearing Instrument Specialist) o CDA (Communicative Disorders Assistant)
8 How many years have you been practicing Audiology? o Less than 1 year o 1 to 5 years o 6 to 10 years o More than 10 years
9 Please indicate which statement best describes the area that you are currently practicing audiology. (You can choose more than one option) o I practice in a small URBAN population centre (With a population of between 1,000 and 29,999 people) o I practice in a medium URBAN population centre (With a population of between 30,000 and 99,999) o I practice in a large URBAN population centre (With a population of 100,000 and over) o I practice in a RURAL area (outside population centre, below 1,000)
10 Indicate the area that best describes where you live. (Please use definitions from above) o Urban (small, medium or large) o Rural
11 Have you ever offered remote hearing aid fitting services using Connected Audiology? o Yes o No
12 Connected Audiology refers to the use of technology to facilitate a connection between clients/patients and an audiologist, in the delivery of audiological services such as remote hearing aid fitting. Other than remote hearing aid fitting, have you ever offered services using Connected Audiology (e.g. counseling, assessments)? o Yes (please specify) _____ o No
13 Which of the following best describes your practice setting? o Hospital setting o Community health centre o Private clinic o School setting o Hearing aid manufacturer o University or college

Table A3

Practice Context Dimension

Practice Context Questions
14 We are interested in learning more about your current practice context. Please indicate if you have access to the following in your place of practice (Check all that apply) o A space to deliver client/patient specific services that offers a quiet environment o A space to deliver client/patient specific services that provides privacy o A space to deliver client/patient specific services that offers adequate lighting o A practice space that is separate from that being used for face-to-face service delivery o A practice space that is accessible outside of regular business hours
15 Please indicate the time of day that you currently offer client/patient services specific to hearing aid fitting o During regular business hours o Outside of regular business hours o Both, regular business hours and outside of business hours
16 Please indicate the time of day that your support staff is currently available to assist with patient/clinic services specific to hearing aid fitting o During regular business hours o Outside of regular business hours o Both, regular business hours and outside of business hours o Neither regular business hours, nor outside of regular business hours

Table A4

Access Dimension

Access Questions

17 Please indicate if the following resources are (Yes) or are not (No) currently available in your place of practice

	Yes	No
An internet connection	○	○
A laptop or desktop computer	○	○
A tablet or smartphone that can be made available to client/patient	○	○
A microphone (this could be integrated into your current computer or your audiometer, for example)	○	○
A video camera (this could be integrated into your current computer or be separate like a webcam, for example)	○	○
Software to convert speech to text	○	○
Access to a language interpreter	○	○
On-demand Information Technology (IT) support	○	○
Scheduled (less frequent) IT support	○	○

18 Please indicate the type of internet connection used with your desktop/laptop computer housing hearing aid fitting software

- ○ Wired (LAN)
- ○ Wireless (WiFi)
- ○ Unsure

19 Please indicate where you are filling out this survey

- ○ In my place of practice
- ○ At home
- ○ Other

20 Please indicate the device you are using to fill out this survey

- ○ Desktop computer
- ○ Laptop computer
- ○ Mobile device

21 We are interested in learning about whether practicing audiologists have access to a sufficient internet connection to facilitate Connected Audiology. We are asking you to take approximately 30 seconds to test your internet connection using an online URL.

Please record both the upload and download speeds. If you have a firewall that prevents your use of the URL, please ask your IT support person if they know the internet connection speed and record that value.

Please use the following URL to complete an internet speed test and press the back button to return to the survey (you can copy and paste the URL to your browser search engine):https://www.speedtest.net/

Once you have completed this task we would ask you ticking both boxes.

Note: once you finish running the test, please press the back button in your browser to return to this survey.

- ○ Upload speed (number including 2 decimal places)
- ○ Download speed (number including 2 decimal places)

Table A5

Social Capital Dimension

Social Capital Questions					
22 Please provide an estimate of how many of your clients/patients:	None	Very Few	About Half	Most	All
Would want to use Connected Audiology to receive audiological services at a distance	○	○	○	○	○
Would want to use Connected Audiology to receive hearing aid fitting support at a distance	○	○	○	○	○
Would want to use a mobile device for Connected Audiology	○	○	○	○	○
Would benefit from being able to include multiple people in a remote hearing aid fitting appointment (e.g., other professionals, caregivers)	○	○	○	○	○

Table A6

Organizational Support Dimension

Organizational Support Questions				
23 Please indicate to what extent you agree or disagree with the following statements related to your current place of practice				
	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
The manager(s)/administrator(s) in my place of practice will be supportive in implementing Connected Audiology	○	○	○	○
There will be widespread acceptance by the colleagues who I work with in implementing Connected Audiology	○	○	○	○
My organization will provide training/learning opportunities specific to Connected Audiology	○	○	○	○

Table A7

Standards Dimension

Standard Questions			
24 Please indicate if organizational guidelines (policy/procedure/protocol/recommendation documents) are implemented or not in your current place of practice			
	No, not Implemented	Yes, Partially Implemented	Yes, Fully Implemented
Guidelines to promote Connected Audiology	○	○	○
Guidelines outlining evidence-based best practice in Connected Audiology	○	○	○
Guidelines on the security of client/patient data obtained during Connected Audiology	○	○	○
Guidelines on the storage/maintenance of client/patient records related to Connected Audiology (e.g., back-up processes for paper, electronic, audio, and video)	○	○	○
Guidelines on obtaining consent for the purpose of delivering Connected Audiology	○	○	○
Guidelines on obtaining consent to include other health care professionals in Connected Audiology appointments	○	○	○
Guidelines on client/patient candidacy for Connected Audiology	○	○	○
Guidelines on scheduling Connected Audiology appointments	○	○	○
Guidelines on reimbursement for services delivered via Connected Audiology	○	○	○
Guidelines on licensure to practice Connected Audiology	○	○	○
Guidelines on maintaining client/patient confidentiality when offering remote service delivery	○	○	○
Guidelines on insurance requirements specific to the delivery of remote services	○	○	○

Table A8

Aptitude Dimension

Aptitude Questions				
25 Please rate your comfort level around the following situations	Novice	Average	Above-average	Expert
Identifying when clients/patients are candidates for remote hearing aid fitting services	○	○	○	○
Using video conferencing to communicate with clients/patients	○	○	○	○
Recognizing body-language and/or emotional cues during video conferencing	○	○	○	○
26 Please rate your comfort level in using each of the following technologies				
Smartphone	○	○	○	○
Computer (Desktop/laptop)	○	○	○	○
Tablet	○	○	○	○
Applications (a.k.a. “apps”) on a smartphone or tablet	○	○	○	○
Videoconferencing technology (including a microphone and camera)	○	○	○	○
27 Please rate your comfort level in downloading applications (a.k.a. “apps”)				
○ Novice				
○ Average				
○ Above-average				
○ Expert				

Table A9

Attitude Dimension

Attitude Questions

28 Please rate the level to which remote delivery of the following hearing aid fitting services will add value to your routine practice

	Not at all Added Value	A Small Added Value	A Large Added Value
Monitoring hearing aid use remotely	○	○	○
Adjusting the level of hearing aid gain remotely	○	○	○
Activating or deactivating hearing aid settings remotely	○	○	○
Verification of the hearing aid output following changes made remotely	○	○	○
Managing feedback concerns remotely	○	○	○
Providing counselling for care/use of a device remotely	○	○	○

29 Please indicate how much effect Connected Audiology will have on the different aspects of your routine practice

	A Large Negative Effect	A Small Negative Effect	No Effect	A Small Positive Effect	A Large Positive Effect
Accommodating appointments outside of typical business hours	○	○	○	○	○
Reducing travel time for clients/patients	○	○	○	○	○
Reducing travel time for myself	○	○	○	○	○
Reducing missed/late appointments due to travel-related constraints (e.g. inclement weather, cost of travel)	○	○	○	○	○
Attending to client concerns sooner than waiting for a face-to-face appointment	○	○	○	○	○
Giving access to services for clients/patients with any travel-related constraints (e.g. remote areas, mobility concerns, high traffic, child care, medically-fragile, special needs)	○	○	○	○	○
Accommodating appointments that include multiple caregivers and/or health care professionals	○	○	○	○	○

30 Please indicate your level of agreement with the following statements:

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
Habits and doing what I have always done will limit my use of remote hearing aid fitting services	○	○	○	○
If implemented, the cost of purchasing a license to practice Connected Audiology will limit my ability to provide remote hearing aid fitting services	○	○	○	○

Attitude Questions				
Time to familiarize myself with set-up new technologies will limit my ability to provide remote hearing aid fitting services	○	○	○	○
I am motivated to keep up with new technologies specific to Connected Audiology	○	○	○	○
I am familiar with the research related to remote hearing aid fitting	○	○	○	○
The provision of remote hearing aid fitting services will influence hearing aid adoption/return rates	○	○	○	○
I am motivated to pursue training/learning opportunities specific to remote hearing aid fitting	○	○	○	○

Table A10

Patient-provider Relationship Dimension

Patient-provider Questions				
31 We would like to know how you feel the provision of remote hearing aid fitting services will influence the patient-provider relationship. Please indicate your level of agreement with the following statements				
	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
I will more easily connect with difficult-to-reach clients/patients and caregivers with remote services	○	○	○	○
I feel that my clients/patients will have realistic expectations around how often I should be available to deliver remote services	○	○	○	○
Most of my clients/patients will prefer face-to-face service delivery over Connected Audiology	○	○	○	○
I will maintain a good patient-provider relationship with my clients/patients via Connected Audiology	○	○	○	○
When incorporating other professionals into a remote appointment, I feel I will maintain good collaborative relationships	○	○	○	○
I feel that the client/patient will perceive remote services delivery as adding value to their care	○	○	○	○
I feel that having access to multiple communication options to use in Connected Audiology (e.g. texting, audio, video, and speech-to-text) will help maintain good patient-provider relationships	○	○	○	○

32 Are there any thoughts you would like to share?

_____

The survey has been completed, if you press submit button, your data will be included in the study and cannot be withdrawn.

Curriculum Vitae

Name:	Luisa Natalia Pérez Vélez
Post-secondary Education and Degrees:	Colegio Mayor de Nuestra Señora del Rosario Bogotá, Colombia 2001-2006, BHSc University College of Cundinamarca Bogotá, Colombia 2007, PGCert Colombian School of Rehabilitation Foundation Bogotá, Colombia 2009-2010, PGCert Western University London, Ontario, Canada 2018-present, M.Sc. Candidate, Health & Rehabilitation Sciences
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Perez, L., Scollie, S. D., Moodie, S. T., Walton, D., & Glista, D. (2020, February 4). *An exploration of audiologists' readiness to adopt connected hearing healthcare for remote hearing aid fitting*. 2020 HRS Graduate Research Conference.