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The effects of improving hearing in dementia

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Abstract

Background: audiological function is impaired in people with dementia and poor hearing is known to exaggerate the effects of cognitive deficits.
Objective: the objective of this study was to assess the effects of increasing auditory acuity by providing hearing aids to subjects with dementia who have mild hearing loss.
Method: subjects were screened for hearing impairment and fitted with a hearing aid according to standard clinical practice. Measures of cognition and psychiatric symptoms, activities of daily living, and burden on carers were made over 6 months. Hearing aid diaries were kept to record the acceptability of the hearing aids to the subjects.
Results: more than 10% of eligible subjects were excluded as removal of wax restored hearing. Subjects showed a decline in cognitive function, no change in behavioural or psychiatric symptoms over the study period. Forty-two percent of subjects showed an improvement on an independently rated measure of change. The hearing aids were well accepted. Both carers and subjects reported overall reduction in disability from hearing impairment.
Conclusions: all patients with hearing impairment require thorough examination. The presence of dementia should not preclude assessment for a hearing aid as they are well tolerated and reduce disability caused by hearing impairment. Hearing aids do not improve cognitive function or reduce behavioural or psychiatric symptoms. There is evidence that patients improved on global measures of change.

Keywords: *aged, dementia, audiometry, hearing loss, mental state schedule*

Introduction

Impairment of hearing is a popular target for health promotion in the elderly. It is a common condition, is often undiagnosed and certainly underdiagnosed. It is a cause of significant morbidity and is often treatable. Estimates of the prevalence of hearing impairment in the elderly vary from 30–60% in community samples and up to 97% for residents of institutions [1]. Sixty-six percent of people newly admitted to a residential home had the same degree of impairment of hearing [2], excluding the residents who were more significantly cognitively impaired. Sixteen percent had a severe to profound hearing loss ($\geqslant$60 dB). In a study of 30 chronically institutionalised residents of a veterans administration facility, only 17% had normal hearing [3].

In normal elderly volunteers, the presence of hearing impairment increases the effort required to recognise speech, leaving less reserve for rehearsal and later recall. Higher IQ mitigates this effect (probably as a result of faster processing speed [4]). It is reasonable to predict that, in dementia where information processing speed is further reduced [5], such a reserve is further compromised and the cognitive effects of hearing loss magnified. The prevalence of hearing impairment in subjects diagnosed with dementia is higher than expected [3]. A case controlled study showed that twice as many subjects with dementia had hearing impairment of 30 dB or more

compared to matched controls (odds ratio 2.0) [6]. The association between dementia and deafness disappears when age is taken into account [1].

There are particular grounds for proposing that hearing loss and dementia are associated. Hearing loss can induce social isolation, which can lead to disorientation [7]. Depression is also associated with poor hearing and this may contribute to the apparent cognitive impairment in the form of pseudodementia [8]. Neurodegeneration in Alzheimer's disease may cause specific damage to those parts of the cerebral cortex involved in auditory processing, but the effects of damage to higher cortical areas associated with language processing may be more profound [9]. The simple explanation that hearing impairment reduces the patients' ability to attend to and respond to spoken test instructions is probably not true. Hearing impaired patients given written rather than verbal test instructions had lower scores on cognitive testing [8]. Of course, people with significant cognitive impairment may not have the ability to come forward for help.

Aims of the study

This study monitored the effects of hearing aids to people with hearing loss and dementia. Efficacy was measured in terms of cognitive function, non-cognitive symptoms and carer burden. The acceptability and compliance with hearing aids was measured, as was the improvement in hearing performance.

Methods

Patients were a convenience sample drawn from South and Central Manchester Hospitals and from Tameside Hospital under the care of the old age psychiatrists. Ethics committee approval was obtained prior to the study. Staff from the multi-disciplinary teams in these districts were asked to refer patients with hearing impairment to the study. All subjects had a diagnosis of primary dementia according to Diagnostic and Statistical Manual of Mental Disorders IV (DSM IV) criteria [10]. Subjects were initially screened for hearing impairment by the referring clinician. Screening was performed by the clinician standing about one metre behind the subject, fully exhaling and whispering simple commands such as 'raise your arm'. Subjects were only included if they had a pure tone average hearing loss in the speech frequencies of $\geqslant 40$ dBHL after removal of any occluding wax. Each subject had a carer able to give an account of the subjects' state during the course of the study, though not necessarily through living with the subject.

Subjects were excluded if they were in possession of a functioning hearing aid. Subjects with active ear disease were referred for appropriate treatment, and reconsidered after resolution of the disease.

An audiological relevant history was taken from each subject with the help of their carer. This included questions on how the hearing loss affected the patient, the presence of tinnitus, balance problems, occupational, military or leisure time exposure to excessive noise, and of a family history of hearing loss. Subjects were examined with an otoscope and occluding wax was removed. Pure tone thresholds (air and bone conduction) and uncomfortable loudness levels were ascertained for each ear using the British Society of Audiology (BSA) Recommended procedures [11, 12]. In some cases interruptions to the procedure were necessary in order to remind the subjects of the response required. Middle ear function was measured using tympanometry (BSA Recommended Procedure 1992 [13]).

Case history, audiograms, tympanometric measures and otological findings were considered with regards to signs of pathology requiring further investigation and referrals made appropriately. Patients who had hearing thresholds of 40 dBHL or worse, averaged at 0.5, 1.0, 2.0 and 4.0 kHz in the better hearing ear had an ear impression made according to BSA recommended procedures [14]. The impression was usually taken for the right ear to optimise the right ear advantage of elderly people, unless audiological findings contraindicated this [15]. Upon receipt of the manufactured ear mould, the patients were fitted with the optimum NHS post-aural hearing aid, set according to the National Acoustics Laboratory (revised) prescription formula [16], using real-ear probe tube microphone measurements. Maximum output levels were set according to the patients uncomfortable loudness levels. These procedures enabled calculation of the Speech Intelligibility Index. This is a derived measure of the proportion of the speech spectrum audible before and after the aid is fitted. It is calculated from the unaided pure tone threshold values and aided real ear acoustical measures recorded by a microphone in the ear canal. In this study measures were taken at 65 dBSPL, which equates to normal conversational intensity.

The patient and the carer were instructed in the use and management of the hearing aid. Particularly close monitoring by the research staff followed the fitting of the aid, so that compliance was maximised. This study did not include a control group.

Outcome variables

The outcome measures were chosen to assess the subjects in four domains: cognitive function, activities of daily living, behavioural and psychological symptoms, and an independent measure of change. The primary outcome measures were:

The Mini-Mental State Examination (MMSE) [17]
The Clinical Global Impression of change (CGI) [18] (independently rated).

The Nursing Home Hearing Handicap Index for both patient (NHHHIP) and carer (NHHHIC).
All ratings were carried out after 1, 3 and 6 months.

The secondary outcome measures were:

The Euro-ADAS, a shortened version of the ADAS [19]
The Instrumental Deterioration for Daily Living in Dementia scale (IDDD) [20]
The MOUSEPAD [21]
The Cornell scale for depression in dementia [22]
The Carer Strain Scale [23]
Carer Burden (visual analogue) scale [24].

Subjects were visited every 2 weeks for the first 12 weeks and then every 4 weeks thereafter until the end of the study at 24 weeks. The NHHHIP and NHHHIC were completed at each visit, and the remainder of the outcome variables were rated at 1, 3 and 6 months.

Statistics

Data analysis was performed by the Medical Statistics department in South Manchester. Baseline to end of study changes in outcome variables were compared using paired *t*-tests or Wilcoxon matched pairs tests as appropriate. The effect of compliance with hearing aid was assessed by repeated analyses of variance. Results are shown with 95% confidence intervals.

Results

Eighty-three patients with primary dementia were referred and assessed for the study. Of these, 45 were not eligible for the study for reasons shown in Table 1.

Thirty-five patients entered the study. One withdrew consent after the baseline assessments, one after 3 months. One died after the first month, and one after 3 months. Thirty-one subjects completed the study. Twenty-five (74%) of the patients were female, and the mean age of participants was 84 years [range 67–96, standard deviation (SD) 6.6]. The average unaided pure tone threshold of the better hearing ear was 59.32 dBHL (SD 9.55) indicating moderate to severe hearing loss.

Table 1. Reasons for subject exclusion

n	Reason
2	No hearing impairment on testing by project staff
6	Already using a hearing aid
9	Removal of wax restored hearing
4	Did not consent to study
14	Dementia too severe to complete assessments
7	Died prior to assessment
1	Unable to read
1	Psychopathology (delusions and hallucinations) made testing impossible
1	Diagnosis of primary dementia not confirmed
45	Total

Primary outcome variables

Primary outcome variables are shown in Table 2. The MMSE scores show the expected decline for this subject group [25]. However, the change score shows that over the 24 weeks of the study, less than 30% deteriorated, and more than 40% improved globally. A recent report by Raskind [26] indicated that in untreated patients with the degree of cognitive impairment comparable to that found in our subjects, 87% would be expected to remain unchanged or decline. This compares to a total of 58% who have remained unchanged or declined in our study (χ^2 analysis, $P<0.001$). While comparisons between trials using different interventions have questionable validity, there is no reason to suggest that the deterioration in the untreated group would be any different to that expected in the present study.

Table 2. Primary and secondary outcome variables

		Baseline ($n=35$)	Week 4 ($n=29$)	Week 12 ($n=26$)	Week 24 ($n=27$)	Statistics: mean difference, 95% CI, significance
Primary outcome variables						
MMSE		18.1			16.1	2.0, 0.51–3.2, $P=0.008$
CGI	Worse		13%	27%	28% ($n=24$)	
	Same		57%	35%	30%	
	Better		30%	38%	42%	
NHHHIP (reduction is improvement)		27.5			20.7	6.8, 1.9–10.7, $P=0.007$
NHHHIC (reduction is improvement)		34.3			21.7	12.6, 8.4–17.0, $P=0.001$
Secondary outcome variables						
Euro-ADAS (mean error score)		29.1			31.1	2.9, –1.2–7.0, $P=0.158$, ns
MOUSEPAD median scores		4	3.5	3.5	5	ns
IDDD median scores		66.0			74.0	$P=0.296$, ns
Cornell median scores		2.0			3.0	$P=0.374$, ns
Carer burden scale median scores		3.0			3.0	$P=0.676$, ns
Carer strain scale median scores		4.5			5.0	$P=0.829$, ns

ns = not significant.

Both measures of hearing handicap show improvements (reduction in scores) over the duration of the study, and the degree of improvement is greater in the carers' version of the scale, compared to the subjects' version. There was agreement between the subjects and their carers in the assessment of handicap caused by hearing loss NHHHIP/C (correlation coefficient $r=0.148$, after adjustment for repeated observations).

The Speech Intelligibility Index indicates a 32.9% increase in the proportion of speech audible after fitting of the hearing aid (Table 3).

Secondary outcome variables

Table 2 shows the secondary outcome variables. The deterioration in the Euro-ADAS (greater error score) is less than that which would be expected for this subject group, but the absence of a control group makes interpreting this small change impossible, and no firm conclusion can be drawn. The measure of activities of daily living shows a decline in ability over the study duration, but this decline is not significant. Measures of psychopathology and behaviour (Cornell and MOUSEPAD) showed no significant change.

Reliability of testing procedure, acceptability and compliance with hearing aid

A small number of subjects had their audiograms repeated. Test-retest differences between audiograms were found to be within normal variability, and there was no evidence to suggest unreliability of audiometric measures.

The hearing aid diary records showed that there was a decline in the use of the hearing aid over the 24 weeks. At the second week, 75% of the subjects were using the aid either every day or most days. By the end of the study, this had declined to 56%. However, subjects who used their hearing aid every day were perceived by the carer according to the NHHHIC to have improved significantly more than those who complied less (mean decrease on NHHHIC=17.4 compared to 8.1 for less compliant group, $P=0.034$). Other outcome measures were not affected by compliance with hearing aid use.

Discussion

This study has shown that:

i. Patients with established dementia and hearing impairment benefit from the provision of a hearing aid.
ii. The improvements in the hearing can be measured using assessments previously validated in people without dementia.
iii. There was a correlation between carers' and patients' estimates of improvements of hearing.
iv. Improving hearing did not benefit cognitive function, activities of daily living, psychiatric symptoms or carer burden.
v. Simple removal of earwax can lead to significant hearing improvement in 10% of patients presenting with hearing loss.

Table 3. Speech intelligibility index (SII). The average unaided and aided indices and average improvement for 65 dBSPL speech

	Mean SII (SD)	Mean difference (SD)
Unaided ear	0.123 (0.11)	0.329 (0.133) i.e. 32.9% improvement
Aided ear	0.47 (0.131)	

This was a study without a comparator group but with independent ratings. This group of mild to moderately cognitively impaired patients found the wearing of hearing aids acceptable in the context of regular supervision. However, it was not found that those who were less cognitively impaired used their hearing aids more regularly. This suggests that to confine hearing aid provision to those who are more mildly impaired may be to deny benefits to some patients who will be more tolerant of them. The SII measures indicate a potential improvement in communication function, but audibility cannot be equated with speech discrimination.

The measures chosen were those commonly used in such research, but their relative insensitivity to change from such low baseline scores may have contributed to the negative findings. There was no particular pattern to the psychopathology as recorded by the MOUSEPAD. Although the sample was small, it might have been expected that delusions or over-valued ideas would be more frequent than the expected 30% [27], but this was not the case in this patient group.

The annual rate of decline in MMSE from a baseline of 18 has been shown to be 3.6 [28] and this is perhaps too great a rate of decline for the hearing aids to reverse.

Conclusions

This pilot study underlines the benefits of providing hearing aids to people with dementia. It is not surprising that there were no demonstrable benefits in terms of improvement in cognitive function, activities of daily living, or carer burden, but reassuring that carer burden did not increase. Future studies may consider including a comparison group – perhaps with a non-functioning hearing aid or with a randomised staggered start design or randomised withdrawal.

Key points

- Almost half of mildly hearing impaired patients with dementia improve when hearing loss is restored.
- Patients with dementia can tolerate routine audiological procedures.
- Ten per cent of patients with dementia and hearing loss can benefit from removal of ear wax.

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