

Supplemental materials

Figure A. Search strategy.

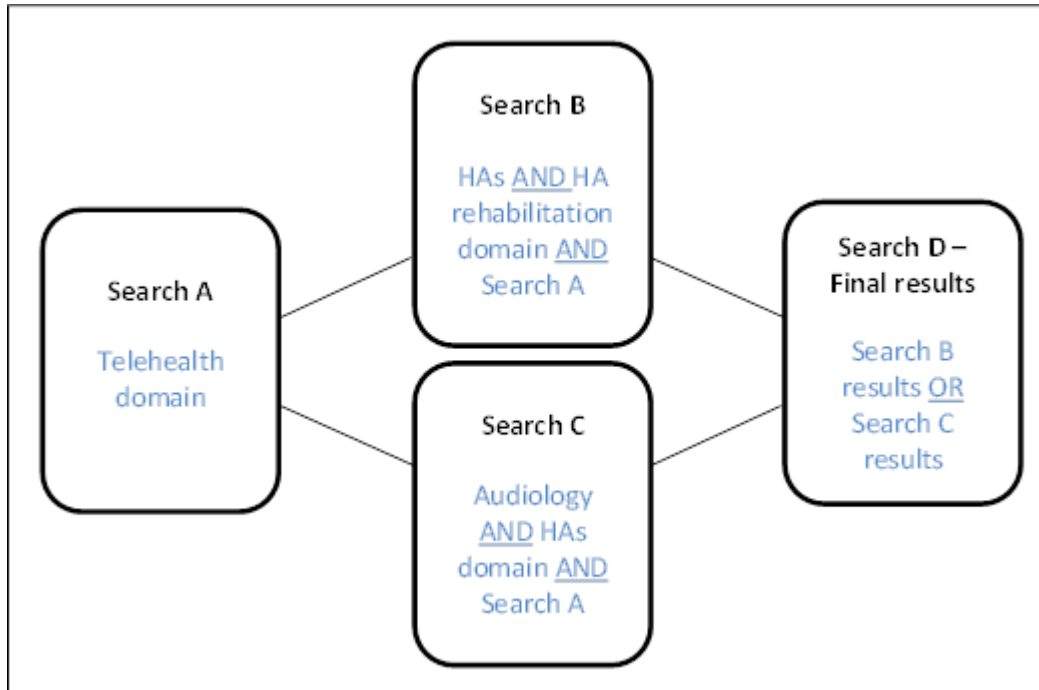


Table A.1. Search history run on CINAHL Plus (EBSCO HOST) database (1937 to current) on 20 May 2017.

Search ID #	Search key words	Number of retrieved results
S7	S5 OR S6	56
S6	S1 AND S2 AND S3	37
S5	S1 AND S2 AND S4	46
S4	Rehabilitation OR fitting OR “follow up” OR “follow-up” OR “outcome assessments” OR “outcomes assessments” OR “outcomes assessment” OR “outcome assessment” OR consultation OR consultations OR “face-to-face” OR intervention OR counselling OR counseling OR “fine-tune” OR “fine-tuning” OR tuning OR adjustment OR adjustments OR programming	658,942
S3	Audiolog*	57,105
S2	“hearing aid” OR “hearing-aid” OR “hearing aids” OR “hearing-aids”	8,758
S1	Telemedicine OR ehealth OR "e_health" OR "e-health" teleintervention OR tele-intervention OR mhealth Or “m-health” OR “m_health” OR telehealth OR "tele-health" OR teleaudiology OR "tele-audiology" OR teleconsultation OR "tele-consultation" OR telefitting OR "tele-fitting" OR remote OR telerehabilitation OR "tele-rehabilitation" OR telepractice OR "tele-practice" OR "telehearing" OR "tele-hearing" OR teleintervention OR tele-intervention OR mhealth Or “m-health” OR “m_health”	31,124

Table A.2. Search history run on Ovid EMBASE database (1946 to current) on 20 May 2017.

Search ID #	Search Mesh Terms	Number of retrieved results
1	exp telemedicine/	7835
2	exp computer communication networks/	14168
3	exp remote consultation/	7678
4	1 or 2 or 3	40761
5	exp hearing aids/	203678
6	exp audiology/	5387
7	exp "correction of hearing impairment"/	3024
8	exp "continuity of patient care"/	651234
9	exp treatment outcome/	1248131
10	exp patient outcome assessment/	370650
11	exp "quality of health care"/	2478012
12	exp "delivery of health care"/	2587676
13	7 or 8 or 9 or 10 or 11 or 12	4599159
14	4 and 5 and 13	28
15	4 and 5 and 6	4
16	14 or 15	28

Table B. Summary of included studies

Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Ferrari, Rasmussen, Paulsen, Andersen & Larsen.	2006	Brazil	Randomized study	Synchronous Internet-based	Fitting	HA programming, verification (REM)	"To evaluate the efficacy of an internet-based HA programming and verification as a tool to improve quality of HA fitting in distant areas."	New HA users. Mild to severe sensorineural HL (around 60% moderate). Symmetrical HL (n=27) 30 participants: control group (n=15) - 60.8/47-78 y.o.; experimental group (n=25) - 61.6/44-75 y.o.)	Control group received standard HA consultation. Intervention group received the HA programming and verification (REM) remotely. Facilitator was an untrained audiologist. At the end of the session, a designed questionnaire was applied to all participants to access confidence, interaction, counselling, communication quality, satisfaction. Ten participants of the intervention group remotely repeated REM in the better ear in 3 distinct intervals (6 weeks), and REIG analysis were reported.	"The findings, yet preliminary, suggest that remote HA programming and verification can be used to improve the quality of HA fitting and professional training."
Ferrari, DV & Bernardez-Braga, GR	2009	Brazil	not reported	Synchronous Internet-based	Fitting	Verification (REM)	"To assess the feasibility of hearing aid probe microphone measurement via remote computing technology."	Experienced HA users. Uni and bilateral HL. 60 participants (105 ears tested - 67/ 18-84 y.o.)	Evaluations took place in the same room and same set up for both, face-to-face (FF) and remote (R) consultations. Participants were in a sound treated room with a loudspeaker positioned in front of them (0.5m away). A facilitator (audiologist not familiar with probe measures) performed the remote measurements after otoscopy by following instructions. Speech noise was used at 65 dB SPL. The REUR, REAR and REIG were measured at frequencies from 250Hz to 6kHz.	"Remote probe microphone measurements are feasible and might improve the quality of public hearing aids services and professional training in Brazil". "Therefore remote computing measures were also affected by the facilitator's ability to follow the instructions provided by the audiologist, via videoconference".

Table B. Summary of included studies (*continued*)

Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Campos, PD & Ferrari, DV	2012	Brazil	Prospective, randomized, blind study	Synchronous Internet-based. (Remote consultations were from another building 300m away).	Fitting	Fitting, verification (REM), programming, instructions and counselling	"To obtain more information regarding the outcomes of teleconsultation for: HA programming, verification, fitting; and the provision of informational counselling to patients, when compared to face-to-face consultations"	New users. Mild to severe HL. Symmetrical HL. Not perceived associated disabilities. 50 participants (39-88 y.o): control group (n=25); experimental group (n=25).	Facilitator (SLP-Aud student without experience in HA fitting) performed: otologic inspection, HA connection to the programming cables and the Hi-Pro interface, HA/ear mould insertion and removal, participant positioning in the test environment and probe tube calibration, insertion and removal. In FF and remote consultations, audiologist performed: HA programming (Hi-Pro use), verification (REMs -used unmodulated speech in noise stimuli - only REIG analysis were reported), fine-tuning, informational counselling, instructions, demonstration and training on HA use and management. Gain sometimes had to be reduced to a comfortable level or modified if complaints persisted. A second evaluator blinded for the service model assessed the outcomes by applying HINT test in quiet and in noise (using HINT PRO software) straight after the fitting consultations. Measured the time spent for specific procedures (fitting, programming, verification, instructions and counselling) and for the overall consultations (FF and R). One month later, patient returned for a FF consultation, the data logging was accessed and the IOI-HA questionnaire was applied. In cases that data logging showed "zero", patients received the service (HA adjustments, instructions and counselling), were booked for a new appointment and then completed the IOI-HA questionnaire.	"Teleconsultation is an effective service model to perform hearing aid programming, verification and to provide informational counselling".

Table B. Summary of included studies (*continued*)

Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Reginato, TTP & Ferrari, DV	2014	Brazil	Prospective, randomized and controlled study	Synchronous Internet-based	Fitting	Fitting, verification (REM), programming, instructions and counselling	"To evaluate professional-patient communication during the process of hearing aid programming and fitting via teleconsultation and patient satisfaction with this kind of service compared to traditional face-to-face consultation"	New users. Mild to severe HL. Symmetrical HL. Not perceived associated disabilities, except for visual impairment correctable with lenses. 40 participants: control group (n=20) - 69.15 ±14.97 y.o; experimental group (n=20) - 69.95±13.46 y.o	Same procedures for control and experimental group. Facilitator (SLP-Aud without any experience in the HA selection and fitting process) to connect the HAs to the programming cables, to calibrate probe tube, insert and remove HA and/or probe tube. After Audiologist perform the HA programming and verification, instructions and counselling on: HA and/or ear moulds handling and care; battery insertion and removal; HA and/or ear mould insertion and removal, program and volume buttons when available, and phone use. PEQ questionnaire was applied in both groups after HA programming and verification procedure to capture patient's experience of interaction, emotion and consultation immediate outcome and to evaluate the quality of the service after consultation. Clinician-patient behaviours were observed in both type of consultations (FF and R) and evaluated using the Davis Observation Code (DOC).	"In the programming and verification process of the individual device of sound amplification, there was a prevalence of technical, information supply and professional in the professional/patient communication behaviours, which may have reflected the generally procedural nature of this consultation as well as the influence of the biomedical model. The performance of the hearing aid programming and fitting via teleconsultation impacted some aspects of professional--patient communication; however, patient satisfaction regarding the care provided was not affected"

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Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Pearce, W; Ching, TYC & Dillon, H	2009	Australia	Pilot-study	Synchronous (wireless broadband mobile card - up to 7.2 megabits per second)	Fitting (case 3) and Follow up (case 4 and 5)	Programming and verification (case 3)/ Fine-adjustments and counselling (case 4)/ instructions (case 5)	"To explore the feasibility of an alternative means of delivering services"	5 participants (2 in assessments and 3 in HA rehabilitation)	"Hearing assistants were trained to assist with fitting headsets or REM probes" in the remote site. Audiologist was in the city clinic and the assistant were in the remote clinic. Assessment (video-otoscopy, audiometry and tympanometry - case 1 and 2); fitting consultation (programming and verification - Case 3); follow-up consultation (adjustments and counselling - Case 4) and also instructions on HA demonstrations - Case 5) were described. No outcome measure was applied.	"Hearing aid fitting and fine-tuning can be carried out remotely. Maintenance of the devices, however, relies on the effectiveness of the local health worker in performing minor trouble-shooting, and knowing about the battery requirements of the range of hearing aids fitted to individual clients on site."
Penteado, SP; Ramos, SL; Battistella, LR; Marone, SAM & Bento, RF	2012	Brazil	Case-study	Synchronous Internet-based. Remote consultation were 200 km away	Fitting	Programming	"To evaluate the benefits and limitations of telemedicine applied to digital HA fittings and to analyse its effective application to hearing rehabilitation under current public policies in Brazil using case presentations from a test telemedicine event."	Bilateral HA experienced users of three different brands (ITC, Open-fit and BTE with ear mould). 3 participants (61, 64, 81 y.o)	A 30 min remote training on the research protocol was provided prior remote consultation to 3 audiologists at the remote site. Despite participants being bilateral HA users, they were fitted in only one ear (justified by not having a secondary objective in assessing the satisfaction with the HA). Their previous HA was maintained in the other ear. HAs were fitted with domes and ear moulds (previously made) and programmed. After that the participants could return to their previous HA without any change. No outcome measure was applied.	"This pioneering work features a remote hearing aid fitting with cooperation between specialists in 2 cities that are 200km apart".

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Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Penteado, SP; Bento, RF; Battistella, LR; Silva, SM & Sooful, P	2014	Brazil	Randomized experimental research design. Pilot study.	Synchronous Internet-based	Follow-up	Fine-adjustments/ counselling	"To examine the feasibility and outcomes of remote HA adjustments by assessing patient satisfaction via the Portuguese version of the SADL questionnaire."	New users (no prior experience with HAs). Mild to severe sensorineural HL. No neurological or psychological impairment, post-lingual HL. 8 participants (71.5 /18-90 y.o)	Facilitator was a non-trained SLP-Aud. Two FF sessions with 15 days apart from each other (one for assessments, ear impressions and another for fitting and initial programming). One follow-up remote consultation after 15 days from the second FF consultation, when HA adjustments and counselling were done and SADL questionnaire was applied straight after the consultation to measure satisfaction with amplification. The results from SADL (means and SD) were compared to the original normative data and to others papers' results that also used SADL.	"Remote HA adjustments (telefitting) have proved effective for these 8 patients, as indicated by their dynamic responses in SADL. Results were comparable to those of patients fitted in the conventional manner (i.e. face-to-face fittings). Thus, the use of telefitting can be seen as an effective method to improve service delivery of hearing health in Brazil."
Laplante-Lévesque, A; Pichora-Fuller, MK; Gagné, J-P	2006	Canada	Multiple-case study	Asynchronous (e-mails)	Follow-up	Counselling	"to explore how an e-health approach could be used to facilitate communication between a new hearing aid user and the audiologist"	New users. Mild to severe sensorineural HL. Sufficient cognitive, visual and manual dexterity to potentially make them manage their HA autonomously and use the computer to check emails. 3 participants (62, 69, 73 y.o)	Daily internet-based communications with the audiologist (researcher) during the first month after HA fitting. The emails provided elements of informational and emotional counselling, to encourage the participants. These were not in replacement of regular appointments with their Audiologists. Content of the daily discussions: hearing fact of the day, questions and comments/experience. Two FF interviews to document their experiences with HA and with the counselling programme: one before HA fitting and other after the follow-up appointment (1 month later). A qualitative analysis was done through all the e-mails and interviews transcripts which were open coded and accorded to grounded theory.	"An internet-based audiological counselling programme in the form of daily e-mails with an audiologist can be a powerful communication medium to explore the day-to-day experiences of new hearing aid users. It also allows the observation of changes in the behaviours and perceptions of new hearing aid users during the period after the hearing aid fitting." and also "can be an interesting communication medium to provide audiological counselling to new hearing aid users."

Table B. Summary of included studies (*continued*)

Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Cherry, R & Rubinstein, A	1994	USA	Randomized study	Synchronous (telephone initiated contact)	Follow-up	Instructions/ counselling	"To determine whether periodic clinician-initiated telephone contact during 3 months period following purchase would reduce the number of unresolved complaints and increase satisfaction, use and perceived benefit."	New (n=33) and experience HA users (n=27). Majority fitted unilaterally in both groups. Mild to moderate HL (based on 3PTA: control-38dB HL ±13.3; experimental 43 dB HL ±14.8). 58 participants: control and experimental group (n=29 - interviews and n=26 - HHIE).	Telephone and no telephone intervention (TI) group. "Subjects in the TI group were contacted by telephone at 6, 9 and 12 wk post-HA fitting in which times they were asked whether they were experiencing any problems (e.g. feedback, discomfort, handling of aid, etc.). Problems were addressed through trouble-shooting (e.g., dead batteries) and counselling over the phone, or if indicated, subjects were scheduled for a clinic appointment. Subjects' questions were answered at that time as well. Four months after the dispensing of the aid, subjects in both groups were interviewed on the telephone regarding their use, satisfaction, and problems" (Audiologist had a prompt list to follow). "A significant other, when available, was also asked several questions regarding use and benefit of the aid in order to verify responses and gain further insight." Complaints transcripts were analysed. HHIE was filled out prior HA fitting in unaided condition. Immediately following the telephone interview (aided condition), the "HHIE questionnaire was mailed along with a self-addressed envelope to evaluate satisfaction, use and perceived benefit. Subjects were asked to respond according to their aided communication function."	N/A.

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Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Cherry R, Rubinstein A.	1995	USA	not reported	Synchronous (telephone calls)	Follow-up	Instructions/ Counselling	" To determine whether early intervention would result in fewer complaints, greater satisfaction and more frequent use at 1 year post-dispensing"	New (n=30) and experience HA users (n=25). Majority fitted unilaterally in both groups. Mild to moderate HL (based on 3PTA: control- 38dB HL / 23-75 dB HL; experimental 40 dB HL/ 15-75 dB HL). 55 participants: control group (n=27) - 74/ 68-92 y.o ; experimental group (n=28) - 79/ 57-88 y.o	Same study as in 1994, but participants were interviewed again at 1 year post-fitting. Between the interviews (4-mo to 1-y) no clinician-initiated telephone contacts were made. For analysis, it was done the registration of complaints during the first 3 months period and at the 4-mo interview (study in 1994); during the 4-mo to 1 year period without no additional clinician-initiated telephone contacts; and at 1 year interview. No questionnaire was applied. Not reported how satisfaction and use were measured.	N/A

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Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Lundberg, M; Andersson, G & Lunner, T	2011	Sweden	Randomized controlled design.	Synchronous (telephone calls)	Follow-up	Counselling	"To examine the effects of a telephone-supported educational program on hearing and hearing aids for hearing aid users."	Experienced users (fitted 1 year before the study) - binaural fitting: 17 of 33 (experimental group) and 12 of 36 (control group). Mild to moderate conductive or sensorineural HL (3PTA: control - 38 dBHL \pm 7.5 -R; 39.4 dBHL \pm 9.0 - L ; experimental - 39.2 dBHL \pm 10.9 - R, 39.2 dBHL \pm 10.6 - L. HHIE score of at least 20 points (indicative of some residual self-reported hearing handicap). 69 participants (60-75 y.o): control (n=36) - 69 \pm 4.6 y.o; experimental (n=33) -68 \pm 4.0 y.o	HHIE, HADS, IOI-HA and COSI were filled out in the recruitment process. Control and intervention group received the same book chapters: (1 & 2) basic information about hearing, (3 & 4) explain the audiogram, (5) challenges when inner ear damage, (6 & 7) information about HAs, including benefits and limitations and (8) communication strategies. The control participants had 2 weeks to read the book, but they did not discuss the contents of the book with a professional. The intervention group received weekly topic-based reading instructions related to the different chapters. Five telephone calls were made (5 weeks program) in which an audiologist discussed new information with the participant as needed. Weekly tasks were given based on COSI goals. HHIE, HADS and IOI-HA were mailed to all participants at the end of the program. The intervention was evaluated at the last visit to the clinic by applying a self-designed form that included questions about the study process. Evaluation of the book was also assessed.	"Reading about hearing and hearing aids can reduce the hearing handicap and reported anxiety in hearing aid users. In this study, discussing the content of the book that was provided with a professional during weekly telephone consultations and having weekly home assignments further improved emotional well-being, as demonstrated by the HHIE (emotional scale) and HADS (depression scale), but these activities had no effect on hearing aid outcomes as measured by the IOI-HA."

Table B. Summary of included studies (*continued*)

Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Thorén, E et al.	2011	Sweden	Randomized controlled study. Proof of concept	Asynchronous (emails/postings)	Follow-up	Counselling	" To evaluate an online education program for adult experienced HA users including professional guidance by an audiologist"	Experienced HA users for at least 1 year (42% using for >10 years). With significant communication difficulties. 90% of the participants were fitted bilaterally. 67% completed education at university level. Moderate sloping HL (4PTA 52 dB HL ± 25). 59 included participants but 48 analysed - 63.5/ 24-84 y.o: control (n=29 included /24 analysed); experimental (n=30 included/24 analysed)	Participants were recruited through advertisements in daily newspapers. Control attended a discussion forum with weekly topics to discuss with each other but no interaction with an Audiologist (for 5 weeks) and received a hard copy of the course book by mail at the end of the programme. Intervention group attended a 5-wk online education programme including weekly interaction with an Aud. Five chapters of a book were used as online weekly modules: introduction and hearing anatomy; measuring HL; five dimensions of hearing; HAs; and coping strategies and future goals. Tasks and assignments related to the book were given to the intervention group and each module ended with a short quiz of five questions on the content of the week's module (access to next module, only if all the questions was correctly answered) while the intervention group discussed with peers in an online open source platform that was monitored. Participants in the intervention group sent their written work to the audiologist who gave e-mail feedback and advice to the participants within five working days. HHIE, SADL, IOI-HA and HADS questionnaires were completed before the program started (T0), immediately after the study was finished (T1), and at the 6-mo follow-up (T2). These questionnaires were administered online and were to measure the perceived hearing aid benefit, satisfaction with hearing aids, perceived activity limitation, and participation restriction.	"The two forms of intervention applied here, (1) rehabilitative online education and interaction with professional audiologists, and (2) peer group online discussions, both provide positive rehabilitation effects, though not in entirely similar domains of outcome. It is suggested that combining elements of both approaches may provide a more comprehensive rehabilitation, without losing the benefits of either approach".

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Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Thorén, ES et al.	2014	Sweden	Randomized controlled study Proof of concept	Asynchronous (emails/postings)	Follow-up	Counselling	"To evaluate an online intervention program for adult experienced hearing-aid uses."	Experienced HA users for at least 1 year (41% using for >10 years). With significant communication difficulties. 90% of the participants were fitted bilaterally. 75% completed education at university level. Moderate sensorineural sloping HL (4 PTA 42 dB HL ± 21). 76 participants - 69.3/ 26-81 y.o: control (n=38); experimental group (n=38)	The intervention group underwent a 5-wk online intervention while the control group was referred to a waiting list. HHIE, IOI-HA and HADS questionnaires were applied online to measure the perceived activity limitation, participation, restriction, perceived HA benefit, satisfaction with the HA and symptoms of anxiety and depression. The questionnaires administration was before the intervention program started, immediately after the online intervention was finished, and at the three-month follow-up (participants were contacted by e-mail). The online intervention program included self-studies, training and professional coaching in hearing physiology, HAs, and communication strategies, as well as online contact with peers. The program was developed based on four elements; (i) Reading (weekly modules: (1 & 2) introduction, hearing anatomy, hearing aids; (3 & 4) communication strategies; and (5) assistive listening devices, applied relaxation, and guidelines for significant others), (ii) Home training (related to the book - each week, the participants had to complete 4 to 6 different tasks and training), (iii) Interaction with an audiologist (to express how they had addressed the weekly training, discuss their experiences, ask questions related to their hearing situation, etc. Audiologist in turn, gave e-mail feedback and advice to the participants on the reflections within five working days), and (iv) Interaction with peers in an online discussion forum (built on the open-source platform - weekly new topic of discussion).	"This study provides further evidence that the internet can be used to deliver intervention of rehabilitation to hearing-aid users."

Table B. Summary of included studies (*continued*)

Author	Year	Country	Study design (reported by the authors)	Telehealth model	Intervention category (type of consultation)	Intervention subcategory (intervention procedures)	Aim	Study population	Procedures	Author's conclusions
Pross, SE; Bourne AL & Cheung SW	2016	USA	Retrospective case-control	Synchronous (real-time video conferencing)	Fitting	Programming and verification	"To assess effectiveness of TeleAudiology for hearing aid services." The primary goal of this project is a non-inferiority analysis of TA relative to IP on patient perception of hearing aid effectiveness.	Not specified if new or experienced HA users – “veterans nationwide who received hearing aids”. National VHA: experimental group (n=1,009): control (n=41,688). Regional VHA: subgroup analysis: control (n=169), 100% male and mean age 74 y.o.; experimental group (n=338), 96% male and mean age 76 y.o.	Participants were patients from two different care delivery venues: Centralized Ambulatory Veterans Health Administration and Community Based Outpatient Clinics (CBOCs). The intervention group received teleaudiology program that was offered to veterans who mainly have difficulty to travel long distance for a face-to-face consultation, It made use of an audiology technician (facilitator) on the remote side that assisted the audiologist that conducted a hearing evaluation, hearing aid fitting, adjustment and real ear measurements. IOI-HA was distributed by mail after hearing aid fitting and was applied to measure HA effectiveness. “Age, sex, IOI-HA scores and elapsed time between return of IOI-HA survey and receipt of hearing aid(s)” were extracted for subgroup analysis.	“IP and TA encounters to provide hearing aid services to veterans are comparable, as both are highly effective based on IOI-HA results. The noninferiority of TA suggests its adoption to non-veterans may improve access while preserving high satisfaction.”