European Archives of Oto-Rhino-Laryngology (2024) 281:4565–4573
https://doi.org/10.1007/s00405-024-08719-5

REVIEW ARTICLE

Do people with cognitive impairment benefit from cochlear implants? A scoping review

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Received: 8 March 2024 / Accepted: 1 May 2024 / Published online: 7 June 2024

Abstract

Purpose To identify and evaluate the evidence for the benefits of cochlear implants for people with cognitive impairment or dementia in terms of speech recognition, quality of life, behavioural and psychological symptoms of dementia, cognition, function in daily life, mental well-being, and caregiver burden.

Methods Ten electronic databases were searched systematically from inception to December 2023 for studies reporting on outcomes for cochlear implants that included adults identified with cognitive impairment, mild cognitive impairment, or dementia.

Results Thirteen studies were included in this review with a combined total of 222 cochlear implant patients with cognitive impairment, mild cognitive impairment. Two studies were non-randomised controlled design, the remainder were single group studies, case series or single case studies. Evidence suggested that people with cognitive impairment benefit in terms of improved speech recognition from cochlear implants, although they may benefit less than those with healthy cognition and the degree of benefit depends on the level of cognitive impairment. There was no evidence for increased adverse events among those with cognitive impairment. There was limited or no evidence for any other outcome.

Conclusion People with cognitive impairment or dementia do benefit from cochlear implants. To inform policy and clinical practice, further data are needed about the broader benefits of cochlear implants for people with cognitive impairment or dementia, and referral, eligibility, and cochlear implant support needs for people with cognitive impairment and their caregivers.

Keywords Cochlear implant · Dementia · Mild cognitive impairment

Introduction

Based on the population estimates of the prevalence and demographics of hearing loss and cognitive impairment, one would predict that around half of adults with severe or profound hearing loss have either mild cognitive impairment or dementia.

Both hearing loss and cognitive impairment are increasingly prevalent with older age. Global prevalence of dementia was estimated at 6.5% among those aged 40–84 years, increasing to 23.5% among those aged over 85 [1]. Prevalence of mild cognitive impairment—a dementia prodrome—was estimated at around 27.8% of people aged over 80 years although estimates vary according to population and study type [2]. In relation to hearing loss, a large US national population survey identified few people with severe or profound hearing loss (≥ 65 dB HL at 0.5–4 kHz) among those aged under 50 years, although prevalence rapidly increased after age 50, up to 7.53% of people aged over 80 years [3]. The greatest numbers of people with severe or profound hearing loss are in older age groups in which dementia and mild cognitive impairment are also most prevalent. Given that hearing loss is associated with lower

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cognitive performance, increased cognitive decline, and increased dementia risk [4], the actual numbers of people living with both dementia and severe or greater hearing loss is probably greater than would be expected if hearing loss and dementia occurred independently.

With aging populations and increasing numbers of people living with dementia, optimising quality of life for people with dementia is a global priority [5]. Hearing interventions may offer an effective, low-risk, acceptable and desired non-pharmacological solution to improve outcomes for people with dementia or mild cognitive impairment [6, 7]. For cognitively healthy adults, cochlear implants offer improved environmental sound and speech perception, with benefits for quality of life, mental well-being, and social engagement [8–10]. Cochlear implant use is cognitively demanding. Optimal use of cochlear implants requires a period of perceptual learning and adjustment to the stimulus provided by the implant. Cochlear implants also require regular maintenance and incorporation into daily routines. Because of the cognitive demands of cochlear implant use, some may assume that people with cognitive impairments may not be good candidates for cochlear implants or may experience limited benefits from cochlear implants. To our knowledge, the potential benefits and disadvantages of cochlear implants for people with cognitive impairment have not been systematically reviewed.

The objective of this scoping review was to synthesise the evidence base regarding the outcomes of cochlear implants for people with severe or greater hearing loss and cognitive impairment (mild cognitive impairment or dementia) in terms of the following outcomes: (i) adverse events including rates of non-use of cochlear implants, (ii) speech recognition, (iii) hearing-related quality of life, (iv) general quality of life, (v) cognition, (vi) rate of cognitive decline, (vii) behavioural and psychological symptoms of dementia, (viii) mental well-being, (ix) activities of daily living; and (x) caregiver burden.

Methods

The protocol for this study was published in the Figshare data registry (22584391). Due to the lack of randomised controlled trials in this area, scoping review methodology was selected as the most appropriate means of analysis. Systematically conducted scoping reviews encompass various study designs and broader subject material than systematic reviews [11]. Scoping reviews explore the breadth and depth of the existing research to identify areas requiring further investigation [12]. Acquisition, extraction, assessment and reporting of the data in the present review was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Statement [13].

Study selection

Studies were eligible for inclusion if they included adult participants who were: (i) resident in community or long-term care settings; (ii) aged over 50 years (to differentiate from atypical young onset dementia) and (iii) clinically diagnosed with a progressive neurodegenerative condition leading to dementia, including 'mild cognitive impairment' (MCI; defined according to Petersen criteria) [14] or minor neurocognitive disorder (according to DSM-5 criteria), 'dementia' (National Institute of Neurological and Communicative Disorders and Stroke criteria) or major cognitive disorder (according to DSM-5 criteria) including Parkinson's disease dementia, frontotemporal dementia, Lewy body disease, vascular dementia and Alzheimer disease or dementia due to other causes. In a change from the registered review protocol, we also included studies with participants identified with cognitive impairment based on a cognitive screening test at study baseline. Participants must have had acquired adult-onset severe or profound neurosensory hearing loss, (determined by audiological testing; e.g. hearing levels over 65 dB HL; at 0.5–4 kHz). Randomised controlled trials, quasi-experimental studies and observational studies were included. For those studies with comparison conditions, the comparison could have included placebo/sham, standard care, alternative intervention, or no intervention.

Outcome measures of interest were: (i) adverse events including rates of non-use of cochlear implants (ii) speech recognition (e.g. consonant-nucleus-consonant (CNC) percent correct word recognition), (iii) hearing-related quality of life (measured with standardised assessments of hearing disability, (e.g. Hearing Handicap Inventory for the Elderly [15]), (iv) general quality of life (measured with standardised assessments, e.g. Health Utilities Index-3 [16]), (v) cognition (as measured with standardised assessments), (vi) rate of cognitive decline (defined as change in cognitive performance), (vii) behavioural and psychological symptoms of dementia (BPSD;[1] including agitation, aggression,

[1] "Behavioural and psychological symptoms of dementia (BPSD)" and "challenging behavior" are commonly used terms to describe repetitive behaviour, wandering, delusions, hallucinations, sleep disturbances, social inappropriateness, depression/anxiety, and physical aggression among people with dementia. We recognise that 'BPSD' is problematic because such terminology objectifies people's experience. Alternative terminology has been suggested (e.g. "responsive behaviours", to recognise behaviours have meaning, and there are physical, emotional or physical environmental factors that influence behaviour). As these is no consensus for suitable alternative terminology, we use "behavioural and psychological symptoms of dementia" as it is currently the most used term.

psychosis and apathy; measured with standardised assessments), (viii) mental well-being, (ix) activities of daily living (including both instrumental activities and activities of daily living measured with standardised checklists); and (x) caregiver burden (measured with standardised assessments, e.g. Zarit Burden Interview [17]). Studies were included if published in any language. Both peer reviewed studies and articles from the grey literature were included. Editorials, newspaper articles and other forms of popular media were excluded. Studies were not selected based on methodological quality.

Data sources

The search strategy included: (i) computer searches of electronic databased; (ii) consultation with an expert network; and (iii) hand-searching the reference lists of eligible papers for additional studies.

The computer search was carried out with Google (where the first 100 results were screened) and Google Scholar, PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), PsycINFO, CINAHL, AgeInfo, Web of Science, and clinical trials registers ClinicalTrials.gov and the WHO international clinical trials registry platform (ICTRP). Search terms were: ("Dementia"[Mesh] OR "Cognitive Dysfunction"[Mesh] OR dementia[tiab] OR alzheimer*[tiab] OR "cognitive impair*"[tiab] OR "cognitive dysfunction"[tiab] OR "cognitive disorder*"[tiab]) AND ("Cochlear Implants"[Mesh] OR "Cochlear Implantation"[Mesh] OR "cochlear prosthes*"[tiab] OR "cochlear implant*"[tiab]).

The computer search was carried out during December 2023. There was no restriction on the publication date; the search period included the earliest possible date in available each database until the date of the search.

To ensure that all available relevant studies were captured in our review, we undertook an international consultation with ten clinical and/or academic experts in audiology and otolaryngology in the UK, Australia, and Germany. The experts were contacted via email and asked whether they were aware of any relevant published, unpublished, or on-going studies that were not identified based on the computer search. Finally, the reference lists of all papers eligible for inclusion in the review were hand searched to identify further studies of interest.

Study selection

Step 1: Study titles were independently reviewed by the authors and selected for further review if the title included mention of evaluation of cochlear implant intervention or management in adults. *Step 2*: Abstracts were independently reviewed by the first and second authors (PD and HC, k = 0.7 substantial agreement) and selected for further review based on the inclusion criteria described above. If a consensus was not reached, the full text of the paper was reviewed. *Step 3*: Full-text articles of abstracts selected in *Step 2* were reviewed by the first and second authors (k = 0.6 substantial agreement). Disagreements were discussed with additional authors (k = 1.0 perfect agreement following discussion). Full-text articles were reviewed according to the eligibility criteria described above. The study selection process and reasons for exclusion were recorded (Fig. 1).

Data extraction and analysis

Data extraction was based on the parameters listed in Table 1, including participant details, intervention type, and outcome measure. Data were extracted from the full-text article by one reviewer and checked by a second reviewer. Disagreements were recorded and resolved by involvement of an additional reviewer.

Results were summarised descriptively according to whether there was a reported improvement, deterioration, or no change in each respective outcome measure. Where the necessary statistics were reported, effect sizes (Cohen's *d*) for statistically significant changes were calculated with a view to summarise the effects of cochlear implants for each outcome variable, if sufficient data were available. Heterogeneity of study design and outcomes of interest, use of informal outcome measures and lack of reporting of the required statistics precluded statistical synthesis of results across studies. Study design was described according to the *Oxford 2011 Levels of Evidence* [18], which are: Level 1, fully powered randomised controlled trials or meta-analysis; Level 2, controlled trials without randomisation; Level 3, retrospective cohort or case–control studies; Level 4, case series or uncontrolled single group study; and Level 5, expert opinion or case report. Risk of bias was assessed using Downs and Black's checklist [19] for assessing the quality of randomised and non-randomised studies. The checklist contains 27 items pertaining to the quality of reporting, internal and external validity, and statistical power with a maximum possible score of 31. Study quality ratings were carried out independently by reviewers PD and HC. Any disagreements were recorded and resolved by involvement of an additional reviewer.

Results

As summarised in Table 1, we identified 13 papers including two non-randomised controlled trials [20, 21], the remainder being uncontrolled single group, case series or case study designs [22–32]. Four studies reported outcomes in the same patient cohort at different time points [26, 27, 30, 31]. Study

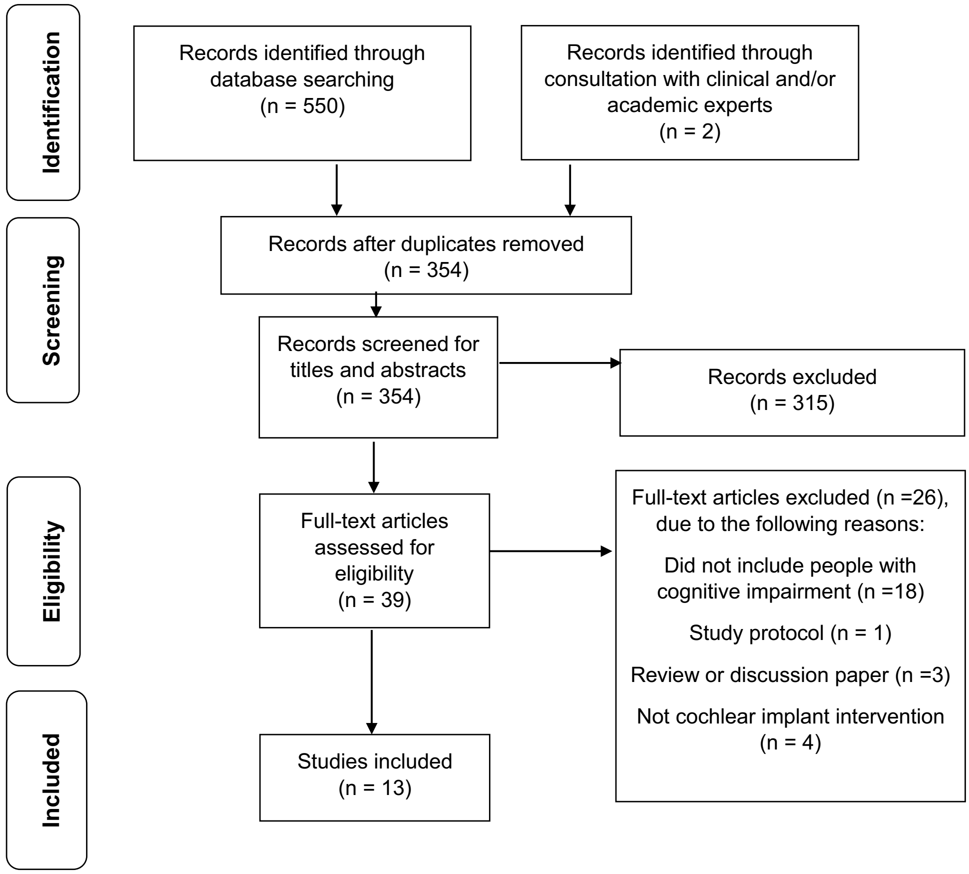

Fig. 1 Preferred reporting items for systematic reviews and meta-analyses flow diagram

quality ratings ranged between 3 and 18 out of a maximum of 31 [19]. The main reasons for low quality ratings were the lack of controlled design elements, unclear generalisability to the population of interest and potential for inclusion bias.

Dementia or MCI status was established predominantly based on a cognitive screening test (Mini Mental Status Examination, Montreal Cognitive Assessment, Self-Administered Gerocognitive Assessment, or Cognitive Disorders Examination) either alone or in combination with other cognitive assessments. Four studies mentioned diagnosis by a clinician, although did not provide details [23–25, 30]. Two studies did not provide details concerning diagnosis of cognitive impairment [28, 29].

Most (8 studies) either did not report on adverse events or non-use or did not report data separately for those with cognitive impairment. The remaining 5 studies reported no adverse events [23, 24, 28, 29], or rates similar to those with healthy cognition [25].

Speech recognition was the most frequently assessed outcome measure. Two studies reported post-implantation improvements in speech recognition that were comparable between those with mild cognitive impairment and those with healthy cognition [20, 32]. A further three studies reported less improvement among those with dementia, mild cognitive impairment or 'cognitive decline condition' than those with healthy cognition [25–27]. Two studies reported stable benefits in speech recognition at 2 years [27] and 7 years [30] post implant among those with mild cognitive impairment or dementia. In contrast, one single case study reported no long-term benefit in speech recognition from the cochlear implant due to cognitive deterioration in a person with dementia [24].

With respect to patient-reported hearing-related quality of life, or general quality of life, one study reported no change in general quality of life post-implant amongst a small group of people with cognitive impairment [32]. One study contained informal reports of improved communication for a single case study of a person with 'early cognitive impairment' [29].

Five studies reported on cognitive outcomes. Four studies reported improvements in cognitive test performance on the Montreal Cognitive Assessment, Cognitive Disorders Examination, Stroop, Test of Attention and Mini Mental Status Examination [20–22, 31], with some people previously identified as having a cognitive impairment reclassified as having healthy cognition based on improved performance on a cognitive screening test [20, 22]. Mosnier et al. [30] reported no statistically significant change in the proportion of people with cognitive impairment after a 7 year follow-up period.

Table 1 Summary of studies included in the review

Author, date	Study design (level of evidence *)	Study quality rating (Max 31)	Participants	Method of determining cognitive impairment	Adverse events; Non-use	Speech recognition	Hearing-related quality of life	General quality of life	Cognition	Behavioural and psychological symptoms	Mental well-being	Activities of daily living	Care partner outcomes
Ambert-Dahan, et al., 2017[22]	Level 4 - uncontrolled single group study.	10	N=8 cognitive impairment or dementia; Mean age 64 (23-83 years) Tested at baseline and 12 months after cochlear implantation.	Screening using Montreal Cognitive Assessment (MoCA) or Cognitive disorders examination (CODEX)	Not reported	Assessed but not reported separately for cognitively impaired groups.	Not reported	Not reported	MoCA: 4 out of 8 participants reclassified as having normal cognition. CODEX: one participant reclassified as Category C (high probability of dementia) from Category D (very high probability of dementia).	Not reported	Not reported	Not reported	Not reported
Babajanian et al., 2022[23]	Level 4 - uncontrolled single group study.	12	N=8 mild cognitive impairment (MCI) Mean age 77.8 (SD= 9.6) years. Average 29 months post-implantation follow-up	Clinician diagnosis	No adverse events	Improvement in post-implant speech recognition (median (AzBio/HINT) = 21% (IQR=24%) versus 44% (IQR 21%).	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Buchman et al., 2020[20]	Level 2 – non-randomised controlled trial.	18	n=47 MCI; n = 49 healthy cognition (HC); Mean age 71 years. Follow-up at 6 months post implantation	Screening using MoCA.	Assessed but not reported separately for cognitively impaired groups.	Improvement in Consonant-Vowel Nucleus-Consonant (CNC) in quiet: 40.9% (95% CI, 35.2%-46.6%); AzBio sentences signal to noise ratio (+10 SNR): 27.5% (95% CI, 21.0%-33.9%) Similar improvements between MCI and HC.	Assessed but not reported separately for cognitively impaired groups.	Not reported	Reduction in the number of participants identified as having MCI at baseline based on MoCA (n=27)	Not reported	Not reported	Not reported	Not reported
Gurgel et al., 2022[21]	Level 3- non-randomised controlled trial	13	N=13 in cognitive impairment; 24 HC; Age 65+ years. Follow up 12 months post implantation.	Screening using Mini Mental Status Examination (MMSE).	Not reported	Not reported	Not reported	Not reported	Improvement in Stroop Colour-Word: -7.2 vs 0.3, p=.03; d2 Test of Attention (Errors): Baseline= 76 vs follow-up= 27 (p=.015). No change in MMSE, digit span tests, Stroop colour-word, Hopkins Verbal Learning Test-Revised (HVLT-R), Hayling sentence completion test, spatial scan, d2 test of attention, Brief Visuospatial Memory Test-Revised, or Trials Making test.	Not reported	No change Global Depression Scale (GDS); 6.5 vs 7.9 (normal range). No interaction with cognitive status.	Not reported	Not reported
Modest et al., 2015[24]	Level 5 – single-subject case study.	10	70-year-old woman with mild dementia associated with superficial siderosis. Follow up 18 months post implantation.	Not reported other than 'diagnosed with dementia'.	No adverse events	Worse CNC Word recognition: Baseline= 42% vs follow-up= 8%.	No sustained subjective benefit from implantation with advancing dementia.	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Wichova et al. 2022[25]	Level 4 – case series	12	N=13 with dementia or 'cognitive decline'; n=89 HC; Aged over 80 years. Follow up >6m post implantation	Dementia or 'cognitive decline condition' diagnosed by primary care physician.	No subgroup analysis for adverse events. Average CI use 10.9hr/day; no difference between cognitive impaired and HC groups	Improvements in speech recognition (CNC words in quiet: 9.4 vs 40.5%; AzBio sentences in noise 10.4 vs 59.5% for whole sample; no differences between cognitive impairment and HC group). Post-implant improvement but poorer sentence recognition in quiet for cognitive impairment group vs HC group (34 vs 55%).	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported

Table 1 (continued)

Wazen et al., 2020[26]	Level 4 – case series	13	14 with MCI or dementia; 26 HC; mean age 78 (65-97) years Follow up 1 year post implantation	Screening using Self-Administered Gerocognitive Assessment (SAGE)	Not reported	Significant improvement in speech recognition, (improvement: CNC 24 vs 49%; Sentences quiet 28 vs 49; sentence in noise 22 vs 28%); although less improvement than HC group.	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Young et al., 2024[27]	Level 4 – case series	13	20 with MCI or dementia; 35 HC; Aged >65 (65 to 93) years Follow up 1 and 2 years post implantation.	Screening using Self-Administered Gerocognitive Assessment (SAGE)	Not reported	Significant improvement in speech recognition at 1 year (CNC 9.8 vs 51.0%; AzBio in Quiet (12.6 vs 61.2%); at 2 years (CNC 9.8 vs 50.2%; AzBio in Quiet 12.6 vs 52.3%); although less improvement than HC group.	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Raymond et al., 2023[32]	Level 4 – case series	14	24 cognitive impairment; 33 healthy cognition; Mean age 68 years. Follow up 1 year post-implantation	Screening using MoCA	Not reported	Improvements in speech recognition (words & sentences in quiet & noise; 47-50% improvement); no difference in improvement for healthy cognition vs cognitive impairment.	Not reported	No change Cochlear Implant Quality of Life-35 (CIQOL-35; n=7 people with cognitive impairment completed)	Not reported	Not reported	Not reported	Not reported	Not reported
Orçan et al., 2018[28]	Level 5 – single-subject case study.	8	81-year-old woman with Alzheimer's dementia	Not reported	No adverse events	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Ohemeng et al., 2019[29]	Level 5 – single-subject case study.	3	103-year-old woman with 'early cognitive impairment'	Not reported	No adverse events	Not reported	Informal report of improved communication	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Mosnier et al., 2018[30]	Level 4 – case series	10	31 MCI; 1 with dementia; 38 HC; aged over 65 years Follow-up at 6m, 1yr, 7yrs post-implantation	Physician classification of MCI based on 'greater degree of cognitive decline than expected' but without significant impairment of daily functioning; dementia based on 'deficit' in two or more areas during study cognitive assessment (MMSE; 5 word test; clock draw; verbal fluency; d2 test of attention; trail making test) and significant social/functional impairment.	Not reported	No change speech recognition between 1 and 7 years.	No change between 1 and 7 years (Nijmegen Cochlear Implant Questionnaire)	Not reported	Cognitive test scores not reported separately for cognitively impaired groups. 2 participants with MCI developed dementia at 7 year follow-up; 10 returned to healthy cognition No statistically significant change in proportion of participant with cognitive impairment	Not reported	Not reported	Not reported	Not reported
Mosnier et al., 2015[31]	Level 4 – case series	13	Mean age 72 (65-85 years); 40 with cognitive impairment. Follow-up at 6m and 1yr post-implantation	Different numbers of participants in 'abnormal' vs 'normal' group depending on cognitive test (MMSE; 5 word test; clock draw; verbal fluency; d2 test of attention; trail making test) 14 'abnormal' MMSE; 81 'normal'	Not reported	Not reported separately for cognitively impaired groups.	Not reported separately for cognitively impaired groups.	Not reported separately for cognitively impaired groups.	Significant improvement in MMSE score for 'abnormal' group (mean 25.8. average improvement 3.7 points at 6m. Improvement maintained at 12m)	Not reported	Not reported separately for cognitively impaired groups.	Not reported	Not reported

Red: worse outcome; Green: improved outcome; Grey: no change

*According to *Oxford 2011 Levels of Evidence* [18]

Only one study reported mental well-being outcomes: Gergel et al. [21] reported no statistically significant change in depression symptoms at 12 months post-implant among those with cognitive impairment. Depression symptoms were within the normal range at pre- and post-implant time points.

No studies reported on behavioural and psychological symptoms of dementia, activities of daily living or care partner outcomes.

Discussion

Cognitive impairment (dementia or mild cognitive impairment) probably affects around half of adults with severe or profound hearing loss who may be candidates for a cochlear implant. To our knowledge, this is the first systematically conducted review of the benefits of cochlear implants for people with cognitive impairment.

Speech recognition

The weight of evidence suggests that people with dementia or mild cognitive impairment do benefit from cochlear implants with respect to improved speech recognition. Although, perhaps due to the impact of cognitive impairment, improvements in speech recognition may not be as great as for those with healthy cognition on average. Benefits of cochlear implants—including long-term prospects for improved communication—may depend on the severity and progression of cognitive impairment. In Wazen et al.'s analysis [26], there was a weak association (r's 0.15–0.19) between pre-operative cognitive performance and post-operative improvement in speech recognition among people with mild cognitive impairment or dementia. One might predict that people with cognitive impairment may require more time and/or training to optimise speech perception with the implant. From the reports in this review, it was not possible to tell whether post-implant improvements in speech perception occurred more slowly in among those with cognitive impairment versus those with healthy cognition.

People with dementia may require additional support to engage with hearing interventions and obtain optimal benefit from treatment [33–35]. Papers in this review did not report what post-implant rehabilitation regimens were provided to patients, nor whether those with cognitive impairment received additional support. To optimise patient outcomes, cochlear implant clinics should develop robust means of identifying those with cognitive impairment and tailoring post-implant rehabilitation support systems to support the needs of those with cognitive impairment.

Cognitive outcomes

Perhaps because of the attention devoted to the potential for hearing interventions to prevent dementia [36], several studies reported on cognitive outcomes post implantation. The general pattern was for improvement, although because there were only two studies that included a control group, it is difficult to be sure whether these apparent improvements in cognitive test performance are due to the cochlear implant, due to a retest effect, or simply due to better audibility of cognitive tests with a spoken component. Note that the potential for hearing interventions for improving cognition and preventing dementia is a different issue to improving outcomes for people living with dementia [37].

Adverse events and non-use

Accelerated cognitive decline has been reported following surgery and general anesthesia [38], along with post-operative cognitive disturbances [39], with adverse outcomes more likely for those with worse pre-operative cognition. In this review, however, there was no suggestion of increased rates of adverse events for those with cognitive impairment. This may be because adverse post-operative events depend on the type of surgery, and cochlear implantation has lower rates of adverse events than other surgeries [40]. Similarly, there was no indication of higher rates of non-use of cochlear implants among people with cognitive impairment compared to those with healthy cognition. One limitation is that non-use of cochlear implants increases over time [8]; most studies in this review included follow-up of up to 1 year only, so any problems with non-use may not have been observed.

Limitations on current knowledge

A general limitation of the included literature is that studies mostly set out to examine outcomes of cochlear implants for older people in general, rather than people with cognitive impairment in particular. Only 3 of the 13 studies in this review aimed to examine outcomes of cochlear implants for people with cognitive impairment. Because studies generally did not focus specifically on outcomes for people with cognitive impairment, several studies did not report some outcomes separately for those with cognitive impairment versus those with healthy cognition, therefore we were unable to report on potential differences between these groups.

All studies were based on routinely collected clinical data. The limitations of the resulting uncontrolled single group, case series and case study designs make it difficult to establish the benefits of cochlear implants reliably in the face of confounding factors including re-test effects and progressive cognitive decline. Furthermore, a critical limitation was that most studies identified cognitive impairment based on a cognitive screening test e.g., the Mini Mental Status Examination. Some cognitive screening tests are known to be impacted by hearing loss [41], and it was not clear what procedures were used to take this into account. Those studies that did report a clinician diagnosis of cognitive impairment did not supply information about what the diagnosis entailed; sensory impairments may increase likelihood of dementia diagnosis due to impact on cognitive tests and similarity of symptoms of hearing loss and cognitive impairment [42]. In summary, one cannot be sure that the people identified with cognitive impairment in the studies included in this review truly had cognitive impairment. Future research would ideally utilise and report clinical criteria for diagnosis of cognitive impairment or use screening tests for cognitive impairment that have been validated for use with people with hearing loss [43, 44].

The current literature is silent on matters of high clinical relevance, including referral of people with cognitive impairment for cochlear implant evaluation, the type and severity of dementia that would indicate that a person is unlikely to use and benefit from a cochlear implant, and additional support needs of people with dementia and their caregivers. Experience in the case of hearing aid rehabilitation suggests that people with dementia may require additional support to consistently use and obtain optimal benefit from a hearing device [33–35].

It is encouraging that there do appear to be benefits in improved speech recognition for cochlear implants for people with cognitive impairment. Treating hearing loss may be particularly important in the context of dementia, because hearing loss exacerbates the impact of cognitive impairment [6]. Hearing interventions may offer an effective solution for reducing the impact of dementia that is highly desired by people living with dementia and hearing loss [45]. Improving outcomes for people living with dementia is a global priority [5], and there is potential for hearing interventions to improve quality of life, mental well-being, behavioural and psychological symptoms of dementia, functional abilities and carer outcomes [7]. Unfortunately, it was unclear whether the reported improvements in psychometric tests of speech recognition translated into improvements in these other outcomes; other outcomes were mostly not assessed or reported in the included studies. To inform policy and clinical practice, it would be useful to index other outcomes that may be important in the context of cognitive impairment, including quality of life, mental well-being, behavioural and psychological symptoms of dementia, functional abilities, and carer outcomes.

Conclusions

Based on population data, one would expect that more than half of adults with severe or greater hearing loss live with mild cognitive impairment or dementia. Cochlear implants offer an opportunity to address the global challenge for improving outcomes for people living with dementia. People with mild cognitive impairment or dementia and severe or profound hearing loss do benefit from cochlear implants in terms of improved speech recognition, with no indication of increased rates of adverse events.

Acknowledgements This work was supported by the National Institute for Health Research (NIHR) Manchester Biomedical Centre (BRC-1215-20007, to H.C. R.M., and P.D.); European Union's Horizon 2020 research and innovation program (Grant 668648 to I.L.); and The Global Brain Health Institute (to I.L.).

Data availability Not applicable.

Declarations

Conflict of interest The research group of Christiane Völter has received funding for research projects that she initiated from MED-EL.

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