ABSTRACT

Objectives. To seek the perspectives of key stakeholders regarding: (1) how eHealth could help meet the hearing and communication needs of adults with hearing impairment and their significant others; and (2) how helpful each aspect of eHealth would be to key stakeholders personally.

Design. Group concept mapping, a mixed-methods participatory research method, was used to seek the perspectives of key stakeholders: adults with hearing impairment (n = 39), significant others (n = 28), and hearing care professionals (n = 56). All participants completed a short online survey, before completing one or more of the following activities: brainstorming, sorting, and rating. Brainstorming required participants to generate ideas in response to the focus prompt, "*One way I would like to use information and communication technologies to address the hearing and communication needs of adults with hearing loss and their family and friends is to…*". The sorting task required participants to sort all statements into groups that made sense to them. Lastly, the rating task required participants to rate each of the statements according to 'How helpful would this idea be to you?' using a 5-point Likert scale. Hierarchical cluster analysis was applied to the "sorting" data to develop a cluster map using the Concept Systems software™. The "rating" data were subsequently analyzed at a cluster level and an individual-item level using descriptive statistics. Differences in cluster ratings between stakeholder groups were examined using Kruskal-Wallis tests.

Results. Overall, 123 statements were generated by participants in response to the focus prompt and were included in subsequent analyses. Based on the "sorting" data and hierarchical cluster analysis, a seven-cluster map was deemed to be the best representation of the data. Three key themes emerged from the data, including using eHealth to: (1) Educate

and Involve Others; (2) Support Aural Rehabilitation; and (3) Educate About and Demonstrate the Impacts of Hearing Impairment and Benefits of Hearing Rehabilitation. Overall median rating scores for each cluster ranged from 3.97 (educate and involve significant others) to 3.44 (empower adults with hearing impairment to manage their hearing impairment from home).

Conclusions. These research findings demonstrate the broad range of clinical applications of eHealth that have the capacity to support the implementation of patient- and family-centered hearing care, with self-directed educational tools and resources typically being rated as most helpful. Therefore, eHealth appears to be a viable option for enabling a more biopsychosocial approach to hearing healthcare and educating and involving significant others in the hearing rehabilitation process, without adding more pressure on clinical time. More research is needed to inform the subsequent development of eHealth interventions, and it is recommended that health behavior change theory be adhered to for such interventions.

INTRODUCTION

Patient- and family-centered care (PFCC) is widely advocated as best practice in the management of chronic health conditions (Australian Commission on Safety and Quality in Health Care, 2010; Berwick, 2002; Institute of Medicine Committee on Quality of Health Care in America, 2001; Department of Health, 2012; Nickel et al., 2018; The Joint Commission, 2010) and is associated with positive outcomes for patients, families, and healthcare providers (Park et al., 2018). The Institute for Patient- and Family-Centered Care conceptualizes PFCC as containing four core concepts: dignity and respect, referring to the consideration of patient and family knowledge and preferences when planning and delivering care; information sharing in a way that is timely, complete, unbiased, and useful; participation in healthcare and decision-making processes; and collaboration between patients, families, health care professionals, and leaders (Johnson & Abraham, 2012). The first of these concepts, dignity and respect, has recently been elaborated on to encompass clinician-patient relationship building (e.g., active listening, expression of care and empathy, honest and transparent communication), personalized care (e.g., knows the patient, involves family, understands patients' personal circumstances), and respect for patient and family member time (Hsu et al., 2019).

Current evidence suggests that PFCC is not routinely practiced in clinical audiology settings. Video observation data of patient-audiologist interactions and qualitative research studies reveal there is an emphasis on patients' biomedical functioning, as opposed to their biopsychosocial functioning; limited shared decision making and collaborative goal setting; infrequent use of patient-centered communication practices (e.g., use of open-ended questions, active listening, empathy); and minimal family member attendance and involvement in appointments (Ali et al., 2018; Ekberg et al., 2014; Ekberg et al., 2015;

Grenness et al., 2015a, 2015b; Meyer et al., 2017; Preminger et al., 2015; Van Leeuwen et al., 2017).

The implementation of PFCC within audiological settings is understandably complex and therefore it is important to consider novel ways to support its implementation. eHealth, defined by the World Health Organization as "the cost-effective and secure use of information and communication technologies (ICT) in support of health and health-related fields" (2021), can be integrated into services in a variety of ways to support the implementation of PFCC (Penedo et al., 2020; Ratanjee-Vanmali et al., 2020; Wildevuur & Simonse, 2015). For example, synchronous, real-time interactions between healthcare professionals, patients, and family members through videoconferencing platforms may help the healthcare professional better understand the environment in which the patient lives and may make it easier for family members to participate in care. Likewise, asynchronous forms of eHealth such as patient web portals, wherein information is shared between individuals at different times, may improve patient-provider communication and facilitate timely information sharing before and in-between appointments (Davoody et al., 2016; Osborn et al., 2010). ICTs can also be used to facilitate self-directed learning and social networking for patients and significant others, through for example, interactive websites and online forums (Kreps & Neuhauser, 2010; Sin et al., 2018).

In the last decade, researchers have been developing and evaluating different forms of eHealth that can be incorporated into adult hearing services (Muñoz et al., 2020; Paglialonga et al., 2018; Swanepoel & Hall, 2010). Examples of eHealth that have been developed for adults with hearing impairment, which have the capacity to promote PFCC, include Internet-based counseling and patient education (Ferguson et al., 2016; Malmberg et al., 2017; Ratanjee-Vanmali et al., 2020; Thoren et al., 2014; Thorén et al., 2011) and discussion forums (Malmberg et al., 2017; Thoren et al., 2014; Thorén et al., 2011). However, there is

likely to be far greater potential for eHealth to support patient- and family-centered hearing care for adults with hearing impairment and their significant others, beyond what is currently available. For example, in a recent study involving focus group interviews with adults with hearing impairment, significant others, and audiologists in Denmark, Nielsen et al. (2018) identified ways in which eHealth could support information provision, hearing rehabilitation, and self-monitoring/assessment across the client journey. The Covid-19 pandemic that began in December 2019, has led to further consideration of how audiology services can be transformed to better embrace eHealth (Saunders & Roughley, 2020; Swanepoel & Hall, 2020). Equally, it has seen a shift in audiologists' willingness to use eHealth (Saunders & Roughley, 2020), and more broadly, patients' satisfaction with rehabilitation services offered via eHealth (Tenforde et al., 2020), making it increasingly likely that eHealth will remain beyond the pandemic.

The present study adopted group concept mapping, a mixed-methods participatory research method, to seek the perspectives of key stakeholders in Australia regarding: (1) how eHealth could help meet the hearing and communication needs of adults with hearing impairment and their significant others; and (2) how helpful each aspect of eHealth would be to key stakeholders personally. Ultimately, these research findings will inform an eHealth research agenda to support the implementation of patient- and family-centered hearing care for adults with hearing impairment and their significant others. Moreover, despite the present study being conducted prior to the Covid-19 pandemic starting, the findings will help inform clinical audiology practice given that clinicians and patients alike have had greater exposure to web-based interactions.

METHODS

Research Design

Group concept mapping was utilized in the present study because it allows for the generation and synthesis of ideas from the perspectives of multiple stakeholders (Goldman & Kane, 2014; Kane & Trochim, 2007; Trochim & Kane, 2005). Data collection involves both qualitative (brainstorming and sorting) and quantitative (rating) components; and data analysis uses quantitative techniques (i.e. multidimensional scaling and hierarchal cluster analysis) to construct representations of how participants view a particular topic (Goldman & Kane, 2014; Kane & Trochim, 2007; Trochim & Kane, 2005). It has been used to further understand topics in a range of health-related areas (Anderson et al., 2014; Sjödahl Hammarlund et al., 2014) as well as in the field of audiology (Bennett et al., 2018; Poost-Foroosh et al., 2015; Poost-Foroosh et al., 2011).

Participants

Individuals from the following stakeholder groups were recruited for this study: adults with hearing impairment, significant others of an adult with hearing impairment (e.g., family members and close friends), and hearing care professionals who had worked with an adult client with hearing impairment in the past 12 months. We did not specifically recruit participant dyads that included an adult with hearing impairment and a significant other, meaning that not all significant others were connected to a participant with hearing impairment in the present study. Participants were excluded if they did not live/work in Australia. We sought representation across a range of locales across Australia, including major cities, inner regional locations, outer regional locations, and remote locations, as defined by the Australian Standard Geographical Classification (Australian Government: Department of Health).

Recruitment of adults with hearing impairment and significant others occurred via The University of Queensland's Communication Research Registry, The University of

Queensland Health and Rehabilitation Clinics, private and public hearing centers in Queensland and Western Australia, Qualtrics panel recruitment, online and paper media outlets, flyers distributed in community settings, and the personal and professional networks of members of the research team. Due to difficulties with participant recruitment, significant others received a small gratuity (AUD $50) to compensate them for their time as we felt it was important that we captured their perspectives in this study given the central role they play in their family member's aural rehabilitation. The decision to reimburse family members for their time was made part-way through the study once the recruitment of adults with hearing impairment had ceased. Hearing care professionals were recruited through the peak professional body for audiologists in Australia, Audiology Australia; advertisements at professional meetings; and private and public hearing centers across Australia. Members of Audiology Australia were eligible to claim Continuing Professional Development points for their participation. Hearing care professionals who were not members of Audiology Australia were not offered a reward; however, Audiology Australia represents around 85% of hearing care professionals and therefore most would have been eligible for the reward.

Overall, 123 individuals participated in the study, including 39 adults with hearing impairment (25M, 10F; M = 70.06 years, SD = 11.43), 28 significant others (6M, 21F; M = 48.81 years, SD = 15.86), and 56 hearing care professionals (7M, 48F; M = 40.48 years, SD = 11.51) (NB: demographic information missing for 6 participants). The majority of adults with hearing impairment and significant others resided in a major city (69.23% and 67.86% respectively) and lived in the community (87.18% and 92.86% respectively). Most adults with hearing impairment reported being retired (74.36%) whilst over half (57.14%) of the significant others worked either full-time, part-time or on a casual basis. Most commonly, the significant others were a child or spouse of a person with hearing impairment. The

159 characteristics of the adults with hearing impairment and significant others who provided
160 demographic data are summarized in Table 1.

161 Approximately 90% of the hearing care professionals were audiologists and most
162 reported working within a major city (71.43%). Over half of the professionals worked within
163 the private sector (62.5%) and approximately a quarter (23.21%) worked for the
164 Commonwealth Government. Almost all the hearing care professionals reported that they
165 worked with clients that lived in the community (92.86%), and over half worked with adults
166 in aged care facilities (60.71%). On average, the hearing care professionals reported working
167 with adults with hearing impairment for 13.31 years (SD = 9.06). See Table 2 for further
168 demographic data for the hearing care professionals.

169 Participation varied across each step of the study, with 89 participants completing
170 brainstorming, 53 participants completing sorting, and 55 participants completing rating.
171 Participants were informed at the beginning of the study that they could participate in one or
172 more phases. It is not uncommon in group concept mapping studies that a higher number of
173 participants participate in the initial brainstorming phase, relative to the sorting and rating
174 phases (Anderson et al., 2014; Rosas & Kane, 2012), with one reason being that the latter
175 phases can be more time consuming. Based on the participants who reported their age (N =
176 82, 53, 55 for brainstorming, sorting, and rating, respectively), the mean ages of the adults
177 with hearing impairment and significant others remained similar throughout each of the tasks.
178 On average, adults with hearing impairment were 69.84 years (SD = 11.90), 71.56 years (SD
179 = 11.97) and 71.75 years (11.43) for the brainstorming, sorting, and rating tasks, respectively,
180 whilst the mean ages for significant others were 49.82 years (SD = 16.50), 45.6 years (SD =
181 16.30) and 46.69 (SD = 16.34) years, respectively. Of the participants who reported their
182 gender (N = 83, 53, 55 for brainstorming, sorting and rating, respectively), the majority of
183 adults with hearing impairment were male (brainstorming = 75%; sorting = 77.78%; rating =

75%), whilst the significant others were predominantly female (brainstorming = 83.33%; sorting = 66.67%; rating = 68.75%). Most of the hearing care professionals were female in the brainstorming (84.62%), sorting (95%) and rating (94.74%) tasks.

'Insert Tables 1 and 2 about here'

Procedure

Ethical clearance was obtained from The University of Queensland's Behavioral and Biological Sciences Human Research Ethics Committee prior to commencing the study. All participants were required to provide written, informed consent prior to participation. Data collection took place between May, 2016 and January, 2018.

After providing consent, all participants received a link to an online survey, hosted by Checkbox or Qualtrics, to record demographic information (e.g., gender, age / years of experience working with people with hearing impairment). Two versions of the survey were developed: one for adults with hearing impairment and significant others, and another for hearing care professionals. Next, group concept mapping was used to first brainstorm how eHealth could address the hearing and communication needs of adults with hearing impairment and their significant others; and at a later date, to sort the ideas into meaningful groups and rate the 'helpfulness' of each idea. The Concept System® Global MAX™ software (Version 2016.046.12; http://www.conceptsystemsglobal.com) was used to facilitate the online brainstorming, sorting, and rating activities. Participants were also given the option to complete the tasks manually using pen and paper, and if they took this option, the research team subsequently added the data to The Concept System® Global MAX™ (2016) software. Participants were given the option of participating in one or more tasks.

Brainstorming

Participants received an email invitation that included a 4-minute video describing ICTs and patient- and family-centered hearing care; instructions on how to complete the brainstorming exercise; and a link to the online brainstorming website. The video was developed by the research team to ensure that all participants approached the brainstorming task with a similar understanding of ICTs and PFCC. On the brainstorming webpage was a cartoon vignette of a frequently reported scenario that could be improved through the use of ICTs (see Figure 1); instructions on how to add new ideas; and two examples of statements that were generated from a pilot brainstorming activity, to assist with initial idea generation. Participants were asked to generate ideas in response to the focus prompt, "*One way I would like to use ICTs to address the hearing and communication needs of adults with hearing loss and their family and friends is to…*". Participants generated ideas anonymously, were able to contribute multiple ideas, and were able to see others' responses. Throughout the brainstorming process, the research team monitored the statements, removing those that were inappropriate or did not answer the focus prompt. Brainstorming remained open until data saturation was reached, as indicated by a slowed response rate and no new ideas being generated.

'Insert Figure 1 about here'

The majority of participants (n = 64, 71.91%) completed brainstorming online. However, three adults with hearing impairment chose to complete the task using pen and paper, along with 22 hearing care professionals who engaged in a face-to-face brainstorming session as part of a workshop facilitated by the lead researcher. Participants who completed the brainstorming task using pen and paper received the same instructions and informational video, however, they were unable to see other participants' responses updated in real-time.

Once brainstorming had finished, the research team compiled and reviewed the generated statements. Statements that were deemed non-relevant, too vague, or outside the

scope or focus of the project were removed. Statements that included multiple meaning units were split into individual meaning units and duplicate statements were consolidated. Where required, the remaining statements were edited to enhance clarity and ensure syntactic similarity, corrected for grammatical errors, and when specific terms (e.g., hearing aid) were used, these were replaced with generic terms (e.g., hearing device). See Table 3 for examples of changes made to the original statements. Throughout the review process, the wording of the statements was kept as close to the participants' original wording as possible.

'Insert Table 3 about here'

Sorting and Rating

Once the list of statements was finalized, participants received an email invitation to complete the sorting and rating tasks. The email included written and video instructions on how to complete the tasks online, along with a link to the sorting and rating webpage. With the exception of 11 participants who chose to complete the sorting and rating activities using pen and paper, these activities were completed online.

The sorting webpage reiterated the instructions on how to sort the statements. Participants were asked to sort all statements into groups that made sense to them, according to their view of each statement's meaning or theme. The instructions stated that participants should not create groups based on priority (e.g. importance) or value (e.g. hard to do), nor have 'Miscellaneous' or 'Other' groups; however they could place statements alone if unrelated to all others. Participants were advised that they could create as many groups as they liked although 5-20 usually worked well. Participants were asked to name each group according to its theme or contents.

For the rating task, participants were asked to rate each of the statements according to 'How helpful would this idea be to you?' using a 5-point Likert scale (1 = Not at all helpful, 5 = Extremely helpful).

Data analysis and Interpretation

Hierarchical cluster analysis was applied to the "sorting" data to develop a cluster map using the Concept Systems software™. First, a binary similarity matrix was generated for each participant based on the number of statements produced in the brainstorming phase, with each cell containing a 1 (grouped together) or 0 (not grouped together) for a pair of statements. These individual matrices were subsequently combined to form an aggregated similarity matrix, with each cell representing the number of participants who grouped a pair of statements together (Trochim, 1989). Based on the aggregated similarity matrix, a two-dimensional point map was created using multidimensional scaling analysis; each point represented one of the brainstormed statements, and its proximity to other points indicated how often they were grouped together by the participants. Points that were closer together were more often grouped together, relative to points that were further apart (Trochim, 1989). A stress index value was calculated to evaluate the validity of the point map, with a smaller value indicating a better fit. A stress index value between 0.155 and 0.352 is considered acceptable (Trochim, 1993), with an average stress index of 0.28 (SD = 0.04) being recorded across 69 concept mapping studies (Rosas & Kane, 2012). Lastly, hierarchical cluster analysis using Ward's algorithm was conducted to generate a series of cluster maps based on the coordinates obtained from the multidimensional scaling analysis (Murtagh & Legendre, 2014). The research team first examined a 10 cluster map, and then examined how the map changed by breaking the data down into fewer clusters, one cluster at a time. The final cluster map represented the best fit, as judged by the research team, and confirmed by participants who were involved in the sorting task. For each cluster, a mean bridging score was computed.

Bridging scores could range between 0-1.0, with clusters having lower bridging scores considered more cohesive and representing items that were more commonly grouped together by the participants (Concept Systems Incorporated, 2013). The cluster names were selected by the research team based on the items in the cluster and the labels suggested by participants.

To check agreement with the analysis, participants were sent the cluster names, descriptions and associated statements via email and were asked to; (1) provide feedback on whether they felt the majority of the statements in each cluster were about the same topic, (2) provide feedback on whether the cluster names and descriptions reflected the statements within them, and (3) confirm if the statements were grouped in a way that made sense to them. Participants were subsequently sent a second version of the analysis (based on the late inclusion of an additional participant) and asked to provide further feedback on the clusters. In total, 11 participants (7 adults with hearing impairment, 2 significant others and 1 hearing care professional) provided positive feedback on the analysis and final cluster solution; the remaining participants did not respond.

The "rating" data were subsequently analyzed at a cluster level and an individual-item level using descriptive statistics. Given that the rating data is ordinal (McDonald, 2014), differences in cluster ratings between stakeholder groups were examined using Kruskal-Wallis and Post Hoc Tests using the Bonferroni procedure. To control for Type1 errors, an alpha level of 0.004 inferred statistical significance. The clusters were subsequently ranked in order of perceived helpfulness for each stakeholder group.

RESULTS

Brainstorming

Across all three stakeholder groups, brainstorming yielded a total of 175 statements describing how ICTs could be used to address the hearing and communication needs of adults with hearing impairment and their family and friends. Compiling and reviewing the generated statements resulted in a final list of 123 statements for the sorting and rating tasks; all participants, irrespective of group, were provided the same list of statements (NB: one statement was repeated twice in the final list by error; see Supplementary material).

Sorting and Rating

The number of groups that participants created when sorting the data ranged from 3 to 14 (M = 8.30; SD = 3.04). The final cluster map which was deemed best representative of the data included seven clusters organized within three overarching themes: (1) Educate and Involve Others; (2) Support Aural Rehabilitation; and (3) Educate About and Demonstrate the Impacts of Hearing Impairment and Benefits of Hearing Rehabilitation (Figure 2). The 'Educate and Involve Others' theme included three clusters: 'educate the community on how to accommodate the needs of people with hearing impairment' (18 statements), 'educate and involve significant others' (29 statements), and 'actively engage family members in hearing rehabilitation' (11 statements). The 'Support Aural Rehabilitation' theme also comprised three clusters, including: 'empower adults with hearing impairment to manage their hearing impairment from home' (18 statements), 'provide information about device management' (11 statements), and 'support hearing loss self-management using multi-media platforms' (20 statements). The final theme, 'Educate About and Demonstrate the Impacts of Hearing Impairment and Benefits of Hearing Rehabilitation', comprised one cluster only (16 statements). A description of, and example statements from each cluster, are presented in Table 4.

'Insert Figure 2 about here'

'Insert Table 4 about here'

Based on the multidimensional scaling analysis, a stress index of 0.304 was computed, which indicated an acceptable goodness of fit (Trochim, 1993). Bridging scores ranged from 0.13 to 0.67, with the cluster "Educate and involve significant others" being most cohesive, and the cluster "Educate the community on how to accommodate the needs of people with HI" being the least cohesive (see Table 4).

Overall, median 'helpfulness' rating scores for each cluster ranged from 3.97 (educate and involve significant others) to 3.44 (empower adults with hearing impairment to manage their hearing impairment from home) on a 5-point Likert scale. However, significant group differences emerged for five of the seven clusters, the exceptions being 'educate and involve others' and 'educate the community on how to accommodate the needs of people with hearing impairment' (see Table 5). Significant differences in helpfulness rankings between adults with hearing impairment and significant others emerged for two clusters: 'educate about and demonstrate the impacts of hearing impairment and benefits of hearing rehabilitation' and 'empower adults with hearing impairment to manage their hearing impairment from home'; adults with hearing impairment perceived these clusters as less helpful, compared to significant others. Significant differences between adults with hearing impairment and hearing care professionals emerged for four clusters: 'educate about and demonstrate impacts of hearing impairment and benefits of hearing rehabilitation', 'provide information about device management', 'support hearing loss self-management using multi-media platforms', and 'actively engage family members in hearing rehabilitation'. For each of these clusters, adults with hearing impairment perceived them as less helpful, compared to hearing care professionals. Overall rankings, based on median rating scores, differed also by participant group (see Table 5). However, the two clusters that were ranked in the top three

by all stakeholder groups were ‘educate and involve significant others’ and ‘educate about and demonstrate the impacts of hearing impairment and benefits of hearing rehabilitation’.

‘Insert Table 5 about here’

DISCUSSION

Our research findings highlight the broad range of possible ICT applications for supporting the hearing and communication needs of adults with hearing impairment and their significant others. Three key themes emerged from the data, including using ICTs to educate and involve others, support aural rehabilitation, and central to both of these, educate about and demonstrate the impacts of hearing impairment and benefits of hearing rehabilitation. These applications align with both traditional synchronous and asynchronous models of eHealth, as well as self-directed educational tools and resources, which fall under the broader eHealth umbrella.

Importantly, differences in the ‘helpfulness’ of clusters were observed between adults with hearing impairment and both significant others and hearing care professionals. With the exceptions of using ICTs to ‘educate the community on how to accommodate the needs of people with hearing impairment’ and ‘educate and involve significant others’, adults with hearing impairment rated the use of ICTs as being significantly less helpful. One could argue that because adults with hearing impairment experience, firsthand, the disabling effects of hearing impairment, they are better able to discern what may or may not be helpful. Alternatively, this finding may reflect an age effect, given that the cohort of adults with hearing impairment was older, compared to the other stakeholder groups. Despite technology use growing in older adults (65+ years) (Pew Research Center, 2017), it remains less in comparison with younger adults aged 30-49 and 50-64 years (Pew Research Center, 2015). Irrespective of why these differences emerged, acknowledgement of stakeholder differences

has important implications for the implementation of eHealth into adult hearing services. It is crucial that audiologists consult with adult clients and significant others when planning an eHealth service to ensure it would be beneficial and acceptable to the end user.

Despite there being differences in absolute rating values, there was consensus among all stakeholders that the use of ICTs to 'Educate about and Demonstrate the Impacts of Hearing Impairment and the Benefits of Hearing Rehabilitation' would be helpful. The ideas grouped within this theme focused on simulating the hearing impairment to build significant others' empathy and to reinforce key messages; and tailoring aural rehabilitation advice to different degrees of hearing impairment and different physical environments. This finding is consistent with some key themes identified by Nielsen et al. (2018) in their focus group study. Ideas within this theme demonstrate how ICTs could be used to augment current hearing services, through the provision of audiovisual information as opposed to verbal and/or written textual information in isolation. This is important since previous research has demonstrated limitations of current traditional practices. For example, verbal and/or written information provided in the clinic is often complex and contains jargon (Caposecco et al., 2014; Nair & Cienkowski, 2010; Sciacca et al., 2017); patients struggle to remember information following audiology appointments (Watermeyer et al., 2015); and the low health literacy abilities of older adults means that understanding such information can be challenging (Caposecco et al., 2016). Indeed, a systematic review and metanalysis in cancer care has shown that video technology and interactive computer-based systems can be more effective than traditional methods of information provision at improving patient knowledge (Gysels & Higginson, 2007). Currently, despite there being some recognition of the potential benefits of simulating hearing impairment to build empathy and understanding in people who do not have a hearing impairment (Zurek & Desloge, 2007), there remains very little empirical research supporting the benefits of using ICTs to do this.

399 eHealth applications within the theme ‘Educate and Involve Others’ reinforce the
400 potential for ICTs to promote a broader psychosocial perspective to the management of
401 hearing impairment, as statements emphasized effective communication as opposed to device
402 use. The statements also highlighted the importance of involving significant others
403 throughout the entire hearing rehabilitation journey; and in fact, making the broader
404 community more aware of the impacts of hearing impairment and how they can best support
405 communication with someone who has hearing difficulties. These applications of eHealth are
406 in-keeping with the large body of qualitative research that describes the wide-ranging
407 psychosocial impacts of hearing impairment, and in particular, the negative emotions
408 experienced by both the person with hearing impairment and their significant others as a
409 result of communication difficulties (Heffernan et al., 2016; Jonsson & Hedelin, 2018; Lucas
410 et al., 2018; Punch et al., 2019). This finding also aligns with the growing emphasis on
411 patient- and family-centered hearing care, and the perceived benefits associated with
412 involving significant others in the hearing rehabilitation process (Habanec & Kelly-
413 Campbell, 2015; Meyer et al., 2015; Preminger, 2003). Current hearing services are typically
414 device-focused and as such, audiologists do not always discuss alternative interventions such
415 as communication education (Convery et al., 2018; Grenness et al., 2015b); however, the
416 findings here show that adults with hearing impairment and their significant others would
417 value the use of ICTs to provide further education about communication.

418 There were some striking differences in how clusters within the theme ‘Educate and
419 Involve Others’ were rated by participants. Where all stakeholder groups agreed that the use
420 of ICTs to educate and involve significant others would be helpful, all also agreed that the
421 use of ICTs to *actively engage* family members in hearing rehabilitation would be less
422 helpful, with it being ranked in the bottom three by each stakeholder group. Where the former
423 cluster described applications that would harness more support for the person with hearing

impairment and their significant others and facilitate a more holistic assessment of a client's hearing difficulties; the latter cluster focused predominantly on the use of ICTs, and in particular, videoconferencing software, to involve family members in specific aspects of the rehabilitation program (e.g., communication training). This finding could be interpreted in two ways. First, it might reflect the overall low use of videoconferencing with adult clients with hearing impairment (Meyer et al., 2019; Singh et al., 2014). Alternatively, it might reflect a preference for in-person family involvement, particularly among adults with hearing impairment whose ratings of "helpfulness" were significantly lower relative to hearing care professionals for the use of ICTs to *actively engage* family members in hearing rehabilitation.

Stakeholder groups did not differ in how helpful they perceived educating the community about how to accommodate the needs of people with hearing impairment; however, where this cluster was ranked second-highest among adults with hearing impairment, it was rated fifth and sixth by significant others and hearing care professionals, respectively. This finding likely reflects the day-to-day frustrations adults with hearing impairment experience as a result of communication difficulties within the broader community (Heffernan et al., 2016; Jonsson & Hedelin, 2018; Lucas et al., 2018; Punch et al., 2019). These experiences may not be fully appreciated by the other stakeholder groups. eHealth has great potential to educate the community about ways to accommodate the needs of adults with hearing impairment, for example, through the use of online public health campaigns.

Where the theme 'Educate and Involve Others' had a broader, psychosocial focus; the statements within the theme 'Support Aural Rehabilitation' focused predominantly on device use. Participants generated statements that highlight how ICTs could be used to support hearing loss self-management (i.e., realistic hearing aid expectations, communication training) and to provide information about device management. Interestingly, the use of ICTs

for these purposes were both perceived as significantly less helpful by adults with hearing impairment, relative to hearing care professionals. For example, where hearing loss self-management was ranked fifth overall for the former group, it was ranked most helpful for the hearing care professionals. Given that hearing impairment is considered a chronic health condition, increasingly more emphasis is being placed on the need for hearing care professionals to better equip their clients with the knowledge and skills required for optimal management of their hearing impairment (Arnold et al., 2019; Convery et al., 2019; Bennett et al., 2018), and this became the focus of a multimedia educational program for novice hearing aid users (Ferguson et al., 2016). Where hearing care professionals may see eHealth as a cost-effective way of supporting hearing loss self-management, adults with hearing impairment involved in the present study appeared less optimistic. The reasons underlying this are not clear; however, it may be that adults with hearing impairment would prefer these aspects of aural rehabilitation to be provided in person. It might also depend on factors relating to age, the individual's hearing impairment (e.g., degree and nature of hearing impairment), and their rehabilitation journey (e.g., first time hearing aid user vs. experienced hearing aid user).

Statements within the theme 'Support Aural Rehabilitation' also reflected how eHealth could be used to empower adults with hearing impairment to manage their hearing impairment from home, through self-control of devices and remote programming. The capacity to use ICTs to enable adults with hearing impairment to program and adjust their hearing devices from home has been an option for some time (Paglialonga et al., 2018), but remains underutilized (Meyer et al., 2019). In the present study, significant others rated the use of ICTs for this purpose as being more helpful, relative to adults with hearing impairment. Nevertheless, this cluster was rated in the bottom-three for each stakeholder group, indicating that overall, ICT use for this purpose may not be of highest priority. The

more advanced uses of technology, such as those described within this cluster, may be seen as prohibitive among some participants. Indeed, among a sample of 202 hearing care professionals in Canada, 47% were disinclined to use ICTs to make hearing aid adjustments remotely and 60% were unwilling to fit hearing aids remotely (Singh et al., 2014). This finding might also reflect the fact that almost two thirds of each stakeholder group involved in the current study lived in a major city and, therefore, likely have good access to services for hearing aid fitting / fine-tuning. Future research is needed to ascertain if greater priority would be given to remote hearing aid adjustments / programming by adults with hearing impairment, significant others, and hearing care professionals who live and/or work in rural and remote communities.

Methodological Limitations and Future Directions

The present study is the first to explore key stakeholders' perspectives on how eHealth can help meet the hearing and communication needs of adults with hearing impairment and their significant others. However, these findings must be considered in the context of the following methodological limitations. First, given that the stakeholder groups differed in age, possible cohort effects need to be taken into consideration when interpreting the results. In addition, the findings represent the views of individuals living in Australia only, and therefore future research is needed to confirm whether or not these priorities are similar in an international context. In particular, differences are likely to emerge in countries where there is a significant shortfall of audiologic services available (McPherson, 2014; Swanepoel et al., 2010; World Health Organization, 2013). In a similar way, priorities are likely to differ between individuals who live in major cities as opposed to rural and remote areas. Our sample sizes precluded an analysis of such differences and therefore this warrants further research. Additionally, while the statements generated provide excellent guidance as to how ICTs can be used to promote PFCC, more comprehensive research is needed to inform the subsequent

development of eHealth interventions. It is recommended that such interventions be developed in the context of health behavior change theory (Coulson et al., 2016). Lastly, given that this research was conducted prior to the Covid-19 pandemic and thus prior to eHealth being used more routinely within audiology and other healthcare settings, it would be interesting to examine changes in key stakeholders' perspectives on how eHealth could be used to meet the hearing and communication needs of adults with hearing impairment and their families.

CONCLUSION

These research findings demonstrate the broad range of clinical applications of eHealth that have the capacity to support the implementation of patient- and family-centered hearing care, with self-directed educational tools and resources typically being rated as most helpful. Clusters which focused predominantly on synchronous forms of eHealth (i.e., 'Actively engage family members in hearing rehabilitation' and 'Empower adults with hearing impairment to manage their hearing impairment from home') were the lowest-ranked clusters by each stakeholder group. Therefore, it seems that eHealth is perceived by many as a means of augmenting current services, as opposed to being a substitute for in-person face-to-face services. In this way, eHealth appears to be a viable option for enabling a more biopsychosocial approach to hearing healthcare and educating and involving significant others in the hearing rehabilitation process, without adding pressure on finite clinical time. Given the current disruption to audiology services as a result of the Covid-19 pandemic, hearing healthcare may be well positioned to implement some of the suggestions proposed by key stakeholders as part of this study into their clinical practice.

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FIGURE CAPTIONS

Figure 1. Cartoon vignette used during brainstorming activity to illustrate frequently reported scenarios that could be improved through the use of information and communication technologies.

Figure 2. Cluster map depicting seven-cluster solution, with each point representing one of the brainstormed statements (n = 53).

800 Figure 1

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802 Figure 2

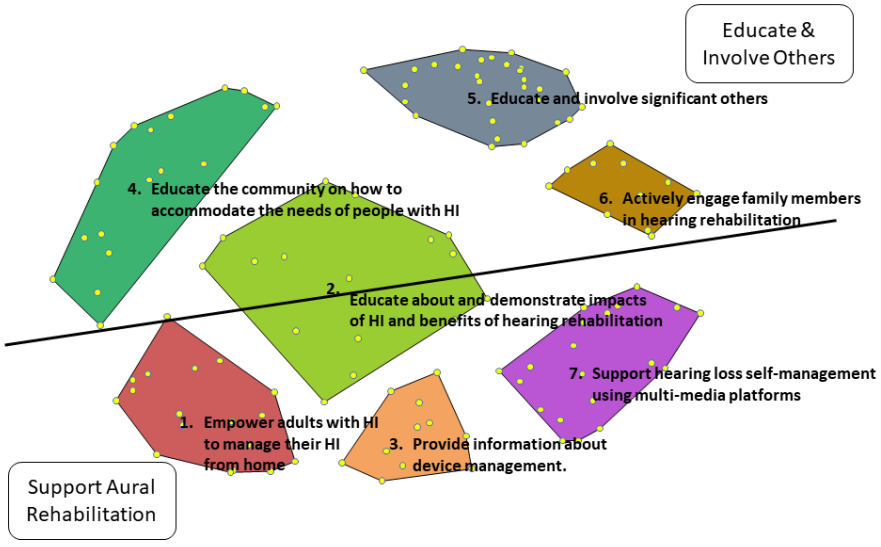

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Table 1

Demographic information for adults with hearing impairment (n = 39) and significant others (n = 28).

	n (%)	
Variable	**Adults with HI**	**Significant Others**
Concept mapping task		
Brainstorming	36 (92.31)	13 (46.43)
Sorting[a]	18 (46.15)	15 (53.57)
Rating[a]	20 (51.28)	16 (57.14)
Gender		
Female	10 (25.64)	21 (75)
Male	25 (64.10)	6 (21.43)
Not reported	4 (10.26)	1 (3.57)
Relationship to person with HI		
Spouse/partner	–	8 (28.57)
Son/daughter	–	9 (32.14)
Grandchild	–	4 (14.29)
Mother/father	–	2 (7.14)
Other (Uncle, brother in law, friend)	–	3 (10.71)
Not reported	–	2 (7.14)
Living situation		
Community	34 (87.18)	26 (92.86)
Retirement village	1 (2.56)	–
Not reported	4 (10.26)	2 (7.14)
Remoteness Area of Residence		
Major city	27 (69.23)	19 (67.86)
Inner regional	7 (17.95)	5 (17.86)
Outer regional	1 (2.56)	2 (7.14)
Not reported	4 (10.26)	2 (7.14)
Current working status		
Retired	29 (74.36)	5 (17.86)
Working full-time	4 (10.26)	10 (35.71)
Working part-time	–	3 (10.71)
Work on casual basis	1 (2.56)	3 (10.71)
Other (e.g., volunteer, home duties)	1 (2.56)	5 (17.86)
Not reported	4 (10.26)	2 (7.14)

Note. HI, hearing impairment; SO, significant other. [a] participant met a threshold criterion of sorting and/or rating at least 90% of the statements.

Table 2

Demographic information for hearing care professionals (n = 56).

Variable	n (%)
Concept mapping task	
Brainstorming	40 (71.43)
Sorting[a]	20 (35.71)
Rating[a]	19 (33.93)
Gender	
Female	48 (85.71)
Male	7 (12.5)
Not reported	1 (1.79)
Primary Professional Role	
Audiologist	50 (89.3)
Audiometrist	2 (3.57)
Nurse/audiometrist	1 (1.79)
Not reported	3 (5.36)
†*Workplace*	
Commonwealth Government	13 (23.21)
Hospital	3 (5.36)
University	1 (1.79)
Private (self-owned practice)	2 (3.57)
Private sector (employee)	35 (62.5)
Manufacturer	1 (1.79)
Other (Not For Profit)	1 (1.79)
Not reported	3 (5.36)
†*Remoteness Area of Workplace*	
Major city	40 (71.43)
Inner regional	9 (16.07)
Outer regional	3 (5.36)
Remote/Very remote	1 (1.79)
Not reported	3 (5.36)
†*Clinical Population*	
Adults in the community	52 (92.86)
Adults in aged care facilities	34 (60.71)
Paediatrics	10 (17.86)
Other	3 (5.36)
Not reported	3 (5.36)

Note. HI, hearing impairment. [a] participant met a threshold criterion of sorting and/or rating at least 90% of the statements. † = multiple responses permitted.

Table 3

Examples of edits made to the statements by the research team.

Reason	Example Statement	Action
Not relevant	"One problem I had with the hearing aid I tested was the sound of my own voice - I hated it!"	Removed
Too vague	"Provide support"	Removed
Beyond the scope/focus of the project	"Flashing smoke alarms to be installed in all public places - shopping centres; motels; movies - at present most rely on audio signal"	Removed
More than one meaning unit	"Send out a weekly newsletters emails or some form of news on living with hearing loss. Having some form of social media platform in a way to educate people and help people come to terms with hearing loss."	Separated into individual meaning units: "Send out weekly newsletters emails or some form of news on living with hearing loss" AND "Have some form of social media platform as a way to educate people" AND "Have some form of social media platform as a way to help people come to terms with hearing loss"
Duplicate statements	"Email contact between hearing professionals and their clients would enable simple queries to be addressed efficiently" AND "Have email communication (e.g. questions, concerns etc.) between appointments as it can be hard to find time to phone people"	Consolidated to: "Have email contact between hearing professionals and their clients that would enable simple queries to be addressed efficiently"
Grammatical errors	"More support for family members as its not just the hearing impaired individual that suffers its the family as a whole"	Corrected to: "Provide more support for family members as it's not just the hearing impaired individual that suffers it's the family as a whole"
Unclear	"Direct them to websites directed towards supporting people with hearing loss e.g. (better Hearing?)"	Edited for clarity: "Direct people to websites aimed at supporting people with hearing loss e.g. Better Hearing"
Not syntactically similar	"'how-to' videos for connecting to other devices/streaming"	Edited for syntactic similarity: "Develop 'how-to' videos for connecting to other devices/streaming"

Incorporated specific term/s	“Have a iPAD in waiting room with presentation on common limitations of hearing aids/CIs”	Specific terms replaced with generic terms: “Have a tablet in waiting room with presentation on common limitations of hearing devices”

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Table 4

Mean (SD) Bridging Scores and Example Statements for the Seven Clusters Derived from Sorting Data (n = 53).

Cluster Name and Description	Example Statements	Bridging Score M (SD)
Theme: Educate about and demonstrate the impacts of HI and benefits of hearing rehabilitation		
Educate about and demonstrate impacts of HI and benefits of hearing rehabilitation How ICTs could be used to educate both clients and others about the impact of HI and the benefits of engaging in hearing rehabilitation. (16 statements)	Provide information about using hearing aids in different environments. Inform clients about different hearing devices for different levels of hearing loss. Develop a video to have in the waiting room that educates about the benefits of being proactive in managing their hearing loss.	0.35 (0.08)
Theme: Educate and involve others		
Educate the community on how to accommodate the needs of people with HI How ICTs could be used to educate the community to best support individuals living with HI, from good communication practices to seeking help for hearing difficulties. (18 statements)	Educate speakers to speak slowly. Educate people who have no hearing loss that patience may be required to get responses. Educate speakers to begin speaking with 'throw away' words (such as listener's name) so the hearer can tune in.	0.67 (0.17)
Educate and involve significant others How ICTs could be used to educate significant others (family members, friends) about the impact of HI and how to involve them in the rehabilitation journey. (29 statements)	Provide more support for family members as it's not just the hearing impaired individual that suffers it's the family as a whole. Encourage family members to participate in the person's rehab 'journey'. Educate family and friends on the impact of living with a hearing loss.	0.13 (0.08)
Actively engage family members in hearing rehabilitation How ICTs could be used to actively engage family members in hearing rehabilitation using a variety of multi-media platforms. (11 statements)	Have communication partner training via videoconferencing. Provide group videoconferences for clients and significant others to allow concepts, like communication training, to be addressed in large groups rather than individually. Videoconference family to explain patient's hearing loss, its effects, benefits and limitations of hearing aids, and communication strategies.	0.44 (0.12)

Cluster Name and Description	Example Statements	Bridging Score M (SD)
Theme: Support aural rehabilitation		
Support hearing loss self-management using multi-media platforms How multi-media platforms, such as videos and apps, could be used to support hearing loss self-management. It primarily covers device management, but also includes communication strategies. (20 statements)	Have a tablet in the waiting room with presentation on common limitations of hearing devices. Develop a video to have in the waiting room that educates about what you need to do for ongoing care/self-management. Develop clear, simple instructional videos to cover the most frequently covered topics e.g. changing wax guards, communication strategies, differences in technologies etc. so that patients can watch this in the waiting rooms pre/post appointments to solidify info given in appointment.	0.46 (0.10)
Provide information about device management How ICTs could be used to provide information about device management, including device options, optimal use of devices, and troubleshooting. (11 statements)	Provide further information on hearing aids and accessories. Provide information about the best use of hearing devices. Provide information about hearing aid management.	0.35 (0.08)
Empower adults with HI to manage their HI from home How ICTs could be used to enable the client to manage their HI from home, through self-control of devices and remote programming, to enabling contact with a hearing care professional. (18 statements)	Increase empowerment via self-control of devices. Provide auditory rehabilitation for clients with hearing devices. Allow clients to make adjustments to own devices.	0.50 (0.13)

Note. HI, hearing impairment; ICTs, information and communication technologies. Bridging scores could range between 0-1, with clusters having lower bridging scores considered more cohesive.

Table 5

Median Perceived Helpfulness Rating Scores and Kruskal-Wallis Results by Cluster and Stakeholder Group (n = 55).

Cluster	Overall		Adults with HI (n = 20)		Significant Others (n = 16)		Hearing Care Professionals (n = 19)		$\chi 2$	*P*
	Mdn (range)	Rank	Mdn (range)	Rank	Mdn (range)	Rank	Mdn (range)	Rank		
Educate about and demonstrate the impacts of HI and benefits of hearing rehabilitation	3.94 (2.19 – 4.88)	2	3.25 (2.19 – 4.44)	3	4.16 (2.81 – 4.75)	1	4.06 (3.00 – 4.88)	3	13.25	.0013†‡
Educate the community on how to accommodate the needs of people with HI	3.83 (1.78 – 4.83)	3	3.36 (1.78 – 4.83)	2	3.83 (2.94 – 4.72)	5	3.89 (2.44 – 4.83)	6	3.48	.1752
Educate and involve significant others	3.97 (1.31 – 4.93)	1	3.46 (1.31 – 4.55)	1	4.02 (2.90 – 4.79)	2	4.17 (3.26 – 4.93)	2	8.81	.0122
Actively engage family members in hearing rehabilitation	3.55 (1.10 – 5.00)	6	2.27 (1.10 – 4.27)	7	3.64 (1.27 – 5.00)	7	3.91 (2.64 – 5.00)	5	12.34	.0021†
Support hearing loss self-management using multi-media platforms	3.65 (1.75 – 4.80)	5	2.95 (1.90 – 4.30)	5	4.00 (1.75 – 4.65)	3	4.25 (2.35 – 4.80)	1	13.43	.0012†
Provide information about device management	3.82 (1.27 – 5.00)	4	3.18 (1.27 – 4.55)	4	3.96 (2.36 – 4.82)	4	4.00 (3.09 – 5.00)	4	12.48	.0019†
Empower adults with HI to manage their HI from home	3.44 (1.50 – 4.94)	7	2.81 (1.50 – 4.39)	6	3.83 (2.0 – 4.95)	5	3.56 (3.11 – 4.44)	7	14.06	.0009‡

Note. HI, hearing impairment. Rating scale 1-5, 1 = not at all helpful, 5 = extremely helpful. † = comparison between adults with HI and hearing care professionals significant, $\alpha = .004$; ‡ = comparison between adults with HI and significant others significant, $\alpha = .004$.