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Investigating the prevalence and impact of device-related problems associated with hearing aid use

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ABSTRACT

Objective: To explore the prevalence of device-related problems associated with hearing aid use, participants' help-seeking behaviours for these problems, and factors associated with hearing aid problems.

Design: A prospective convenience cohort design surveying 413 adult hearing aid users (34 to 97 years of age) recruited from seven clinics across Australia.

Results: Almost all participants (98%) indicated that they were experiencing at least one of the hearing aid problems included on the survey. The number of hearing aid related problems reported by participants ranged from 0 to 25 (of a possible 26), with a mean of 10

problems (SD = 5). The three most reported problems were related to difficulty hearing in noisy environments, hearing in windy environments, and understanding certain voices. Participants had reported less than half (46.33%) of the total problems identified to their clinic (range = 0 to 100%, mean = 43.40, SD = 13.92). Participants who reported experiencing a greater number of hearing aid problems also reported lower levels of hearing aid benefit, and satisfaction with their hearing aids.

Conclusions: The majority of hearing aid owners experience problems with their hearing aids. Addressing these problems would likely contribute to improved hearing aid outcomes.

INTRODUCTION

Despite the improved hearing-related and general-health related quality of life associated with hearing aid use (Ferguson et al., 2017; Chisolm et al., 2007), up to one quarter of hearing aid owners do not use their hearing aids daily (Hartley et al., 2010; Hickson, Clutterbuck & Khan, 2010; Kochkin, 2010), as required for optimal hearing aid success (Hickson, Meyer, Lovelock, Lampert & Khan, 2014). These low levels of hearing aid use are often attributed to problems experienced with the hearing aid device (McCormack & Fortnum, 2013), such as issues relating to physical fit (Hartley et al., 2010; Gianopoulos et al., 2002), sound quality (Bennett et al., 2018a; Bertoli et al., 2009; Kochkin, 2000a), difficulty handling the device (Bennett et al., 2018a; Öberg et al., 2012; Tomita, Mann & Welch, 2001), and issues with ongoing maintenance requirements (such as cleaning and basic repairs) (Bennett et al., 2018a; Kochkin, 2000a). A recent qualitative study interviewing hearing aid owners and clinicians identified 80 individual problems associated with hearing aid use (Bennett et al., 2018a); however, the prevalence and impact of these problems in

populations of hearing aid owners is unknown. Identifying those individual problems having the greatest impact on hearing aid outcomes would facilitate improved audiological services.

Surveys are available that evaluate some of the problems associated with hearing aid use, such as the Hearing Aid Users Questionnaire (HAUQ: Dillon et al., 1997), Satisfaction with Amplification in Daily Life (SADL: Cox & Alexander, 1999), Hearing Aid Skills and Knowledge (HASK: Saunders et al., 2018), and the Hearing Aid Skills and Knowledge Inventory (HASKI: Bennett et al., 2018c). However, these surveys do not aim to evaluate device-related problems associated with hearing aid use specifically; they aim to evaluate related yet different constructs, such as satisfaction or handling skills, and thus encompass only a few of the problems identified by Bennett et al. (2018a). Given that existing questionnaires only assess specific dimensions related to device-related problems, the development of a more comprehensive survey is therefore required to assist hearing aid owners and clinicians in identifying and thus addressing hearing aid device-related problems.

Although hearing healthcare clinicians can rectify many hearing aid device-related problems through modifications to the hearing aid or provision of hearing aid skills training (Bennett et al., 2016; Goggins & Day, 2009), problems relating to hearing aid use persist and continue to contribute to low hearing aid adherence (McCormack & Fortnum, 2013). It has been suggested that some hearing aid owners are unaware that they are experiencing problems (Desjardins & Doherty, 2009), and thus may not report them to their clinician. Others may choose not to actively seek help for their problems, perceiving them to be the responsibility of the clinician to identify and address (Bennett, Laplante-Lévesque, & Eikelboom, 2018b). A better understanding of the device-related problems that hearing aid

owners are more likely and less likely to experience and report to their clinician could assist in the development of clinical tools to improve audiological care related to hearing aid use. Furthermore, a clinical survey itemising common hearing aid device-related problems could help hearing aid users to identify any problems they may be experiencing.

This study explored (i) the prevalence of device-related problems associated with hearing aid use, (ii) participants' help-seeking behaviours for the problems they were experiencing, and (iii) demographic- and outcomes-related factors associated with these problems. To achieve this, a survey was developed to facilitate device-related problem identification in adults hearing aid users.

METHODS

Ethical approval for these studies was granted by the Human Research Ethics Office of The University of Western Australia.

Survey development

Recently validated tools developed to address the low levels of hearing aid management skills identified in hearing aid owners, took the approach of itemising a comprehensive list of the management skills required to manage one's hearing aid to assist the identification of management issues (Saunders et al., 2018; Bennett et al., 2018c). As such, this study undertook the same approach, developing a survey itemising a comprehensive list of problems associated with hearing aid use to facilitate device-related problem identification.

The current survey was informed by the data generated from Bennett et al. (2018), wherein they used a mixed method, concept mapping, to identify the device-related problems associated with hearing aid use. Concept mapping provides a systematic approach

to developing a conceptual framework of a phenomenon of interest, and thus is an ideal platform for survey item development (Rosas & Camphausen, 2007). Involving stakeholders representing the intended end users of the survey to put forth ideas regarding the phenomenon of interest and give meaning to the ideas, provides clear conceptual grounding and ensures the content domains accurately represents the phenomenon under investigation (Rosas & Camphausen, 2007; Sheatsley, 1983). Seventeen hearing aid owners and twenty-one hearing healthcare clinicians identified 80 individual problems relating to hearing aid use within four concepts (Bennett et al., 2018a):

- 1) Hearing Aid Management (29 items) described problems relating to hearing aid use, handling and ongoing care. For example, "The hearing aid owner has difficulty inserting the hearing aid" and "The hearing aid flicks across the room when the HA owner takes their glasses off".
- 2) Hearing Aid Sound Quality and Performance (21 items) described problems relating to hearing aid performance and sound quality, which may be influenced by the clinicians programming of the hearing aid or the hearing aid owners expectation or use of the hearing aid. For example, "The hearing aid makes everything sound too loud" and "The hearing aid sounds tinny and sharp".
- 3) Feelings, Thoughts and Behaviours (18 items) described problems related to the personal and individual experience of getting used to hearing aids, which may have been influenced by the wearers' expectations, reluctance (internal barriers) and motivation (desire to succeed). For example, "The hearing aid owner has unrealistic expectations of what the hearing aid should be able to do" and "The hearing aid owner is disappointed with hearing aids given the cost".

- 4) Information and Training (12 items) described problems relating to the transfer of information and training from the clinician to the hearing aid owner. For example, "The hearing aid owners were not informed that loan aids are available while hearing aids are being repaired" and "The clinician did not explain what all the extra pieces in the hearing aid the box were for".

The research team chose to include items from the first two concepts as they described device-related problems (such as fit, comfort, and management), as well as aspects relating to performance (associated with sound quality and benefit in desired situations). It was decided to exclude items from the latter two concepts as they described person-related problems such as feelings, thoughts and behaviours of hearing aid owners in relation to getting used to hearing aids (including expectations, motivation and apprehensions) as well as problems associated with acquisition of knowledge and skill. The research team excluded unsuitable statements that were not directly describing device-related hearing aid problems; four from the Hearing Aid Management domain and three from the Hearing aid Sound Quality and performance domain, for example "The nursing staff lose the hearing aid regularly". Similar statements were merged to reduce the total number of items on the survey. The original version of the survey had 28 items; 16 representing the Hearing Aid Management domain and 12 representing the Hearing aid Sound Quality and Performance domain. Five of the items representing the Hearing Aid Management domain were derived by merging similar statements; for example, "The ear moulds work their way out of the hearing aid owners ears when chewing" was merged with "The hearing aid falls off/out of the hearing aid owners ear" to generate item 3. Four of the items representing the Hearing aid Sound Quality and Performance domain were derived by merging similar statements; for

example, "Hearing on the phone is still difficult when wearing the hearing aid, especially in a noisy environment" was merged with "The HA owner has difficulty hearing people clearly over the phone" to generate item 26.

All items were rephrased as self-report questions with the same response options. Response options of "Yes", "No", and "Not applicable" were selected so that the survey would identify whether or not the participant was currently experiencing difficulty with each of the problems listed. The survey was scored by summing the number of problems being experienced (i.e. Yes responses). The degree of difficulty was not assessed.

Pilot testing. Administration of the survey during clinical consultations was piloted by eight clinical audiologists not involved in development of the survey: two male and six female, ranging in age from 26 to 51 years (mean = 36, SD = 8), with a range of clinical experience (range = three to 28 years, mean = 11, SD = 8.45). They were asked to administer the survey in their daily clinical practice and provide feedback on the content and usability of the survey. Minor changes to the survey were made based on the clinicians' feedback, such as rewording and condensing the layout so that all items appeared on a single page. The merging of like items resulted in a reduction from 28 items (original version) to 26 items (final version used in this study). The items "*Is your hearing aid uncomfortable?*" and "*Does your hearing aid make your ears itch?*" were combined to become item 2. *Is your hearing aid uncomfortable, or does it make your ears itch?* Additionally, "The hearing aid flicks across the room when the HA owner takes their glasses off" was removed as the clinicians felt that its clinical value was covered by item 3. *Does your hearing aid fall off/out of your ear?*

The survey was then pilot tested on the 17 hearing aid owners who did not participate in the subsequent study. They were sent a paper copy of the survey via mail and asked to provide feedback on the appropriateness of the survey wording and whether they felt the survey was beneficial or worthwhile. Eleven participants returned a completed survey, including: six male and five female, ranging in age from 67 to 89 years (mean = 78, SD = 8). No changes to the survey were suggested by these participants.

Materials

Participants completed a survey set comprising (a) a short clinical history, (b) the survey investigating hearing aid problems (developed for the purpose of this study), (c) a question asking whether they had sought help from their hearing clinic for each of the problems listed on the problems survey (response options "Yes", "No" and "Not applicable"), (d) the International Outcome Inventory for Hearing Aids (IOI-HA) (Cox & Alexander, 2002), and (e) the self-administered Hearing Aid Skills and Knowledge Inventory (HASKI-self) (Bennett et al., 2018c). The survey set was available in paper and electronic format.

The short clinical history form was used to gather participant demographic and device data: including age, gender, fitting configuration (monaural or binaural fitting), style of hearing aid (BTE: Behind-The-Ear; or ITE: In-The-Ear), age of current hearing aid (> or < 12 month old), duration of hearing aid use (total number of years of experience), hearing aid funding source (whether they paid in full for their hearing services: private; or received Australian government subsidies: Gov), and overall satisfaction with hearing aids (with the response options 1=Very Dissatisfied, 2=Dissatisfied, 3=Neutral, 4=Satisfied and 5=Very Satisfied) (Kochkin, 2000b).

The IOI-HA is a seven item, multi-dimensional measurement of hearing aid daily use, benefit, residual activity limitations, satisfaction, residual participation restrictions, impact on others, and quality of life (Cox & Alexander, 2002). Each item on the IOI-HA is evaluated on a five-point Likert scale with the overall score calculated by averaging the scores across all items. The IOI-HA is commonly used in audiology clinical practice and is considered a gold standard for evaluation of hearing aid outcomes, and thus was used to explore the relationship between hearing aid problems and hearing aid outcomes. Specifically, daily hours of hearing aid use (item 1), self-reported hearing aid benefit (item 2), and overall IOI-HA scores were utilised.

The HASKI-self is a self-administered survey evaluating 73 items of skill and knowledge required for hearing aid use (Bennett et al., 2018c). A higher score indicates greater competency for hearing aid management skills (i.e., a score of 100% signifies complete competency). The HASKI-self was used to explore the possible relationship between problems relating to hearing aid use and hearing aid management skills and knowledge.

Participants

Hearing aid owners were recruited from seven privately-funded hearing clinics across Australia. Clinics were based in Queensland (n = 2), New South Wales (n = 3), and Western Australia (n = 2). Six of the participating clinics were provided access to government funded services. Each clinic followed their normal clinical processes for hearing aid fitting: the number of appointments provided for a hearing aid fitting rehabilitation program, the time allowance for these appointments, and the hearing aid verification and validation methods employed. Consequently, the individual hearing aid owners' experiences during the process of obtaining the hearing aid(s) may have varied in this study.

All clients of participating clinics aged 18 years or older who had received their latest (most recent) hearing aids up to five years prior to the date of data collection were identified as potential participants. No inclusion or exclusion criteria were placed on life-long duration of hearing aid ownership (total years of hearing aid ownership) to ensure a mix of experienced and new users were included.

Procedure

Each clinic generated a list of potential participants, i.e. all clients on their database that fit the inclusion criteria. A random subset of all the clinic's potential participants was selected. A total of 600 invitations were mailed and another 850 invitations were emailed. The response rates were 29% and 28% respectively.

Data analysis

Data were entered into Microsoft Excel and analysed using SPSS.

Prevalence of hearing aid problems. The percentages of the participants experiencing each problem were calculated.

Help-seeking for hearing aid problems. The percentages of the participants that reported seeking help from their clinic, and whether or not the problem was resolved were calculated.

Factors associated with hearing aid problems. Associations between the number of hearing aid problems being experienced (hearing aid problems survey scores) and seven participant and hearing aid device factors were evaluated using eight separate linear regression analyses. Factors included participant age and gender, style of hearing aid, fitting configuration, age of current hearing aid, years of hearing aid use, funding for services, and hearing aid skills and knowledge (HASKI-self total score). Four separate linear regression analyses were also used to explore whether the number of hearing aid problems being

experienced (total survey scores) could predict hearing aid outcomes and satisfaction: IOI-HA total score, perceived hearing aid benefit (IOI-HA item 2), hours of daily hearing aid use (IOI-HA item 1), and self-reported satisfaction with hearing aids.

ANOVA was used to investigate whether the presence / absence of individual hearing aid problems were associated with hearing aid outcomes, as indicated by the IOI-HA total score.

RESULTS

Participants (n = 413) ranged in age from 34 to 97 years (mean = 71.14 years, SD = 11.50). More than half were male (61%) and 39% were female. Length of time of hearing aid ownership ranged from six months to 61 years (mean = 10.1 years, SD = 10.5). BTEs were worn by 84.67% (n = 350), and 38.67% wore ITEs (n = 63). The majority of participants wore binaural hearing aids (92.73%, n = 383), and 7.27% were monaurally fitted (n = 30). The mean IOI-HA scores across all items ranged from 1.2 to 5 (mean = 3.97, SD = 0.65), consistent with previous measures in Australian populations (mean = 3.91, SD = 0.65; Range = 1.29 to 5; Hickson et al., 2010). HASKI-self mean scores ranged from 13.79% to 100% (mean = 65.94; SD = 17.81). No outliers were identified and data were normally distributed. The following data for prevalence of and help-seeking for hearing aid problems were obtained from newly developed survey created for the purpose of this study.

Table 1. The percentage of participants that reported experiencing each of the individual problems, and whether they had sought help from their hearing clinic regarding this problem. Note the percentages are based on the number of participants that responded to each question, as indicated by "n" in brackets.

Hearing aid problems investigated	Currently a problem for participants %(n)	Participants reported this problem, yet the problem persists %(n)	Participants have <u>not</u> sought help for this problem %(n)
Hearing Aid Management			
1. Do you have trouble inserting the hearing aid?	18.87 (77)	45.21 (33)	54.79 (44)
2. Is your hearing aid uncomfortable, or does it make your ears itch?	46.78 (189)	30.72 (51)	69.28 (138)
3. Does your hearing aid falls off/out of your ear?	29.20 (120)	30.93 (30)	69.07 (90)
4. Does your hearing aid whistle (feedback)?	38.83 (160)	45.97 (57)	54.03 (103)
5. Does your hearing aid get lost?	15.85 (65)	35.19 (19)	64.81 (46)
6. Do you have trouble changing the battery, or knowing when to change the battery?	7.90 (32)	29.63 (8)	70.37 (24)
7. Do you have trouble cleaning the hearing aid?	21.32 (87)	46.67 (35)	53.33 (52)
8. Do you have trouble making program or volume changes on the hearing aid?	25 (86)	39.68 (25)	60.32 (61)
9. Do you have trouble changing the small components of the hearing aid, such as the microphone cover or dome or wax guard?	29.61 (106)	45.88 (39)	54.12 (67)
10. Are you unsure what the buttons on your hearing aid do?	23.16 (82)	31.75 (20)	68.25 (62)
11. Do you have trouble using your remote control/ charger unit Bluetooth streamer/ TV streamer/FM system/ Rodger pen?	28.08 (41)	35.29 (12)	64.71 (29)
12. Are you unsure what to do when your hearing aid stops working?	22.28 (88)	64.52 (40)	34.48 (48)
13. Are you unsure how to fix your hearing aid if it gets wet?	42.44 (160)	20.49 (25)	79.51 (135)
14. Are you unsure how to use your dry aid kit (dehumidifier or dry store)?	23.55 (57)	12.5 (5)	87.5 (52)
Hearing Aid Sound Quality and Performance			
15. Does your hearing aid make some sounds too loud?	44.12 (180)	63.46 (99)	36.54 (81)
16. Do you have trouble hearing certain voices with your hearing aid?	76.41 (311)	62.98 (165)	37.02 (146)

17. Does your hearing aid pick up sounds that you do not want to hear?	60.10 (241)	61.65 (127)	38.35 (114)
18. Does your hearing aid sound sharp and high pitched?	33.50 (136)	65.45 (72)	34.55 (64)
19. Do you hear better through one hearing aid than the other and does this bother you?	22.34 (82)	52.31 (34)	47.69 (48)
20. Does your hearing aid have trouble picking up people speaking from behind you?	57.57 (232)	42.19 (81)	57.81 (151)
21. Does your hearing aid have trouble picking up people speaking from the next room?	72.73 (288)	35.19 (82)	64.81 (206)
22. Are you unhappy with the sound of your own voice?	20.79 (84)	42.65 (29)	57.35 (55)
23. Does the hearing aid distort the sound when you are listening to music?	22.42 (89)	45.33 (34)	54.67 (55)
24. Does your hearing aid have trouble picking up people speaking in noisy environments?	87.25 (356)	58.25 (173)	41.75 (183)
25. Does your hearing aid have trouble picking up people speaking in windy environments?	74.56 (296)	34.41 (85)	65.59 (184)
26. Do you find hearing on the phone difficult when wearing the hearing aid?	48.64 (196)	50.31 (81)	49.69 (115)

Prevalence of hearing aid problems

The number of hearing aid related problems reported by participants ranged from 0 to 25 (of a possible 26), with a mean of 10 problems (SD = 5). Of 413 adult hearing aid owners participating in this study, 98% indicated that they were experiencing at least one of the hearing aid problems included on the survey. Every item included on the hearing aid problems survey was reported to be problematic by at least one participant (of the 98% who reported at least one problem). The prevalence of individual problems ranged from 7.90% to 87.25% (Table 1). Item 6. *Do you have trouble changing the battery, or knowing when to change the battery?* was the problem least often reported by participants (n=32). The three most commonly experienced problems were item 24. *Does your hearing aid have trouble picking up people speaking in noisy environments?* (n = 356), item 16. *Do you have trouble hearing certain voices with your hearing aid?* (reported by 76.41% of participants; n = 311);

and item 25. *Does your hearing aid have trouble picking up people speaking in windy environments?* (reported by 74.56% of participants; n = 296).

Help-seeking for hearing aid problems

Overall, participants indicated that they had reported 46.33% of their problems (n = 1459) to their clinic, and 53.67% of their problems (n = 1690) had not been reported to their clinic. Individually, participants had reported between 0 and 100% (mean = 43.40, SD = 13.92) of their hearing aid problems to their clinic (Table 1). One participant indicated that they had not reported any of the 23 hearing aid problems they were currently experiencing to their clinic. In contrast, one of the participants had reported all 13 of the problems they were experiencing to their clinic, yet the problems persisted. The two problems least likely to be reported to the clinic were item 14. *Are you unsure how to use your dry aid kit (dehumidifier or dry store)?* (12.5% of participants, i.e. of the 40 participants who indicated this item as a current problem, 5 of them had reported the problem to their clinic) and item 13. *Are you unsure how to fix your hearing aid if it gets wet?* (20.49% of participants, i.e. 25 of 122 had reported this problem to their clinic).

The three problems most commonly reported to the clinic but unresolved (i.e. still a problem) were item 18. *Does your hearing aid sound sharp and high pitched?* (65.45% of participants, i.e. 72 of 110 had reported this problem to their clinic), item 12. *Are you unsure what to do when your hearing aid stops working?* (64.52% of participants, i.e. 40 of 62 had reported this problem to their clinic), and item 15. *Does your hearing aid make some sounds too loud?* (63.46% of participants, i.e. 99 of 166 had reported this problem to their clinic).

Table 2. Factors associated with hearing aid problems (survey mean scores).

Participant data (%, n)	B	p (Sig.)	95%CI
Personal demographics			
Age (<55, 56-65, 66-75, 76-75, >86)	0.001	0.082	<0.001 to 0.003
Gender (Male, Female)	-0.013	0.487	-0.049 to 0.023
Hearing aid device demographics			
Style of hearing aid (BTE, ITE)	-0.014	0.558	-0.063 to 0.034
Fitting configuration (Monaural, Binaural)	-0.048	0.158	-0.116 to 0.019
Age of current hearing aid (>12 months, >12 months)	0.066	0.001	0.029 to 0.103
Years of hearing aid experience (When did you get your first ever hearing aid)	0.00002	0.688	-0.00008 to 0.0001
Funding for services (Gov, Private)	0.026	0.170	-0.011 to 0.063
Hearing aid skills and knowledge (Total HASKI score)	-0.005	<0.001	-0.006 to -0.004
Hearing aid outcomes			
Self-reported hearing aid benefit (IOI-HA item 2)	-0.043	<0.001	-0.059 to -0.027
Satisfaction with hearing aids	-0.077	<0.001	-0.095 to -0.059
Overall outcomes (IOI-HA scores)	-0.101	<0.001	-0.124 to -0.077
Self-reported daily hours of hearing aid use (IOI-HA item 1)	-0.013	0.154	-0.032 to 0.005

Note: BTE: Behind-The-Ear; ITE: In-The-Ear; Gov: Government subsidised services; IOI-HA: International Outcomes Inventory for Hearing Aids; HASKI: Hearing Aid Skills and Knowledge Inventory; HASKI-self: Hearing Aid Skills and Knowledge Inventory – self-administered version.

Factors associated with hearing aid problems

Age of the current hearing aid, and hearing aid skills and knowledge (total HASKI-self scores) were identified as factors associated with hearing aid problems (total survey scores) (Table 2). Participants who had owned their hearing aid(s) for more than 12 months were found to self-report a greater number of hearing aid related problems than those who had owned their hearing aid for less than 12 months. Participants with poor hearing aid

management skills and knowledge (low HASKI-self scores) were more likely to self-report a greater number of hearing aid problems. No significant interactions were identified between variables. Those participants self-reporting a greater number of hearing aid problems also self-reported lower hearing aid benefit and satisfaction, and responded with lower IOI-HA scores (Table 2).

Table 3. The association between individual problems listed on the survey (presence of absence of problems) and hearing aid outcomes (IOI-HA total scores).

Hearing aid problems investigated	Significant differences in IOI-HA scores between those individuals who were experiencing the problem and those who were not using ANOVA
Hearing Aid Management	
1. Do you have trouble inserting the hearing aid?	0.002
2. Is your hearing aid uncomfortable, or does it make your ears itch?	<0.001
3. Does your hearing aid falls off/out of your ear?	0.001
4. Does your hearing aid whistle (feedback)?	0.485
5. Does your hearing aid get lost?	0.898
6. Do you have trouble changing the battery, or knowing when to change the battery?	0.009
7. Do you have trouble cleaning the hearing aid?	0.329
8. Do you have trouble making program or volume changes on the hearing aid?	0.001
9. Do you have trouble changing the small components of the hearing aid, such as the microphone cover or dome or wax guard?	0.002
10. Are you unsure what the buttons on your hearing aid do?	0.089
11. Do you have trouble using your remote control/ charger unit Bluetooth streamer/ TV streamer/FM system/ Rodger pen?	0.152
12. Are you unsure what to do when your hearing aid stops working?	0.063
13. Are you unsure how to fix your hearing aid if it gets wet?	0.052
14. Are you unsure how to use your dry aid kit (dehumidifier or dry store)?	0.027
Hearing Aid Sound Quality and Performance	
15. Does your hearing aid make some sounds too loud?	<0.001
16. Do you have trouble hearing certain voices with your hearing aid?	<0.001

17. Does your hearing aid pick up sounds that you do not want to hear?	<0.001
18. Does your hearing aid sound sharp and high pitched?	<0.001
19. Do you hear better through one hearing aid than the other and does this bother you?	0.105
20. Does your hearing aid have trouble picking up people speaking from behind you?	<0.001
21. Does your hearing aid have trouble picking up people speaking from the next room?	<0.001
22. Are you unhappy with the sound of your own voice?	<0.001
23. Does the hearing aid distort the sound when you are listening to music?	<0.001
24. Does your hearing aid have trouble picking up people speaking in noisy environments?	<0.001
25. Does your hearing aid have trouble picking up people speaking in windy environments?	<0.001
26. Do you find hearing on the phone difficult when wearing the hearing aid?	0.008

The individual problems found to be associated with poorer hearing aid outcomes are reported in Table 3. A greater number of individual problems describing hearing aid sound quality and performance were found to be associated with hearing aid outcomes, than those individual problems describing hearing aid management.

DISCUSSION

The purpose of this study was to explore the prevalence of problems relating to hearing aid use, participants' help-seeking behaviours for the problems they were experiencing, and factors associated with hearing aid problems.

The hearing aid problems most often reported by participants in the present study were related to sound quality and performance, primarily understanding speech in the presence of a competing noise. There is an extensive body of work highlighting the negative impact that difficulty hearing in noise can have on hearing aid uptake (for a review, see Ng & Loke, 2015) and hearing aid use (for a review, see McCormack & Fortnum, 2013). It is worth noting, however, that the level of the background noise is often a modifiable factor, and

that a reduction in the level of noise can result in improved speech intelligibility (Levitt, 2001). Thus, educating hearing aid owners on appropriate ways to modify the levels of background noise in their environments could help them to overcome or prevent noise related problems.

A key finding of the current study was that over half (54%) of the problems reported by participants had not been reported to the clinic. This is a missed opportunity, as those problems that were identified as being least likely to be reported to the clinic were largely resolvable. For example, problems relating to wind noise (a vibrational sound caused by a turbulent flow of air hitting the microphone) can be reduced by decreasing the gain for low-level inputs, increasing the compression ratio for high-level inputs, and activating modulation-based noise reduction algorithms (Chung, 2012). Problems relating to device management (such as hearing aid retention and comfort, or use of the program buttons or dry aid kit) are solvable through device modification and client retraining (Bennett et al., 2016; Bennett et al., 2018c; Saunders et al., 2018).

Exploration of the reasons for not seeking help for hearing aid problems was beyond the scope of this study; however, the literature suggests that participants may not have sought help as they may have been unaware that they were experiencing problems (Desjardins & Doherty, 2009), unaware that the problems that they were experiencing were rectifiable (Southall, Gagné & Leroux, 2006), or unsure how to get help (Bennett, Laplante-Lévesque & Eikelboom, 2018b). A recent study using group interview with hearing aid owners and hearing healthcare clinicians identified 70 different ways in which people respond to hearing aid problems, including helpful behaviours (such as problem solving or seeking external help) and unhelpful behaviours (such as putting up with the problem or experiencing negative emotions that thwart help-seeking) (Bennett, Laplante-Lévesque & Eikelboom,

2018b). Hearing healthcare clinicians could improve patient outcomes by increasing use of the helpful behaviours, such as offering written handouts or training DVDs (Ferguson et al., 2016), group training sessions (Collins et al., 2013) and by involving communication partners (Preminger, 2003; Preminger & Lind, 2012). Clinicians could promote problem solving behaviours not only by training hearing aid owners in trouble shooting techniques, but also through promoting use of trial and error techniques derived from the hearing aid owners' personal experiences (Bennett et al., 2018b).

Another key finding of the present study was the persistence of hearing aid problems, even after being reported to the clinic. Across the study sample, 46% of problems identified had been reported to the clinic and yet were unresolved. It is possible that some of these problems may not be rectifiable for some people. Of those participants who also reported difficulty managing the small components of the hearing aid (such as the microphone cover or dome or wax protection system), nearly half had reported these issues to the clinic, yet the problems persisted. Previous studies have indicated issues with the design of hearing aid features, including microphone covers that are too small for hearing aid owners to manage themselves (Bennett et al., 2016) or manual controls that are difficult to manage due to age related reductions in dexterity and haptic touch (Singh et al., 2013).

It is also possible that hearing aid problem resolution did not occur due to communication mismatch. In the present study, nearly two thirds of participants that experienced issues with the loudness and sharpness of their hearing aids indicated having previously reported these issues to their clinician. While loudness and sharpness are required for audibility of sounds, comfort of the device is required to ensure ongoing use (Dillon, 2008). Therefore clinicians play a pivotal role in finding the balance between the

right settings to meet client needs for audibility and listening comfort. It is possible these clients may have tried to express their hearing aid problems to their clinician, but their clinician may not have understood or fully heard their clients concerns. Clinicians' tendencies to ignore content raised by clients in the audiology setting, and instead focus on their own agenda, have been previously described in the literature (Ekberg, Grenness & Hickson, 2014; Grenness et al., 2015; Meyer et al., 2017). Qualitative studies with hearing aid owners have highlighted the importance of comprehensive, clear and simple information and training to prevent hearing aid problems from arising, and empower hearing aid owners to resolve these problems as they arise (Bennett et al., 2018a; Poost-Foroosh et al., 2011). Targeted interventions may be the key to improving hearing healthcare clinicians' listening and counselling skills in the audiology setting (Coleman et al., 2018; Munoz et al., 2017).

The significant positive association found between hearing aid problems, and hearing aid management skills and knowledge highlights the importance of hearing aid education and training for optimal audiological outcomes. A recent qualitative study involving adults with hearing loss and hearing healthcare clinicians identified the overwhelmingly large amount of hearing aid related information that has to be transferred from clinician to client during the rehabilitation process (Bennett, Meyer, Eikelboom, et al., 2018e). Data suggested that clinicians may (consciously or subconsciously) withhold aspects of hearing aid information from clients due to the large amount of information and training that audiologists are currently expected to administer in a very small time period. When clinicians make a judgement call as to those hearing aid owners who require particular items of information or training and those who do not, it is possible that some hearing aid owners do not receive the information or training they require. Use of existing surveys, such as the

HASK (Saunders et al., 2018) or HASKI (Bennett et al., 2018c) to improve hearing aid training could potentially prevent hearing aid problems arising, and consequently address the large number of hearing aid problems experienced by hearing aid owners. Furthermore, education and training programmes have been developed to assist the process of hearing aid adoption and use, with these program showing promising outcomes (Ferguson et al., 2016; Thorén et al., 2014).

The relationship between prevalence of hearing aid problems and self-reported hearing aid outcomes, benefit and satisfaction identified in the present study is not surprising, yet it highlights the importance of hearing aid problem prevention and resolution. An important component of the management of chronic illness is the enabling and encouragement of self-management of the condition (Holman & Lorig, 2004). The benefits of self-management skills in hearing aid ownership have been demonstrated in their association with successful hearing aid outcomes (Barker et al., 2016). A recent Cochrane review assessing the long-term effectiveness of interventions to promote the use of hearing aids, found that when clinicians promoted self-management of the condition, clients reported less hearing handicap and improved verbal communication over the short term. Self-management education promotes problem-solving skills, where the objective is to empower and prepare individuals to self-manage their hearing loss and associated problems (Handscorn et al., 2017). This can be achieved through giving information, practicing or role-playing in the clinic, or by asking people to practise tasks at home (Barker et al., 2016). Informing clients of the common problems that arise with hearing aid ownership, teaching them how to prevent these problems from occurring, and empowering them with the skills and knowledge to address these problems in the event that they do arise promotes self-management of the hearing loss.

Clinical implications

Although the survey developed in this study was designed primarily for research purposes, it has potential applications for clinical use as a tool to assist with the identification of problems relating to hearing aid use, facilitating early detection and resolution of hearing aid problems, and subsequently improving hearing aid outcomes. When setting up a hearing aid, clinicians will program it based on research driven prescriptive formulas (Keidser, Dillon, Flax, Ching & Brewer, 2011). However, when wearing the hearing aid in their real-life environment, clients often experience issues with physical fit and comfort, as well as sound quality and performance. Clients often return to the clinic with these complaints, requiring the clinician to make modifications to the hearing aid. There are currently no real evidence-based guidelines for how to make these modifications, nor limits as to how the clinician might adjust the hearing aid (Dillon et al., 2006). During this process clinicians face the balancing act of determining the nature of the client's complaint, deducing the acoustics associated with the problematic situation, inferring which parameter of the hearing aid to adjust, including the appropriate direction and extent of the adjustment to be made, and all while maintaining the settings currently providing benefit to the client (Dillon et al., 2006). Through this complex process, clinicians generally address one problem at a time. That is, when a client reports a problem, the clinician adjusts the hearing aid to address that problem, potentially causing or exacerbating other problems relating to sound quality and performance (Bennett et al, 2018a). For example, reducing amplification may overcome issues relating to feedback, but may simultaneously reduce audibility for speech. Development of a clinical survey identifying the full array of problems being experienced by an individual hearing aid owner (and those areas in which the hearing aid is performing well) could facilitate informed decision making on which hearing aid

parameters to adjust and by how much so as not to compromise the well performing aspects of hearing aid function. Furthermore, if a large number of problems are identified, such a survey could facilitate shared decision making regarding which problems should be addressed first within the limited time of the appointment. Additionally, such a survey could assist information sharing, such as facilitating discussions surrounding the trade-off that occurs between some hearing aid features. For example, if the survey identifies that the client is having difficulty with audibility of children's voices and also issues with the hearing aid sounding tinny, then the clinician can use these two personal examples to explain that adjusting the high frequency amplification of the hearing aid will improve one but simultaneously exacerbate the other. This could support the clinician in personalising discussions around acclimatisation and expectations.

Limitations and future research

While this study was conducted with a large and diverse multicentre sample of hearing aid owners, all participants were older adult hearing aid owners from Australia and thus the prevalence and impact of hearing aid problems in other populations is unknown. Further research investigating the experience of hearing aid problems in sub-populations such as those with poor dexterity or haptic touch, vision impairment, low working memory, language barriers, or rural access or funding restrictions could provide valuable insight. The response rate in this study was lower than those reported elsewhere; however, this is likely due to the differing approach undertaken. That is, where other studies sent reminder emails, we only sent potential participants one copy of the survey (paper or electronic) and made no further contact. The lack of reminders may have influenced the response rate, but

also biased the results in that participants wanting to report their hearing aid difficulties may have been more inclined to complete the survey. Although the current study employed rigorous methods for the development and pilot testing of the survey evaluating hearing aid problems, it is plausible that the wording of some of the items may have caused confusion for some clients due to the double negative or vague wording used. For example, item 12 “Are you unsure what to do when your hearing aid stops working?” may be too vague. Similarly, in item 2 the term “uncomfortable” may be interpreted as physical discomfort (as intended) or as acoustic discomfort, which may have caused confusion for some participants. As such further refinement and validation of the survey is required before we can recommend it for clinical use.

Participants’ cognitive function was not evaluated in this study, so we are unable to determine whether all participants were able to complete the survey accurately. Investigations into whether baseline cognitive function affects experiences with hearing aid problems, or ability to complete the self-report surveys would be useful to inform the clinical application of such surveys. The current study classified hearing aid problems as either being reported to the clinic or not. No time frame was placed on this question therefore it is possible that for some hearing aid owners, the problem had persisted for many months or years and they have actively chosen not to report the problem; however, for others, it is possible that the problem had only recently arisen, and they may not yet have had a chance to report them. While the findings of this study suggest that the number of hearing aid problems experienced can impact on hearing aid outcomes, it would be interesting to explore whether the severity of problems being experienced also impacts on outcomes. Future research might also look at whether hearing aid owners’ self-reported hearing aid problems are congruent with clinicians’ perceptions of problem presence.

Specifically, whether items such as difficulty hearing in noise are due to modifiable parameters (such as device settings, or clients' appropriate use of the device in noisy situations, including positioning of oneself in relation to the noise source), or whether they are due to non-modifiable parameters (such as the severity of the hearing loss or the limitations of current hearing aids).

CONCLUSIONS

The majority of hearing aid owners experience problems with their hearing aids, many of which has never been reported to the clinic or remained unresolved once reported. The problems related to the sound quality and performance of the hearing aid was amongst the highest reported but unresolved experiences. Participants who reported experiencing a greater number of hearing aid problems also reported lower levels of hearing aid benefit and satisfaction with their hearing aids as well as lower knowledge and management skills. Addressing the device-related problems associated with hearing aid use would likely contribute to improved hearing aid outcomes.

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