eHealth supported hearing care with online and face-to-face services

– patient characteristics, experience and uptake of a hybrid online and face-to-face model

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A thesis submitted in partial fulfilment of the requirement for the degree

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Husmita Ratanjee-Vanmali, has obtained, for the research described in this work, the application research ethics approval.

The author declares that she has observed the ethical standards required in terms of the University of Pretoria's code of ethics for researchers and the Policy guidelines for responsible research.

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"Knowledge is only potential power. It becomes power only when, and if, it is organized into definite plans of action, and directed to a definite end" - Napoleon Hill

"The one that has led you so far will guide you further" - Rumi

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In the first year it sleeps,
in the next few years it grows deep,
and it is only in the fifth year that it leaps.

Nurture, patience and resilience.

~ Husmita N Ratanjee-Vanmali

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PUBLICATIONS AND RESEARCH OUTPUTS

The following original articles are part of this thesis:

1. **Ratanjee-Vanmali, H.,** Swanepoel, D. W., & Laplante–Lévesque, A. (2019). Characteristics, behaviors and readiness of persons seeking hearing health care online. *International Journal of Audiology, 58*(2), 107–115. doi:10.1080/14992027.2018.1516895

2. **Ratanjee-Vanmali, H.,** Swanepoel, D. W., & Laplante–Lévesque, A. (2020). Patient uptake, experience and satisfaction using web-based and face-to-face hearing health services: Process evaluation study. *Journal of Medical Internet Research, 22*(3), e15875. doi:10.2196/15875

3. **Ratanjee-Vanmali, H.,** Swanepoel, D. W., & Laplante–Lévesque, A. (2020). Digital proficiency is not a significant barrier for taking up hearing services with a hybrid online and face-to-face model. *American Journal of Audiology, 29*(4), 785–808. doi:10.1044/2020_AJA-19-00117

Parts of the thesis were included as a series of clinical articles in *The Hearing Journal*:

1. **Ratanjee-Vanmali, H.,** Swanepoel, D. W., & Laplante–Lévesque, A. (2020). Strengthening the role of the Audiologist in the digital age. *The Hearing Journal, 6*(73), 38–39. doi:10.1097/01.HJ.0000669892.80715.e1

2. **Ratanjee-Vanmali, H.,** Swanepoel, D. W., & Laplante–Lévesque, A. (2020). Optimizing audiology websites to increase patient reach. *The Hearing Journal, 7*(73), 31–33. doi:10.1097/01.HJ.0000689432.30631.73

3. **Ratanjee-Vanmali, H.,** Swanepoel, D. W., & Laplante–Lévesque, A. (2020). Implementing a hybrid model of online and in-person audiological care. *The Hearing Journal, 8*(73), 16–19. doi:10.1097/01.HJ.0000695824.94586.a0

4. **Ratanjee-Vanmali, H.,** Swanepoel, D. W., & Laplante–Lévesque, A. (2020). Digital proficiency and Teleaudiology: Key implications in hearing care. *The Hearing Journal, 9*(73), 18–20. doi:10.1097/01.HJ.0000717160.38022.5c

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1. **3rd International Internet & Audiology meeting:** University of Louisville, United States of America, 27th–28th July 2017. Poster presentation*: Strengthening the role of the audiologist in the digital age: Initial study findings regarding people seeking hearing health care online–who are they?*

2. **HEaring Across the Lifespan Conference:** Cernobbio, Lake Como, Italy, 7th–9th June 2018. Podium presentation*: Characteristics, behaviors and readiness of persons seeking hearing health care online.*

3. **34th World Congress of Audiology:** Cape Town, South Africa, 28th–31st October 2018. Podium presentation*: Characteristics, behaviors and readiness of persons seeking hearing health care online.*

4. **4th International Internet & Audiology meeting:** University of Southampton, United Kingdom, 17th–18th June 2019. Poster presentation*: Online audiology – patient satisfaction with a hybrid service delivery model.*

5. **The American Academy of Audiology's Virtual Academy Research Conference (ARC) 2020:** Tele-Audiology: Theory to Practice: 6th August 2020. Online podium presentation: *Telehealth Supported Audiology Services with Hybrid Online and Face-to-Face Care.*

ABSTRACT

Title:	eHealth supported hearing care with online and face-to-face services: Patient characteristics, experience and uptake of a hybrid online and face-to-face model
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Hearing loss is considered a global health concern with 466 million people affected worldwide. Current hearing health care delivery models are based on several consecutive face-to-face consultations that occur in-person. Information and communications technology, and especially mobile technology, can be used to support or enhance health care delivery. This can be employed in addition, or as an alternative to, current patient treatment pathways.

This project developed a hybrid hearing health care approach by combining online and face-to-face services. The services were offered using a five-step approach: (1) online hearing screening, (2) motivational engagement by voice/video calling, messaging, or emailing, (3) diagnostic hearing testing in a face-to-face appointment, (4) counseling, hearing aid trial and fitting using face-to-face and online methods, and (5) online aural rehabilitation, counseling and ongoing coaching using face-to-face and online methods. Three studies were conducted.

Study I investigated the readiness, characteristics and behaviors of patients who sought hybrid hearing health care. Over three months (June–September 2017), 462 individuals completed the online hearing screening test: 59% (271/462) of those failed (age M = 60; SD = 12), indicating that further assessment and treatment might be required. These patients had been aware of their hearing loss for a period of between

5 to 16 years. A significant positive correlation was observed between age and speech reception threshold ($r = 0.21$; $p < .001$), where older participants presented with poorer scores. Five participants completed readiness measurement scales and attended a face-to-face diagnostic hearing evaluation during this time.

Study II investigated patient uptake, experience and satisfaction with hybrid hearing health care using a process evaluation. The process evaluation study was conducted over a three-month period for patients who sought services from the clinic over a period of 19 months (June 2017–January 2019). A total of 46 patients seen at the clinic were invited to complete an online questionnaire regarding their experiences and satisfaction with the steps completed and services provided. Of those, 31 (67%) patients responded (age M = 66; SD = 16). Of the 61% of patients who had previously sought hearing services, 95% reported the hybrid clinic services as superior. Two main themes emerged from the patient's comparison of their experience with the hybrid clinic versus previous experiences: clinician engagement (personal attention, patience, dedication, thorough explanations, professional behavior, exceeding expectations, friendliness and trust) and technology (latest technology, advanced equipment and hearing aid trial). Patients who completed all five steps, including acquiring hearing aids and taking part in an online aural rehabilitation program (continued with hearing health care), were significantly older and had significantly poorer speech reception thresholds compared to those who did not acquire hearing aids after the diagnostic hearing test and hearing aid trial (discontinued hearing health care). A significant positive correlation was found between age and the number of face-to-face appointments attended per patient ($r = 0.37$; $p = .007$).

Study III investigated whether digital proficiency (proficiency with mobile devices and computers) was a predictor of the uptake of hybrid hearing health care. A total of 931 individuals failed the online hearing screening test and had submitted their details to the clinic for further care over a 24-month period (June 2017–June 2019). Of the 931 online test takers, 53 persons (age M = 64; SD = 15) who attended a face-to-face diagnostic hearing testing completed a mobile device and computer proficiency questionnaire. An exact regression model identified age as the factor associated with patients completing all five steps, including acquiring hearing aids and taking part in an online aural rehabilitation program (continued with hearing health care) from a

hybrid model (β = .07; *p* = .018). Older patients were more likely to continue to seek hearing health care. Digital proficiency was not significantly associated with adults with hearing loss taking up services through a hybrid hearing health care model.

The results from these three studies demonstrate that asynchronous internet-based services such as an online hearing screening test can be used to create awareness of hearing health care. It is possible to provide online support to patients during the initial stages of seeking hearing health care online prior to the first face-to-face visit. Patient uptake, satisfaction and experience of using hybrid hearing health care services are positive when compared to traditional methods of service delivery. Hearing health care models that combine face-to-face and online methods hold promise for audiologists willing to incorporate online modalities into current treatment pathways. This research project highlights the opportunity for audiologists to provide services and personalized support to patients using a combination of face-to-face and online modalities.

KEYWORDS

Computer proficiency

Digital health care

eHealth

Hearing health care

Hearing loss

Hearing screening

Hybrid model of health care delivery

Internet-based interventions

Mobile device proficiency

Online hearing screening

Online and face-to-face modalities

Patient-centered care

ABBREVIATIONS

COVID–19	Coronavirus disease 2019
CPQ–12	Computer proficiency questionnaire
dB HL	Decibels in hearing level
DIN	Digit–in–noise test
eHealth	Electronic health
GSMA	Global System for Mobile Communications Association
HHC	Hearing health care
HL	Hearing loss
Hz	Hertz
ICT	Information and communications technology
LMIC	Low- to middle-income countries
MDPQ–16	Mobile device proficiency questionnaire
NPC	Non-profit company
NPS	Net-promoter score
PTA	Pure tone average
SAPS	Short assessment of patient satisfaction
SNR	Signal-to-noise ratio
SRT	Speech reception threshold
WHO	World Health Organization

DEFINITIONS OF KEY TERMS

ASYNCHRONOUS	Referred to as a store-and-forward method for when data is collected and then sent for interpretation or usage at a later time using a network. Asynchronous services rely on either the audiologist or the patient completing a task at a particular time without the other person present.
eHEALTH	The use of information and communication technologies for heath. Offering health care services by using electronic tools and methods.
FACE-TO-FACE	In-person care where the patient and the audiologist are physically present in the clinic together in real time.
ONLINE SERVICES	Health services offered using the internet.
SYNCHORNOUS	Synchronous services refer to when both the audiologist and the patient are present and communicate in real time either online or during face-to-face appointments.

CHAPTER 1: INTRODUCTION

The aim of this chapter is to provide an overview of the literature on electronic health (eHealth) for the provision of hearing health care (HHC). The three studies conducted as part of this PhD project are introduced.

1.1 Background

Hearing loss is a global issue and concern that impacts individuals, communities and societies. According to the World Health Organization (WHO), 466 million people, or over 5% of the world's population, live with disabling[1] hearing loss (WHO, 2019a). One-third of people above the age of 65 live with disabling hearing loss. Prevalence of hearing loss varies greatly across the world. Low- and middle-income countries (LMICs) in South Asia, Asia Pacific and Sub-Saharan Africa report the highest prevalence rates (WHO, 2019a). In 2015, hearing loss was the fourth leading cause of years lived with disability (Wilson et al., 2017).

The negative consequences of hearing loss are severe and multi-faceted, including functional, social, emotional and economic effects (WHO, 2019a). Without appropriate diagnosis and intervention, hearing loss has serious consequences on quality of life, societal integration and mental health (Arlinger., 2003; Livingston et al., 2017; Wilson et al., 2017). Further negative consequences of untreated hearing loss include an increased risk of falls, depression and unemployment (Davis et al., 2016; Gopinath et al., 2012; Mahmoudi et al., 2019). Hearing loss is often regarded as an invisible disability or a less important health condition and is not prioritized compared to comorbid conditions (Besser et al., 2018; Mackenzie & Smith, 2009). Hearing loss is the leading preventable risk factor for dementia during midlife (45–65 years) (Livingston et al., 2017). Therefore, action to treat hearing loss and thereby decrease the risk of dementia in older age is highly recommended (Livingston et al., 2017).

[1] WHO defines a disabling hearing loss as greater than 40 decibels (dB HL) in the better hearing ear in adults and greater than 30 dB HL in the better hearing ear in children.

Earlier treatment for hearing loss could lead to beneficial outcomes as one continues to age (Livingston et al., 2017).

Help-seeking for hearing loss is often delayed. It takes an individual between seven to 10 years from the time that hearing difficulties are noticed to the first investigation (Davis et al., 2007; Simpson et al., 2019). The delay in seeking HHC is partly attributed to limited accessibility and affordability of care (Swanepoel et al., 2010). Another contributing factor to the delay of seeking HHC is the stigma of hearing loss, as hearing loss is often associated with aging and cognitive decline (Wallhagen, 2010). Annually, unaddressed hearing loss carries a global cost of US $750 million which affects the individual and society at large (WHO, 2019a; Wilson et al., 2017).

1.2 Challenges of current hearing care treatment models for adults

1.2.1 Limited professionals

Ear and hearing care professionals are unequally distributed in the world, with a higher concentration in high- and upper-middle-income countries (WHO, 2013). In 2015, many countries within Sub-Saharan Africa such as Ethiopia, Kenya, Malawi, Nigeria, Sudan and Zimbabwe, reported poor ratios of between 0.001 to 0.020 audiologists for every 100 000 people (Mulwafu et al., 2017). In South Africa, the ratio of audiologists per 100 000 people was reported to be 1 in 2009 and 0.8 in 2015 (Mulwafu et al., 2017). In comparison, in the United Kingdom, this ratio was 4 in 2009 (Fagan & Jacobs, 2009; Mulwafu et al., 2017). This comparison highlights the scarce personnel resources available for the provision of HHC services in LMICs and in South Africa. Within Sub-Saharan Africa, only three audiology training programs exist; Ghana, Kenya and South Africa, and often in LMICs, especially in Sub-Saharan Africa, training programs have not increased the number of professionals trained despite the population growth (Mulwafu et al., 2017). Increasing the number of ear and hearing care professionals in LMICs requires substantial investments in infrastructure, training and staffing (Mulwafu et al., 2017). A recent study highlights that without significant interventions of training more professionals, South Africa will experience a critical shortfall of audiologists by 2030 (Pillay et al., 2020).

1.2.2 Centralized model

In South Africa especially, a primary health care approach is initiated whereby services are decentralized (Tanser et al., 2006). However, ear and hearing services are not always available at this level, with care offered at secondary and or tertiary levels of care, leaving communities without access to HHC as equipment is expensive and mostly stationary (Louw et al., 2017). Therefore, a need to use other methods for the provision of HHC is required (Louw et al., 2017; Swanepoel & Clark, 2019). This thesis uses the term face-to-face to describe in-person care.

1.2.3 Requirement for multiple appointments

HHC is traditionally provided by trained audiologists or hearing instrument specialists and patient care is structured as several in-person face-to-face appointments at a center (i.e., at a hospital or HHC clinic). Hearing aids are the most common form of treatment for adult hearing loss (Wilson et al., 2017). Typically, several appointments are scheduled for the assessment, fitting and fine-tuning of hearing aids. There is often a mismatch between patient expectation and their experience of the hearing aids (Knudsen et al., 2010). Therefore, patients usually require multiple appointments to digest new information, learn new skills in adapting to hearing aids, as well as for troubleshooting and fine-tuning of hearing aids to meet their hearing needs (Bennett, Meyer, et al., 2018; Knudsen et al., 2010).

During face-to-face consultations, a great amount of information is normally exchanged between the clinician and the patient. Research suggests that patients forget between 40–80% of the information given by a doctor during a face-to-face consultation (Kessels, 2003). To be able to use their devices, patients require more information pre- and post-hearing aid fitting compared to what they typically receive currently (Kelly et al., 2013).

1.3 eHealth as a tool to support hearing health care service delivery

The WHO defines eHealth as “the use of Information Communication Technologies (ICT) in support of health and health-related fields’’ (WHO, 2019b). ICT present opportunities to treat patients, conduct research, educate the health workforce, track

diseases and monitor public health. The use of ICT in medicine is called telemedicine or telehealth; in the field of ear and hearing health the terms tele-otology and tele-audiology have been used (Swanepoel & Hall, 2010). Due to the lack of consistency, people have adapted their own terms. eHealth, telehealth, tele-audiology and eAudiology are used interchangeably to describe the dissemination of health or HHC using the internet (Rushbrooke & Houston, 2016). This thesis uses the term eHealth.

Despite eHealth being initially intended to improve access to care due to distance, it can improve other care aspects, such as convenience and efficiency (Rushbrooke & Houston, 2016). Furthermore, eHealth can ensure that HHC patients are connected to the services they need (Gladden et al., 2015). This allows health care professionals to avoid disease-focused, fragmented, provider-centered care and ensure patient-centered and outcome-based care (Gladden et al., 2015). eHealth shifts care from the traditional clinic into the daily lives of patients by striving to link the patient with the right care and with the right provider at the right time (Gladden et al., 2015). It also holds the promise to improve current service delivery to maximize access to care and improve efficiency by reducing costs and increasing impact (Clark & Swanepoel, 2014; Swanepoel et al., 2010). However, the current use of eHealth has been limited globally (Tao et al., 2018).

The impact of eHealth is reliant on the affordability and accessibility of internet availability. Whilst some communities may have limited access, the percentage of the population with internet access is rapidly increasing. For example, the number of mobile internet users grew from 2.4 billion in 2014 to 3.8 billion in 2019, representing 49% of the world population (Global System for Mobile Communications Association [GSMA], 2015, 2020). Internet connectivity makes possible the use of synchronous and asynchronous modes of communication between the audiologist and patient. Synchronous services rely on both the audiologist and the patient being present and communicating in real-time. Asynchronous services rely on either the audiologist or the patient completing a task at a particular time without the other person present. Asynchronous service delivery is referred to as a store-and-forward method as data is collected and then sent for interpretation or usage at a later time (Krumm, 2016). In this way, using eHealth to deliver audiology services in a decentralized manner provides patients with care who may otherwise not have access to care (Louw et al.,

2017; Tanser et al., 2006). Decentralization of services would assist service delivery in light of limited HHC professionals who are often not geographically accessible to patients Using synchronous and asynchronous online modalities for screening, readiness management, counseling and aural rehabilitation allows for the supplementation of the existing traditional HHC patient journey. By gathering patient information asynchronously, prior to or between face-to-face appointments, allows for the use of this pre-collected information to reach a higher level of engagement between the audiologist and patient during the face-to-face appointment.

Online tools hold the promise of improving the current treatment model as an initial asynchronous hearing screening service and providing more accessible support during hearing aid adaption without needing more professionals. eHealth can make services more available and a combination of online and face-to-face services can be offered. This provides the opportunity to share information, knowledge and services most needed by the patient at appropriate times instead of only providing information or services during face-to-face appointments. This hybrid approach supports patient-centered care throughout the process, from acknowledging hearing loss to seeking help and acquiring hearing aids and rehabilitation (i.e., the patient journey).

1.4 eHealth in hearing health care

The first systematic review of eHealth audiology services was published in 2010 (Swanepoel & Hall, 2010). The authors found that eHealth held significant potential for service accessibility to underserved communities, however, further empirical studies were recommended to guide implementation into practice (Swanepoel & Hall, 2010). Limited documentation of patient perceptions of eHealth services and cost-benefit studies were available (Swanepoel & Hall, 2010). Furthermore, the lack of protocols and service delivery models available or specified for different populations limited the integration into practice for all areas within the audiology profession, from hearing screening, diagnostic testing, hearing aid fitting and fine-tuning and aural rehabilitation (Swanepoel & Hall, 2010).

Subsequently, countless studies and four systematic reviews (Bush et al., 2016; Molini-Avejonas et al., 2015; Paglialonga et al., 2018; Tao et al., 2018;) were

published. Table 1.1 summarizes five published systematic reviews of eHealth in hearing care. Two systematic reviews focused on the final step of the patient journey and the other three covered the entire patient journey. The existing evidence for eHealth highlighted that research is fragmented and that limited evaluation of eHealth programs across the entire patient journey is available. Systematic reviews published since 2010 have further highlighted research needs, especially regarding factors leading to implementation success (Paglialonga et al., 2018; Tao et al., 2018).

Current evidence suggests that there is a lack of guidance for eHealth implementation into practice. There is also a need to shift research focus from technical feasibility to patient perspectives, including experiences and satisfaction. Most studies report on treatment outcomes rather than on the processes related to accessing and receiving eHealth HHC services. Table 1.1 lists papers reporting patient experiences and satisfaction of eHealth in HHC (Brännström et al., 2016; Malmberg et al., 2018; Penteado et al., 2014). While studies focusing on patient experience and satisfaction report overall feedback gathered from patients who received HHC through eHealth, process evaluation studies systematically and thoroughly evaluate the method by which service delivery was offered, and patient feedback is specific to the steps included in the service delivery model (Moore et al., 2015). Only three process evaluations of eHealth in HHC are currently available (Table 1.1). The first process evaluation investigated the use of multimedia videos to assist patients in adjusting to hearing aids and support the aural rehabilitation process (Ferguson et al., 2016). The second process evaluation focused on an internet-based cognitive behavioral therapy intervention for patients with tinnitus (Beukes et al., 2018). The most recent process evaluation investigated an online aural rehabilitation program using videos to measure professional perceptions in a group of HHC providers in The Netherlands. The results suggest that these HHC professionals working at private HHC clinics lacked motivation to offer an online aural rehabilitation program to their patients. The researchers attributed this lack of motivation to external and contextual factors such as a shortage of professionals, policy changes within the HHC clinic chain and a lack of re-training of HHC professionals over the research period of several months (Meijerink et al., 2020). All three process evaluation studies to date focused on services that were offered free of charge as part of public care or research studies.

In summary, research efforts to date have mostly focused on eHealth service feasibility and outcomes at one step of the patient journey. There is a need for further investigation of eHealth services across the entire patient journey, from hearing screening to hearing rehabilitation.

Table 1.1

eHealth Within Hearing Health Care: Systematic Reviews as well as Patient Satisfaction and Process Evaluation Studies Categorized According to the Relevant Step(s) of the Hearing Health Care Patient Journey

	Hearing screening	Diagnostic hearing testing	Hearing aid fitting	Hearing aid fine-tuning	Hearing rehabilitation
eHealth services* *Only systematic reviews included	-	-	-	-	Tao et al., 2018 Bush et al., 2016
			Paglialonga et al., 2018 Molini-Avejonas et al., 2015 Swanepoel & Hall, 2010		
Patient experiences/ satisfaction with eHealth services** **Recent relevant literature included	–	–	–	Penteado et al., 2014	Malmberg et al., 2018 Brännström et al., 2016
Process evaluation of eHealth services** **Recent relevant literature included	–	–	–	–	Meijerink et al., 2020 Beukes et al., 2018 Ferguson et al., 2016

1.5 Barriers to implementation of eHealth supported hearing care

eHealth implementation implies a change of practices by audiologists. A systematic review of audiologists' knowledge and perceptions of eHealth highlighted positive attitudes and reported that most training was done on the job, at continuous professional development courses and during post-graduate training (Ravi et al., 2018). Whilst 269 audiologists from 28 countries shared positive attitudes towards eHealth, less than 25% reported using eHealth clinically (Eikelboom & Swanepoel, 2016). Over 200 Canadian audiologists and hearing instrument specialists expected eHealth to have a minimal effect on the quality of HHC and of patient-clinician interactions (Singh et al., 2014). However, many respondents indicated that eHealth would improve service accessibility, while a minority reported that eHealth would negatively impact the quality of HHC offered; hearing care professionals were concerned that their interactions and their relationship with new HHC patients could suffer (Singh et al., 2014).

Audiologists have expressed concerns regarding automated testing, fearing that it could jeopardize future job stability (Clark & Swanepoel, 2014). However, the authors argued that automated testing, which allows for some HHC screenings and assessments to be conducted using eHealth remotely, could allow audiologists to spend more time on complex tasks (Margolis & Morgan, 2008). Hearing aid fitting, personal adjustment counselling (addressing the patient's concerns and assisting with the adaptation to hearing aids or other devices) are often regarded as more complex tasks often requiring additional time with the patient (Margolis & Morgan, 2008). Therefore, if time is gained on simpler tasks due to automation then this could result in service provision to more patients and greater service delivery efficiency (Margolis & Morgan, 2008). Innovative HHC service delivery which combines eHealth and community health workers have been proposed to increase access and complement current services (Lin et al., 2016).

Further to this, the costs and benefits of eHealth implementation within existing health care infrastructures and models are yet to be systematically investigated through economic evaluations (Swanepoel & Hall, 2010). Empirical research to establish and

validate implementation guidelines has been recommended (Swanepoel & Hall, 2010). Recent systematic reviews concluded that a paucity of research currently exists regarding cost-effectiveness and reimbursement of services, lack of infrastructure for patients and professionals, inadequate supply of trained professionals, restricted licensure laws, concern over patient confidentiality and reliability of results, the need for additional professional training, quality comparison of online versus face-to-face interactions and malpractice concerns (Bush et al., 2016; Ravi et al., 2018). Another recent Canadian study of 42 audiologists providing HHC to adults and pediatric populations highlighted six factors which influenced their uptake of offering eHealth services following a patient receiving hearing aids: 1) technology and infrastructure, 2) audiologist-centered considerations, 3) HHC regulations, 4) patient-centered consideration, 5) clinical implementation considerations, and 6) TECH (accessible technology, easy to use, robust connection and help available) factors and perceived attitude and aptitude of stakeholders (Glista et al., 2020).

1.6 Patient usage of the internet and eHealth HHC

In the United States, a recent study of 556 adults with hearing loss indicated that the majority turned to the internet first (54%), followed by HHC professionals (34%) as their initial source of information (Manchaiah et al., 2020). Of these individuals, 70% spend more than 10 hours a week on the internet with Facebook and YouTube, the most used social media platforms (Manchaiah et al., 2020). Other studies indicate that adult patients are willing to use online HHC services (Convery et al., 2020; Meyer et al., 2019; Paglialonga et al., 2018; Rothpletz et al., 2016). From this research, two main findings include: 1) older adults who are preparing to take action for hearing loss are willing to access online HHC with a simple interface and partake in short-term training to use online programs, and 2) adult patients and their significant others have the necessary equipment and are already using ICT or online platforms to access health services (Convery et al., 2020; Meyer et al., 2019; Paglialonga et al., 2018; Rothpletz et al., 2016).

1.7 eHealth supported hearing care combining online and face-to-face services

eHealth can support HHC service delivery models by combining online and face-to-face methods. To reduce the effects of hearing loss, internet interventions can be offered at different stages along the patient journey. Therefore, this project investigated how HHC service delivery can be supported by eHealth along the entire patient journey. This project also explored patient uptake, experience and satisfaction with using a combination of online and face-to-face modalities in a hybrid HHC model. Finally, the association between mobile device and computer proficiency and the uptake of hearing services was also investigated.

This project proposed an eHealth supported hearing care model with online and face-to-face services for adult patients. The hybrid model included both online and face-to-face components. When designing the hybrid model, modalities of the patient-clinician contact points were selected according to the available technology and evidence, whilst ensuring that quality of care and patient-centeredness were maintained.

The eHealth components included online hearing screening, communication by voice/video calling and instant messaging and online aural rehabilitation. Traditional components were included in face-to-face appointments, as validated eHealth alternatives were not yet available at the conception of this project. Face-to-face components included audiological diagnostic evaluation, including video otoscopy, as well as real-ear measurements. Face-to-face appointments were maintained for three reasons; 1. The ability for the patient and clinician to build rapport and trust, as initial communications were made online, 2. If any audiological red flags were identified, medical referrals warranted were made timeously and 3. Physical audiological test equipment calibrated annually ensured test consistency and quality for all patients. More information regarding the hybrid model is available in Chapter 2.

1.8 Research project

This research project consisted of three original studies which focused on eHealth supported HHC with online and face-to-face services. The three studies attempted to fill gaps in the available eHealth literature.

Study I investigated the characteristics, behaviors and readiness of persons seeking HHC online.

Study II conducted a process evaluation to assess patient uptake, experience and satisfaction of using a combined online and face-to-face HHC model.

Study III assessed whether digital proficiency was associated with the uptake of hearing services using a hybrid online and face-to-face HHC model.

Chapter 2 describes the methodology adopted for each of the three studies. Chapters 3–5 are three manuscripts either published or accepted for publication in peer-reviewed journals. Finally, Chapter 6 discusses the results of the three studies and highlights their strengths, limitations and clinical implications.

CHAPTER 2: METHODOLOGY

The aim of this chapter is to outline the research objectives, design, participants and equipment and materials. It also highlights research procedures, statistical analyses and data processing conducted. Finally, the ethical considerations adhered to are described.

2.1 Research objectives and design

The main aim of this project was to evaluate the proposed eHealth supported hearing care model with online and face-to-face services for adult patients. The main aim was divided into three objectives. Each objective was addressed with a study. Each study was summarized in an article for a peer-reviewed journal. Table 2.1 summarizes each of the three studies with title, research objective, journal, publication status and corresponding thesis chapter.

Table 2.1

Summary of Studies I to III: Title, Research Objective, Journal, Publication Status and Corresponding Thesis Chapter

Study	I	II	III
Title	Characteristics, behaviors and readiness of persons seeking hearing health care online	Patient uptake, experience and satisfaction using web based and face-to-face hearing health services: process evaluation study	Digital proficiency is not a significant barrier for taking up hearing services with a hybrid online and face-to-face model
Research objective	To investigate individuals' characteristics, behaviors and readiness to seek HHC using eHealth supported online and face-to-face modalities in a hybrid service delivery model.	To investigate patient uptake, experiences and satisfaction of acquiring hearing aids, online aural rehabilitation and support services through an eHealth supported hybrid HHC service delivery model by means of a process evaluation study.	To describe the digital proficiency (mobile device and computer proficiency) of a group of adults with hearing loss who took up HHC through an eHealth supported online and face-to-face service delivery model.
Journal	International Journal of Audiology	Journal of Medical Internet Research	American Journal of Audiology
Publication status	Published	Published	Accepted
Thesis chapter	3	4	5

Table 2.2 describes the study designs and types of data. All three studies adopted a prospective cohort design where quantitative methods of analysis were employed. Qualitative thematic analysis supplemented the quantitative data in the first two studies. Prospective cohort studies are observational in nature and they study the outcomes of treatments over a period of time (Caruana et al., 2015). Non-probabilistic purposive patient sampling was used for all three studies (Leedy & Ormrod, 2013).

Study I was an explorative descriptive study which outlined the characteristics, behavior and readiness of online hearing health seekers. Online methods were used to invite individuals to complete a free online hearing screening test and, upon failing the test, these individuals were requested to indicate their readiness to seek HHC.

Study II was a process evaluation of the hybrid HHC five-step model based on the framework of Linnan and Steckler (2002). This framework proposes the following stages to the design and implementation of a process evaluation: 1) create the inventory of process objectives based on theory, 2) reach a consensus of the questions to be answered by the stakeholders of the project, 3) identify and 4) create the measurement tools, 5) design, 6) implement and 7) administer quality control, 8)

collect, 9) manage and 10) clean data, 11) analyze data, 12) report findings and 13) refine interventions, 14) measurements and the 15) analysis tool (Linnan & Steckler, 2002). The process evaluation questionnaire combined close-ended and open-ended questions, the latter questions providing context to the ratings collected by the former questions.

Study III was a prospective study investigating which patient characteristics were associated with the uptake of HHC services through a hybrid HHC model. Patients received two validated digital (mobile device and computer) proficiency questionnaires prior to attending a face-to-face diagnostic hearing evaluation appointment. An explorative study was conducted to examine which patient parameters were associated with the acquisition of hearing aids and the completion of online aural rehabilitation and support services through a hybrid online and face-to-face model.

Table 2.2

Study Design and Data Type for Studies I-III

Study	I	II	III
Title	Characteristics, behaviors and readiness of persons seeking hearing health care online	Patient uptake, experience and satisfaction using web based and face-to-face hearing health services: process evaluation study	Digital proficiency is not a significant barrier for taking up hearing services with a hybrid online and face-to-face model
Research study design	Prospective cohort study		
	Explorative, descriptive study	Process evaluation study	Explorative study
Data type	Mostly descriptive quantitative data, supplemented by qualitative approach		Quantitative data

2.2 eHealth supported hearing care model

Table 2.3 describes the five-step HHC hybrid model used in this project with the research procedures followed. The PhD candidate assumed the dual role of clinician and researcher and is referred to as the clinician in this thesis.

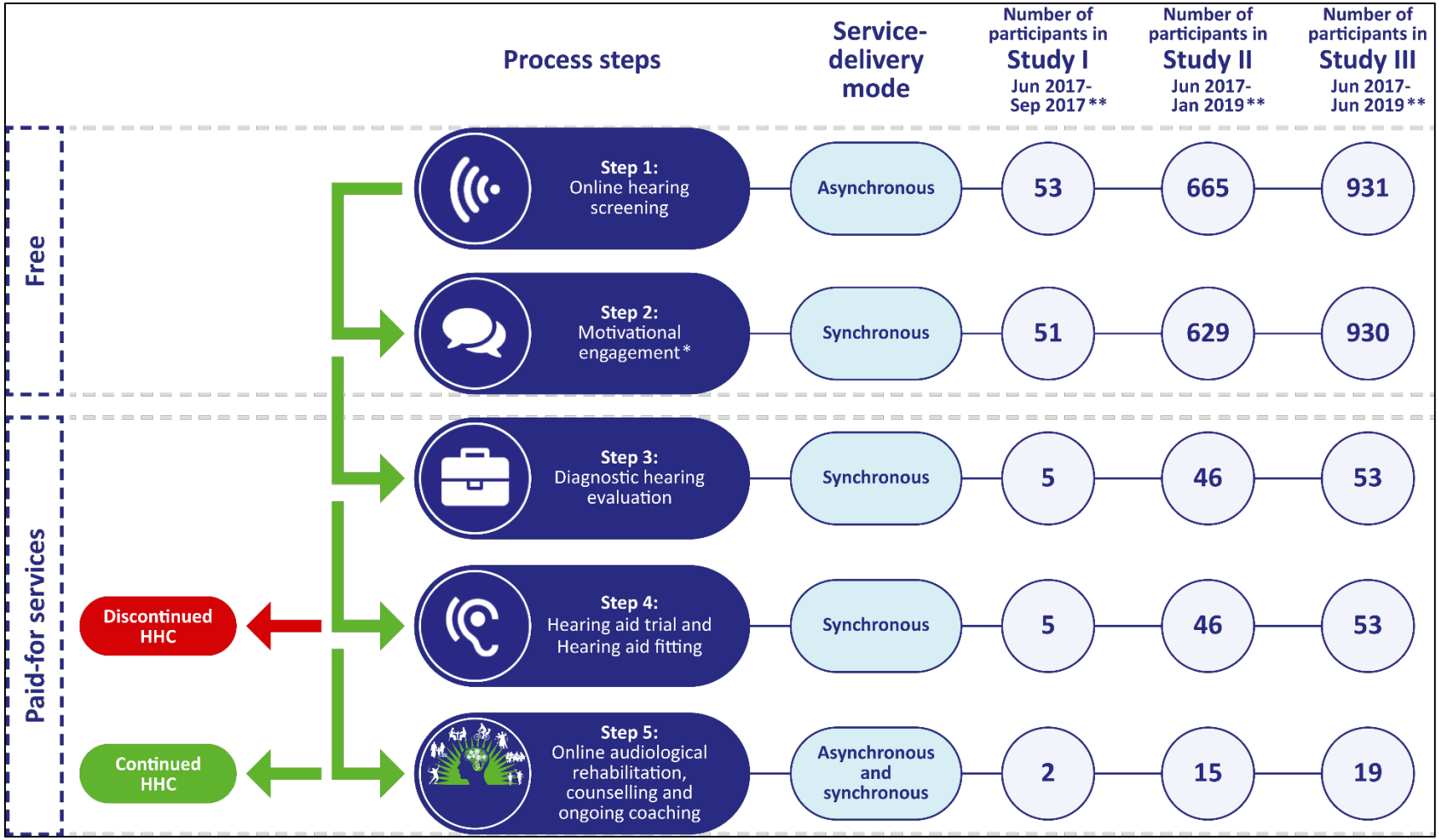
Table 2.3

Description of the Online and Face-To-Face Hearing Care Service Across Each Step of the Hearing Care Model

Step	Description of the five steps
Step 1 Asynchronous	• An online hearing screening test was placed on the Hearing Research Clinic website (www.hearingresearchclinic.org) which could be accessed asynchronously. • Online advertising (Facebook, Google AdWords and Google Display Networks) raised awareness of hearing loss and encouraged people to visit the clinic website to complete the online screening test. The ads targeted people within the greater Durban area, based on their location saved on their Google/Facebook profile and recorded in the mHealth data management system. The online screening test used: • A validated triple digit-in-noise (DIN) test with an adaptive procedure (Potgieter et al., 2016, 2018). • Three digits were presented in the presence of background noise and the participant entered the correct digits into a webpage widget. • The signal-to-noise ratio (SNR) at which a person recognized correctly 50% of digits was recorded. • Higher SNR scores indicated poorer hearing ability. • The pass/fail threshold was based on validation data which correlated to a 25 dB HL four frequency pure tone average (0.5, 1, 2 and 4 kHz). • Two different thresholds were used according to self-reported English competency (0=not competent at all and 10=perfectly competent) (Potgieter et al., 2018). • Participants who rated their English competency between 0–5 and scored ≤ -7.50 dB SNR passed the hearing screening; people who rated their English competency between 6–10 and scored ≤ -9.55 dB SNR passed the hearing screening (Potgieter et al., 2018).
Step 2 Synchronous	• Motivational engagement was conducted by synchronous communication methods. • The individual's readiness to seek HHC was assessed using the "line" (Rollnick et al., 1999; Tønnesen, 2012) and the "staging algorithm" (Milstein & Weinstein, 2002).
Step 3 Synchronous	• The clinic only booked face-to-face appointments with patients who had completed the online hearing screening test, completed the readiness questions and were prepared to seek further HHC. • The clinician and the patient met for a face-to-face diagnostic evaluation at the patient's home or at the clinic which was a medical office rented on a weekly basis.
Step 4 Synchronous	• If clinically indicated, patients were offered a 2–4-week bilateral hearing aid trial. • After the trial, patients could acquire their own hearing aids, with the financial assistance of their medical insurance program, if relevant.
Step 5 Asynchronous/ Synchronous	• A continuous therapeutic relationship ensured the patient was supported along their journey to better hearing. • An online aural rehabilitation program was offered and patients were encouraged to complete it. • Ongoing coaching and monitoring were provided by means of ongoing appointments to re-instruct, counsel, fine-tune hearing aids and receive feedback.

Figure 2.1 outlines the use of synchronous and asynchronous methods of interactions between the patient and the clinician across the five steps. The five steps were based on the pathway described in Table 1.1 (hearing screening, diagnostic hearing testing, hearing aid fitting and fine-tuning and online aural rehabilitation). Furthermore, Figure 2.1 summarizes the data collection periods and potential patients who completed the online hearing screening test and submitted their details for contact from the clinic of each of the three studies. Study I included data collected mainly from step 1 over a period of three months (June–September 2017). Studies II and III included data collected over all five steps over a period of 19 months (June 2017–January 2019) and 24 months (June 2017–June 2019), respectively.

Steps 1 and 2 were offered free of charge and steps 3–5 were paid-for services. Potential participants from the greater Durban area (digital methods were focused within the target geolocation) who could not afford services in steps 3–5 were referred to a public health facility where services were offered for free or at a reduced cost and were informed that a waiting period for services was to be expected. It was decided to have fees associated with steps 3–5 to avoid volunteer bias and to improve the generalizability of the findings to real life private settings. The project scope covered people who visited the clinic website and who “continued with HHC”, i.e., who acquired hearing aids, online aural rehabilitation and support services through this eHealth supported hybrid (online and face-to-face) service delivery model.



*This step was started for all participants, but not completed if participants did not wish to continue with HHC.
**The number of participants listed for each study refers to those who completed the online hearing screening test and submitted their details for further contact from the clinic. This number does not reflect the number of people who visited the clinic website only or who did complete the online screening test but did not submit their contact details for further HHC.

Figure 2.1 *Five Steps of an eHealth Supported Hearing Health Care Model using Online and Face-to-Face Modalities Including a Summary of Patients across Studies I-III*

2.3 Research participants

Online methods were used as a recruitment strategy by offering the free online hearing screening test to individuals ≥ 18 year of age, within a 60 km radius of Durban, South Africa. The 60 km radius was chosen as participants were required to travel to the clinic or the clinician travel to the patient for services to be rendered and, therefore, did not expect participants or the clinician to travel further than the defined location. After completing the online hearing screening test, participants could submit their details for contact from the clinician and proceed with care (steps 2–5).

People who failed the online hearing screening test (step 1) and submitted their details for contact from the clinician were included in the studies ("participants"). Participants who attended a face-to-face diagnostic hearing evaluation (step 3) were considered patients of the clinic and referred to as "clinic patients". A total of 931 participants had completed the online hearing screening test (step 1) and submitted their contact details at the end of the two-year study period from the greater Durban area.

2.4 Ethical considerations

The research project was approved by the Postgraduate Committee of the Faculty of Humanities of the University of Pretoria on 4th May 2017 (GW20170409HS) (Appendix A). The research project was conducted according to the ethical guidelines of the World Medical Association Declaration of Helsinki (2013) and the South African Protection of Personal Information Act (Republic of South Africa, 2013). Table 2.6 highlights these ethical principles.

To ensure autonomy, participants provided informed consent before the research began in step 1 and at the beginning of step 3 at the face-to-face appointment. Participants were informed that they had the right to withdraw from the study at any time and without consequence. The participant consent form (Appendix B) outlined the purpose of the study as well as its voluntary and non-invasive nature. Participants did not receive any financial benefit from participating in this research study as services and hearing aids were paid-for services at the accepted medical insurance rates.

Participant confidentiality was protected during and after the study, with no means of linking patient responses to any demographic data, thereby ensuring anonymity. Data were anonymized before they were shared with research collaborators. All data systems were password protected and only accessible to the clinician. All participant data, including consent forms and hard and electronic data, have been stored in the University of Pretoria's Research Data Repository for the next 10 years and will thereafter be securely destroyed.

To ensure beneficence, the potential participants were informed that the benefit of study participation was a contribution to the advancement of knowledge and clinical practice with HHC. The clinician committed to securing the well-being of all patients from harm and the possible benefits of their involvement in the study.

To ensure justice, the study was offered to all adults aged ≥ 18 and over within the greater Durban area searching for HHC online. Patients were not excluded based on gender, ethnic background or socio-economic status. This study partnered with hearing clinics within the greater Durban area. Patients who did not meet the inclusion criteria were referred to the partner HHC clinics.

Table 2.4

Ethical Framework Applied in this Project

Ethical principles	Steps taken to ensure project adhered to ethical principles	Relevance to study	Reference
Non-maleficence	The research protocol was submitted for consideration, comment, guidance and approval to the University of Pretoria post-graduate studies and ethics committee.	The study commenced after ethical clearance was obtained from the Faculty of Humanities Research Proposal and Ethics Committee at the University of Pretoria (Appendix A).	WMA Declaration of Helsinki, 2013
Beneficence, Non-maleficence	Medical research with humans is to be administered by clinically trained professionals.	A South African audiologist with more than 10 years' experience, registered with the Health Professions Council of South Africa, conducted the research.	WMA Declaration of Helsinki, 2013
Autonomy, Confidentiality, Non-maleficence,	Participants in a research study were to be volunteers, be provided with the necessary information, be informed of the aims and objectives, as well as the affiliations of the researcher, funding and any conflicts of interests, risks and benefits of the research study.	Informed consent was provided by each participant willing to participate in this research project. This was outlined in an informed consent form (Appendix B) where information regarding the research study was outlined and explained in detail with the research study's aims, objectives, affiliations of the clinician, funding and most importantly, the option to opt-out of the research project. Participants were ≥ 18 years of age; no minors were involved in this study.	WMA Declaration of Helsinki, 2013; POPI Act, 2013
Autonomy, Confidentiality, Non-maleficence	The right to safeguard the research participants' integrity where precautions were taken to respect the privacy and confidentiality of the participant's information and minimized the impact of the study on the participant's physical and mental well-being.	Every participant had the right to privacy and confidentiality of their information, behavior, attitudes, beliefs and test results. It was the clinician's responsibility and duty to act with understanding regarding the participant's privacy. By no means were participants' audiological results shared without permission from the participant. Confidentiality was maintained by coded responses from participants and therefore only anonymized data were reported upon. Participant audiological results were stored locally on a PC and participant notes were stored separately in a cloud-based system. Both systems were password protected and only accessed by the clinician. Participant data, which were cleaned, sorted and coded into a Microsoft Excel document, were also password protected. Only anonymized data were shared with the statistician in a Microsoft Excel document.	WMA Declaration of Helsinki, 2013; POPI Act, 2013
Confidentiality, Non-maleficence	Processing of personal information by direct marketing.	The online hearing screening test was made available on the clinic's website and online methods were used in a set geolocation where services were provided. Once the participant completed the online hearing screening test, they viewed their result without the need to provide any further identifying information. Only if the participant wished for the clinician to make contact, the participant provided consent and their contact details. No participant results were shared without the participant's permission. The mHealth studio is password protected and only the clinician could access the data.	POPI Act, 2013
Beneficence, Confidentiality	Results from research studies were reflected accurately in published research publications and when presented at conferences.	On publication of results in peer-reviewed journals and at conferences, all results from this study were accurately reported, which included both the nature of positive and negative results. All sources of funding, affiliations and any conflicts of interests were also reported.	WMA Declaration of Helsinki, 2013
Beneficence	References made to published literature were acknowledged and cited appropriately.	Acknowledgment of the research conducted by others which informed this research project were cited appropriately.	WMA Declaration of Helsinki, 2013

2.5 Research equipment and material

Table 2.5 summarizes the equipment and materials used to support the five steps of all three studies and how they were used.

Table 2.5

Equipment and Materials Used to Provide Services across Each Step of the Hybrid Hearing Health Care Model

Equipment/ material	Description	Process steps (see Figure 2.1)					Reference
		1	2	3	4	5	
Audiological equipment							
L460	Portable computer to administer computer-based audiological software package	√	√	√	√	√	Lenovo Inc, Quarry Bay, Hong Kong
Callisto suite 1.8.0 – AC440	Portable diagnostic system that includes video otoscopy, audiometry (bone and air conduction), speech audiometry and real ear measurements			√			Interacoustics A/S, Middelfart, Denmark
Titan suite 3.4.0 – IMP440	Portable tympanometer including acoustic reflexes (ipsi- and contralateral)			√			Interacoustics A/S, Middelfart Denmark
Cloud-based software							
Google Analytics	Web analytics service offered by Google which tracked and reported website traffic data	√					Google LLC, California, United States of America
Triple digit-in-noise (DIN) test	Online hearing screening test (web widget)	√					Potgieter et al., 2016, 2018; hearX Group (Pty) Ltd, Pretoria, South Africa
mHealth studio	Password protected storage for completed online hearing screening tests	√					hearX Group (Pty) Ltd, Pretoria, South Africa
Qualtrics	Software package to host and administer online questionnaires			√		√	Qualtrics, Utah, United States of America
Statistical package for social sciences (SPSS)	Software package to arrange, clean and order data and perform statistical analyses					√	IBM Corp, New York, United States of America
Statistical Analysis Software (SAS)	Software package to support data management, advanced analytics, multivariate analysis, business intelligence and predictive analytics					√	SAS, North Carolina, United States of America
Microsoft Excel 2013	Spreadsheet to enter, anonymize and prepare data and create summary tables and graphs	√				√	Microsoft, Washington, United States of America
Questionnaires / self-report measures							
Mobile device proficiency questionnaire (MDPQ-16) and computer proficiency questionnaire (CPQ-12)	Digital proficiency was measured using a 16-item and 12-item MDPQ and CPQ questionnaires respectively across a five-point Likert scale *(never tried, not at all, not very easily, somewhat easily and very easily)*		√				Boot et al., 2015; Rogue & Boot, 2018
Short Assessments of Patient Satisfaction (SAPS)	Patient satisfaction was measured on a 7-item questionnaire and responses were recorded on a five-point Likert scale (*very dissatisfied to very satisfied and strongly disagree to strongly agree)*			√		√	Hawthorne et al., 2014
Readiness measure: “line”	Readiness for hearing help-seeking was measured on a single-item question using a Likert scale (0 to 10)		√				Rollnick et al., 1999; Tønnesen, 2012
Stages of change measure: “staging algorithm”	Patients had to indicate which one of the four statements which best reflected their current situation in the consideration of seeking HHC		√				Milstein & Weinstein, 2002
Net Promoter Score (NPS)	Patients reported their willingness to recommend the services from the hybrid clinic to their friends and family on a single-item question using a Likert scale (0 to 10)			√		√	Reichheld & Markey, 2011
Communication tools							
WhatsApp instant messaging, electronic mail and audio/video phone calls	Patients maintained communication with the clinician through various tools	√	√	√	√	√	WhatsApp, California, United States of America and others

Software programs were used to collect participant data. Before completing the hearing screening, people were asked to enter their birth year (to include participants ≥ 18 years of age into study), gender and English proficiency levels. After test results were displayed, the patient could opt to provide contact details and consent for the clinician to make contact. The data were stored in the password-protected cloud-based software mHealth studio (hearX Group Pty (Ltd), Pretoria, South Africa). Online questionnaires in Study II were administered with Qualtrics (Utah, USA) (Qualtrics^{XM}, 2020) and the clinician downloaded the data collected into an Excel sheet (Microsoft Excel, 2013). Patient data from the mHealth studio was also transferred into this Excel (Microsoft Excel, 2013) before analysis.

2.6 Research procedures

Table 2.6 details the research procedures performed across the five steps.

Table 2.6

Research Procedures Completed across Each Step of the Hybrid Hearing Care Model

Step	Research Procedure
Step 1 Asynchronous	• Completion of the online screening test formed step 1 of the patient journey • A pass or fail score was displayed immediately • Participants ≥ 18 years of age, who failed the online screening test and were invited to submit their details (name, telephone number and email address) and provided online consent for the clinician to make contact

Step 2 Synchronous	• The clinician contacted participants who submitted their details first by email requesting an appropriate time for a 15-min voice or video call
	• Even if the participant did not respond to the email, the clinician attempted to voice call all participants *(For the first 12 months, the clinician conducted these calls. For the last 12 months, the clinician trained and supervised a trained interviewer to conduct these calls)*
	• Motivational engagement (the line and staging algorithm) was conducted by synchronous voice calling or instant messaging
	  ○ The Line is from the Ida Institute which assessed readiness of improving ones hearing on a scale of 0–10.The line was measured by asking the patient: "How important is it for you to improve your hearing right now on a scale of 0 to 10? Where 0 is not important and 10 very much so?"
	  ○ Staging algorithm: Patients had to indicate which one of four statements which best reflected their current situation when read out to them over the phone
	• If the participant showed readiness to seek HHC (> 5 on the line rating scale and the staging algorithm a score of 3 or 4), a face-to-face diagnostic hearing evaluation was booked
	• For Study III, two digital proficiency questionnaires were sent in the appointment confirmation email prior to step 3

Step 3 Synchronous	• A battery of audiological tests was completed (see section 3.3.4 for details) • A medical referral was made if warranted. If no medical referral was warranted the consultation continued with a bilateral hearing aid trial in the same appointment (step 4) if clinically warranted • If patients did not meet the inclusion criteria (< 18 years of age, not from the greater Durban area, hearing loss ≥ 100 dB HL or lack of internet access) they were referred to one of three clinics who provided informed consent to being part of the referral network (Appendix C) • Patients who could not afford to pay for clinic services (steps 3 to 5) were referred to public health care facilities • For Study II, an online questionnaire was sent to patients on completion of step 3 • Patients received reminders by means of instant messaging and emails to promote participation in these questionnaires
Step 4 Synchronous	• Patients fitted with the trial hearing aids were monitored closely by the clinician using synchronous and asynchronous online modalities to track progress, adaptation to hearing aids as well as answer any questions which may have surfaced • Any concerns were addressed with the patient in a timely manner (between 9am to 5pm from Monday to Friday) • Before the trial period ended, if the patient was ready to purchase their own hearing aids an order was placed • Hearing aid type and style were chosen to meet audiological profile and personal preferences, ensuring that all parameters (acoustics, signal processing, etc.) were addressed • The demo hearing aids were then replaced with the patient's ordered hearing aids during a face-to-face appointment and real-ear measurements were completed • An online aural rehabilitation program was offered for asynchronous use
Step 5 Asynchronous/ Synchronous	• Patients were encouraged to complete the online aural rehabilitation program (which consisted of five modules: (i) becoming a successful hearing aid user, (ii) understanding my own hearing loss, (iii) handling my hearing aids, (iiii) managing difficult communication situations, and (iv) communicating my own hearing loss. The program included a combination of videos, tasks, testimonials and reading assignments. The completion of a module would unlock the next module. The 5 modules were completed all at once or weekly as per the patient's availability) • Communication was maintained between synchronous face-to-face appointments using online synchronous and asynchronous modalities

2.7 Data processing and analysis

Several data processing and statistical analysis methods were used for the three studies. Data processing involves the integration of data collection from multiple sources and the presentation of the data in a cohesive and logical manner (Babbie & Mouton, 2001). Data processing involves the preparation of data which includes coding and cleaning of the data set after which the analyses are performed (Terre Blanche et al., 2006). Statistical software, SPSS V25 (IBM Corp, New York, USA) was used in all three studies and in addition, Study III employed SAS V9.4 (SAS, 2020) to perform quantitative data analysis. Table 2.7 explains the data processing and analyses conducted in the three studies. Examples included descriptive statistics, Pearson correlation and t-test in Study I, Mann-Whitney U test and Cronbach's α in Study II and correlation analysis and exact regression analysis in Study III.

Table 2.7

Data Processing and Statistical Analyses Conducted for Studies I–III

Study	I	II	III
Title	Characteristics, behaviors and readiness of persons seeking hearing health care online	Patient uptake, experience and satisfaction using web based and face-to-face hearing health services: process evaluation study	Digital proficiency is not a significant barrier for taking up hearing services with a hybrid online and face-to-face model
Data processing	• Website data (the number of website visits, geolocation of website visits, website pages viewed per visit, age and gender of the visitors to the website ≥ 18 years and types of devices used to access and view the website) were extracted from Google Analytics • Online hearing screening test results were extracted from mHealth studio (hearX Group (Pty) Ltd, Pretoria, South Africa) into an Excel sheet (Microsoft Excel, Washington, USA) • Quantitative data was cleaned and coded for analysis • Quantitative analysis was performed using SPSS V25 (IBM Corp, New York, USA) except for Study III which used exact regression analysis performed using SAS V9.4 (North Carolina, USA)		
	• Open ended questions were coded		
Statistical analyses (qualitative methods used to supplement quantitative analysis*)**	**Descriptive statistics**		
	• The number of online hearing screening tests completed, number of participants who completed (passed and failed) the online hearing screening test and devices used to complete the online hearing screening test were tabulated • The following participant variables were described: age, gender, SNR, years aware of hearing loss, continued or discontinued with HHC • Mean and standard deviation was calculated for participants' age, SNR and readiness (line and staging algorithm) of those who completed step 3 • Number of participants who completed each of the five steps in the hybrid HHC model		
	• Displayed the time of day (across 24 hours of a day) and day of week (across 7 days of the week) by the age of participants who completed the online hearing screening test • *The reasons to which patients did not proceed from step 3-4 were analyzed by thematic analysis and double checked by an independent researcher**	• Descriptive analysis of the Short Assessment of Patient Satisfaction (SAPS) • A process evaluation of all five steps in the hybrid HHC model were reported upon based on a five-point Likert scale, ranging from strongly disagree to strongly agree • NPS score was calculated based on the patients' likelihood to recommend the clinic to family and friends using a 10-point Likert scale of 0–10 which results in a positive or negative integer • *Open-ended questions on the online questionnaire were analyzed by thematic analysis and double checked by an independent researcher**	• A mean, standard deviation and range was calculated for age, SRT, better-ear four frequency Pure-Tone Average (4FPTA) and years aware of hearing loss • A mean and standard deviation was calculated for the line and staging algorithm for patients who continued and discontinued with HHC • A mean, standard deviation and range were calculated for mobile device (MDPQ-16) and computer proficiency (CPQ-12) scores
	Inferential statistics		
		• Shapiro-Wilk test was used to test for normality	

	• A Pearson correlation test was calculated for age and SNR • The mean age and standard deviation were calculated of participants who passed (n=191) and participants who failed (n=271) the online screening test and were compared to each other using a t-test • A t–test was used to compare the mean age of the participants who submitted their details (n=53) versus the group of participants who did not submit their details (n=220)	• Internal validity of the online questionnaire was measured using Cronbach's α • Correlation analysis was calculated between age and number of face-to-face appointments and age and number of online support instances required • A Mann-Whitney U-test compared the difference between the responder and non-responder groups in terms of age, gender, SNR, the line, staging algorithm, years aware of hearing loss and devices used to complete the online hearing screening test	• Cronbach's α was calculated for mobile device (MDPQ-16) and computer proficiency (CPQ-12) scores • Correlation analysis was conducted between predictor variables and the uptake of HHC to inform the inclusion of independent variables for the exact regression analysis • Correlations were calculated between age and MDPQ-16 and CPQ-12 respectively • Mann-Whitney U-test was used to compare differences between the two patient groups • Point-biserial correlations were used to test associations between ordinal and continuous variables • An exact logistic regression analysis was conducted to determine the factors associated with continuing with HHC

CHAPTER 3: CHARACTERISTICS, BEHAVIOURS AND READINESS OF PERSONS SEEKING HEARING HEALTH CARE ONLINE

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3.1 Abstract

Objectives

This study describes characteristics, behaviors and readiness of people who are interested in seeking hearing health care (HHC) online.

Design

A non-profit clinic was established from which services through a virtual clinic are offered. Most of the patient–audiologist interactions are conducted online. We used online means to invite individuals to take a free online digit-in-noise (DIN) test. Upon failing the test, individuals reported their readiness to seek HHC by using two tools: the line and the staging algorithm. Individuals ≥18 years of age, within the greater Durban area, South Africa, were eligible to participate in the study.

Results

A total of 462 individuals completed the online DIN test during the first 3 months. Of those, 58.66% (271/462) failed the test and 11.04% (51/462) submitted their details for further contact from the clinic audiologist. Five individuals proceeded to a comprehensive hearing evaluation and hearing aid trial: all those individuals showed

readiness to seek further HHC on the measurement tools. These individuals have reported knowing of their hearing challenges prior to taking the test and have waited for a period of between 5 and 16 years before seeking HHC. A significant association between age and DIN test result was found.

Conclusion

This explorative study is the first clinic to utilize digital tools across the entire patient journey in combination with face-to-face interactions in providing HHC. Internet-connected devices provide an opportunity for individuals to seek HHC and for providers to offer initial services to detect, counsel and support persons through the initial engagement process of seeking HHC. This may open up new audiology patient pathways through online hearing screening, assessment of readiness to seek further HHC and enhancement of service delivery using hybrid services by combining online and face-to-face modes of synchronous and asynchronous communication.

3.2 Introduction

According to the World Health Organization (WHO), 466 million people, or over 5% of the world's population, live with disabling hearing loss (WHO, 2017). Prevalence of hearing loss varies significantly across the world and is higher in sub-Saharan Africa, South Asia and Asia Pacific than in other parts of the world (WHO, 2017). With an ageing world population and with hearing loss being more prevalent in older age, hearing health- care (HHC) needs will grow (Mulwafu et al., 2017).

Hearing loss has become a global health concern (Wilson et al., 2017). In 2010, hearing loss accounted for the 11th leading cause of years lived with disability (YLD), which then rose to the 4th leading cause in 2013 and 2015 (Wilson et al., 2017). The WHO estimates an annual global cost of 750 billion international dollars for unaddressed hearing loss including costs associated with the health sector, educational support, loss of productivity and societal costs (WHO, 2017). Without appropriate diagnosis and intervention, hearing loss has severe consequences on quality of life, loss of autonomy, impaired driving ability, mental health, societal integration and participation (Arlinger, 2003; Davis et al., 2016). Untreated hearing loss is often associated with various negative health conditions like depression, isolation and dementia in adults aged ≥65 years (Livingston et al., 2017). The HHC could contribute to the prevention or delay of dementia, with one-third of dementia cases being preventable (Livingston et al., 2017).

Help-seeking for hearing loss is often delayed, taking an individual on average between 7 and 10 years from the time that hearing difficulties are first noticed to further investigation (Davis et al., 2007; Hickson et al., 2014; Meyer et al., 2014). On average, initial hearing aids are fitted at 74 years of age (Henshaw et al., 2012). The delay in seeking HHC is often due to the negative association of hearing loss with ageing, cognitive impairment, stigmatization, embarrassment, loneliness, restricted employment options (Mulwafu et al., 2016; Wilson et al., 2017) and partly attributed to limited accessibility and affordability of care (Swanepoel et al., 2010). Access to HHC for many individuals is scarce and awareness of hearing loss is low (WHO, 2013: Lin et al., 2016). Other barriers to access and affordability of services are due to limited accessibility to HHC solutions, high out-of-pocket costs with current treatment models

and limitations of currently available hearing device technologies (Clark & Swanepoel, 2014; Lin et al., 2016).

Human resources for ear and hearing care are unequally distributed in the world, with a higher concentration of HHC professionals in high- and upper-middle-income countries (WHO, 2013). In low- to middle-income countries, the shortage of HHC professionals to the large population requiring services is well documented (Fagan & Jacobs, 2009; Mulwafu et al., 2017). However, higher income countries like those in Europe also face a shortage of healthcare professionals which is mostly due to retirement rates surpassing recruitment rates (Lapão & Dussault, 2017). A significant increase in the number of trained professionals is, however, unlikely, as training programs are costly and on average take 2 to 4 years to complete (Clark & Swanepoel, 2014).

Technological innovations could also improve access to HHC and the automation of specific tasks (Clark & Swanepoel, 2014). Innovative HHC service delivery through eHealth and community health workers are needed to improve access and to complement current service delivery models (Lin et al., 2016). Service delivery supported by eHealth could be part of the solution as connectivity can facilitate better access to HHC professionals and services. Mobile phones are becoming more affordable. By the end of 2016, two-thirds of the world had a mobile subscription (Global System for Mobile Communications Association (GSMA), 2017). In 2020, it is projected that three-quarters of the population will subscribe to mobile services, with penetration rates of up to 50% in sub-Saharan Africa and 87% in Europe (GSMA, 2017). With the promise of more people around the world being connected, this presents the opportunity to use this connectedness for global sustainability initiatives.

Telephone-based hearing screening tests have been tested in approximately 10 countries, including the Netherlands, United Kingdom and Australia (Smits et al., 2004; Smits et al., 2006; Stenfelt et al., 2011; Dillon et al., 2016). This adaptive test presents three digits in noise (DIN) and the listener has to recognize 50% of the digits correctly (Potgieter et al., 2018). In areas like sub-Saharan Africa where telephone landline penetration is poor, a self-administered hearing screening test available on a mobile device increases accessibility to HHC services (Potgieter et al., 2018). A South African

household survey reported 87% of households had access to at least one mobile device, while 9.4% of households had access to both landlines and a cellular device, with only 0.1% of households solely having a landline connection (Statistics South Africa, 2016a).

Earlier research successfully used electronic mail (email) communication between audiologists and patients as a tool to help first-time hearing aid users through the personal adjustment process (Laplante-Lévesque et al., 2006). More recent research points to the successful use of Internet-based support systems for hearing aid users as an online aural rehabilitation tool (Thorén et al., 2014; Brännström et al., 2016) as well as offering Internet-based cognitive behavioral therapy interventions for patients with tinnitus (Beukes et al., 2016). Computers and Internet delivery of hearing screening, information and intervention have been reported as a feasible method of dissemination to adults with hearing loss between the ages of 50 and 74 years (Henshaw et al., 2012). The increase in mobile penetration globally holds promise that more individuals will have access to the Internet, which may increase accessibility to HHC services. Therefore, this study aimed to target the ≥40-year age group in the light of the increased accessibility and feasibility to dissemination knowledge to individuals with hearing loss.

The challenges described above include the rise of hearing loss globally, the consequences of untreated hearing loss in terms of costs, the association to detrimental health conditions as well as the poor audiologist to patient ratio. It is therefore imperative that identification and treatment of hearing loss be addressed more proactively. This study aims to describe the characteristics, behaviors and readiness of individuals who seek HHC online through a virtual clinic offering using a sample from the greater Durban metropolitan area, South Africa. A secondary objective was to describe considerations in the virtual audiology clinic setup and processes.

3.3 Methods

This is an exploratory project, describing online hearing health seeking characteristics, behaviors and readiness of persons who seek HHC through a virtual eHealth research

clinic in South Africa. The University of Pretoria Faculty Of Humanities Research Ethics Committee approved the research (GW20170409HS).

3.3.1 A description of the virtual audiology clinic

A non-profit entity, Hearing Research Clinic Non-Profit Company (NPC) (http://hearingresearchclinic.org), was established in June 2017 in Durban, KwaZulu-Natal, South Africa. The greater Durban area (eThekwini) has a population of approximately 3.7 million people (Statistics South Africa, 2016b). This is a virtual clinic: most of the patient–audiologist interactions are conducted online, with two face-to-face interactions in the patient's home or office, or a satellite site for the clinic. This face-to-face visit ensures any diagnostic red flags would be identified until a time that technology could possibly support this step with eHealth means. Patients pay for their services out-of-pocket and receive partial coverage from their private medical insurance if relevant. In South Africa, 17% of the population is covered by private medical insurance (Statistics South Africa, 2016a). The clinic is a test bed to determine the viability of offering services through a hybrid model of face-to-face and online communication and services. The reason for the clinic being established as an NPC was to ensure that patients pay for the services they receive to avoid any confounding influence of receiving services free of charge.

The clinic aims to provide services throughout the patient journey, from the time of the first investigation of hearing challenges, through to hearing evaluation and treatment. We propose five steps using a hybrid eHealth model to support the patient along their journey to better hearing (Figure 3.1). This model uses both synchronous (real-time) and asynchronous (store-and-forward) modes of service delivery between the audiologist and patient. Asynchronous refers to data being collected and then sent via a network for later interpretation and usage (Krumm, 2016).

As described above, the Hearing Research Clinic Non-Profit Company advertises its services through online presence and word of mouth. The clinic website was launched on 23rd June 2017 and has a responsive design to accommodate different devices. The quality of information presented on websites as well as attention to design, layout and readability is paramount for successful engagement and to ensure that the written

information provided does not exceed the literacy levels of online hearing health seekers (Laplante-Lévesque et al., 2012; Laplante-Lévesque & Thorén, 2015).

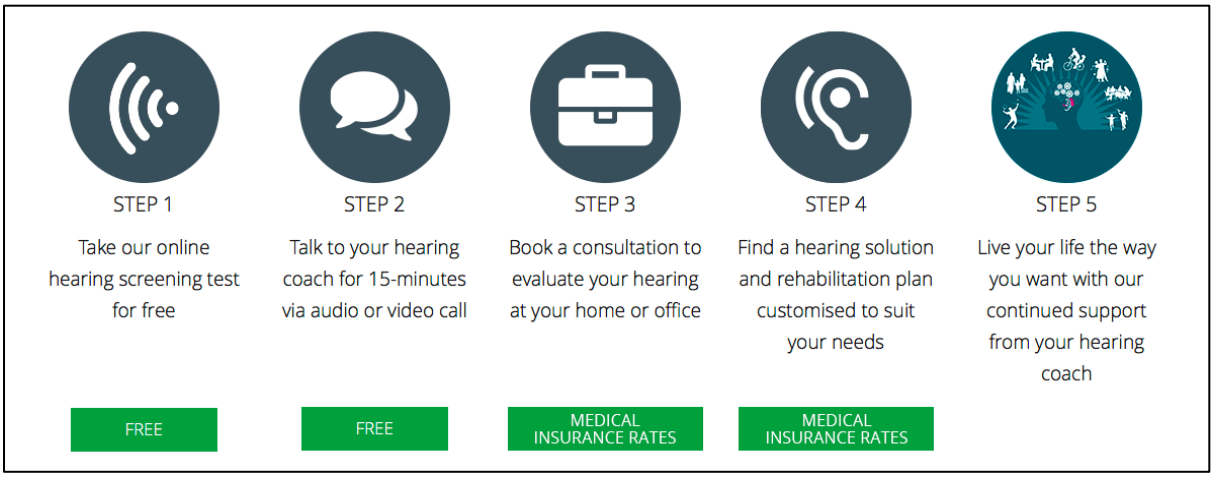

Figure 3.1

Five Steps in the Patient Journey, using Synchronous (Real-Time) and Asynchronous (Store-and-Forward) Modes of Service Delivery Website

Therefore, the following five considerations were taken into account for the design and content of the website: (1) short sentences with limited text were used to ease readability; on average a, Flesch–Kincaid Grade Level of 8.8 was achieved on the web pages, where below 9 is considered good; (2) large fonts; (3) upbeat tone of voice; (4) segmentation of the website information into five sections; and (5) pictures that represent the cultural diversity of South Africa.

3.3.2 Participants

Inclusion criteria for the study were to be of adult age (18 years), living within the greater Durban area and have access to a mobile, tablet or computer with Internet or mobile data access. The study period covered the first three months of the launch of the clinic (23rd June–22nd September 2017).

Characteristics of people who visited the clinic website

3.3.3 Recruitment

Before Step 1 (Figure 3.1), persons in the greater Durban area were invited to visit the clinic website to take the online DIN test on the website. A Facebook page was created

for the clinic. A link to the DIN test which is hosted on the clinic's website was promoted on the clinic's Facebook page. During the study period, online advertising through the social media platform Facebook was the primary method of recruitment. Online advertising was targeted to Facebook users in the age group of ≥40 years and within the geolocation of the greater Durban area. Information regarding the importance of seeking HHC was disseminated from the clinic's Facebook page utilizing advertisements (images and videos), articles and blogs. These were used to capture the attention of the audience and promote the importance of knowing one's hearing status. Eight Facebook posts were targeted to the ≥40 years age group. The clinic also shared one press release when it was launched. An online eHealth news channel published the press release and shared the press release on their Facebook page which was later shared on the clinic's Facebook page. Other means of recruitment included one interview on a community radio station, promotion of the clinic website by the WhatsApp messaging platform to personal friends and family contacts and finally word of mouth.

3.3.4 Procedures

Figure 3.1 depicts the five steps of the patient pathway. Each step is described regarding the type of data collected, data collection method (synchronous and asynchronous), as well as the process of both the clinic audiologist and the participant.

Step 1 – online screening. The completion of the online DIN test hosted on the clinic's website is Step 1 (Figure 3.1) of the patient pathway. This step is conducted asynchronously. At the completion of the DIN test, a score is immediately displayed indicating whether hearing loss may or may not be present (pass/fail result). At this point, all individuals had the opportunity (by consent) to share their contact details (name, telephone number and email address) with the clinic audiologist to make contact. More information on the DIN screening test is provided below.

Step 2 – audio/video phone call. During Step 2 (Figure 3.1), the clinic audiologist emailed (asynchronous communication) the individual to suggest a time and date for a 15-min audio or video call (synchronous) to discuss their hearing concerns. Even if no response was obtained by email, all participants who supplied their details were followed up with an audio call. During the call, the clinic audiologist addressed the individual's hearing concerns and used readiness assessment tools (the line and the staging algorithm) to determine whether the individual was ready for Step 3. When a participant scored above 5 on the line rating scale from 0 to 10 (Rollnick et al., 1999; Tønnesen, 2012) and the staging algorithm a score of 3 or 4 (Milstein & Weinstein, 2002), a face-to-face visit for the comprehensive hearing evaluation was scheduled. Reasons from participants not willing to proceed to Step 3 are listed in Table 3.4.

Step 3 – hearing evaluation and hearing aid trial. Step 3 (Figure 3.1) consisted of a face-to-face (synchronous) appointment either at the participants' home or at the satellite clinic. At this point, the individual provided written informed consent to participate in this project. This face-to-face visit included an in-depth case history (including history of hearing challenges, period of time since first difficulty, symptoms and signs, medical history, exposure to noise and so on), a comprehensive hearing evaluation which included counselling, a discussion of treatment plan options and a two-week hearing aid trial period if the participant wished to proceed. During the trial period, the participant and clinic audiologist were in contact via audio or video call (synchronous) and/or instant messages WhatsApp/text messages/email (asynchronous) to discuss the progress and note any challenges the participant faced with the hearing aids.

Step 4 – hearing solution and rehabilitation plan. Step 4 (Figure 3.1) consisted of the participant successfully benefitting from the hearing aids and opting to purchase their hearing aids to continue their treatment plan. The fitting and verification of the hearing aids are conducted in a face-to-face appointment. These participants were then offered access to an online aural rehabilitation program.

Step 5 – continued support and coaching. Continuous face-to-face and online support is offered from the clinic audiologist to the participant for additional fine-tuning of hearing aids as well as support during the personal adjustment to hearing aids. An online aural rehabilitation program (Eriksholm Guide to Better Hearing) is also offered to these participants to become satisfied hearing aid users. The International Outcome Inventory – Hearing Aids (IOI-HA), as well as satisfaction ratings, measure the outcomes after completion of the Eriksholm Guide to Better Hearing (Cox et al., 2000).

3.3.5 Material and apparatus

Online hearing screening. The online DIN test is a triple-digit hearing screening test developed and validated for South African English which uses an adaptive digit-to-noise ratio procedure (Potgieter et al., 2016, 2018). The software widget (hearX Group (Pty) Ltd, Pretoria, South Africa) is embedded on the clinic website using validated materials (Potgieter et al., 2016, 2018). Digits are considered universal and less reliant on language competence. On beginning the DIN test in Step 1, each individual is required to insert their date of birth as well as their first language and self-reported English-speaking competency level on a scale of 1–10. For each individual completing the DIN test, the signal-to-noise ratio (SNR) was recorded. The geolocation was also provided which allowed verifying that participants were within the test geolocation that is the greater Durban area. A pass on the DIN test was based on validation data correlating the speech reception threshold (SRT) to a four-frequency pure tone average (4FPTA: 0.5, 1, 2 and 4 kHz) ≤25 dB HL and refer or failed result to 4FPTA >25 dB HL. The DIN test uses English digits which is more familiar as language competency poses a challenge in the multilingual population of South Africa, with 11 official languages and only 9.6% of the population are native English speakers (Statistics South Africa, 2011). Therefore, self-reported English competency level was categorized into two groups (0–5 and 6–10) leading to the following cut-off scores; English competency levels of 0–5 required ≤ -7.50 dB SRT and English competency levels of 6–10 required ≤ -9.55 dB SRT to pass the screening DIN test (Potgieter et al., 2018). The DIN test results are stored in a cloud-based system called mHealth studio which records information on all DIN tests taken even if no contact details were submitted with an accurate geolocation (hearX Group, 2020). Only the clinic audiologist has access to the back-end cloud-based mHealth studio (hearX Group, 2020) which is password protected securing participant data.

Website visits. Data regarding usage, length of time spent on the website, new users who are unique to the website and recurring users to the website, type of mobile devices, operating systems used to access the website and IP address to track location were collected using Google Analytics (Google.com, 2017a). Data were not collected on all users to the website as firewall and cookie settings on some devices block websites from collecting this type of data. Also, some mobile browsers send compressed files to Google Analytics making it difficult to correctly identify the browser and device used to take the DIN test (Google.com, 2017a). Google Analytics does not report data on users 18 years according to the laws protecting minors. Google Analytics reports its data to be accurate with a low error rate of less than 2% (Google.com, 2017b).

Readiness measures. Two readiness measures, the line and the staging algorithm, were used during Step 2 of the patient journey. The line is a one-item measure of readiness for hearing help-seeking which consists of the question: How important is it for you to improve your hearing right now? Responses were recorded on a Likert scale from 0 to 10, where 0 indicates not at all and 10 indicates very much (Rollnick et al., 1999; Tønnesen, 2012). The Ida Institute have adapted the line for use within the audiology profession (Ida Institute, 2009). The staging algorithm is a one-item questionnaire assessing stages of change (Milstein & Weinstein, 2002). The question has four possible answers, each corresponding with a stage of change: (1) I do not think I have a hearing problem and therefore nothing should be done about it (pre-contemplation); (2) I think I have a hearing problem. However, I am not yet ready to take any action to solve the problem, but I might do so in the future (contemplation); (3) I know I have a hearing problem and I intend to take action to solve it soon (preparation) and (4) I know I have a hearing problem and I am here to take action to solve it now (action) (Milstein & Weinstein, 2002).

Data analysis. Data were analyzed using the software IBM SPSS Statistics for Windows, version 24 (SPSS Inc., Chicago, IL). Statistical significance was set at $p < 0.05$. Descriptive statistics were used to analyze the characteristics, online behaviors and readiness of the people who seek HHC online.

3.4 Results

3.4.1 Website traffic information.

Within the three-month study period (23rd June–22nd September 2017), 2693 people visited the clinic website, of which 2667 (99.03%) were new (unique) visitors. This data are presented in Table 3.1. The majority (83.66%) of visitors were from South Africa. Only data pertaining to visitors located in the greater Durban area are presented as only participants from this target geolocation were eligible for further HHC (Steps 3–4) through the clinic. A total of 1852 visitors from the greater Durban area and aged ≥18 years, of which 1834 (90.10%) were new visitors, are described below.

Table 3.1

Description of Website Traffic in the Three-Month Study Period (23rd June–22nd September 2017) Obtained from Google Analytics for the Greater Durban Area

	Number (Percentage)
Total website traffic	2693 (100%)
South Africa	2253 (83.66%)
Greater Durban Area	1852 (82.20%)
Users (Greater Durban Area)	2035
New	1834 (90.10%)
Returning	201 (9.90%)
Age (Greater Durban Area)	
18-24	24 (2.40%)
25-34	71 (7.11%)
35-44	112 (11.22%)
45-54	180 (18.04%)
55-64	257 (25.75%)
65+	354 (35.47%)
Total number of age recorded	998 (37.06%)
Gender (Greater Durban Area)	
Female	758 (76.88%)
Male	228 (23.12%)
Total number of gender recorded	986 (36.61%)
Devices (Greater Durban Area)	
Mobile	1541 (83.21%)
Tablet	238 (12.85%)
Computers	73 (3.94%)
Total number of devices recorded	1852 (68.77%)
Operating system (Greater Durban Area)	
Android	1364 (73.65%)
iOS	409 (22.08%)
Windows	61 (3.29%)
Other	18 (0.98%)
Total number of operating systems recorded	1852 (68.77%)

3.4.2 Page visits, age and gender and device usage

On average, website visits indicated 1.17 sessions, 1.95 page views per session and 1 min and 38 s spent on the website per session. A total of 354 (35.47%) of 998 users were 65 years of age within the targeted geolocation. During the study period, the majority (76.88%) of website visitors were female. Most participants viewed the

website from a mobile phone (83.21%), followed by a tablet (12.85%) and computer (3.94%) (Table 3.1). Most (73.65%) of the 1852 users who visited the website did so through an Android mobile phone.

3.4.3 Behaviors and readiness of people who took Step 1 (completing DIN test)

During the study period, 24.95% (462 of 1852) of the website visitors completed the DIN test (Table 3.2). Of the 462 individuals, 191 passed and 271 failed the online DIN test. The majority (442 people, 95.67% of the sample) of the participants in Step 1 reported English as their first language followed by Afrikaans 3.90% (18), Xhosa 0.22% (1) and Other (Marathi) 0.22% (1).

Table 3.2

First Language and Self-Reported English-Speaking Competency for Participants in Step 1 (n = 462)

First Language	English Competency						Total
	5	6	7	8	9	10	
English	0	0	0	0	0	442	**442**
Afrikaans	5	1	0	4	6	2	**18**
Xhosa	0	0	1	0	0	0	**1**
Other	0	0	1	0	0	0	**1**
Total	**5**	**1**	**2**	**4**	**6**	**444**	**462**

Fifty-one individuals (18.82%) submitted their contact details to engage in Step 2 after completing the DIN test. After contacting the fifty-one individuals by voice calls and/or email, five participants (9.80%) proceeded to Step 3 (hearing evaluation and hearing aid trial) and then two participants (40.00%) proceeded to Step 4 (see Table 3.3). The five participants in Step 3 waited for a period of 5–16 years to seek HHC from the time of suspecting hearing difficulty. Both participants in Step 4 indicated a score of 10 on the line and chose option 4 on the staging algorithm, indicating their readiness to seek help and to take action regarding their hearing challenges. The two participants in Step 4 have been registered to use the online aural rehabilitation program (Eriksholm Guide

to Better Hearing), therefore placing them in Step 5 for continuous coaching to becoming satisfied and competent hearing aid users.

Table 3.3

Number of Participants for each step of the Patient Journey at the end of the Three-Month Study Period (22nd September 2017)

Pre-Step 1 Website behavior	Step 1 DIN test	Step 2 Submitted details after fail result	Step 3 Evaluation and hearing aid trial after submitting details	Step 4 Treatment selected after evaluation & trial
Visitors to the website 1852	Total tests: 24.95% (462/1852) Fail: 58.66% (271/462) Pass: 41.35% (191/462)	18.82% (51/271)	9.80% (5/51)	40.00% (2/5)

3.4.4 Age of participants.

The reported age range of individuals who completed the DIN test (n = 462) was 22–94 years, with a mean age of 56.61 years (SD 12.65). A Pearson correlation test indicated a statistically significant correlation ($p < 0.05$; r = 0.21) between age and the SNR (n = 462). Older participants presented with poorer SNR scores (Figure 3.2).

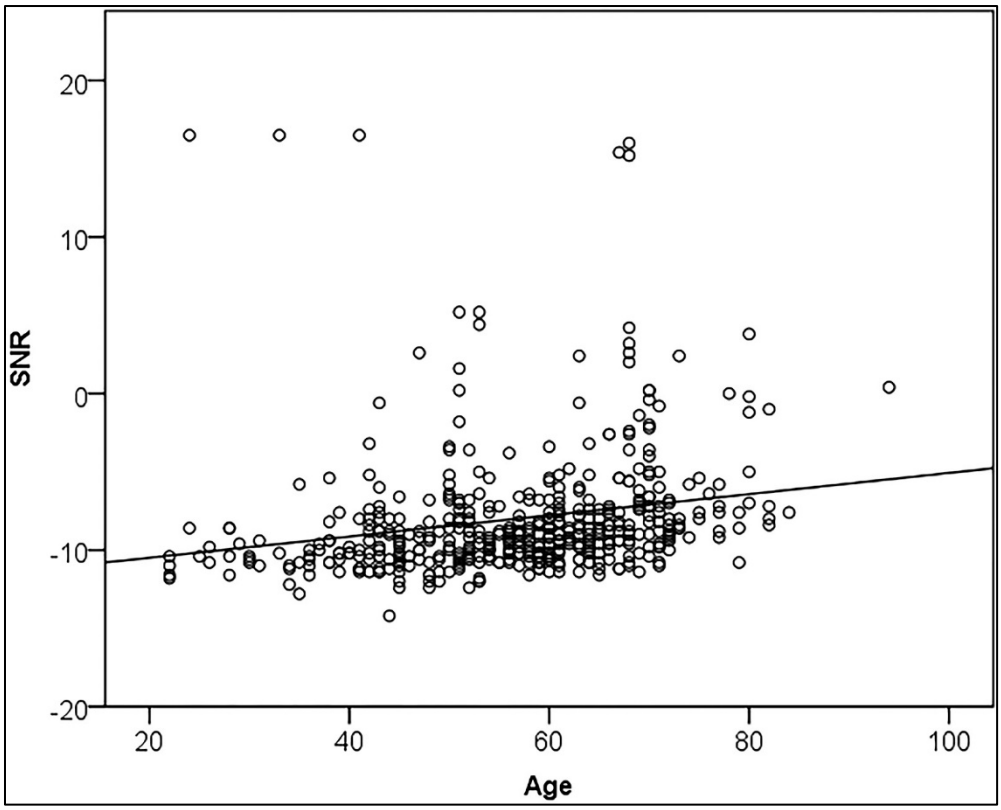

Figure 3.2

Relationship of DIN Test Result (SNR) and Age of Participants who Completed the DIN Test (n = 462)

3.4.5 Relationship between age and DIN test score

As expected, this relationship was also reflected in the characteristics of those who passed/failed the DIN test. The minimum age of the 271 participants who failed the DIN test in Step 1 was 24 years and a maximum of 94 years, with a mean of 60.22 years (SD 11.77). When compared to the 191 individuals who passed the DIN test, this group had a minimum age of 22 years and a maximum of 79 years with a mean of 51.49 years (SD 12.11). People who passed the DIN test were significantly younger than those who failed the DIN test, t (460) = 7.76, $p < .001$. Participants (n = 51) who proceeded to Step 2 included 29 (56.86%) females and 22 (43.14%) males with ages ranging from 28 to 85 years (mean age 60.08 years; SD 11.65). A mean SNR of -6.18 dB (SD 5.22) for the group of 51 participants who submitted their details and mean age of 59.94 years (SD 11.64) was recorded. For the group of 220 participants who did not submit their details, a mean SNR of -6.19 dB (SD 4.43) and mean age of 60.29 years (SD 11.83) were recorded. No statistical significance was found between SNR and age of the 51 participants who submitted their details compared to 220 participants

who did not submit their details, t (269) = 0.021, p = .98 and t (269) = 0.19, p = .85 respectively. The participants' reasons (Step 2) for taking action or not to Step 3 were collected during the audio call in Step 2 (see Table 3.4). Only 51 participants (18.82%) showed interest in seeking further HHC (Step 3). Four of the five participants in Step 3 were first-time amplification users, while one participant was experienced with amplification and has used hearing aids.

Table 3.4

Summary of Themes that Participants in Step 2 Reported in Regards to Taking Action Towards Step 3 (n = 51)

Not interested	**38 (74.51%)**
No answer	17 (44.74%)
Investigation: • curious to try the online test • has hearing aids and curious to recheck if hearing loss is still present	11 (28.95%)
Incorrect contact details	3 (7.89%)
Doctor said nothing can be done	3 (7.89%)
Finance	3 (7.89%)
Other: Beyond geographic location	1 (2.63%)
Interested	**13 (25.49%)**
Possibly in the future	8 (61.54%)
Trialed hearing aids but not purchased	3 (23.08%)
Trialed hearing aids and purchased	2 (15.38%)

3.4.6 Time of day and day of the week that DIN test was completed

A graphical representation below indicates (Figure 3.3) a high portion of the 462 users who took the DIN test completed the test in the morning and evening. The highest number of DIN tests completed during the day was 28 at 7 am, 34 at 1 pm and 30 participants between 7 pm and 10 pm. This indicates that HHC services can be made available for self-administration (asynchronously) outside of the traditional 9 am to 5 pm work day. When looking further at DIN tests taken, Friday had the highest number (31) of tests taken especially in the age group 65 years (see Figure 3.4). More than 65

participants completed the DIN test on Sunday, Wednesday, Friday and Saturday. This suggests that HHC services can be administered asynchronously at a time and place convenient for HHC seekers, often beyond the traditional five-day workweek according to different age groups.

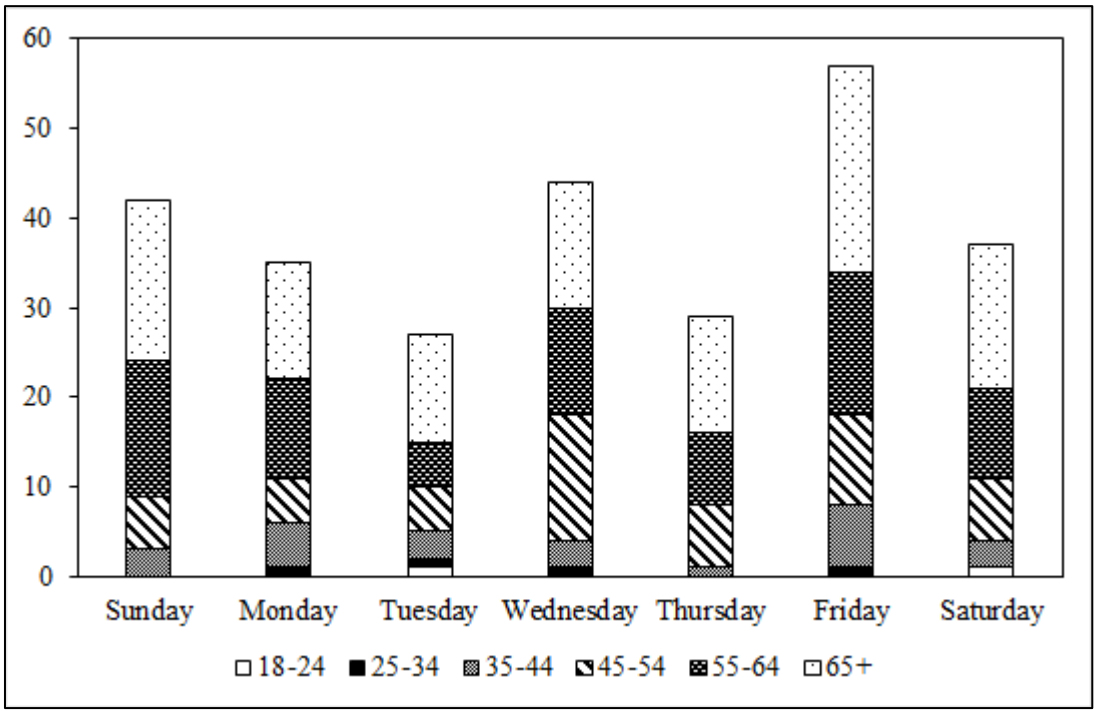

Figure 3.3

Distribution of DIN Tests Completed Per Age Group and Per Day of the Week (n = 462)

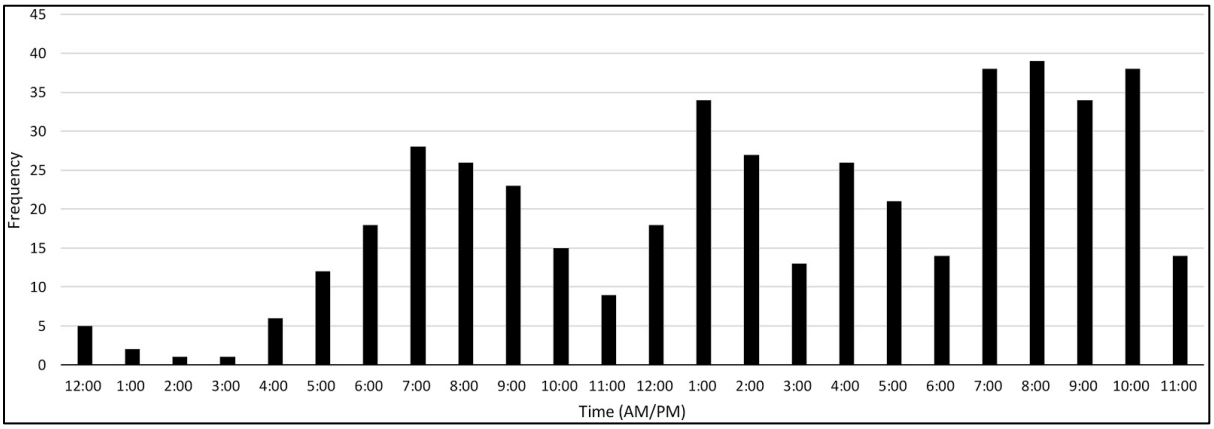

Figure 3.4

Distribution of DIN Tests Completed per Time of Day (n = 462)

3.5 Discussion

There is a pressing need for HHC services to meet the demand of an ageing population. The consequences of untreated hearing loss are detrimental on a micro-level of one's family and communication partners as well as at a macro-level affecting society at large. With the unequal distribution of resources and services challenging HHC, offering services using a combination of virtual and face to face in a hybrid offering is a possible alternative service delivery model.

Making individuals aware of the importance of testing their hearing and knowing their hearing status is a possible first step to raising HHC awareness. While the typical age for an initial hearing aid fitting is 74 years (Henshaw et al., 2012), this study used the advancements of technology to attract a broader age group (40 years) of individuals to take a DIN test using online modes of recruitment. Making the DIN test available online allows for seekers of HHC to have access to a tool to screen their hearing asynchronously. This study provides insights on offering HHC services through a virtual platform. Internet-based recruitment methods were used to create awareness of HHC services by offering free online hearing screening (DIN test) to individuals within the Durban area, South Africa. Within a limited period of three months, 1852 people visited the website within the targeted location. Of those, approximately 1 in 4 completed the online DIN test. Only 18.82% (n = 51) of individuals who failed the DIN test indicated possible further help-seeking with 9.80% (n = 5) of those taking the next step of completing a comprehensive hearing evaluation and 40% (n = 2) of those choosing to purchase hearing aids. Characteristics of people regarding age, gender and devices used to seek HHC online and the behaviors related to motivation and readiness to seek HHC online are discussed below.

3.5.1 Age, gender and devices of people who seek HHC online

The clinic achieved its goal to target older adults with 35.47% (354/998) of users older than 64 years of age within the target geographic location through online recruitment. Online recruitment can, therefore, be one way in which to target an older age group from a specific geographical area. The majority (76.88%) of visitors to the webpage were female. The gender difference found in seeking HHC is comparable to literature which reported males to be more reserved in their actions (Smits et al., 2006).

According to the Pew Research Center, 68% of the American adult population use the social media platform Facebook. When looking closer at the gender split, 62% of males use Facebook and females are slightly higher at 74% (Pew Research Center, 2018). This indicates that more women are active on social platforms than men and tend to seek HHC help earlier than men. An implication of this would mean that providers of HHC should create gender-specific content to reach these specific target groups.

Mobile phones were most frequently (83.21%) used to access the DIN test over tablets and computers. In South Africa where lined Internet is limited, more individuals have access to a mobile device with Internet capabilities which increases one's accessibility to online services. Sub-Saharan Africa remains the fastest growing mobile market in the world with 420 million unique mobile subscribers and a penetration rate of 43% reported at the end of 2016 (GSMA, 2017). By 2020, more than half a billion unique mobile subscribers will be from this region, by which time half of the population will subscribe to a mobile service (GSMA, 2017). Android operating systems were predominantly (73.65%) used to access the website in this study geolocation highlighting the importance of responsive website design. This finding infers that mobile services developed for the test region of Durban, South Africa, are to be compatible on an Android platform.

Using the insights from the time of day and week that participants completed the online DIN test, this supports asynchronous hearing screening which can be self-administered at a time and place convenient for a person which brings HHC to them. Essentially offering services on the clinic's website which can be accessed 24/7 by a potential HHC seeker. This supports the notion put forward that this new era of healthcare is moving beyond the traditional clinic but rather into the daily lives of patients by striving to link the patient with the right care with the right provider at the right time (Gladden et al., 2015).

3.5.2 Motivation to seek HHC services

More individuals completed the online DIN test and did not submit their contact details and this would indicate that people are curious to know their hearing status, however, not ready to take action. Many individuals could have opted to seek HHC services from other providers after being made aware of their hearing result through the DIN test.

This study, however, did not track these individuals. A study which followed up on individuals 4–5 months after failing a telephone-based DIN hearing screening test indicated that only 36% sought further HHC services (Meyer et al., 2011), while previous studies indicated that 46% and 57% of individuals who failed a DIN test sought further HHC services when recommended (Smits et al., 2006). In this study, the number of people who took Step 1 (DIN test) is high and fewer individuals went on to take Step 2 by providing their details to make contact with the clinic audiologist. After Step 1, 81.18% of individuals did not leave contact details for the audiologist in Step 2. Persons may have dropped out since it may be more familiar to receive HHC information in a face-to-face consultation. This could also reflect that online seekers may not know how to validate the quality of online healthcare services or may not be ready to receive this type of information online without the referral of their healthcare provider. Therefore, this highlights the need to normalize online HHC offerings. The clinic was newly established for this project and did not have referral sources other than the online recruitment strategies described.

The individuals who decided to seek help (Steps 3–4) indicated higher scores on the line and staging algorithm indicating that motivational interviewing tools provide useful insights for planning rehabilitation (Ingo et al., 2017). In a study of 224 participants (Ingo et al., 2017), mean score of 6.14 (SD 2.80) was obtained on the line as compared to a mean score of 7.80 (SD 2.59) in our study. The difference in the mean scores and SD could be attributed to the small sample size which produced higher results in our study. Our study had two participants in the contemplation stage and three participants in the action stage of the staging algorithm. In the Ingo et al. (2017) study, 44.60% of persons were in the contemplation stage and 7.60% were in the action stage with the remainder of the 47.80% of participants in the pre-contemplation (2.70%) and preparation (45.10%) stages of the staging algorithm. Younger participants had significantly lower (i.e., better) SNR scores and therefore were more likely to pass the DIN test in our study.

While many isolated eHealth studies have been conducted within HHC, there is a scarcity of studies of the entire patient journey using an eHealth paradigm. This study systematically combined the available tools to form this hybrid model of synchronous and asynchronous services while still remaining agile to include newer tools once

technology allows for services to be offered online. Even though not all steps along the patient journey are ready to be included using online services; this is the first of its kind to place together the pieces which are ready to be tested using the advantages of both face-to-face and online modes of communication. This real-life study aims to be a sustainable model which other audiologists can look upon for inspiration when adapting to the changing landscape of HHC. The next steps of this study are to investigate the experiences and outcomes of the patients who have received HHC services through this hybrid model as well as a cost consequence analysis.

3.5.3 Implications and future directions

The implications of the virtual clinic offering make online hearing screening (DIN test) possible through asynchronous methods allowing access to individuals to take the screening test without the involvement of the audiologist are the first step towards the positive use of the audiologist's time be spent on other more complex tasks. Pre-qualifying individuals for hearing loss could potentially lead to time-saved for audiologists, as individuals who then opt to further their hearing help-seeking through diagnostic measures are made aware that hearing loss may be present. Another possibility is that individuals who may not have been aware of their hearing status may now become aware of their hearing challenges through an online offering which could potentially reach a younger audience using online recruitment strategies. Research points to the advances of innovative technology and greater access to global connectivity are opportunities which may change current HHC service delivery methods to maximize access, efficiency and impact (Clark & Swanepoel, 2014). Moving the pre-qualifier as the online hearing screening test (DIN test) allows audiologists to free up some time to spend more time on complex tasks such as counselling and hearing aid fittings as well as to provide services to more patients, increasing service delivery efficiency (Margolis & Morgan, 2008; Swanepoel et al., 2010).

Despite the online availability of HHC services, barriers to help-seeking continue to exist. This is indicated by a low number of individuals who provided their contact details after failing the DIN test. This explorative research study has provided initial results for the inclusion of a hybrid patient model within the HHC profession.

To the authors' knowledge, this study is the first clinic of its kind, utilizing digital tools across the entire patient journey combined with face-to-face interactions to provide HHC. Currently, research along the entire patient journey using eHealth as a service delivery medium is still insufficient.

3.5.4 Study limitations

A limitation of the current study is its recruitment methods, which relied mainly on Facebook and not on other online sources such as doctor websites, patient organizations, or forums where people who might be more readily looking for HHC services or be trusting of online HHC information. Another limitation is that the website is only available in English and requires some literacy skills (reading level of at least Grade 9), whereas in South Africa there are 11 official languages and low literacy is common (Van der Berg, 2015). However, 442 of the 462 participants who completed the DIN test reported level 10 English competency which indicates a high literacy level. Our study also did not focus on the reasons why some individuals visited the website but did not begin or complete the DIN test, suggesting that they had other needs than those the website addressed.

3.6 Conclusions

This study shows promise of using online recruitment to a virtual hearing clinic. The proposed hybrid model (combination of online and face-to-face modes of communication) holds promise by which services can be offered. Providers of services can take advantage of such a model to support an individual during the initial stages of seeking HHC online prior to a physical appointment. This can be done by using the hours in a day and days of the week strategically to provide access to services outside of office hours by using asynchronous methods which takes advantage of a virtual offering of services with the potential of being open 24/7. The use of online platforms to create awareness of prevention and promotion of hearing loss and HHC services is possible and effective. As technological advancements increase over the coming years and accessibility increases, integration of this proposed hybrid model into existing audiology practices can lead to new audiology patient pathways through online hearing screening, assessing readiness to seek further HHC services using synchronous and asynchronous methods and the enhancement of service delivery models.

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CHAPTER 4: PATIENT UPTAKE, EXPERIENCE AND SATISFACTION USING WEB-BASED AND FACE-TO-FACE HEARING HEALTH CARE SERVICES: PROCESS EVALUATION STUDY

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4.1 Abstract

Background

Globally, access to hearing health care is a growing concern with 900 million people estimated to suffer from disabling hearing loss by 2050. Hearing loss is one of the most common chronic health conditions, yet access to hearing health care is limited. Incorporating Web-based (voice calling, messaging, or emailing) service delivery into current treatment pathways could improve access and allow for better scalability of services. Current electronic health studies in audiology have focused on technical feasibility, sensitivity, and specificity of diagnostic hearing testing and not on patient satisfaction, experiences, and sustainable models along the entire patient journey.

Objective

This study aimed to investigate a hybrid (Web-based and face-to-face) hearing health service in terms of uptake, experience, and satisfaction in adult patients with hearing loss.

Methods

A nonprofit hearing research clinic using online and face-to-face services was implemented in Durban, South Africa, using online recruitment from the clinic's Facebook page and Google AdWords, which directed persons to an online Web-based hearing screening test. Web-based and face-to-face care pathways included assessment, treatment, and rehabilitation. To evaluate the service, an online survey comprising (1) a validated satisfaction measurement tool (Short Assessment of Patient Satisfaction), (2) a process evaluation of all the 5 steps completed, and (3) personal preferences of communication methods used vs methods preferred was conducted, which was sent to 46 patients who used clinic services.

Results

Of the patients invited, 67% (31/46) completed the survey with mean age 66 years, (SD 16). Almost all patients, 92% (30/31) reported that the online screening test assisted them in seeking hearing health care. Approximately 60% (18/31) of the patients accessed the online hearing screening test from an Android device. Patients stayed in contact with the audiologist mostly through WhatsApp instant messaging (27/31, 87%), and most patients (25/31, 81%) preferred to use this method of communication. The patients continuing with hearing health care were significantly older and had significantly poorer speech recognition abilities compared with the patients who discontinued seeking hearing health care. A statistically significant positive result (*P*=.007) was found between age and the number of appointments per patient. Around 61% (19/31) of patients previously completed diagnostic testing at other practices, with 95% (18/19) rating the services at the hybrid clinic as better. The net promoter score was 87, indicating that patients were highly likely to recommend the hybrid clinic to friends and family.

Conclusions

This study applied Web-based and face-to-face components into a hybrid clinic and measured an overall positive experience with high patient satisfaction through a process evaluation. The findings support the potential of a hybrid clinic with synchronous and asynchronous modes of communication to be a scalable hearing health care model, addressing the needs of adults with hearing loss globally.

4.2 Introduction

Background

Globally, access to hearing health care (HHC) is a significant challenge affecting 466 million people, and this number is expected to rise to 900 million people by 2050, who are estimated to have disabling hearing loss [1]. The limited access to HHC results in most affected persons to live with untreated hearing loss, which has far-reaching consequences for individuals and the society at large [2]. Untreated hearing loss affects health, independence, well-being, and employment opportunities and is associated with social isolation, depression, and an increased risk of dementia [3-8]. Alongside recent estimates of a global cost of US $750 billion to hearing loss [1], this chronic condition is now recognized as a significant public health concern [9,10].

Hearing Health Care Models

Traditional HHC service delivery models focus on face-to-face, clinic-based testing, hearing aid or device fittings, counseling, and rehabilitation requiring several patient visits. HHC can be made more accessible through scalable models of care that capitalize on global trends in connectivity and technology [11]. For example, by the end of 2018 there were 5.1 billion mobile subscribers, which represents 67% of the global population, and 3.6 billion mobile device internet users, which accounts for 47% of the global population [12].

The use of these telecommunication and information technologies in medicine is called telemedicine or telehealth; in the field of ear and hearing health, the terms tele-otology and tele-audiology are also used [13]. Owing to the lack of consistency and confusion, many professionals have adapted their own term, ie, electronic health (eHealth), telehealth, tele-audiology, and now eAudiology are all terms that are often used interchangeably to describe the dissemination of health or hearing health services using the internet [14]. Although tele-practice was initially intended for services to be delivered to individuals at a distance, where patients could not interact with health professionals or the patient and the health professional were at two different locations, a newer approach is to provide HHC to the patient who may be close in distance to the health professional but chooses tele-practice as a service delivery option out of

convenience [14]. Telehealth relies on access to the internet, and while some communities may have limited access, connectivity is rapidly expanding [12,15].

TeleHealth in Hearing Health Care

There is a growing body of evidence on the use of telehealth in HHC, including screening [16,17] diagnostic assessment [18,19], hearing aid fitting [20,21], and rehabilitation [22,23]. Studies to date have tested the use of tele-audiology at specific points along the patient journey and have mostly been proof-of-concept studies [13,15,24,25] that have not translated into sustainable telehealth practices [24]. There is a significant need to not only evaluate service delivery models that incorporate telehealth approaches along the patient journey in terms of effectiveness and efficiency but also to establish patient acceptance and satisfaction [13]. Measuring patient outcomes is important, as positive outcomes indicate improvements on patient satisfaction, adherence, and health status [26]. This therefore highlights the need for measuring patient satisfaction.

A dearth of evidence on patient satisfaction when using telehealth HHC services is apparent [13], as only a few studies report on patient satisfaction with tele-audiology. In one study, patients who had their hearing aids fitted remotely were followed up upon, and a high level of patient satisfaction was noted [21]. In another study, there was no difference in terms of the hearing aid benefit between in-person and tele-audiology hearing aid services [22]. In these 2 studies, patient satisfaction with tele-audiology was measured only once, and the measurement was limited to treatment outcomes, rather than an indication of the process of receiving HHC services through a different service delivery medium.

Offering hearing services completely online along the entire patient journey is challenging. Online components were selected based on validated and evidence-based tools, which would not compromise the quality of patient care (eg, online hearing screening, communication by phone and WhatsApp, and online rehabilitation). These components (e.g., video-otoscopy, audiological diagnostic evaluation, and real-ear measurements) were included in face-to-face appointments as online alternatives were not yet available at the conception of this study. The model is described further in the following section and in the study by Ratanjee-Vanmali et al. [27].

In a previous study, we reported on the behaviors of participants who failed the online hearing screening test. Approximately 25% (13/51) of participants proceed from motivational engagement to diagnostic testing and the remainder 75% (38/51) do not transition for the following reasons: unanswered phone call, 45% (17/38), further investigation (curious about the online hearing screening test or owns hearing aids but wants a confirmation of hearing loss, 29% (11/38), incorrect contact details, 8%(3/38), doctor did not advocate for further treatment, 8%(3/38), limited finances, 8% (3/38), and beyond the test geolocation, 3% (1/38) [27]. Therefore, this highlights the need to understand patient experience, satisfaction, and engagement in seeking HHC through such a hybrid model and which components encourage them to continue to seek HHC.

Objective of Study

This study aimed to describe a process evaluation of HHC through a hybrid clinic combining online and face-to-face services [27], with a focus on patient uptake, experience, and satisfaction.

4.3 Methods

4.3.1 Data Collection Procedure

The institutional review board approved the research (GW20170409HS).

4.3.2 Hybrid Service Delivery Model

This research project established a nonprofit hearing research clinic [28] in Durban, South Africa. The clinic relied on online patient recruitment, offering a free online hearing screening. Online recruitment using Facebook and Google was used to target adults aged ≥40 years within the target geolocation from the clinic's social media account. Although the typical age for first-time hearing aid users is 74 years [29], the motivation for advertising to a younger audience was to reach the children of the parents aged 65 to 75 years who would resonate with the advertisements and share or encourage their family members to complete the online screening test. Advertisements (images and videos), articles, and blogs were created and used on the clinic's Facebook page regarding the importance of HHC and knowing one's hearing status or ability, and Google AdWords related to hearing test, audiologist, and tinnitus were used.

Upon completion, patients could opt to provide their contact details to be contacted by the clinic. If patients contacted the clinic without taking the online hearing screening test, they received a link encouraging them to complete the online test. At the beginning of every face-to-face appointment, the clinic audiologist verified the completion of the online hearing screening test. Asynchronous and synchronous online communication, as well as face-to-face communication supporting screening, diagnostics, hearing aid fitting, rehabilitation, and continuous monitoring and coaching, were offered. In total, 5 steps were included in the patient journey (Figure 4.1). The first 2 steps in the model (ie, Web-based hearing screening and motivational engagement, see the following section) were free. Participants paid for the 3 final steps, with some of the participants having access to reimbursement through their health insurance.

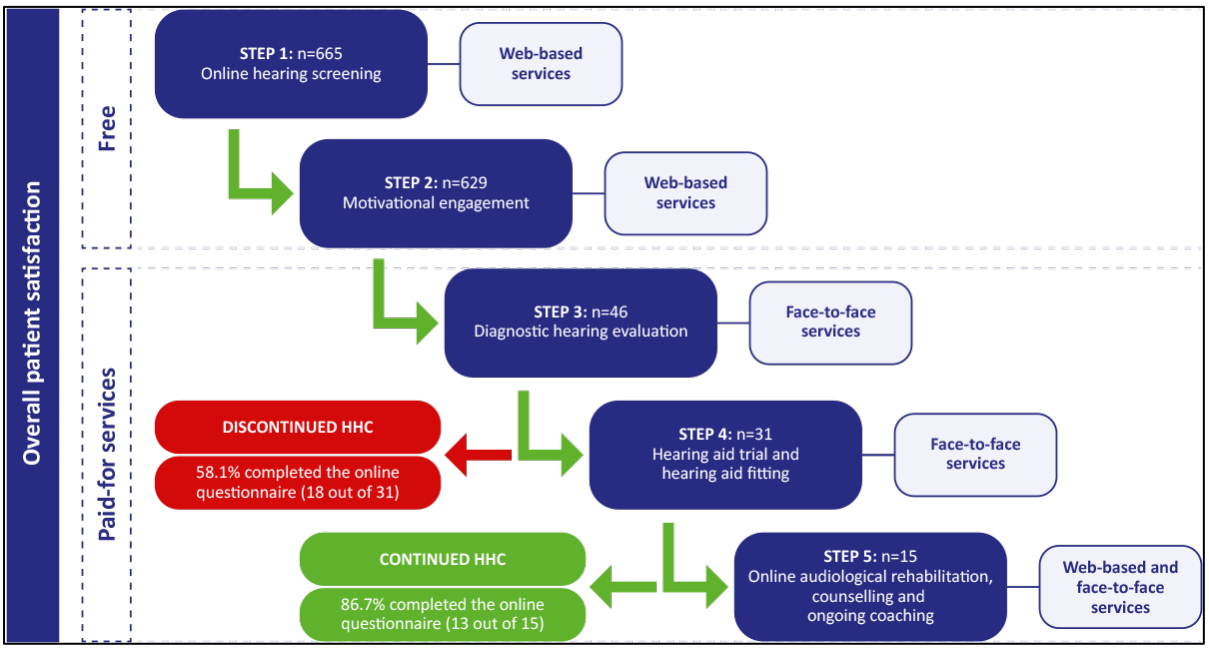

Figure 4.1: Five steps in a hybrid (Web-based and face-to-face) hearing health care (HHC) service delivery model.

4.3.3 Steps in the Hybrid Hearing Health Care Delivery Model

Step 1: Online Hearing Screening—Web-Based. The online hearing screening test is an adaptive triple digit–in–noise test developed and validated for South African English that determines a speech reception threshold [30,31]. The online hearing screening test that comprised 23 user entries was provided as a software-enabled Web widget [32] hosted on the clinic's website.

When beginning the online hearing screening test, each participant was required to provide their date of birth. For each participant completing the online hearing screening test, the signal-to-noise ratio (SNR) where 50% of digits are recognized correctly, was recorded. The geolocation was also provided, which helped verify whether participants were within the geolocation of the test, i.e., the greater Durban area. The pass or fail threshold of the online hearing screening test was based on optimal sensitivity and specificity to a 4-frequency pure tone average at 0.5, 1, 2, and 4 kHz ≤25 dB HL in the better ear.

On completion of the screening test, individuals were informed of their result in terms of pass or fail. Individuals could share their contact details if they wanted the clinic audiologist to contact them. The online hearing screening test results were stored in mHealth Studio Cloud; even if individuals did not share their contact details, the result was stored with an accurate geolocation which ensured that only data from the target location was used in the analysis [32]. Only the clinic audiologist had access to the password-protected mHealth Studio Cloud [32].

Step 2: Motivational Engagement—Web-Based. This step consisted of a phone call or WhatsApp message thread where the clinic audiologist assessed the readiness to book a face-to-face diagnostic hearing evaluation and provided motivational engagement.

Individuals who shared their contact details received an email with the clinic audiologist's contact details, motivational engagement questions, and suitable times and dates for a phone call.

Readiness measurement and motivational engagement consisted of 2 validated tools: the line and staging algorithm that were used with the participant over the phone. The

line is a single-item measure to assess readiness for hearing help-seeking in one question: “How important is it for you to improve your hearing right now?” Responses are recorded on a Likert scale from 0 to 10, where 0 indicates not at all and 10 indicates very much [33,34]. The staging algorithm is also a single-item question assessing the stages of change with 4 possible answers, each corresponding with a stage of change: (1) I do not think I have a hearing problem, and therefore nothing should be done about it (pre-contemplation); (2) I think I have a hearing problem. However, I am not yet ready to take any action to solve the problem, but I might do so in the future (contemplation); (3) I know I have a hearing problem, and I intend to take action to solve it soon (preparation); and (4) I know I have a hearing problem, and I am here to take action to solve it now (action) [35]. When participants scored above 5 on the Likert rating scale of 0 to 10 [33,34] and scored 3 or 4 in the staging algorithm [35], a face-to-face visit for the comprehensive hearing evaluation was scheduled. Higher ratings indicate greater readiness to take action.

Step 3: Diagnostic Hearing Evaluation—Face-to-Face. This step consisted of a face-to-face appointment where the clinic audiologist completed a battery of assessments including an in-depth case history, video-otoscopy, acoustic reflexes, pure tone audiometry (air and bone conduction), and speech audiometry. If no red flag (e.g., sudden onset of hearing loss, middle ear pathology, and asymmetrical hearing loss, sudden onset of tinnitus, aural fullness, and vertigo) suggesting a medical referral was raised, a hearing aid trial was recommended.

Step 4: Hearing Aid Trial and Fitting—Face-to-Face. A successful hearing aid trial entailed that the patient acquired hearing aids fit according to their personalized gain setting, signal processing, noise management system, automatic systems, style, and color. During the hearing aid trial, a receiver in the ear with domes chosen to meet acoustic requirements was fit to meet the patient's audiological profile. Patients were then offered a choice to opt for the style of hearing aids they preferred once counselled on the acoustic performance, physical characteristics of the available hearing aids, and personal needs (from in-the-ear custom options to behind-the-ear hearing aids). Trial hearing aids were then fit and customized to the audiometric profile of the patient using real-ear measurements to take individual ear canal properties into account.

Step 5: Audiological Rehabilitation, Counselling, and Ongoing Coaching—Web-Based and Face-to-Face. All patients who acquired hearing aids were offered an online audiological rehabilitation program [36] and the clinic audiologist coached them routinely.

The online audiological rehabilitation program consisted of 5 modules (becoming a successful hearing aid user; understanding my own hearing loss; handling my hearing aids; managing difficult communication situations; and communicating my own hearing loss) that are a combination of videos, tasks, testimonials, and reading assignments. The completion of a module would unlock the next module. The 5 modules were completed all at once or weekly as per the patient's availability. Through pre-recorded videos, a coach guided the participants through the different modules and components. More information regarding the hybrid clinic has been reported elsewhere [27].

4.3.4 Materials

Online Questionnaire

An online questionnaire was used to determine the experience and satisfaction of patients seeking and receiving HHC using the hybrid clinic, incorporating online and face-to-face services. The online questionnaire was hosted and administered by Qualtrics^{XM} (Provo, Utah) [37]. The responses were password protected and only accessible to the clinic audiologist. This closed survey was only administered to

patients who provided consent to partake in the study. Participation was voluntary; no incentives were offered to encourage completion of the questionnaire.

The questionnaire (Appendix D) consisted of 3 sections totaling 41 questions for the group that discontinued HHC (exited at step 3) and 43 questions for the group that continued with HHC (exited at step 5). The 3 sections consisted of (1) a validated satisfaction measurement tool (Short Assessment of Patient Satisfaction [SAPS] [38]; (2) a process evaluation of all the 5 steps (online hearing screening, motivational engagement, diagnostic hearing evaluation, hearing aid trial and fitting, and online rehabilitation together with counseling and ongoing coaching) completed as seen in Figure 4.1; and (3) personal preferences of communication methods used versus methods preferred and HHC experiences compared with previous care, which were sent to 46 patients who used clinic services. Reporting of the questionnaire was separated into 2 overall sections: (1) evaluation of the steps and (2) patient experiences and satisfaction with the hybrid service delivery model.

The online questionnaire included a process evaluation, recorded on a 5-point Likert scale, which evaluated all the 5 steps (Figure 4.1). The method (Appendix E) was inspired by Linnan and Steckler [39]. They propose how to design and implement a process evaluation by creating the inventory of process objectives based on theory; reaching a consensus of the questions to be answered by the stakeholders of the project; identifying and creating the measurement tools; designing, implementing, and administering quality control; collecting, managing, and cleaning data; analyzing data; reporting findings; and refining interventions, measurements, and the analysis tool [39]. The process evaluation questionnaire was developed to include all aspects of the hybrid service delivery model which included and excluded a clinician's involvement, where no systematic differences were found in the ratings. Closed and open-ended questions on patient experiences and preferences related to the hybrid clinic services compared with a traditional model were surveyed along with communication methods used and those preferred. Answers to open-ended questions were analyzed using an inductive thematic analysis that was conducted by the first author and then reviewed by an independent researcher [40].

Overall Satisfaction

SAPS [38] assesses overall patient satisfaction with 7 items targeting treatment, explanation of treatment results, clinician care, participation in medical decision making, respect by the clinician, time with the clinician, and satisfaction with hospital or clinic care. The questionnaire has been validated in clinical settings and has good internal and test-retest reliability [38]. For this study, the questionnaire was tailored to audiology by replacing the term doctor or other health professional to audiologist [41]. The minimum score is 0, and the maximum score is 28, where higher scores indicate greater satisfaction. Typical total SAPS scores from other research reported mean scores of 22 (SD 5) and 8 (SD 4) [38,42].

The net promoter score (NPS) is a single question about willingness to recommend a product or service that companies commonly use [43]: “On a scale from 0-10, how likely are you to recommend this clinic (Hearing Research Clinic NPC) to your friends and family?” A follow-up question asking respondents to explain the rating followed. The NPS is calculated by classifying the respondents into promoters (9-10), passives (7-8), and detractors (≤6). The NPS is obtained by subtracting the percentage of detractors from the percentage of promoters [43].

4.3.5 Procedures

The online questionnaire was sent via email to 46 patients who completed the diagnostic hearing evaluation (steps 1-3). Data for each patient gathered from their files were linked by their email address and then hidden to ensure anonymity and were issued patient numbers during data analysis. Data were collected over 3 months (December 2018-February 2019); patients had sought help from the clinic during a period of 19 months (June 2017-January 2019). All patients who completed the survey were in contact with the clinic within 6 months of completing the online questionnaire.

The initial email invitation was sent on December 4, 2018, and a WhatsApp message was sent prompting patients to check their email mailboxes for the questionnaire. Up to seven reminder messages (email and WhatsApp) were sent to nonresponses over 12 weeks.

Patient data were stored in two locations: (1) a cloud-based system for appointment times and notes and (2) a server-based system for diagnostic results. Both systems were password protected and only accessible by the clinic audiologist.

4.3.6 Participants

Purposive sampling was used to collect patients' experiences and satisfaction of the hybrid clinic services. Patients who failed the online hearing screening provided consent to be contacted by the clinic audiologist before submitting their details. Written consent to partake in the study was provided during the face-to-face diagnostic hearing evaluation (step 3).

4.3.7 Statistical Analysis

Data were analyzed using SPSS Inc, version 25 (IBM Corp, Chicago, Illinois) [44]. Statistical significance was set at $P<.05$. The Shapiro-Wilk test (nonparametric test) was used to test normality, which confirmed that the data were not normally distributed. Cronbach alpha was used to test the internal validity of the entire process evaluation questionnaire.

4.4 Results

4.4.1 Characteristics of Online Seekers of Hearing Health Care

The reporting of questionnaire results is in accordance, as far as possible, with the Checklist for Reporting Results of Internet E-Surveys [45].

A total of 665 participants completed the online hearing screening test and submitted their details for further HHC services during this evaluation period. A total of 629 participants were contacted by telephone or WhatsApp for motivational engagement; a few were unreachable owing to incorrect details submitted. Out of the 629 participants contacted, 46 (7%) became patients of the clinic and sought HHC services (Figure 4.1). Of the 46 patients invited, 31 (67%) completed the online survey and were aged between 35 and 101 years (mean 66, SD 16), the majority, 58% (n=18)

being men. On average, patients had experienced hearing difficulties for 13 years (SD 15) and presented with an average speech reception threshold of −3.0 dB SNR (SD 8). The online questionnaire was internally consistent and reliable; Cronbach alpha values were between 0.70 and 0.77, where a value above 0.70 was considered acceptable [46]. No significant differences were found on the Mann-Whitney U test between the responder (n=31) and non-responder (n=15) groups in terms of age, gender, SNR, the line, staging algorithm, years aware of hearing loss, and devices used to complete the online hearing screening test.

4.4.2 Process Evaluation of 5 Steps in Hybrid Hearing Health Care Delivery Model

Step 1: Online Hearing Screening—Web-Based

Patients (N=31) accessed the online hearing screening from Android (18/31, 58%), iOS (9/31, 29%), and Windows PC (4/31, 13%) devices. The majority of patients agreed or strongly agreed that the online hearing screening was simple to complete (24/25, 96%), was quick and informative (23/26, 88%), was easy to use (23/26, 89%) and assisted them to continue HHC (24/26, 92%; Table 4.1).

Table 4.1: Patient evaluation of the online hearing screening test.

Questions related to the online hearing screening test	Strongly disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Agree, n (%)	Strongly agree, n (%)
Taking the online test was simple (n=25)	0 (0)	1 (4)	0 (0)	14 (56)	10 (40)
Taking the online test was quick (n=26)	0 (0)	0 (0)	3 (12)	17 (65)	6 (23)
Taking the online test was informative (n=26)	0 (0)	0 (0)	3 (12)	17 (65)	6 (23)
I found this online test easy to use (n=26)	0 (0)	1 (4)	2 (8)	15 (58)	8 (31)
I thought the online test was fast (n=26)	0 (0)	5 (19)	7 (27)	9 (35)	5 (19)
The test result seemed reliable (n=26)	0 (0)	1 (4)	2 (8)	15 (58)	8 (31)
Online test has helped me to take the next steps to improve my hearing (n=26)	0 (0)	0 (0)	2 (8)	10 (39)	14 (54)

Step 2: Motivational Engagement—Web-Based

Patients agreed and strongly agreed that the mode of communication was easy (26/26, 100%), quick (27/27, 100%), provided useful (26/26, 100%) and relevant (25/26, 96%) information, assisted in taking the next step (25/26, 96%), and assisted in booking the diagnostic hearing evaluation (27/28, 96%; Table 4.2).

Table 4.2: Patient evaluation of motivational engagement using a voice call/ messaging (WhatsApp).

Questions related to a voice call/messaging (WhatsApp)	Strongly disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Agree, n (%)	Strongly agree, n (%)
The phone call/WhatsApp message was informative (n=26)	0 (0)	0 (0)	0 (0.)	15 (58)	11 (42)
The phone call/WhatsApp message was an easy way for me to communicate with the audiologist/clinic (n=26)	0 (0)	0 (0)	0 (0)	15 (58)	11 (42)
The phone call/WhatsApp message helped me in taking the next step (n=26)	0 (0)	0 (0)	1 (4)	11 (42)	14 (54)
The phone call/WhatsApp message provided me with relevant information regarding my hearing (n=26)	0 (0.)	0 (0)	1 (4)	14 (54)	11 (42)
The phone call/WhatsApp message helped me to take the next step and book my hearing evaluation consultation (n=28)	0 (0)	0 (0)	1 (4)	12 (43)	15 (54)
The phone call/WhatsApp message was a quick way for me to communicate with the audiologist/clinic (n=27)	0 (0)	0 (0)	0 (0)	14 (52)	13 (48)

Patients communicated with the clinic using WhatsApp messaging (27/31, 87%), emails (25/31, 81%), voice calls (24/31, 77%), text messages (4/31, 13%), and Facebook Messenger (2/31, 7%). The majority of patients preferred the following

methods of communication with the clinic audiologist: WhatsApp messaging (25/31, 81%), email (20/31, 65%), or voice calls (19/31, 61%).

Step 3: Diagnostic Assessment—Face-to-Face

Patients attending face-to-face diagnostic appointments agreed and strongly agreed that the test was comprehensive (31/31, 100%), provided the information needed (31/31, 100%), was easy to complete (31/31, 100%), and was trustworthy (31/31, 100%) with sufficient time spent taking it (31/31, 100%; Table 4.3).

Table 4.3: Patient evaluation of the diagnostic hearing evaluation.

Questions related to the diagnostic hearing evaluation	Strongly disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Agree, n (%)	Strongly agree, n (%)
The diagnostic hearing test was comprehensive (N=31)	0 (0)	0 (0)	0 (0)	13 (42)	18 (58)
The audiological consultation provided me with the information I needed (N=31)	0 (0\)	0 (0)	0 (0)	13 (42)	18 (58)
The diagnostic hearing test was an easy test to complete with the guidance from the audiologist (n=30)	0 (0)	0 (0)	0 (0)	9 (30)	21 (70)
It was beneficial to have a hearing aid trial option available after my diagnostic hearing test (in the first consultation) (n=28)	0 (0.)	0 (0)	1 (4)	6 (21)	21 (75)
It was easy to use the hearing aid during the trial period offered to me (n=28)	0 (0.)	0 (0)	2 (7)	8 (29)	18 (64)
I trust the results from my diagnostic hearing test (n=30)	0 (0)	0 (0)	0 (0)	11 (37)	19 (63)
The time spent on my diagnostic hearing test was adequate (N=31)	0 (0)	0 (0)	0 (0)	13 (42)	18 (58)

More than half of the patients (19/31, 61%) had previously completed a diagnostic hearing evaluation (step 3) at other practices. In comparison with previous

experiences, one person rated the hybrid clinic as the same while the other 18 patients rated their experiences as better.

From the open-ended responses, two main themes emerged for the differences between prior experiences and the hybrid clinic: clinician engagement and technology. Clinician engagement included aspects of personal attention, patience, dedication, thorough explanations, professional behavior, exceeding expectations, friendliness, and trust. Technology included aspects of the latest technology and equipment and offering trial hearing aids.

Step 4: Hearing Aid Trial and Fitting—Face-to-Face

Patients agreed and strongly agreed that a hearing aid trial helped to experience the difference that hearing aids can make in their life (26/27, 96%). All patients who acquired their hearing aids (steps 4-5) agreed and strongly agreed that the hearing aid trial and its usage was beneficial (Table 4.4).

Table 4.4: Patient evaluation of the hearing aid trial and fitting.

Questions related to the hearing aid trial and fitting	Strongly disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Agree, n (%)	Strongly agree, n (%)
The hearing aid trial helped me experience the difference hearing aids can make in my life (n=27)	0 (0)	0 (0)	1 (4)	5 (19)	21 (78)
The opportunity to try hearing aids helped me make an informed decision to buy hearing aids (n=13)	0 (0)	0 (0)	0 (0)	5 (39)	8 (62)
I felt it was easy to use the hearing aids in the trial period which gave me the confidence in my ability to use it on my own (n=13)	0 (0)	0 (0)	0 (0)	5 (39)	8 (62)
I trust that the hearing aids will assist me to hear better in my daily life (n=13)	0 (0)	0 (0)	0 (0)	4 (31)	9 (69)
The time I had to trial the hearing aids in my daily life (home/work) was adequate (n=13)	0 (0.)	0 (0)	0 (0)	3 (23)	10 (77)

My quality of life has improved by using my hearing aids (n=13)	0 (0)	0 (0)	0 (0)	4 (31)	9 (69)

Of those patients who were fitted with hearing aids (steps 4-5), the majority (6/9, 67%) complimented the service received, were satisfied with the care offered, and did not have suggestions for service improvements. Reasons for patients not continuing with HHC (11/18, 61%) included cost as a prohibitive factor (7/18, 39%), concerns regarding the stigma of wearing hearing aids (3/18, 17%), and belief that the hearing loss was not severe enough to warrant the use of hearing aids (3/18, 17%). One person suggested a financing option to make hearing aids more affordable.

Step 5: Audiological Rehabilitation—Web-Based and Face-to-Face

Except for 1 person, all patients agreed and strongly agreed that the online audiological rehabilitation was helpful (8/9, 89%). In addition to the program, support was offered to patients as required both online and by face-to-face methods.

4.4.3 Overall Satisfaction—Web-Based and Face-to-Face Clinic Services

The mean SAPS score of the 31 patients reported was 26 (SD 3; Table 4.5). There were only 3 instances where 1 patient was unsure (neither satisfied nor dissatisfied) regarding his or her satisfaction in terms of the effect of the HHC treatment, choices available to the patient, and dissatisfaction with the care received. In total, 3 patients (3/31, 10%) felt that the time with the clinic audiologist was too short.

The NPS score was 87, which indicates that patients are highly likely to recommend the clinic to friends and family. The majority of patients (21/31, 68%) provided reasons for their rating including competence, result-driven exceptional service (11/31, 35%), tailored service (4/31, 13%), and reliable and efficient service (2/31, 6%).

The three most important reasons for continuing with HHC services with the hybrid clinic were as follows: personalized care and understanding audiologist, who is patient and accommodating (11/31, 36%); confidence in the audiologist, kind, caring, helpful, caring, efficient (8/31, 26%); and technical knowledge of the product and equipment (5/31, 17%).

A significant positive correlation was found between age and the number of appointments (r=0.367; p = .007) and a positive but not significant correlation (r=0.216; p = .12) was reported between age and the number of support instances.

Table 4.5: Overall SAPS scores categorized according to "Very dissatisfied", "Dissatisfied", "Satisfied" and "Very Satisfied" for patients who sought hearing health care (N=31).

SAPS category	Range of score	Frequency (%)
Very dissatisfied	0-10	0 (0)
Dissatisfied	11-18	1 (3)
Satisfied	19-26	14 (45)
Very satisfied	27-28	16 (52)

4.5 Discussion

4.5.1 Hybrid Hearing Health Care Delivery Model

This study provides insights into a hybrid service delivery model that assessed adult patients' perspectives on online and face-to-face services offered. An asynchronous Web-based hearing screening successfully recruited patients seeking HHC online. Patient experiences with this online screening test were positive and, together with motivational engagement, were rated as time-efficient, valuable, and supporting continuation with HHC. This study employed non-opportunistic testing as participants actively opted to visit the website and complete the online hearing screening test. The potential reasons for mixed findings on the ease of testing, which comprised 23 user entries, could be due to the internet speeds (Wi-Fi or mobile data 3G or 4G) in terms of wait time when loading the widget on mobile devices or computers, proficiency with the digital device, or the actual test duration. Hearing screening tests are typically offered in isolation, and longitudinal studies show that a significant percentage of people do not follow-up with diagnostic measures and rehabilitation [47-49]. Approximately 75% (38/51) of patients who failed an online hearing screening test did not continue with HHC as reported in our previous study [27]. Another study reported that older adults who were considering or preparing to take action for their hearing loss were willing to access online HHC and that a simple user interface and short-term training may optimize the usability of online HHC programs for them [50]. In line with this, this study offered hybrid diagnostic and rehabilitative HHC services directly

following the hearing screening. This is the first report to perform a process evaluation of a hybrid model of HHC. Previous reports focused on the validation of these tools and not on patient experiences [47,51].

WhatsApp messaging was rated highly, and patients were satisfied with this mode of communication. Patients used and preferred WhatsApp messaging as the primary communication method with the clinic where a dedicated mobile phone with WhatsApp, phone calls, and email was set up for this hybrid clinic. In other health professions, physicians have successfully incorporated WhatsApp into clinical practice with no need for further training or technical competency building [52].

The advantages and disadvantages of using WhatsApp in clinical practice are well documented within health care [53]. However, there is no uniformity in the usage of WhatsApp, as a recent study reports that doctors were more likely to use WhatsApp in patient communication or share information with colleagues than nurses [54]. Research evidence suggests that WhatsApp can be a promising tool that allows health professionals and the general public to communicate or allows communication among health care professionals themselves to compare and learn from each other [55]. There is still a need for high-quality research to evaluate the value and risks of using it as a health communication tool [54,55].

The diagnostic hearing evaluation (step 3) was an integral step to establish a therapeutic relationship in this hybrid model. A strength of this model was that the therapeutic relationship already commenced before the face-to-face appointment (step 3) and was continued through the patient's HHC journey with the same clinic audiologist either online or in-person. The benefit of clinician continuity is mixed; in a physician environment, seeing a known provider is found to be beneficial in terms of a cost-benefit factor [56], whereas in an audiological setting, no difference was noted on hearing aid outcomes when patients are attended to by different clinicians [57].

Previous tele-audiology studies have taken steps toward investigating patient satisfaction within remote hearing aid fittings [21], services [22], and programming and fitting [58] with reasonable patient satisfaction noted. However, the first 2 studies reported findings based on standardized hearing aid outcome measures (International

Outcome Inventory for Hearing Aids and Satisfaction with Amplification in Daily Living) rather than a process evaluation of patient experiences and satisfaction with HHC [17,18]. The last study [58] measured patient experience satisfaction using a validated questionnaire and found that patient satisfaction with hearing aid programming and fitting via tele-audiology versus face-to-face was the same.

The online audiological rehabilitation offering was reported as a positive addition to this hybrid clinic's services. eHealth might be a viable option to offer tele-audiology services to both adult patients and their significant other as they already use internet-connected technologies to access health care, and this could promote patient-centered care from a biopsychosocial context [59]. Telehealth interventions for audiology are expanding, and research conducted on audiological, vestibular, and tinnitus rehabilitation show promising results [25].

4.5.2 Overall Satisfaction

Patient satisfaction in this study, which used 5 steps in a hybrid HHC service delivery model, was found to be higher than previously published SAPS data. In this study, the SAPS mean score was 26 (SD 3) as compared with findings from an incontinence clinic (mean SAPS score 22, SD 5) [38] and a psychiatry clinic (mean SAPS score 8, SD 4) [42]. The NPS score in this study was high (87) in comparison with an NPC score of 52 in a study of 728 patients who rated their satisfaction with synchronous videos across the health department [60]. NPS scores from another health field in the National Health System in the United Kingdom reported the following scores, however the response scale was slightly altered from the original: joint replacement was 60 with individual scores for total hip replacement and total knee replacement of 71 and 49, respectively [61]. Other researchers have highlighted the attractiveness of adapting the NPS for health care as it is less reliant on the literacy of responders, limited resources are needed to adapt the tool, and it provides more valuable information than a binary yes or no scale [62].

The audiologist's clinical engagement and professional services were identified as essential components in the positive patient experiences in this study. Previous research also indicates that patients prefer patient-centered interactions with a health

professional, and this is associated with high satisfaction [63]. Offering patient-centered care has also been proposed as a way to improve hearing aid adoption [64].

Even though 61% (19/31) of patients experienced previous HHC services from other audiologists or clinics, 95% (18/19) rated the services offered in this hybrid clinic more favorably. Patient experience and satisfaction were equally high and positive in both online and face-to-face service offerings in this hybrid clinic. However, there is still a paucity of evidence regarding the uptake of eHealth HHC, its effectiveness, and the satisfaction of patients using such service delivery models. As technology evolves, so will the continuum of direct-to-consumer and traditional face-to-face models. This study applied online and face-to-face components into a hybrid clinic and measured high patient satisfaction through a process evaluation. This model still required the need for 1 or 2 face-to-face appointments with the audiologist compared with more traditional clinical pathways. The fact that older patients needed more appointments may indicate that more audiological support is needed in the initial stages of adapting to hearing aids where additional support could be offered using asynchronous methods. This study provides initial evidence that can support audiologists who are limited in numbers but are required to provide services to a large area. This model may also provide patients with an alternative service delivery model, who could benefit from a combination of online and face-to-face appointments. Individual audiologists can customize this hybrid model to meet the needs of their patient demographic and for those patients willing to seek HHC differently.

This study offered individuals searching for HHC within the target location with an online hearing screening test as the first action to initiate care. Combining online and face-to-face communication methods also allowed patients to stay in touch with the audiologist when needed. Patients paid for their HHC services, removing volunteer biases and highlighting the potential of this model to translate into a scalable clinical practice. However, patients who pay for their hearing aids could introduce another bias or view services as more favorable, and this could be considered a limitation. Another limitation of the study is the lack of a comparator to establish whether this hybrid model was better or worse as compared with more traditional HHC delivery models where satisfaction could be measured as being similar in face-to-face only with no online services employed. The fact that the same person served as the clinician and as the

researcher collecting the online questionnaires and that patients could have been influenced to provide favorable ratings (social desirability bias) could also be considered limitations in this study. The completion of the questionnaire is also vulnerable to both nonresponse bias (15/46, 33% of patients did not respond to the questionnaire) and recall bias. It is not possible to separate the influence of the audiologist's skills versus the hybrid model when analyzing the patients' satisfaction with the care received. This study also had a relatively small sample within a defined area of South Africa that required patients to have internet access and the necessary digital skills to complete an online hearing screening test, which limits generalizability. Future studies in modifications to the service delivery models would benefit from a comparator group designed into research studies and to test mobile and computer proficiency and the effects of age on the uptake of HHC in such a hybrid model. Another future consideration would be to document the long-term effects in terms of economic viability and scalability of such a model. This hybrid model is the first concept to be tested, and we foresee modifications to this service delivery model made possible in the future when technology advances to facilitate more audiological services remotely to meet the needs of the patient and the audiologist.

4.6 Conclusions

In conclusion, the positive patient experience and satisfaction demonstrates the potential of hybrid online and face-to-face HHC to meet patient needs. Sustainable and scalable service delivery models that incorporate eHealth are required to meet the challenges of untreated hearing loss globally.

4.7 References

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CHAPTER 5: DIGITAL PROFICIENCY IS NOT A SIGNIFICANT BARRIER FOR TAKING UP HEARING SERVICES WITH A HYBRID ONLINE AND FACE-TO-FACE MODEL

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5.1 Abstract

Purpose: The aim of this study was to determine the effect of self-perceived digital proficiency on the uptake of hearing services through a hybrid online and face-to-face hearing health care model.

Method: Adults were recruited via online methods to complete an online hearing screening test within the greater Durban area in South Africa. On submission of contact details after failing the screening, contact was made via telephone to assess readiness for further hearing care. If motivated and willing to continue, a face-to-face appointment for diagnostic hearing testing was confirmed, at which time an email with an online mobile device and computer proficiency survey was sent. Hearing services were offered using combined online and face-to-face methods.

Results: Within two years (June 2017-June 2019), 1 259 people from the target location submitted their details for the clinic audiologist to contact, of whom 931 participants (73.95%) failed the screening test. Of these participants, 5.69% (53/931, 57.41% men) attended a face-to-face diagnostic hearing evaluation. Mobile device and computer proficiency scores were not a predictor of acquiring hearing services.

Age was the only significant predictor (p=.018) for those continuing with hearing care. Patients who continued with hearing care by acquiring hearing aids and support services were older (mean=73.63 years; 11.62 SD) and on average aware of their hearing loss for a longer time (mean=14.71 years; 15.77 SD), as compared to those who discontinued hearing health care, who were younger (mean=59.21 years; 14.42 SD) and on average aware of their hearing loss for a shorter time (mean=6.37 years; 9.26 SD).

Conclusions: Digital proficiency is not a predictor for acquiring hearing services through a hybrid online and face-to-face hearing care model. Hybrid services could allow professionals to assist patients in a combination of face-to-face and online services tailored to meet individual needs, including convenience, and personalized care.

5.2 Introduction

Mobile devices and computers have become an integrated component of daily life. Most people over the age of 65 years use information and communication technology to maintain family and social connections and to access information related to health and routine activities (Vroman et al., 2015). Approximately 90% of people aged between 50 and 91 years use Internet services such as Facebook and Twitter to find and share health information (Tennant et al., 2015). Adults who were younger, more educated, and used more electronic devices, were significantly associated with higher online health literacy (Tennant et al., 2015). Several descriptive internet and computer research studies have been conducted within audiology (see Table 5.1 for a summary). There is a lack of consistency regarding the terms and concepts used, for example, skills, competency, and proficiency mentioned. Only one study utilized a validated measure to assess computer literacy in adults with hearing loss (Moore et al., 2015). To date, no study has considered mobile proficiency, which is increasingly becoming the mode of choice to access information.

Technology use by adults with and without hearing loss and between those who take up hearing aids differ. Generally, older adults with hearing loss use technology or the Internet more than their normal-hearing counterparts (Gonsalves & Pichora-Fuller, 2008; Thorén et al., 2013). People with hearing loss who do not use hearing aids are less likely to use other technologies (computers, automated teller machines, email, and Internet) than their peers with normal hearing and those using hearing aids (Gonsalves & Pichora-Fuller, 2008). The extent of use and ability to use technology in this study were associated with education, occupation, method of transportation, and language (Gonsalves & Pichora-Fuller, 2008). In another study, age, gender, and education were associated with the extent of Internet use and not the degree of hearing loss (Thorén et al., 2013).

Reports also show that younger (50-62 years) adults with hearing loss had greater usage of computers and Internet than their older (63-74 years) counterparts, and those who reported greater computer skills also reported greater computer confidence (Henshaw et al., 2012). Similarly, another study reported, Internet use was higher in the youngest age group (25-64 years) compared to the oldest age group (75-96 years,

p = ≤ .001), with the highest internet usage reported by younger males with higher levels of education (Thorén et al., 2013). The same is evident from another study where higher self-reported Internet competency was associated with younger age, better hearing thresholds, higher educational status, and being male (Maidment, et al., 2016). In a study of 26 older adults aged between 55 to 95 years with hearing loss using a validated computer literacy questionnaire, a significant negative correlation was found between computer literacy and age (Moore et al., 2015). Computer literacy and computer self-efficacy were also negatively correlated with age, with additional negative relationships between computer literacy and computer anxiety, and computer self-efficacy and computer anxiety (Moore et al., 2015). Computer self-efficacy was positively correlated with perceived ease of use (Moore et al., 2015).

In summary the main factors associated with people who have hearing loss and the ability to use technology, or the Internet, or self-reported Internet competency are; younger in age (Gonsalves & Pichora-Fuller, 2008; Henshaw et al., 2012; Maidment et al., 2016 & Thorén et al., 2013), have higher levels of education (Gonsalves & Pichora-Fuller, 2008; Maidment et al., 2016; Thorén et al., 2013) and are male (Maidment et al., 2016; Thorén et al., 2013).

Interestingly, computer skill/competency was not associated with use or adherence to the intervention (auditory training, working memory training, and multimedia educational support) delivered by DVD for TV or computer or via the Internet (Ferguson & Henshaw, 2015). Computer skills and internet access influenced participant preference for the delivery method of multimedia educational support program, where all those who never used a computer and majority of the beginners chose the DVD for TV use (Ferguson & Henshaw, 2015). In an intervention group of patients who watched educational video segments, patients with higher Internet competency scores also viewed the video segments less number of times, which could indicate the ease of knowledge/skills transfer (Maidment et al., 2016). Internet competency was the only statistically significant predictor of practical hearing aid knowledge and practical hearing aid skills in those who received an intervention, which may indicate they are better equipped to put new knowledge into practice (Maidment et al., 2016).

Table 5.1

Summary of Computer and Internet Research on Adults with Hearing Loss

Author (year)	Country	n	Age range (years)	Validated questionnaire	Focus area			Method	Main findings
					Computer skills/ competence	Internet use/ competence	Other technology		
Gonsalves & Pichora-Fuller, 2008.	Canada	135	65-87	Non-validated			ability to use a broad variety of common communication technologies	Study conducted in 2006 Random selection from pool of healthy older adults who volunteer to participate in university laboratory research	Participants with hearing loss (52; 38.5%) Used hearing aids (n=28; 20.7%) Full study sample participated in leisure activities which were more communication – demanding and used technology to a greater extent than the average senior
Henshaw, Clark, Kang, & Ferguson, 2012.	United Kingdom	1235	50-74	Non-validated 16-item postal questionnaire	Computer skill: i. Never used a computer, ii. Beginner, iii. Competent Computer confidence: i. Not competent at all, ii. I usually need help, it takes me a while but I can manage, iii. Confident	Internet use		Year in which study was conducted is not stated	Computer and internet use was greater in younger (50-62 years) than older (63-74 years) adults Older adults with slight hearing loss had greater odds of computer use than adults with no hearing loss Those with moderate and greater hearing loss had lower odds of computer use than adults with no hearing loss 84 people reported, with those who reported greater computer skills also reported greater computer confidence
Thorén, Öberg, Wänström, Andersson, & Lunner, 2013.	Sweden	158	20-98	Non-validated multiple-choice questionnaires		Internet and email use		Study conducted in 2009 Patients from an audiology clinic Purposive sampling	60% of adults with hearing loss used computers and internet Age, gender and education explained the level of internet use and not degree of hearing loss ($p < .000$). Internet use was higher in the younger (25-64 years) compared to older age group (75-96 years)

									Higher usage of internet in adults with hearing loss compared to general population (OR 1.74, 95% CI 1.23-3.17, *p* = .04)
Moore, Rothpletz, & Preminger, 2015.	United States of America	26	55-95	Validated i.Patient-Technology Acceptance questionnaire (Or, 2008); ii. Northstar Digital Literacy Assessment to access computer literacy (Cytron-Hysom, Hadley, Vanek, Graif, & Asp, 2012).	Computer literacy Computer anxiety Computer self-efficacy	Acceptance of internet-based hearing health care		Year in which study was conducted is not stated Failed hearing screening	Anxiety Older adults with hearing loss had poorer computer literacy scores than those just a few years younger Computer literacy and computer self-efficacy were negatively correlated with age, with additional negative relationships between computer literacy and computer anxiety and computer self-efficacy and computer anxiety Computer self-efficacy was positively correlated with perceived ease of use An indirect relationship was observed between age and computer self-efficacy and between age and computer anxiety
Ferguson & Henshaw, 2015.	United Kingdom	231	50-74	Non-validated questionnaires	Computer competence: i. Never used, ii. Beginner, iii. Competent	Adherence to computerized and online interventions		Studies conducted between 2009-2014 Four intervention studies: -Two auditory training studies -One working memory -One study of multimedia educational support	Approximately 15% of participants never used a computer Computer competence was not associated with use or adherence of the intervention (auditory training, working memory training and multimedia educational support) delivered by DVD for TV or computer or via the internet Computer skills and internet access influenced adults preference of the delivery method of multimedia educational support program
Maidment, Brassington, Wharrad, & Ferguson, 2016.	United Kingdom	n=203	42 –95, first time hearing aid users	Non-validated questionnaires		Self-reported internet competency: i. Never used, ii. Beginner, iii. Competent Assess whether		Year in which study was conducted is not stated Prospective, randomized-control trial Multimedia educational intervention	20% reported never used the internet and 29% were beginner in the intervention group vs. 22% never used the internet and 32% were beginners in the control group Self-reported competent internet users of 51% in the intervention group vs. 46% in the control group Internet competency did not differ significantly between the intervention and control groups

						internet competency predicts practical hearing aid knowledge and		(interactive video tutorial) Delivered through DVD for TV or computer and online	In intervention group, higher internet competency was associated with more knowledge of practical hearing aid challenges Better internet competency was associated with better practical hearing aid handling skills at the follow-up appointment Higher internet competency was significantly associated with watching the multimedia videos less amount of time Internet competency was the only significant factor in predicting practical hearing aid knowledge, with variance of 12%. Internet competency also significantly predicted practical hearing aid handling skills Internet competency was a significant predictor of hearing aid knowledge and skills after controlling for demographic attributes (age, hearing threshold, educational status and gender)

Individuals with hearing loss often delay seeking help. On average, people wait 7-10 years before taking action to address their hearing concerns (Davis et al., 2007; Simpson et al., 2019), with the typical age for first hearing aid fitting reported to be around 74 years of age (Henshaw et al., 2012). Multiple non-audiological and audiological factors influence the uptake of hearing aids. Examples of non-audiological factors include; self-efficacy in the use of hearing aids, readiness to improve hearing, stages of change, expectations of hearing aids, self-perceived hearing loss and hearing aid benefit, demographics, support from significant others, social pressure and the level of health literacy needed to understand hearing aid materials (Ferguson et al., 2016; Klyn et al., 2020; Ng & Loke, 2015; Pronk et al., 2017). Examples of audiological factors include; severity of hearing loss, onset and duration of hearing loss, type of hearing loss, insertion gain and acceptance of background noise (Knudsen et al., 2010; Ng & Loke, 2015; Pronk et al., 2017).

In a recent study, age was not a significant predictor of hearing aid uptake (Simpson et al., 2019). However, age and readiness were predictors and modifiers in a study of 377 adults who either continued or discontinued a hearing aid trial (Pronk et al., 2017). The duration of hearing loss is an important factor during the pre-fitting stage of patients seeking hearing health care (HHC) (Knudsen et al., 2010). Hearing loss duration significantly impacts adjustment to hearing aids: Patients who experience hearing loss for a longer period of time may have had more time to prepare themselves for wearing and using hearing aids (Meyer et al., 2014). Advanced stages of change are also associated with longer hearing loss duration (Laplante-Lévesque et al., 2013; Laplante-Lévesque et al., 2015). To the authors' knowledge, no research is available regarding the digital proficiency of patients with hearing loss and their uptake of hearing aids.

The uptake of hearing aids is also influenced by the beliefs and attitudes of the person with hearing loss. A health behavior change model assesses the person's beliefs and attitudes to help predict hearing aid outcomes (Saunders et al., 2016). One behavior change model used in HHC is the transtheoretical model of health behavior change, or the stages of change model. According to this model, people move along a continuum of stages towards behavior change from pre-contemplation to contemplation, preparation, and action. The staging algorithm asks patients to select

one of four statements, where each statement characterizes a stage of change (Milstein & Weinstein, 2002).

Computer and Internet-delivered hearing information, hearing screening, and intervention could be feasible for people who do not typically present themselves to an audiologist (Henshaw et al., 2012). Increasing digital competence in older adults is making online HHC interventions a viable option (Ferguson & Henshaw, 2015). Published online interventions for hearing loss include online hearing rehabilitation programs using videos of real persons with functional tasks for completion and testimonials of persons who have experienced similar hearing challenges and their advice for new hearing aid users (Ferguson & Henshaw, 2015; Greenwell et al., 2015; Thorén et al., 2015). To date, however, the translation of such programs into sustainable clinical practice beyond research projects has been limited.

The advent of mobile technology provides the opportunity to use mobile device applications, enabling HHC interventions to be personalized and on-demand when delivered via mobile devices to patients as well as their families and significant others (Paglialonga et al., 2018). Hearing aids are increasingly controlled by mobile applications enabling remote fine-tuning, sound environment monitoring, and enhancements (Paglialonga et al., 2018). There is a preference and a move towards application-based and online eHealth studies (Paglialonga et al., 2018). In our previous study, we reported that 87.10% of individuals completed online hearing screening testing from a mobile device and only 12.90% from a computer (Ratanjee-Vanmali et al., 2020).

In this study, standardized self-report questionnaires were used to measure self-perceived digital proficiency, and more specifically, mobile device and computer proficiency. Digital proficiency measures must reflect currently used digital solutions. Available measures include the Mobile Device Proficiency Questionnaire and the Computer Proficiency Questionnaire (Boot et al., 2015; Roque & Boot, 2018). The terms *proficiency* and *skills* are often used synonymously. In the present study, “proficiency” describes an individual’s ability to perform a particular task or skill. Proficiency can be measured through self-report or behavioral observation. This study describes the self-perceived digital proficiency (i.e., mobile device and computer

proficiency) of a group of adults who took up hearing services through a hybrid online and face-to-face HHC model. Furthermore, it assesses whether the mobile device and computer proficiency were associated with the uptake of such services. We hypothesize that lower digital proficiency is associated with lower uptake of hybrid HHC services.

5.3 Methods

5.3.1 Setting/ recruitment

A non-profit entity- Hearing Research Clinic Non-Profit Clinic (NPC), was established in June of 2017 in Durban, KwaZulu-Natal, South Africa. A free online hearing screening test (Potgieter et al., 2016, 2018) was placed on the clinic's website, and online methods [Google and Facebook] were used to recruit adults above the age of 18 within the target location. The online screening test result was displayed at the end of the test (pass or refer), and an option to submit contact details for the clinic audiologist (first author) to make contact was made available to each test taker. The clinic audiologist then made contact with the potential patients to assess their readiness to complete diagnostic hearing testing and then became patients of the clinic. Patients paid for the hearing health services, which removed volunteer biases. Five steps made up the patient journey from the completion of the online hearing screening test to the fitting of hearing aids. Full details of the clinic and process can be found in Figure 5.1 and elsewhere (Ratanjee-Vanmali et al., 2019).

5.3.2 Participants

All patients who provided consent to be contacted after failing the online screening test were contacted. After telephonic readiness measurements and motivational engagement was assessed (the clinic audiologist conducted these telephone calls solely for the first 12 months after which a layperson was trained intensively and is coached regularly) and then a face-to-face diagnostic hearing test was scheduled with the clinic audiologist. All the participants who failed the online test, submitted their details, reached by on their provided telephone number, and completed the face-to-face diagnostic hearing test were included in this study, therefore indicating a purposive sampling method was used.

5.3.3 Materials

Online hearing screening test. The online hearing screening test is an adaptive triple digit-in-noise (DIN) test developed and validated for South African English (Potgieter et al., 2016, 2018). The DIN test was provided as a web widget (hearX Group, 2020), which was hosted on the clinic's website. Each individual began the test by inserting their date of birth and then continued with the 23 user tries of the triple-digit test (Potgieter et al., 2016, 2018). Each DIN test completed resulted in a Speech Reception Thresholds (SRT; the level at which 50% correct was achieved) recording. Only at the end of the online hearing screening test after the participant viewed the result, if interested, they could submit their details to be contacted by the clinic.

Measures of readiness and stages of change. A one-item measure of readiness, sometimes called "The Line", was used (Rollnick et al., 1999; Tønnesen, 2012). The question asks: How important is it for you to improve your hearing right now? Responses were recorded on a Likert scale from 0 to 10, where 0 indicates *not at all*, and 10 indicates *very much*. Scores were dichotomized into two groups describing low readiness (≤ 5) or high readiness (> 6). A one-item measure of stages of change, sometimes called "staging algorithm", was used (Milstein & Weinstein 2002). Respondents are asked to pick one of four statements that best describe their situation. Each statement corresponds to a stage of change: (a) I do not think I have a hearing problem, and therefore nothing should be done about it (Stage 1: Pre-contemplation); (b) I think I have a hearing problem. However, I am not yet ready to take any action to solve the problem, but I might do so in the future (Stage 2: Contemplation); (c) I know I have a hearing problem, and I intend to take action to solve it soon (Stage 3: Preparation) and (d) I know I have a hearing problem, and I am here to take action to solve it now (Stage 4: Action). Scores were dichotomized into two groups describing early stages of change (the stages pre-contemplation, contemplation, and preparation) or the late stage of change (action stage). The binary grouping was necessary based on the uneven distribution of the small sample size across the four categories. The action stage was considered the most overt behavioral change, as it entailed considerable commitment of time and energy and it requires the person to modify behavior, experiences, and the environment to overcome their challenges (Prochaska et al., 1992).

Mobile device and computer proficiency questionnaires. The two questionnaires included in this study were the abbreviated versions of the Mobile Device Proficiency Questionnaire (MDPQ-16) (see Appendix F) (Roque & Boot, 2018) and the Computer Proficiency Questionnaire (CPQ-12) (see Appendix G) (Boot et al., 2015). The MDPQ-16 consisted of 16 questions with eight domains, and the CPQ-12 consisted of 12 questions with six domains. The MDPQ-16 and CPQ-12 share the following assessment domains: basics, communication, Internet, calendar and entertainment. However, the abilities queried are different and generally are more complex for the MDPQ-16 than the CPQ-12. For example, the questions for the CPQ-12 basics domain examine the ability to use a computer keyboard to type and the ability to use a mouse. In contrast, the questions for the MDPQ-16 basic domain examine the ability to navigate onscreen menus using the touchscreen and the ability to use the onscreen keyboard to type. For the entertainment domain, the CPQ-12 assesses the ability to watch movies, videos and listen to music on the computer whereas the same domain on the MDPQ-16 assesses the ability to use the device online store to find games and other entertainment as well as listen to music. The questionnaires differ further in that the CPQ-12 includes a printer domain and the MDPQ-16 includes the domains privacy and troubleshooting, as well as software management.

The first page of the MDPQ-16 included images of the devices and information that educated patients on the type of devices of interest included on both questionnaires: mobile devices (tablets and smartphones) and computers. Scoring of the questionnaire was from a minimum of 1 to a maximum of 5; 1=*never tried*, 2=*not at all*, 3=*not very easily*, 4=*somewhat easily* and 5=*very easily*. The final score was calculated by adding the average response of each to produce a total MDPQ-16 and CPQ-12 score. The higher the score indicated better digital proficiency.

Pure-tone average – better ear. A pure-tone average (PTA) was calculated by taking the calculated hearing threshold across four frequencies (500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz) conducted during diagnostic hearing testing using equipment by Interacoustics A/S, Callisto Suite AC 440 (version 1.8.0) in a quiet environment (Interacoustics A/S, 2019). A better-ear PTA was recorded for each patient.

5.3.4 Procedure

This study was conducted under the ethical approval of the University of Pretoria Faculty of Humanities Research Ethics Committee (GW20170409HS). All participants provided online and written consent to be contacted and to partake in this study.

Patients who sought help from the clinic within the target location between the periods of June 2017 and June 2019 were included in this study (see Figure 5.1). Of the 53 patients who took up HHC services through a hybrid model, 34 patients discontinued HHC (after trialing hearing aids in Step 4), and 19 patients continued with HHC by trialing and then obtaining their own hearing aids (continued to Step 5). Of the 53 patients, 22 (41.51%) were female, and 31 (58.49%) were men, with an age range of 33-101 years (SD 15.09). In this paper patient groups are described as follows: those who took up hearing services by completing a face-to-face diagnostic hearing evaluation (step 3), those who discontinued HHC (step 4), and those who continued with HHC (step 5).

Information collected before the consultation.

Participants who submitted their details on failing the online hearing screening test (Step 1) were contacted by email and telephone. Readiness measures, The Line, and stages of change were completed with the participants over the phone to assess their motivation and readiness to move ahead with HHC (Step 2). A face-to-face appointment for diagnostic hearing testing was then confirmed if the participants scored ≥ 5 on The Line and Stage 3 or 4 on the stages of change. After this, an appointment confirmation email was sent to patients, which included information regarding the date and time of appointment, address of the clinic, preparation, bringing a significant other to the appointment, and expectations of the appointment were outlined. A link to the MDPQ-16 and CPQ-12 was included in the email, hosted and administrated by Qualtrics^{XM} (2020). The responses were password protected and only accessible to the clinic audiologist. Patients who did not complete the questionnaires before their appointment were requested to complete the questionnaires before the consultation begun or if assistance was required, the clinic audiologist read out the questions for the patient to complete it immediately. This email appointment confirmation was sent to 53 patients.

Information collected during the consultation. The clinic audiologist reviewed the results of the MDPQ-16 and CPQ-12 before the patient attended the face-to-face appointment. When the MDPQ-16 and CPQ-12 scores indicated that digital proficiency was rather limited, additional support was offered to patients. Additional support offered to patients included, downloading of a mobile application to the patient's mobile phone, pairing mobile phone with the patient's hearing aids and regular interaction and instructing on use of the mobile application to adjust volume and change programs This face-to-face appointment was conducted with the clinic audiologist where the following information was gathered: an in-depth case history, needs assessment, medical history, the length of time the patient was aware of their hearing difficulty/challenges/loss, and a full audiological diagnostic evaluation (Step 3). Results of the audiological assessment were presented to the patient, and then treatment options, together with counseling, were discussed with the patient. If no red flags were observed (sudden onset of hearing loss, middle ear pathology, and asymmetrical hearing loss, sudden onset of tinnitus, aural fullness, and vertigo), needing referral to an otolaryngologist (ear, nose and throat specialist), the patient was fitted with a trial set of hearing aids and were counselled based on their needs (Step 4). After trialing the set of hearing aids, patients had the option to purchase their own set of hearing aids, were offered an online audiological rehabilitation program and were offered ongoing coaching and counseling when needed (Step 5).

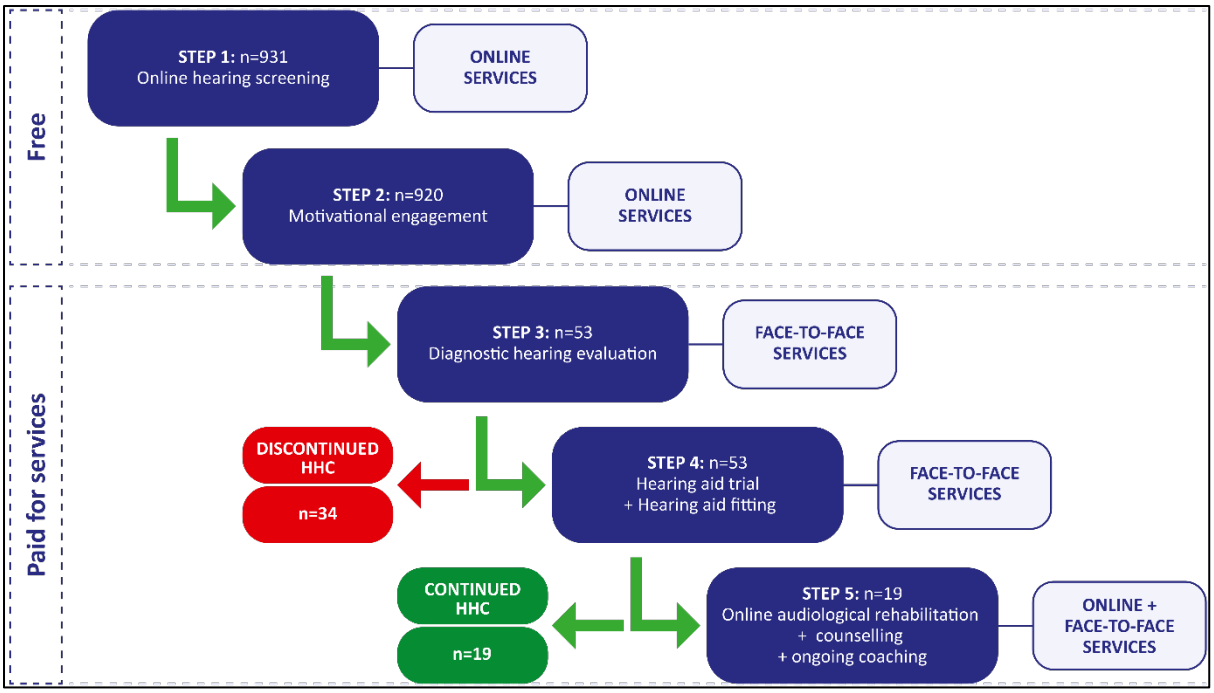

Figure 5.1

Five Steps of a Combined Online and Face-to-Face Hybrid Hearing Health Care Model

5.4 Data analysis

Data were analyzed using SPSS version 25 (2015) and SAS version 9.4 (SAS, 2020). The Shapiro-Wilk test was used to check the distribution of the following variables; MDPQ-16, CPQ-12, SRT, age, years aware of hearing loss, and better-ear PTA. None of these variables were normally distributed, and therefore, nonparametric tests were used. Statistical significance was set at p <.05. The Mann-Whitney U test (non-parametric test) was used to compare the differences between the two patient groups; discontinued HHC (step 4) and continued HHC (step 5). Point-biserial correlations were used to examine associations between continuous and binary variables and Spearman correlations were used to examine associations between Likert-type (ordinal) and continuous variables.

To determine which factors were associated with who continued with HHC, an exact logistic regression analysis was conducted using SAS software (version 9.4) (SAS, 2020). Exact logistic regression models a binary outcome variable (whether or not a patient would acquire hearing aids and support services through a hybrid online and

face-to-face model) with one or more predictor variables (SRT, MDPQ-16, CPQ-12, gender, years aware of hearing loss, age, readiness, stages of change and better-ear PTA). The following potential predictors were omitted from the exact logistic regression as they were highly correlated (point-biserial or Spearman correlations) with other variables included in the model: CPQ-12, readiness, years aware of hearing loss, and better-ear PTA.

The categories of the stages of change were collapsed into two groups: The first three stages were compared to the fourth stage. Exact logistic regression was used as it is more robust to limited samples: The analysis was completed on data from 53 participants. The small sample size provided sufficient power to include numerous independent variables in an exact logistic regression model.

5.5 Results

5.5.1 Description of participants

Over two years (June 23, 2017, to June 22, 2019), 8118 participants completed the online hearing screening test. Of those, 7898 were from South Africa, and 6982 (86.01%) were from the target location of greater Durban, South Africa. Within this period, 1259 people from the target location submitted their details for the clinic audiologist to make contact; 931 (73.95%) failed the online hearing screening test, and 328 (26.05%) passed it. Of the 931 participants who failed and submitted their details, 53 (5.69%) participants became patients (57.41% male) of the clinic and took up hearing services with a hybrid online and face-to-face model by attending a face-to-face diagnostic hearing evaluation (see Table 5.2).

The majority (84.91%) of the 53 patients accessed the online hearing screening test through a mobile device using either Android (60.38%) or iOS (24.53%), with a small minority using a Windows PC (15.09%). Most patients who completed step 3 (84.91%) were in the preparation or action stages of readiness to take up HHC (see Table 5.2). After the diagnostic hearing evaluation, 35.85% of patients continued with HHC by purchasing hearing aids (see Table 5.2).

The mean better-ear PTA score was 38.48 dB HL (SD 19.50) for the total group who trialed hearing aids (n=53). People who continued with HHC (n=19) had a mean better-ear PTA of 46.11 dB HL (SD 23.14) and people who discontinued with HHC (n=34) has a mean better ear PTA 34.15 dB HL (SD 15.95). When looking closer at the patient groups who discontinued HHC versus those who continued HHC, the following differences were noted. Compared to patients who continued HHC, patients who discontinued HHC were younger, had higher SRT and better-ear PTA scores and were aware of their hearing loss for a shorter period of time (see Table 5.2 for comparisons). Regarding the stages of change scores, patients who discontinued HHC and were equally divided between stages pre-contemplation, contemplation and preparation (n=17) and action (n=17), as compared to patients who continued HHC; 63.2% of patients reported stage action (n=12) (see Table 5.2).

Table 5.2

Description of Patient Characteristics and Readiness in Seeking Hearing Health Care

Variable	Step 3 Total Group (n=53)	Step 4 Continued HHC (n=19)	Step 5 Discontinued HHC (n=34)
Age			
- Mean (SD)	64.38 (15.09)	59.21 (14.42)	73.63 (11.62)
- Range	33 – 101 years	33 – 86 years	52 – 101 years
Speech-in-noise recognition threshold			
- Mean (SD)	-4.68 (6.51)	-6.51 (3.96)	-1.41 (8.72)
- Range	-10.80 – 16.0 dB	-10.80 – 5.60	-10.80 – 16.00
Pure-tone average (better ear)			
- Mean (SD)	38.43 (19.50)	34.15 (15.95)	46.11 (23.14)
- Range	9 – 88 dB HL	9 – 79 dB HL	9 – 88 dB HL
Years aware of hearing loss			
- Mean (SD)	9.36 (12.52)	6.37 (9.26)	14.71 (15.77)
- Range	0.1 – 60 years	0.1 – 40 years	0.5 – 60 years
Readiness stage on staging algorithm % (n)			
- Stage 1: Pre-contemplation	3.8% (2)	5.9% (2)	0.0% (0)
- Stage 2: Contemplation	11.3% (6)	14.7% (5)	5.3% (1)
- Stage 3: Preparation	30.2% (16)	29.4% (10)	31.6% (6)
- Stage 4: Action	54.7% (29)	50.0% (17)	63.2% (12)

5.5.2 Mobile device and computer proficiency in adults who sought HHC online

The mobile proficiency (MDPQ-16) and computer proficiency (CPQ-12) mean scores and ranges are reported in Tables 5.3 and 5.4. With regards to the domains on each of the proficiency questionnaires, lowers scores were found on more complex tasks such as data and file storage, calendar use, entertainment and privacy settings (see Tables 5.3 and 5.4). Statistically significant differences were found on the Mann-Whitney *U* test between patients in step 4 (discontinued HHC) and step 5 (continued HHC) on the following domains of the MDPQ-16; basics (p = .037), data file and storage (p = .026), calendar (p = .013), privacy (p = .022) and troubleshooting and software management (p = .024) (see Table 5.3). Only two statistically significant

differences were found on the CPQ-12 between the groups in Steps 4 and 5 on the following domains: calendar (p = .025) and entertainment (p = .040; seeTable 5.4).

The reliability of the MDPQ-16 (see Table 5.3) and CPQ-12 (see Table 5.4) was assessed with Cronbach's alpha, where alpha of above .70 was considered acceptable (Field, 2018). The overall reliability of the MDPQ-16 was excellent (Cronbach's α=.90), with the reliability of the eight domains ranging from .66 to .99. The overall reliability of the CPQ-12 was also Excellent (Cronbach's α=.93), with the reliability of the six domains ranging from .84 to .97. Correlation analyses between uptake of HHC services and potential predictor variables were conducted to inform the inclusion of independent variables for the exact logistic regression to determine possible predictors for persons who continued with HHC.

Table 5.3

Mean and Standard Deviation (SD) for Mobile Proficiency Measurement using the Mobile Device Proficiency Questionnaire (MDPQ-16) of all Patients who Completed Steps 3, 4, and 5

MDPQ-16 (n=53)	**Step 3 Total group (n=53) (*M; SD*)**	**Range (min-max)**	**Step 4 Discontinued HHC (n=34) (*M; SD*)**	**Step 5 Continued HHC (n=19) (*M; SD*)**	**Mann-Whitney (*p* value)**
MDPQ-16 total:	28.83; 9.63	8.50-40.00	31.28; 11.35	25.58; 12.39	190.00 (.013*)
1. Mobile Device Basics	4.40; 1.15	1.00-5.00	4.65; 0.85	3.95; 1.47	230.50 (.037*)
2. Communication	4.07; 1.45	1.00-5.00	4.24; 1.30	3.76; 1.67	275.50 (.322)
3. Data and File storage	3.04; 1.81	1.00-5.00	3.41; 1.78	2.37; 1.71	210.00 (.026*)
4. Internet	4.10; 1.45	1.00-5.00	4.25; 1.34	3.84; 1.64	283.50 (.396)
5. Calendar	3.44; 1.79	1.00-5.00	3.93; 1.59	2.58; 1.84	197.50 (.013*)
6. Entertainment	3.44; 1.30	1.00-5.00	3.38; 1.39	3.55; 1.14	305.50 (.740)
7. Privacy	3.41; 1.49	1.50-5.00	3.75; 1.45	2.79; 1.40	203.50 (.022*)
8. Troubleshooting and Software Management	3.34; 1.66	1.00-5.00	3.68; 1.67	2.74; 1.52	206.50 (.024*)

Note. HHC = hearing health care.
*p < .05.

Table 5.4

Mean and standard deviation (SD) for computer proficiency measurement using the Computer Proficiency Questionnaire (CPQ-12) of all patients who completed Steps 3, 4, and 5

CPQ-12	Step 3 Total group (n=53) (Mean; SD)	Range (min-max)	Step 4 Discontinued HHC (n=34) (Mean; SD)	Step 5 Continued HHC (n=19) (Mean; SD)	Mann-Whitney (p-value)
CPQ-12 total:	23.86; 7.30	6.00-30.00	25.31; 7.73	21.90; 9.60	230.50 (.085)
1. Computer Basics	4.55; 1.10	1.00-5.00	4.62; 0.99	4.42; 1.31	316.00 (.793)
2. Printer	4.00; 1.54	1.00-5.00	4.18; 1.42	3.68; 1.73	287.50 (.445)
3. Communication	4.47; 1.25	1.00-5.00	4.62; 1.02	4.21; 1.59	305.00 (.574)
4. Internet	4.21; 1.29	1.00-5.00	4.32; 1.12	4.00; 1.56	304.50 (.714)
5. Calendar	3.36; 1.81	1.00-5.00	3.77; 1.69	2.63; 1.83	209.50 (.025*)
6. Entertainment	3.50; 1.57	1.00-5.00	3.81; 1.5	2.95; 1.59	217.00 (.040*)

Note. HHC = hearing health care.
*$p < .05$.

The following statistically significant correlations were found between; CPQ-12 and MDPQ-16 (corr = .74, $p < .001$), readiness and stages of change (corr = .60, $p < .001$) and between better-ear PTA and SRT (corr = .75, $p < .001$). Thus, CPQ-12, readiness and better-ear PTA were excluded from the model since the correlations were moderate to strong (corr =.6 and higher; Akoglu, 2018). It should be noted that the correlation between years aware of hearing loss and the stages of change was statistically significant, albeit only moderate (corr = .33, $p < .001$). Years aware of hearing loss was initially included in the model, however, since it did not contribute significantly to the model ($p = .053$), it was excluded from the final model.

MDPQ-16 was chosen for the regression model as the majority of patients (84.91%) completed the online hearing screening test from a mobile phone rather than a computer. The exact logistic regression included the MDPQ-16, SRT, gender, age, and stages of change as predictor variables. Only age was a significant predictor for

those continuing with a hybrid HHC model β=0.072 (parameter estimate) with 95% CI [0.01, 0.144] and *OR* = 1.075 with 95% CI [1.011, 1.155], both with *p* = .018. Older people were more likely to continue with HHC. The odds ratios for age were 1.075, indicating that for every year a person gets older, they are 1.08 times more likely to continue with a hybrid HHC model with R^2 = .275, accounting for 27.5% variance (see Table 5.5).

Table 5.5

Results of Exact Logistic Regression Identifying Predictors of Taking up Hearing Services with a Hybrid Online and Face-to-Face Model (n=53)

Factor	Exact parameter estimates	Odds ratio (95% CI)	Two-sided p-value
MDPQ-16	0.013	1.01 (0.94, 1.10)	.769
SRT	0.09	1.09 (0.98, 1.24)	.109
Gender (male benchmarked against female)	0.068	1.07 (0.24, 5.48)	1
Age	0.072	1.08 (1.01, 1.16)	.018*
Stages of change (Action benchmarked against Pre-contemplation, contemplation and preparation)	0.357	1.43 (0.32, 6.48)	.827

Note. CI = confidence interval; MDPQ-16 = Mobile Device Proficiency Questionnaire; SRT = speech reception threshold; CPQ-12 = Computer Proficiency Questionnaire.
*$p < .05$.

A positive strong (r^2=.69) correlation between age and the MDPQ-16 indicated that patients who continued with HHC are older and scored poorer (see Figure 5.2a). Whereas between CPQ-12 and age, a positive moderate (r^2=0.40) correlation is reported for the group who continued with HHC (see Figure 5.2b). Total group scores indicate a positive moderate (r^2=.40; $p < .001$) correlation between age and MDPQ-16 and a positive weak correlation (r^2=0.22; p = .009) between age and CPQ-12.

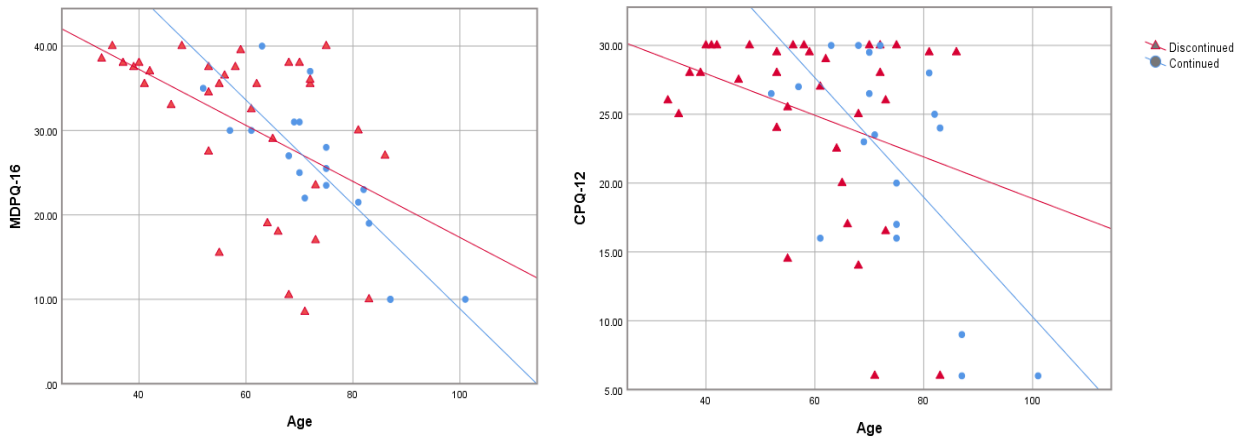

Figure 5.2

Relationship between (5.2a) Age and Mobile Device Proficiency Questionnaire (MDPQ-16 and (5.2b) Age and Computer Proficiency Questionnaire (CPQ-12) for Patients who Discontinued and Continued Hearing Health Care

5.6 Discussion

This study characterized self-perceived mobile device and computer proficiency of 53 adults with hearing loss who took up hearing services through an online and face-to-face model. In this study, average proficiency scores for mobile device and computer use were 28.83 (SD 9.63) out of 40 (MDPQ-16) and 23.86 (SD 7.30) out of 30 (CPQ-12), respectively. Only age was significantly associated with uptake of hearing services, with older subjects being more likely, using a hybrid online and face-to-face service.

There is a dearth of research on mobile proficiency with summarized results (see Table 5.1) in adults with hearing loss showing that, apart from one study, all computer skills and Internet research used non-validated measures. Younger people typically score higher on digital proficiency measures. Our study showed higher mobile proficiency compared to other studies of adults without hearing impairment (Moret-Tatay et al., 2019; Roque & Boot, 2018). However, computer literacy in this study is slightly lower than for adults with significant computer experience, where older adults were less computer proficient (Boot et al., 2015). Computer proficiency scores in this study (CPQ-12=23.86, SD 7.30) compared well with a group of persons with significant computer experience (CPQ-12=25.67, SD 3.84) from the general public (Boot et al.,

2015). Although people might not be proficient with complex tasks, they may be able to access online health care by completing the online hearing screening test without difficulty or asked for assistance. People with hearing loss may have a better computer and mobile device proficiency than the general population (Gonsalves & Pichora-Fuller, 2008; Thorén et al., 2013) due to the visual nature of online communication being less reliant on hearing. However, since this study used purposive sampling, which targeted adults with hearing loss who were accessing information online, comparison with studies that used random sampling should be made with caution as the respondents were all Internet users.

Gonsalves and Pichora-Fuller (2008) reported that people with hearing impairment without a hearing aid used the Internet and e-mail significantly less than those with hearing aids. The non-hearing-aid users also appeared to use the computer, fax, and ATM less than those with normal hearing and those using hearing aids. In comparison, a more recent study reported that technology use did not vary from people who did not own or wear their hearing aids versus those who did after controlling for age, gender, and living arrangement (Ham et al., 2014). Results from the present study further support that the findings that digital proficiency does not affect the uptake of HHC services when combining online and face-to-face services. This study is the first to assess digital proficiency of patients in a combined online and face-to-face HHC model as compared to previous studies which used a traditional face-to-face model. A large percentage of patients (67.39%) in the hybrid model presented here took up hearing services by completing a diagnostic hearing evaluation but then discontinued care by not opting for hearing aids and support services (Ratanjee-Vanmali et al., 2020).

Even though in this study, self-perceived digital proficiency decreased as the age of respondents increased, mobile device and computer proficiency were not associated with the uptake of hearing services through a hybrid of online and face-to-face services. However, age was associated with the uptake of hybrid HHC services; with older patients more likely to continue with HHC. A previous study (Ham et al., 2014) reported that older adults and being female were associated with decreased technology use.

Even though the patients initiated HHC by completing the first step of the online hearing screening test, the majority (84.91%) from a mobile device, this patient group were already aware of their hearing difficulties and capable of using the Internet from their mobile devices. Therefore, providers need to be cognizant when developing their online content to ensure that it employs a responsive design for positive mobile phone user experiences (Ratanjee-Vanmali et al., 2019).

The rapid increase in connectivity and mobile device usage has made online hearing screening very accessible (De Sousa et al., 2018). This study suggests that the older the patient, the more likely they will continue with HHC, even though their self-perceived digital skills (mobile and computer proficiency) may be lower. Lower proficiency did not prevent older adults from seeking and continuing HHC in a hybrid hearing care service, in which the first step entailed an online hearing screening test. Digital literacy is, therefore, not necessarily a hindrance to the uptake of online services. Providing good design and usability can go a long way towards increasing the accessibility of mobile HHC services (Convery et al., 2020). Since patients in this sample sought HHC with the first step of an online hearing screening test, their level of digital proficiency was not associated with the uptake of hearing services which suggest that online options for HHC may be important avenues for adults with hearing loss.

This study is the first report on self-perceived mobile device proficiency in people with hearing loss. Logistic regression was used to control for the effect of covariates on the relationship between digital proficiency and the uptake of hearing services using a hybrid model of online and face-to-face methods. The small sample size provided less statistical power to the analyses, but an exact regression model was utilized to account for confounding variables.

The sample is not representative of the general population as it sampled patients who used online methods to access HHC. However, digital proficiency levels in this group did not influence the uptake of hearing services through a combination of online and face-to-face methods. Adult patients with lower mobile and computer proficiency may have had the support/assistance from a significant other to acquire hearing aids and support services from a hybrid service delivery model. The exact regression model

could have been strengthened by including other factors associated with hearing aid adoption such as severity of hearing loss (measured or perceived), self-reported activity limitations or participation restrictions, perceived benefits and barriers to hearing aid adoption, and support from significant others (Meyer & Hickson, 2012).

5.7 Conclusion

Self-perceived digital proficiency, or the ability to use mobile devices and computers, was not a predictor for acquiring hearing aids and support through an online and face-to-face (hybrid) HHC model. Age was the only factor predicting uptake of online and face-to-face HHC services, with older patients being more likely to continue with HHC. With the availability of carefully designed eHealth tools to supplement current service delivery models, digital proficiency may not be vital for the uptake of such services. Hybrid services encourage hearing care professionals to assist patients in face-to-face modalities in combination with online services. Treatment plans can be tailored to meet the individual needs of the patient, thereby delivering convenient, personalized, and patient-centered care by utilizing a hybrid service delivery offering.

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CHAPTER 6: DISCUSSION, CLINICAL IMPLICATIONS AND CONCLUSION

The aim of this chapter is to discuss and contextualize the results, critically evaluate the research conducted in terms of the strengths and weaknesses, their implications for clinical practice, recommendations for future research and to draw conclusions. Recommendations for incorporating digital tools to enhance HHC service delivery are proposed in light of the research findings. Finally, future research avenues are discussed.

This thesis aimed to evaluate an eHealth supported online and face-to-face HHC model investigating patient experiences and behaviors across the entire patient journey, including online hearing screening, diagnostic hearing evaluation, hearing aid trial and fitting, online aural rehabilitation and support services.

6.1 Summary of findings

The project included three studies. Study I reported the characteristics, behaviors and readiness of adults from the greater Durban area who sought HHC online from the Hearing Research Clinic in the period June–September 2017. Patients reported having waited between 5 to 16 years to seek HHC from the time of suspecting hearing difficulty. Of the 1852 participants who visited the clinic website, 462 participants completed the online hearing screening test. The majority (83%) of visitors accessed the website from a smartphone, of which 74% were Android based. They had a mean age of 57 years (range = 22–94 years; SD 13). A statistically significant positive correlation (r = 0.21; p < .001) was found between age and online hearing screening test results, where older participants presented with poorer results. Of the 462 online test takers, 59% (271/462) failed the online hearing screening test and 11% (51/462) submitted their details for further HHC from the clinic. In total, 60% of online hearing screening tests were completed outside a traditional workday (i.e., before 9.00 am and after 5.00 pm). Within these three months, five patients proceeded to a diagnostic hearing evaluation. Asynchronous methods allowed access to online hearing screening outside of standard clinic opening hours. This supports the concept of HHC

that ensures that individuals have access to information and services at a time and place convenient for them. Study II further examined the hybrid HHC services, this time conducting a process evaluation to describe patient uptake, experiences and satisfaction. Patients sought HHC from the clinic over a period of 19 months (June 2017–January 2019). An overall patient satisfaction, measured with the SAPS questionnaire, of 97% was reported; out of 31 patients, 16 reported being very satisfied, 14 satisfied, and 1 dissatisfied. Most patients (87%) favored instant messaging to contact the clinician and most (81%) preferred this method of communication over voice calling or emailing. Patients who continued with HHC were older (mean age = 74 years, 12 SD) and had poorer speech recognition abilities (mean SNR = -1.41 dB; SD 9) than patients who discontinued HHC (mean age = 59 years; SD 14; mean SNR = -6.51 dB; SD 4). A statistically significant positive correlation (r = 0.367; p = .007) was found between age and the number of face-to-face appointments needed. About two-thirds of patients had previously completed diagnostic testing at other practices, with 95% of those rating services through the hybrid model as better. The fact that patients were likely to recommend the clinic to their family members and friends and rated services highly support the potential of a hybrid HHC service delivery model. These findings confirm that eHealth supported online and face-to-face HHC can address the needs of adults with untreated hearing loss.

Study III investigated the patient characteristics associated with the uptake of HHC services through a hybrid HHC model using an exact regression model analysis. Patients who accessed HHC services from the clinic over a period of 24 months (June 2017–June 2019) were included in the analysis. Overall patients who discontinued HHC reported higher scores across all domains on the MDPQ-16 and CPQ-12 than patients who continued with HHC. Lower scores were recorded on both questionnaires with regards to more complex tasks such as data and file storage, calendar use, entertainment and privacy settings. Statistically significant differences were found between patients who continued with HHC versus those who discontinued HHC on the following domains of the MDPQ-16; basics (p = .37), data file and storage (p = .026), calendar (p = .013), privacy (p = .022), and troubleshooting and software management (p = .024). Only two statistically significant differences were found on the CPQ-12, between the two patient groups on the domains of calendar (p = .025) and entertainment (p = .040). Even though differences were found between patients who

continued versus discontinued HHC, study III found that digital proficiency (mobile device proficiency) was not significantly associated with the uptake of hearing services (hearing aids and online aural rehabilitation) through the eHealth supported service delivery model. Age was the only significant factor associated with continuing HHC (β = 0.072, OR = 1.075 with 95% CI [1.011, 1.155], *p* = .018). Patients who continued with HHC were older (mean age = 74 years; 12 SD; range = 52–101 years) than those who discontinued HHC (mean age = 59 years; SD = 14 SD; range = 33–86 years). This study therefore highlights that digital proficiency is not vital in the uptake of eHealth services which are carefully designed for the target population and which supplement current service delivery models.

6.2 Research strengths and limitations

This section critically evaluates the strengths and limitations of this project.

6.2.1 Research strengths

Six strengths were identified across Studies I–III. First, this project is the first to evaluate eHealth supported hearing care using online and face-to-face services for adult patients with hearing loss along the entire patient journey. The services were offered along the different stages of seeking HHC online, screening and motivational engagement, diagnostic assessments, selection and fitting of hearing aids, online aural rehabilitation and support services.

Second, the research displayed ecological validity by providing care to real patients from the initial engagement to adopting hearing aids and support services to becoming successful communicators.

Third, the same clinician saw all patients, therefore allowing for continuity of care that is not always possible when patients are transferred to a separate research facility, which also limits patient data availability for research purposes. Clinical research studies are often conducted in collaboration with existing clinical settings, where the research consists of an isolated point along the patient journey, providing only a narrow view of the patient and their care. By following the patient along the entire patient journey in a single research and clinic setting, as in this study, a holistic report of the patient and their hearing needs is allowed for. In a recent study of people who

could opt to be contacted by an audiologist after completing an application-based hearing screening test, only 14% of them contacted an audiologist for further care and only 3% of those indicated that they were contacted by an audiologist directly (Schönborn et al., 2020). This indicates that if hearing screening was offered as a service from an audiology clinic, there could be a greater commitment in following up on those individuals who failed and submitted their details for further HHC.

Fourth, this is the first process evaluation study that assessed online and face-to-face modalities across the entire patient journey from first investigation of hearing help-seeking to selection and fitting of hearing aids together with online aural rehabilitation and support services from a patient perspective. Other eHealth interventions process evaluations to date focused on a single point along the patient journey, for example, online aural rehabilitation following hearing aid fitting (Ferguson et al., 2016; Meijerink et al., 2020) or tinnitus rehabilitation (Beukes et al., 2018). Study II evaluated the patient's perspective on all five steps of the hybrid HHC model, i.e., the complete journey as opposed to a single step. Therefore, Study II results provide a complete and holistic view of patient experiences with the hybrid HHC model.

Fifth, patients paid for services received in steps 3–5, which limited volunteer bias. The research findings are therefore more likely to be generalizable to other clinical settings where patients pay for their services. To date, studies within HHC and eHealth have reported on services that were offered free of charge to patients as part of public care or research studies (Beukes et al., 2018; Ferguson et al., 2016; Meijerink et al., 2020).

Sixth, the three studies used different research methods based on sample sizes which corroborate results. Study I, a prospective study, allowed for the investigation of patient characteristics and behaviors of those searching for HHC online. The navigation patterns report from Google Analytics provided insights into how patients accessed the website, time spent on the website and fall-out rates of online screening tests initiated to completion. Study II, a descriptive and explorative study, allowed for a deeper understanding of patient uptake, experiences and satisfaction ratings of those who utilized HHC services through an eHealth supported hybrid model. Based on the framework by Linnan and Steckler (2002), a process evaluation of each of the

five steps in the hybrid HHC model was conducted. The open-ended questions provided context and clarity to the ratings provided in the closed-ended questions. Lastly, Study III, also explorative and longitudinal in nature, included all patients who sought HHC from the clinic over a 24-month period. An exact logistic regression model analysis tested the patient characteristics associated with the uptake of HHC services. As recruitment was undergoing, the pool of participants who completed the online hearing screening continuously increased from Study I to III over a period of three months, 19 months and finally 24 months.

6.2.2 Research limitations

Four limitations were identified across Studies I–III. First, the clinic was established for the purpose of this PhD project. The clinician designed, implemented, recruited participants and provided the online and face-to-face HHC services. Whilst most HHC clinics start from an existing patient database and have support personnel, this was not the case for this project. This resulted in a limited sample size as the clinician spent significant time recruiting potential participants, providing care and completing administrative tasks such as patient scheduling, billing and following up on payments with medical insurance companies, etc. An alternative option would have been a collaboration with an existing audiology clinic to access a larger pool of potential participants and, therefore, a larger sample size. This could have enabled additional statistical analyses, and potentially the creation of a control group receiving traditional HHC, for further comparisons. However, patients would not have been recruited only through online methods. The absence of a control group receiving standard care means that intended comparisons of cost-effectiveness of the hybrid HHC model in comparison with traditional HHC models had to be abandoned.

A related limitation is that the PhD candidate took on the role of researcher and clinician, except for the last 12 months of the project where the clinician trained and supervised a trained interviewer to conduct the calls in step 2. It would have been relevant for clinical and research tasks to be completed by different people, thereby reducing the risk of social desirability bias when participants assessed in Study II their experiences and satisfaction with the services received. The Study II process evaluation questionnaire was designed so that questions covered both services involving as well as not involving the clinician. To minimize the risk of social desirability

bias, patients reported their experiences and satisfaction ratings from home using online questionnaires. They were anonymized before analysis, so ratings would not influence patient treatment procedures.

In Study II, 67% (31/46) of the patients who received the online questionnaires completed them. Therefore, some non-responder bias may have occurred i.e., patients who completed the questionnaires might have been systematically different from those who did not. Reasons for patients not completing the online questionnaires include not understanding how to complete the questionnaires, determining that the questionnaire was excessively lengthy, that its questions were sensitive or that the questionnaires were not completed as incentives were not related to this task. Indeed, in Study II, the questionnaire completion rate was higher in patients who continued with HHC than in those who did not continue with HHC. This could have resulted in a biased representation of patients' experiences and satisfaction reported which currently sheds a positive light on a hybrid HHC service delivery model. A higher questionnaire completion rate would have reduced the likelihood of bias by further encouraging patients to complete the questionnaire or by introducing an incentive.

Finally, patients included in this research project were self-selected and, therefore, may not be a representative sample of the whole population of the greater Durban area, or of people who seek HHC online. However, it was a conscious methodological decision to recruit people who could already navigate the online platforms, either with or without assistance, in this project. This recruitment method ensured that the people recruited were similar to people who would otherwise seek HHC online. Therefore, generalizability of these findings is limited to people who seek HHC online. Results cannot be further generalized as patients who seek HHC online in other parts of the world may have different access to resources, digital proficiency and willingness to use online platforms.

6.3 Clinical implications

Five main clinical implications arise from this research. First, online hearing screening on a responsive website was a successful tool to raise awareness, engage and pre-qualify individuals searching for HHC services and solutions online. In Study I, most

participants visited the clinic website from a mobile phone with 60% of the online hearing screening tests completed outside the usual hearing clinic hours. These findings highlight the importance of a well-designed responsive website (i.e., adapts to different devices and screen formats and resolutions for a good user experience) for audiology clinics along with a targeted digital strategy. With online tools embedded (e.g., online hearing screening, Ida Institute Telecare tools (Ida Institute, 2019)) on a website, individuals can seek HHC at their convenience asynchronously prior to the initial commitment of traditional face-to-face methods. This allows audiologists to provide services to patients 24/7 without the need of being present outside of traditional working hours.

Second, the internet can be used to attract younger cohorts of adults searching for online services and can promote adult hearing screening to those who may not yet present themselves at audiology clinics but who may experience some hearing challenges. The average age of the online test takers (n=462) in Study I was 57 years, considered as the “midlife years” by Livingston et al. (2017), and a modifiable action to treat hearing loss during these years are promoted to decrease the risk of dementia in later life (Livingston et al., 2017). This project identified that individuals who took the first step to seek HHC through this hybrid model are younger on average than patients who first present themselves to audiologists, at the age of 74 years (Henshaw et al., 2012).

Third, flexible communication methods should be employed for patients. Audiologists can determine the patient’s preferred method/s of communication. In Study II, patients preferred unconventional methods of communication, with instant messaging ranking highest. Patient circumstances (employment status, accessible devices, etc.) informed preferred methods of communication. Patients preferred instant messaging (e.g., WhatsApp: 81%) over more traditional forms of communication (e.g., emails: 65%, voice calls: 61%) with the clinician. As ICT increasingly allow for service delivery with synchronous and asynchronous methods, audiologists benefit from following the changing needs of individuals seeking HHC and incorporating newer ICT into clinical practice. People seeking HHC increasingly spend time online, for example, to communicate with family members and friends or to search for health information (Manchaiah et al., 2020). If future patients are online, then it makes sense for HHC

providers to use online platforms in meaningful ways to provide relevant information and raise awareness regarding HHC (Manchaiah et al., 2020). Patients are most likely to adopt eHealth communication tools which they already use, or which emulate their commonly used ICT. While audiologists display reservations in adopting eHealth tools (Eikelboom & Swanepoel, 2016; Glista et al., 2020; Ravi et al., 2018), patients' willingness to use online HHC services is evident from several recent studies (Convery et al., 2020; Meyer et al., 2019; Paglialonga et al., 2018; Rothpletz et al., 2016). These findings also highlight that older adults who are preparing to act are also willing to access online HHC with simple interfaces, willing to undertake training to use online programs and have ICT tools and online platforms to access health services studies (Convery et al., 2020; Meyer et al., 2019; Paglialonga et al., 2018; Rothpletz et al., 2016). It is vital for audiologists to adapt to the change and invest in the necessary infrastructure and training to provide eHealth services to patients who are ready to receive such services.

Fourth, audiologists can use synchronous and asynchronous modalities to offer services to patients throughout their hearing journey, beyond face-to-face appointments. In Study II, approximately two-thirds of patients (61%) experienced previous HHC services from other audiologists or clinics, however, the majority (95%) of these patients rated the services received from this hybrid clinic more favorably. These results contribute to the evidence base supporting HHC services offered by a hybrid service-delivery mode (Swanepoel & Clark, 2019). This will allow for the time spent in face-to-face appointments to be more meaningful by using asynchronous methods to better prepare or provide information to the patient, thereby addressing more complex matters in-person.

Finally, limited digital proficiency is not a deterrent for the uptake of hybrid HHC services. Study III showed that older age was associated with the uptake of HHC services through a hybrid model, but digital proficiency was not. Online seekers of HHC services extend beyond those with high digital proficiency. Whilst audiologists might assume that patients with low or medium digital proficiency are not suitable candidates for eHealth services, the findings do not support this assumption. The audiologist aware of the patients' needs can tailor a treatment plan that uses eHealth together with face-to-face modalities. For example, older patients may benefit from

additional support, either from family and friends or by audiology support staff (Coco et al., 2020). Our findings showed that older patients required more face-to-face appointments which could be conducted using a combination of modalities instead of only via face-to-face methods.

6.4 Recommendations for an improved hybrid HHC service delivery model

Results from Studies I to III evaluated different aspects of the five-step eHealth supported hearing care service delivery model used in this project. Based on findings from the three studies, Figure 6.1 outlines the elements of potential future hybrid HHC models using newer technologies available since the inception of this project.

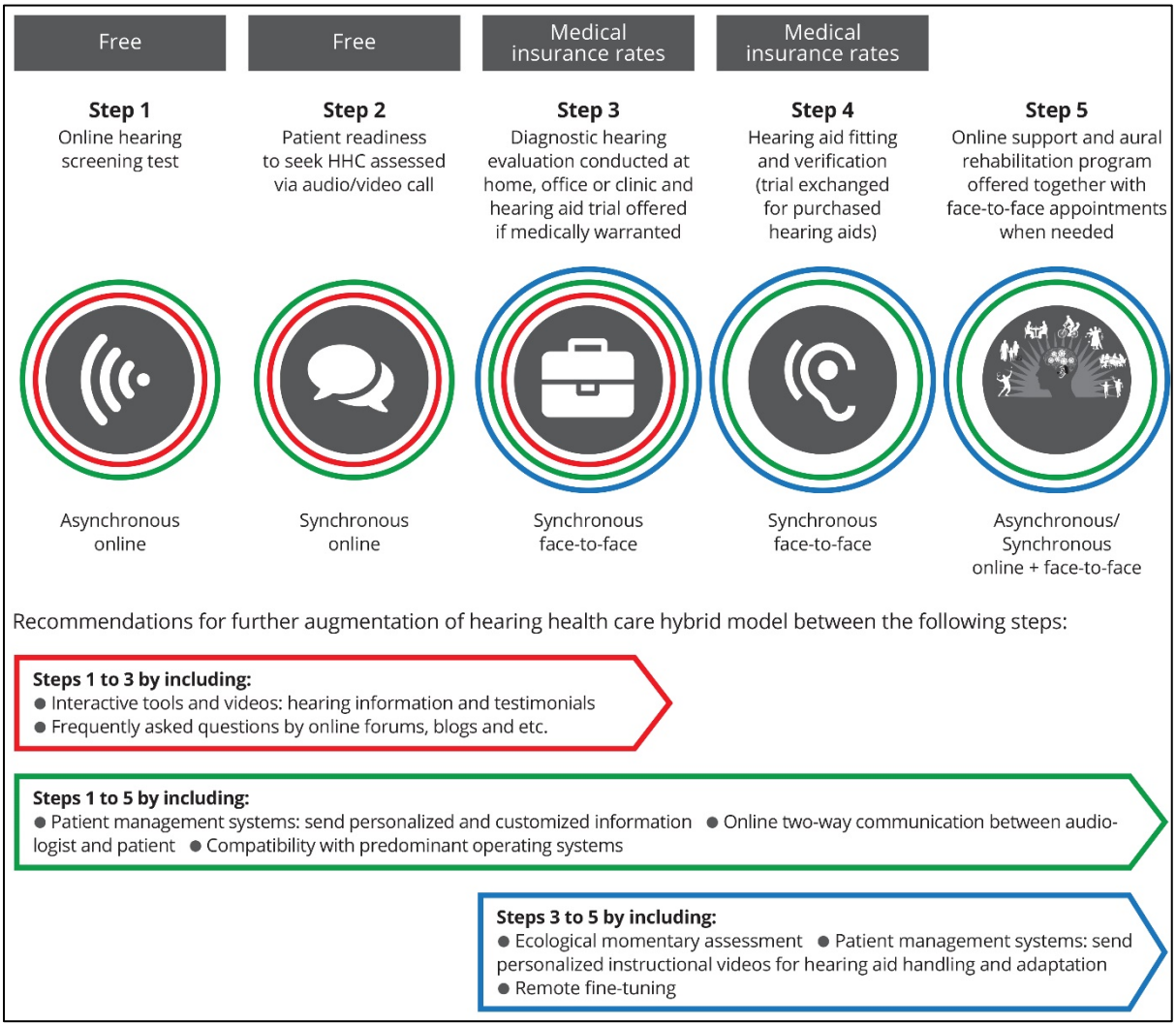

Figure 6.1

Recommendations for Further Augmentation of the Five-Step HHC Hybrid Service Delivery Model

The following suggestions are made with the aim to further improve the five-step HHC hybrid model tested in this research project which are based on the clinician's experience and recent research findings within the field. The elements suggested in the arrows of Figure 6.1 are new to this hybrid model and were not included at the inception of the project, early in 2017.

Audiologists promoting self-guided support systems by means of personalized information, videos and testimonials can assist patients and significant others during the different stages of readiness with HHC seeking, including during the initial acclimatization period of hearing aids. Self-guided support systems providing information along the entire patient journey asynchronously, allows for patients and significant other to access information at a time and place most convenient and relevant for them. By preparing patients and their significant others with information prior to, or between, face-to-face patient-clinician appointments, allows for time spent in-person to focus on more complex matters. These self-guided support systems can also be used to promote the use of mobile applications to communicate with the clinician allowing for the provision of patient-centered care for patients capable and willing to use online tools between face-to-face appointments.

Online tools can also be used for closer follow up during the initial stages of accessing HHC between steps 1, 2 and 3 (Figure 6.1). Some examples of this would be to use interactive tools, e.g., interactive infographics and quizzes: 1) a video testimonial could provide information of others who have sought HHC, 2) an online system where patients can post questions or concerns regarding their next step in the HHC model through peer-support and monitored by the audiologist, and 3) on online forum or blog of frequently asked questions which answers important questions like the importance of hearing and process involved in improving one's hearing, etc. Brännström and colleagues (2016) have documented positive experiences and overall satisfaction in first-time hearing aid users and audiologists who used an online support system (videos, testimonials, written information and links to websites) in Sweden (Brännström et al., 2016). Another support system using multimedia elements (videos, illustrations, animations, photos, sounds and testimonials) for first-time hearing aid users also involving audiologists reported high uptake and adherence in the United

Kingdom (UK) for online and/or offline use (Ferguson et al., 2016). Recent research highlighted that early delivery of these multimedia elements resulted in greater self-efficacy and readiness for self-management of hearing loss (Gomez & Ferguson, 2020). Whilst these two support programs did not cater for all patient needs, these types of support programs could benefit from customizable and personalized information or solutions offered to meet the different needs of patients and not a one-size-fits-all approach. Another consideration is that applications are made compatible with the dominant operating systems and mobile devices in mind, i.e., Android, as evidenced by the 60% of participants who completed the online hearing screening test over a two-year period did so from an Android mobile device.

Research also points to the successful use of mobile applications to enable remote fine-tuning of hearing aids and receiving assistance (Convery et al., 2020; Meyer et al., 2019). This method of communication between the patient and the clinician is increasingly becoming available to those patients already fitted with hearing aids which are Bluetooth compatible for two-way connection through an application. The ability to remotely adjusting patient's hearing aids is becoming increasingly favorable at a time and place convenient for the patient (Davidson & Marrone, 2020). Remote fine-tuning of hearing aids is suggested between steps 3, 4 and during step 5 in Figure 6.1 to further augment the five-step hybrid HHC model.

Furthermore, ecological momentary assessment can capture real-word and real-time experiences from the patient (Timmer et al., 2018). Ecological momentary assessment can be used as a method to send patients automated feedback options to rate the sound quality of their hearing aids in different sound environments during their trial period and to understand patients' initial reactions and adaptations to enhanced sound through hearing aids, which can be introduced between steps 3, 4 and during step 5 (Figure 6.1). The audiologist can act on this information, for example, through remote fine-tuning or initiating a troubleshooting video call. Information from ecological momentary assessments can assist audiologists to inform remote fine-tuning at a scheduled appointment time for patients during their hearing aid trial period. After the end of the trial period, remote fine-tuning can be used if a patient prefers or cannot attend a face-to-face visit for readjustment of their hearing aids or when the need arises. Recent studies suggest that ecological momentary assessment is a feasible

and valid method to measure hearing aid outcomes (Andersen et al., 2020; Timmer et al., 2018, 2017).

Also, a patient management system could allow for the provision of personalized and customized information sent to patients across all five steps of the hybrid model (Figure 6.1), as an online support portal has shown positive feedback and experiences of first-time hearing aid users (Brännström et al., 2016). For example, instruction videos pertaining to the patient's hearing aid style can support the initial adjustment period of hearing aids, as seen in Study II where older patients required more face-to-face appointments in the initial stages. Patients require additional pre- and post-hearing aid fitting information with regards to the adaptation to hearing aids (Bennett, Laplante-Lévesque, et al., 2018; Bennett, Meyer, et al., 2018; Kelly et al., 2013), and this information and counselling could be offered using eHealth platforms. eHealth could also increase accessibility and affordability of related areas within the audiology profession (i.e., balance and tinnitus; (Beukes & Manchaiah, 2019).

6.5 Hybrid HHC and COVID-19

After the completion of data collection and during the finalization of the thesis, a wave of COVID-19 infection hit the world, which the WHO defined as a pandemic in March 2020. South Africa, like many countries around the world, has put in place nationwide mobility restrictions. Whilst no vaccine or cure is yet available, physical distancing is the most appropriate method to limit virus transmission. This has implications for health care service provision.

The COVID-19 pandemic has highlighted the critical role of connected technologies to maintain activities whilst practicing physical distancing. eHealth offers a solution to meet HHC demand through the provision of care at a distance using online methods. In one way, the COVID-19 pandemic has accelerated eHealth trends that were already shaping the future of HHC. Whilst professional uptake of eHealth has been cautious (Eikelboom & Swanepoel, 2016; Glista et al., 2020; Ravi et al., 2018), eHealth service delivery is increasing. One example is from the University of Duke Medicine where eHealth services have increased from < 1 % to 70% of total visits, reaching more than

1000 video visits per day within a 4-week period during the pandemic (Wosik et al., 2020).

The COVID-19 pandemic has prompted independent audiology clinics to investigate new ways of providing services to patients. Embracing the changes to plan for a new future shaped by innovative technologies within a patient-centered approach can support the role of audiologists. eHealth plays a critical part in mitigating the risk of close physical contact between patients and care providers (Swanepoel & Hall, 2020). These changes in service provision, necessitated by the current COVID-19 pandemic, has shifted the discourse around eHealth HHC, so that beyond being convenient, it also mitigates infection risks, keeps patients and clinicians safe, and is beneficial for patients' busy schedules, reduces transport costs and environmental impact and improves access.

The current COVID-19 pandemic has further underscored the relevance of the research presented in this thesis. A hybrid HHC model that reduces direct patient contact is now a very important strategy for audiologists to continue providing services (Davidson & Marrone, 2020). This is particularly important for provision of services to typical audiology patients with age-related hearing loss who are at highest risk of developing complications as a result of the COVID-19 infection. This hybrid HHC model provides an alternative method to continue to provide patient care by using synchronous and asynchronous modes of communication at different stages along the patient journey with scheduled face-to-face appointments only when required. This research project incorporated asynchronous eHealth modalities in preparing patients for minimized face-to-face consultations by ensuring continuous support along the patient journey using online modalities that enhance traditional service delivery.

6.6 Recommendations for future research and clinical guidelines

The project results and conclusions revealed suggestions for future research and clinical guidelines.

The five steps of the eHealth supported hearing service model presented in this project were constructed based on the available tools at the project conception in the first half

of 2017. Therefore, the hybrid offering could be enhanced with more widely available technological solutions such as remote hearing aid fine-tuning and ecological momentary assessment, as described in a revised five-step hybrid HHC model in Figure 6.1.

Another interesting investigation would be to evaluate this revised hybrid HHC model (Figure 6.1) within existing traditional clinics. The clinic audiologists could provide HHC whilst a separate person could investigate the model in a larger patient population whilst addressing the potential sources of bias identified above.

A randomized control trial with long-term follow-up of patients receiving care through a traditional HHC model versus the revised hybrid HHC model (Figure 6.1) could help compare adherence and short- and long-term outcomes of each model. An economic analysis of these two service delivery models should be completed to guide further service provision.

The model suggested in Figure 6.1 can be adapted to different economic income groups and health care systems, both public and private in terms of the five-step model by enhancing what is already in place in clinics or what can be introduced to the service-delivery. Furthermore, it can be adapted by selecting specific materials and appropriate information to meet the needs of different patient populations such as pediatric, conditions such as tinnitus and vestibular problems and treatments such as cochlear implants.

Beyond future research, the study findings can inform clinical recommendations. These could include, for example, that participants who completed the online hearing screening test receive an annual reminder with a link to the online hearing screening test to promote annual hearing screening. This will increase HHC awareness and could promote earlier help seeking. Hearing loss is the leading preventable risk factor for dementia in midlife years and one-third of dementia cases are preventable (Livingston et al., 2017). This project found that middle-aged adults are online and took the first step by completing an online hearing screening test and submitted their details for further contact. Online methods can promote HHC information and hearing screening as an alternative service delivery option to those who may not seek

traditional HHC services. All audiology clinics could implement online hearing screening to their service offering. With regards to governmental policy, online hearing screening or a national application offering could be offered to all, free of charge as a universal health coverage with the same level of importance placed on adult hearing screening as per newborn hearing screening.

Evidence-based clinical guidelines for audiologists wanting to incorporate eHealth in their service delivery should be developed. These guidelines could assist in providing an implementation framework, outlining protocols and software and hardware requirements when implementing eHealth modalities into current service delivery.

6.7 Conclusion

This project demonstrated that providing HHC using online and face-to-face methods in a hybrid service delivery model is possible and successful as an alternative model or as a supplement to the existing face-to-face only model. Adults with hearing loss seeking online HHC by means of online hearing screening or online HHC support are not necessarily excluded, even if digital proficiency is low. This highlights the opportunity for audiologists to support patients using a combination of online and face-to-face services personalized to the patients' needs, thereby ensuring support is offered when and where most needed.

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APPENDICES

Appendix A: Ethical clearance letter

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Research Ethics Committee

11 May 2017

Dear Mr Ratanjee-Vanmali

Project:	**Strengthening the role of the audiologist in the digital age**
Researcher:	**H Ratanjee-Vanmali**
Supervisor:	**Prof D Swanepoel**
Department:	**Speech-Language Pathology and audiology**
Reference number:	**10308602 (GW20170409HS)**

Thank you for the application that was submitted for ethical consideration.

I am pleased to inform you that the above application was **approved** by the **Research Ethics Committee** at a meeting held on 4 May 2017. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

We wish you success with the project.

Sincerely

Prof Maxi Schoeman
Deputy Dean: Postgraduate Studies and Ethics
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail:tracey.andrew@up.ac.za

CC: Prof D Swanepoel(Supervisor)
CC: Prof B Vinck (HoD)

Appendix B: Participant consent form

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities

Department of Speech-Language Pathology and Audiology

Date:

Participant Name:

RE: PARTICIPANT INFORMATION AND INFORMED CONSENT FOR INCLUSION IN STUDY

You are being asked to participate in a study investigating how individuals search for accessing hearing health care online.

This study forms a part of my Doctoral degree in Audiology which I am currently undertaking at the University of Pretoria. The research study I am conducting is entitled: **Strengthening the role of the audiologist in the digital age.** Ethical clearance has been obtained from the University of Pretoria, to conduct this study (GW20170409HS).

The **purpose** of this study is to evaluate how audiologists can use electronic health tools to offer hearing related services. The **procedure** of the study entails that you seek hearing related services and communicate with your audiologists through the online communication channels. Intervals for face-to-face and online contact appointments are set together with you and which are suitable for your lifestyle. You will receive email and SMS notifications and reminders regarding your appointment time and dates.

There is no physical pain associated with partaking in this study. The results of this study will help strengthen the role of the audiologist and provide guidance on how audiologists can improve service delivery and access to hearing health care using digital tools in the future.

Your participation in this study is entirely voluntary. You can refuse to participate or stop at any time during the study without any reason and without any negative consequences.

All identifying information (age and gender) and medical information (hearing status) of participants and all data will be treated with strict **confidentiality**. No names will be used at any stage as each participant will be allocated a code. No identifying information of any participants will be included in the data to be stored. The data collected will be stored for research and archiving purposes for a minimum of 15 years according to the University of Pretoria regulations. Research reports and articles in scientific journals will not include any

information that may identify you. I would thus like to obtain permission for your participation in this study.

Sincerely,

Ms Husmita Ratanjee-Vanmali

PhD student researcher

T: 063 403 2683

E: u10308602@tuks.co.za

Professor De Wet Swanepoel

Research Supervisor

T: 012 420 4280

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CONSENT TO PARTICIPATE IN THIS STUDY

I hereby confirm that the person asking my consent for participation in this study has told me about nature, process, risks, discomforts and benefits of the study. I have also received, read and understood the above-written information regarding the study. I am aware that the results of the study, including personal details and medical information, will be anonymously processed and presented in research reports. I am giving consent for my participation willingly. I have had time to ask questions and have no objection to participating in the study. I understand that I will not be penalised in any way should I wish to discontinue the study. This decision will not influence the health care that I receive now or in the future.

I, _____ (name)

_____ (ID number)

Hereby give my permission for participation in this study which includes hearing related services offered to me.

Participant signature _____

Signed on this day _____ (dd/mm/yyyy)

Participant cell phone number _____

Appendix C: Invitation and consent for partner clinics

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities

Department of Speech-Language Pathology and Audiology

RE: INVITATION LETTER AND INFORMED CONSENT FOR INCLUSION IN REFFERAL PROGRAM

I am currently undertaking my Doctoral degree at the University of Pretoria and am very interested in conducting a research study entitled: Strengthening the role of the audiologist in the digital age. Ethical clearance has been obtained from the University of Pretoria to conduct this study (GW20170409HS).

The **purpose** of this study is to evaluate how audiologists can use electronic health tools to offer hearing related services. The **procedure** of the study entails investigating and evaluating how audiologists can incorporate eHealth tools to communicate with patients to offer hearing related services. Not all of the possible participants who enrol will meet the inclusion criteria set for this study. These participants would need to be referred to a hearing care practice within their accessibility. Therefore, I would like to invite you to belong to the referral program.

By signing this agreement, I agree to be a part of the partner clinics, that participants who fail to meet the inclusion criteria will be given the option of three partner clinics within their proximity. I am aware that the participant will have the freedom to book an appointment at the clinic of their choice.

I, _____based

at _____Clinic

at_____

_____address,

and _____contact number,

wish to belong to the partner clinic referral program.

Signature:

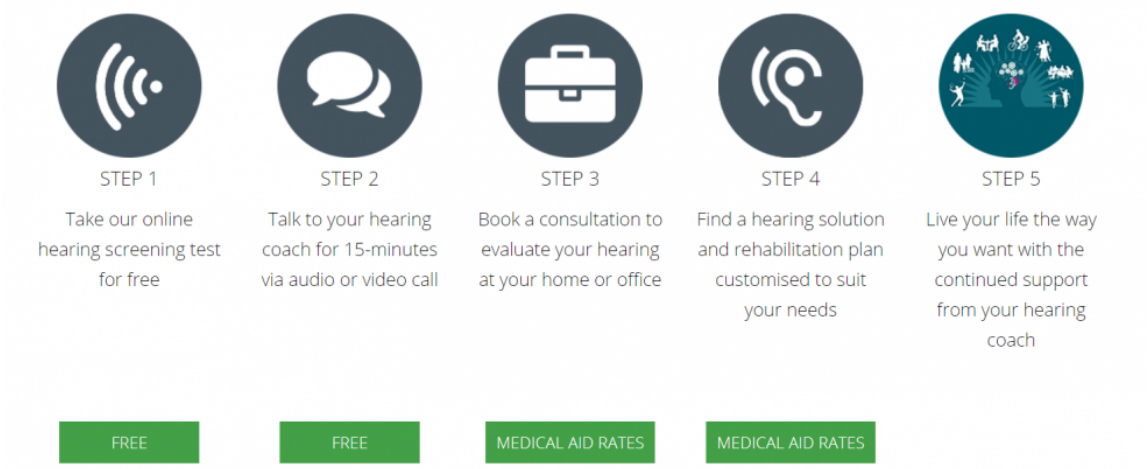
Date:

Appendix D: Online questionnaire: Patient experience and satisfaction with hearing health care received

Section A: Short Assessment of Patient Satisfaction [Hawthorne et al., 2014]

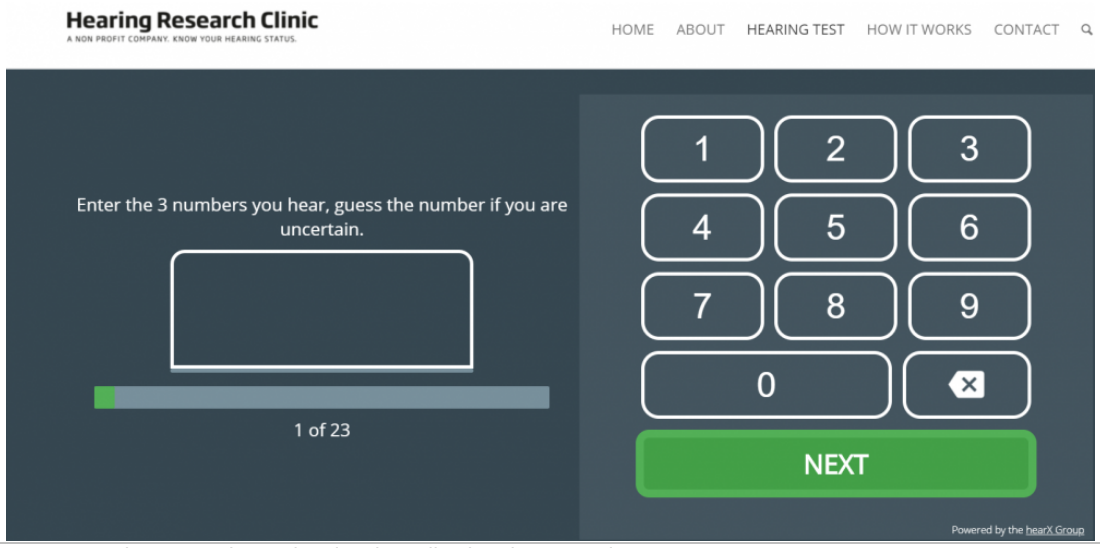
Section B: Process Evaluation

Please answer the questions on the following pages relating to the steps you have completed in seeking help with the Hearing Research Clinic NPC. Click on the arrow to continue.



Step 1: Online hearing screening test

Do you remember taking an online hearing screening test, which played numbers in background noise? If 'no', select "I did not complete this step (N/A)", if 'yes', go ahead as is. Click on the arrow to continue.



Please answer these questions related to the online hearing screening test:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	I did not complete this step (N/A) (6)
B1. Taking the online test was simple (1)						
B2. Taking the online test was quick (2)						
B3. Taking the online test was informative (3)						
B4. I found this online test easy to use (4)						
B5. I thought the online test was fast (5)						
B6. The test result seemed reliable (6)						
B7. Taking this online test has helped me to take the next steps to improve my hearing (7)						

Step 2: Phone call/WhatsApp

Do you remember talking to us on the phone or by WhatsApp to discuss your hearing challenges?' If 'no', select "I did not complete this step (N/A)", if 'yes', go ahead as is.

Please answer these questions related to the phone call/WhatsApp messaging to assess your hearing challenges:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	I did not complete this step (N/A) (6)
B8. The phone call/WhatsApp was informative (1)						
B9. The phone call/WhatsApp was an easy way for me to communicate with the audiologist/clinic (2)						
B10. The phone call/WhatsApp helped me in taking the next step (3)						
B11. The phone call/WhatsApp provided me with relevant information regarding my hearing (4)						
B12. The phone call/WhatsApp helped me to take the next step and book my hearing evaluation consultation (5)						
B13. The phone call/WhatsApp was a quick way for me to communicate with the audiologist/clinic (6)						

Step 3: Hearing evaluation consultation

Do you remember completing your hearing evaluation with our Audiologist? If 'no', select "I did not complete this step (N/A)", if 'yes', go ahead as is. Click on the arrow to continue.

Please answer these questions related to the diagnostic hearing test you completed with our audiologist:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	I did not complete this step (N/A) (6)
B14. The diagnostic hearing test was comprehensive (1)						
B15. The audiological consultation provided me with the information I needed (2)						
B16. The diagnostic hearing test was an easy test to complete with the guidance from the audiologist (3)						
B17. It was beneficial to have a hearing aid trial option available after my diagnostic hearing test (in the first consultation) (4)						
B18. It was easy to use the hearing aid during the trial period offered to me (5)						
B19. I trust the results from my diagnostic hearing test (6)						
B20. The time spent on my diagnostic hearing test was adequate (7)						

Step 4: Your customized hearing solution and rehabilitation plan

Do you remember being fitted with your trial hearing aids or to purchase your own hearing aids? If 'no', select "I did not complete this step (N/A)", if 'yes', go ahead as is.

Please answer these questions related to your hearing aid trial:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	I did not complete this step (N/A) (6)
B21. The hearing aid trial helped me experience the difference hearing aids can make in my life (1)						

The following questions B22-B25 -only shown to group who discontinued HHC (did not complete all five steps):

B22. Reasons why, I did not proceed with purchasing my hearing aids (select all that apply):
(*Randomization of answers was implemented by online software)*

- ☐ I believe hearing aids are too costly (1)
- ☐ I am concerned about the way hearing aids would look on me (2)
- ☐ I am concerned about what my family and friends would think of me as a person wearing hearing aids (3)
- ☐ I do not believe I could use hearing aids (4)
- ☐ I do not believe my hearing impairment is bad enough yet to seek hearing health care (5)
- ☐ I did not try any hearing aids (7)
- ☐ Other, please explain:(6) _____

B23. What would you need to continue with treatment for your hearing loss?

_____

_____

B24. Have you gone elsewhere to get help for your hearing challenges?

Yes (4)

No (5)

Display This Question:

If B24. Have you gone elsewhere to get help for your hearing challenges? = Yes

Or B24. Have you gone elsewhere to get help for your hearing challenges? = No

B25. Please explain why?

_____

The following questions B22B-B27B -only shown to group who continued with HHC (completed all five steps):

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	I did not complete this step (N/A) (6)
B22B. The opportunity to try hearing aids helped me make an informed decision to buy hearing aids (2)						
B23B. I felt it was easy to use the hearing aids in the trial period which gave me the confidence in my ability to use it on my own (3)						
B24B. I trust that the hearing aids will assist me to hear better in my daily life (4)						
B25B. The time I had to trial the hearing aids in my daily life (home/work) was adequate (5)						
B26B. My quality of life has improved by using my hearing aids (6)						
B27B. The online program was helpful to me (7)						

Section C: Personal preferences

C1. Select all the types of communication that you **used** to stay in touch with your audiologist:

- ☐ Phone call (1)
- ☐ Email (2)
- ☐ WhatsApp (3)
- ☐ SMS messages (4)
- ☐ Facebook (5)
- ☐ Other, please specify (6) _____

C2. Select all the types of communication that you **prefer** to use in order to stay in touch with your audiologist:

- ☐ Phone call (1)
- ☐ Email (2)
- ☐ WhatsApp (3)
- ☐ SMS messages (4)
- ☐ Facebook (5)
- ☐ Other, please specify (6) _____

C3. Think about **how much you used** your present hearing aid(s) over the past two weeks (during your trial period). On an average day, how many hours did you use the hearing aid(s)?

- None (1)
- Less than 1 hour a day (2)
- 1 to 4 hours a day (3)
- 4 to 8 hours a day (4)
- more than 8 hours a day (5)

C4. Have you had **previous** hearing tests/evaluations completed by another clinic/audiologist?

- Yes (1)
- No (2)

Display This Question:

If C4. Have you had previous hearing tests/evaluations completed by another clinic/audiologist? = Yes

C5. How do you **rate your experience** with this clinic (Hearing Research Clinic NPC) compared to your past experiences?

- Worse (1)
- Same (2)
- Better (3)

Display This Question:

If C4. Have you had previous hearing tests/evaluations completed by another clinic/audiologist? = Yes

C6. What's different **compared** to your previous experiences with other audiologists?

_____

_____

C7. What made you **continue** with your treatment plan with the Hearing Research Clinic NPC? Name your top 3 reasons.

_____

_____

_____

C8. On a scale from 0-10, how **likely are you to recommend** this clinic (Hearing Research Clinic NPC) to your friends and family?

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Please explain your rating above:

_____

_____

C9. How do you think we can **improve our services**?

_____

_____

_____

_____

Appendix E: Framework for the process evaluation of Web-based and face-to-face services offered in the hybrid hearing health care model

Process evaluation categories as inspired by Linnan and Steckler (2002)	Study process that supports this model	Persons involved
Clarify the theory that underlies intervention development	Literature study search: • General eHealth • eHealth in hearing care • Motivation/readiness engagement within health psychology and behavioral sciences • Patient satisfaction in health care	• Primary investigator (first author) • Collaborators (second and third authors) • Industry experts
Create theory-informed interventions	• A patient satisfaction survey found (SAPS) [40] • Process evaluation [38] • Qualitative, open-ended question formulation within a health care service delivery model • NPS [43]	• Primary investigator (first author) • Collaborators (second and third authors) • Industry experts
Create an inventory of process objectives	• Alignment with key stakeholders on the study objectives and the knowledge generation of hybrid HHC[d] services and learning about patient behaviors and preferences	• Primary investigator (first author) • Collaborators (second and third authors) • Industry experts
Reach consensus on the process evaluation questions to be answered	• Pilot conducted on a process evaluation questionnaire with 10 independent researchers within the HHC field • Consultation and alignment with a statistician regarding the internal validity and robustness of the questionnaire	• Primary investigator (first author) • Collaborators (second and third authors)

	• Alignment with key stakeholders of the final themes and questions included into the questionnaire	• Independent researchers • Statistician
Identify or create measurement tools to assess prioritized process objectives	• The first section in the online questionnaire incorporated a validated measure of general patient satisfaction (SAPS) • The second section incorporated all 5 steps, allowing for patient feedback on each step and a component they encountered of the hybrid model • The third section included open-ended questions, as well as a comparison with previous care and a rating of the services received using the net promoter score	• Primary investigator (first author) • Collaborators (second and third authors) • Industry experts
Design, implement, and administer quality control assurances	• Design: The design was based on the university-accepted online questionnaire design • Implement: Online questionnaires were sent using patients' email addresses and were then coded to ensure anonymity before analysis commenced • Quality control and assurances: The questionnaire was tested by 5 independent researchers using the online software, Qualtrics, for correct transitioning, flow, quality, and compatibility with different devices • Data were downloaded and stored offline every month by the first author	• Primary investigator (first author) • Collaborators (second and third authors) • Independent researchers
Collect, manage, and clean data	• Data were collected over a period of 3 months • Data were only accessed by the clinic audiologist • Data were coded to ensure anonymity • Data were cleaned and coded before the analysis began	• Primary investigator (first author) • Participants in this study

Analyze data	• Coded data were sent to a statistician to assist with data analysis	• Primary investigator (first author) • Statistician
Create user-friendly reports on the selected process objectives	• Dissemination of results by conference presentations (poster and podium) • Results shared in a peer-reviewed International Scientific Indexing accredited journal	• Primary investigator (first author) • Collaborators (second and third authors) • Industry experts
Refine theory, interventions, measurements, and analysis tools	• On the basis of the results from the 5 steps of the patient journey included in this process evaluation, strengths and limitations were highlighted • The suggested recommendations are outlined • Future research considerations are outlined	• Primary investigator (first author) • Collaborators (second and third authors)

[a]eHealth: electronic health.
[b]SAPS: Short Assessment of Patient Satisfaction.
[c]NPS: net promoter score.
[d]HHC: hearing health care.

Appendix F: Mobile Device Proficiency Questionnaire (MDPQ-16)

Mobile Device Proficiency Questionnaire (MDPQ-16)

About the MDPQ

This questionnaire asks about your ability to perform a number of tasks with a **mobile device**.

What is a Mobile Device?

A mobile device is a device that allows you to perform many of the same tasks as a standard computer but without the use of a physical keyboard and mouse. Instead, these devices use a touchscreen as their interface between the user and computer programs (called Apps – short for applications).

Mobile devices come in many sizes. Depicted above are two different sized tablets, as well as a smartphone. These are the types of devices we are interested in.

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Please answer each question by placing an X in the box that is most appropriate.

If you have not tried to perform a task with a mobile device or do not know what a task is, please mark "NEVER TRIED", regardless of whether or not you think you may be able to perform the task. **Remember, you are rating your ability to perform each of these tasks specifically using a mobile device (tablet or smartphone).**

---

1. Mobile Device Basics

Using a mobile device I can:	**Never tried** (1)	**Not at all** (2)	**Not very easily** (3)	**Somewhat easily** (4)	**Very easily** (5)
a. Navigate onscreen menus using the touchscreen					
b. Use the onscreen keyboard to type					

2. Communication

Using a mobile device I can:	**Never tried** (1)	**Not at all** (2)	**Not very easily** (3)	**Somewhat easily** (4)	**Very easily** (5)
a. Send emails					
b. Send pictures by email					

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3. Data and File Storage

Using a mobile device I can:	Never tried (1)	Not at all (2)	Not very easily (3)	Somewhat easily (4)	Very easily (5)
a. Transfer information (files such as music, pictures, documents) on my mobile device *to* my computer					
b. Transfer information (files such as music, pictures, documents) on my computer *to* my mobile device					

4. Internet

Using a mobile device I can:	Never tried (1)	Not at all (2)	Not very easily (3)	Somewhat easily (4)	Very easily (5)
a. Find information about my hobbies and interests on the Internet					
b. Find health information on the Internet					

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5. Calendar

Using a mobile device I can:	Never tried (1)	Not at all (2)	Not very easily (3)	Somewhat easily (4)	Very easily (5)
a. Enter events and appointments into a calendar					
b. Check the date and time of upcoming and prior appointments					

6. Entertainment

Using a mobile device I can:	Never tried (1)	Not at all (2)	Not very easily (3)	Somewhat easily (4)	Very easily (5)
a. Use the device's online "store" to find games and other forms of entertainment (e.g. using Apple App Store or Google Play Store)					
b. Listen to music					

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7. **Privacy**

Using a mobile device I can:	Never tried (1)	Not at all (2)	Not very easily (3)	Somewhat easily (4)	Very easily (5)
a. Setup a password to lock/unlock the device					
b. Erase all Internet browsing history and temporary files					

8. **Troubleshooting & Software Management**

Using a mobile device I can:	Never tried (1)	Not at all (2)	Not very easily (3)	Somewhat easily (4)	Very easily (5)
a. Update games and other applications					
b. Delete games and other applications					

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Appendix G: Computer Proficiency Questionnaire (CPQ-12)

COMPUTER PROFICIENCY QUESTIONNAIRE

Note: Questions that are retained in the short form of the CPQ (CPQ-12) are indicated with an asterisk

This questionnaire asks about your ability to perform a number of tasks with a computer. Please answer each question by placing an X in the box that is most appropriate. If you have not tried to perform a task or do not know what it is, please mark **"NEVER TRIED"**, regardless of whether or not you think you may be able to perform the task.

1. Computer Basics

I can:	Never tried$_1$	Not at all$_2$	Not very easily$_3$	Somewhat easily$_4$	Very easily$_5$
a. Turn a computer on and off					
b. Use a computer keyboard to type *					
c. Use a trackball					
d. Use a mouse *					
e. Adjust the volume of the computer speakers					
f. Adjust size of the text on screen					

2. Printer

I can:	Never tried$_1$	Not at all$_2$	Not very easily$_3$	Somewhat easily$_4$	Very easily$_5$
a. Print documents					
b. Print photographs					
c. Load paper into the printer					
d. Load ink into the printer *					
e. Fix the printer when paper jams *					

3. Communication

I can:	Never tried$_1$	Not at all$_2$	Not very easily$_3$	Somewhat easily$_4$	Very easily$_5$
a. Open emails *					
b. Send emails *					
c. Send the same email to multiple people at the same time					
d. Store email addresses in an email address book or contact list					
e. View pictures sent by email					
f. Send pictures by email					
g. Chat using Internet chat rooms					
h. Chat using instant messaging					
i. Post messages to the Internet (e.g., to blogs, Facebook, Twitter, online forums)					

4. Internet

I can:	Never tried$_1$	Not at all$_2$	Not very easily$_3$	Somewhat easily$_4$	Very easily$_5$
a. Use search engines (e.g., Google)					
b. Find information about local community resources on the Internet *					
c. Find information about my hobbies and interests on the Internet *					
d. Read the news on the Internet					

I can:	Never tried$_1$	Not at all$_2$	Not very easily$_3$	Somewhat easily$_4$	Very easily$_5$
e. Make purchases on the Internet					
f. Bookmark websites to find them again later (e.g., make favorites)					
g. Save text and images I find on the Internet					

5. Calendar

I can:	Never tried$_1$	Not at all$_2$	Not very easily$_3$	Somewhat easily$_4$	Very easily$_5$
a. Use a computer to enter events and appointments into a calendar *					
b. Check the date and time of upcoming and prior appointments *					
c. Set up alerts to remind me of events and appointments					

6. Entertainment

I can:	Never tried$_1$	Not at all$_2$	Not very easily$_3$	Somewhat easily$_4$	Very easily$_5$
a. Use a computer to play games					
b. Use a computer to watch movies and videos *					
c. Use a computer to listen to music *