

Compensating for Presbycusis-Related Disability: How to Optimize the Care of Hearing-Impaired Elderly Patients?

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Abstract

Age-related hearing loss—also know under the generic term of "presbycusis"—cause disorders of oral communication. By limiting the perceptual-cognitive stimulation of hearing-impaired elderly subjects, it can favor the emergence of psychological and cognitive impairments, among other complications. Presbycusis is a handicap causing a real loss of autonomy, since it deprives the patient of effective communication. Current treatment consists in compensation for hearing loss by wearing bilateral hearing aids, but several studies show that many presbycusis patients do not wear their devices. A major reason is the lack of benefit felt by the patients when using hearing aids. Indeed, presbycusis, which also leads to perceptual distortions, cannot be compensated by hearing aids only. In this paper, we wish to expose the limits of this unimodal approach and suggest more appropriate solutions.

Résumé : Les troubles auditifs liés à l'âge –désignés sous le terme générique de « presbyacousie »– sont à l'origine d'un trouble de la communication orale qui, en limitant les

stimulations perceptivo-cognitives des sujets âgés malentendants, favoriserait l'émergence de troubles psychologiques et cognitifs, entre autres complications. La presbycousie est un handicap qui entraîne une réelle perte d'autonomie, puisqu'elle prive le patient d'une communication efficace. Le traitement actuel consiste à compenser la perte auditive par le port de deux aides auditives, mais plusieurs études montrent que beaucoup de malentendants appareillés ne portent pas leurs appareils. Une des raisons principales est le manque de bénéfice ressenti de l'appareillage auditif. En effet, la presbycousie, qui entraîne également des distorsions perceptives, ne peut pas être uniquement compensée par les aides auditives. Nous souhaitons donc exposer les limites de cette prise en charge unimodale et proposer des solutions plus adaptées.

Key words

Hearing aid, healthcare network, communication, education of caregiver, presbycusis, audioverbal therapy, hearing aid rehabilitation.

***Mots-Clés :** Appareillage auditif, réseau de soins, communication, éducation thérapeutique de l'aidant, presbycousie, rééducation audio-verbale, réhabilitation audioprothétique.*

1. Introduction

Presbycusis is a sensorineural hearing loss that slowly evolves and becomes obvious at 55-60 years [1, 2]. The evolving phenomenon of hearing loss increases with age and is considerably aggravated by acoustic trauma, the use of ototoxic drugs [3] and probably genetic factors [4, 5].

If not treated early enough, presbycusis can have deleterious effects on quality of life and disrupt the psychological and social balance of the patient [6]. Its insidious gradual onset means that the patient does not recognize his hearing loss, thereby potentially causing isolation, depression, mood disorders and cognitive impairment [7].

Studies of the Alzheimer Presbycusis Research Group (GRAPsanté, 2007) [8] and the Lin's team (2011) [9] have identified age-related hearing loss as an independent risk factor for cognitive deterioration in the elderly. Presbycusis actually causes disorders of oral communication which, by limiting the perceptual-cognitive stimulation of hearing-impaired elderly subjects, anticipates the emergence of cognitive impairment by auditory deafferentation [10]. Thus, according to the results of the AcouDem study [8], the risk of developing cognitive problems is multiplied by 2.5 times in patients with hearing impairment with social impact.

These data support the need to provide bilateral hearing aids at an early stage, which is the only effective treatment at the present time [11]. But in effect, it turns out that many patients who are fitted do not wear their hearing aids. [12] The main reasons are a discomfort, difficulties in handling, maintenance costs, and especially lack of perceived efficiency. Indeed, many presbycusis patients are dissatisfied by the performance of their hearing aids and often give up wearing them. A study of the pathophysiology of presbycusis and its consequences allows us to understand this situation and propose solutions.

2. Experienced difficulties

2.1. Physiological data

The main problem of the presbycusis patient is that he hears but does not understand. Physiologically speaking, this is due to an impairment of outer hair cells which predominates at the cochlear base, region of high frequency coding. These high frequencies are extremely important in communication because 60% of elements relevant for speech recognition are located within the upper area to 1000Hz frequency [13].

These neurosensory hair cells of the Cortiorgan are very fragile and do not have the ability to restore or renew themselves. Therefore, when injured, distortions appear beyond repair. [1] Initially, the patient compensates very well for these perceptual distortions, but the more the deafness evolves, the harder it is to offset them. There is a discrepancy between sound shape in memory and the perceived form, creating confusion in understanding a verbal message [14]. For the moment, no cure for presbycusis exists. The rehabilitation is to balance two types of disorders: loss of hearing, corrected by the amplification provided by hearing aids, and suprathreshold distortions, compensated by the aural rehabilitation work proposed by a speech therapist [14]. When outer hair cells are "sick", hearing aids can "put them again into action". But when dead, they no longer have any effect. The inertia of certain areas of the cochlea, called "dead regions", is very common in presbycusis [15], although the standard pure tone audiometry does not identify them. In addition, hearing aids are not sophisticated enough to assign as many channels as there are in the cochlea. These few silent areas cannot be "reactivated" by hearing aids and accentuate the lack of understanding, thereby causing a persistent social disorder. In addition, if hearing aids can be satisfactory at beginning, the inevitable deterioration of hearing will cause them to become insufficient. It is therefore necessary to compensate for this gradual deficit [16]. It is also important to understand the state of mind of the hard of hearing person.

2.2. The presbycusis's state of mind

The presbycusis's profile should be determined from the beginning of the rehabilitation process. Before receiving audiometric evidence of his deafness, the patient is in denial. He blames his difficulties of understanding on his interlocutors. For him, they speak too fast or articulate increasingly poorly. Deafness may even make him aggressive in these situations because understanding requires higher sound levels, at the risk of reaching the pain threshold.

When diagnosis is made, often late, constraints related to hearing aids (cost, aesthetics, comfort, misconceptions ...) can significantly delay the treatment. However, the early adoption of equipment, in addition to patient compliance, is essential for effective rehabilitation [17].

Finally, when he gets hearing aids, presbycusis patient is often disappointed and dissatisfied with the outcomes. He finally gives up the idea of hearing better and leaves his hearing aids, isolating himself and sinking into depression [12].

Technological advances alone thus do not seem sufficient in presbycusis's rehabilitation, although they are indispensable. An earlier treatment supported by a multidisciplinary team would bypass the current difficulties arising from presbycusis, especially since these difficulties have important, but preventable, socioeconomic impacts.

2.3. Socioeconomic data

From an economic point of view, although the cost of hearing aids is high, it is much less when compared to the complications caused by deafness. Indeed, dementia, mood disorders, depression, and social isolation of the elderly are very costly to society. Psychotropic drugs, for example, are not effective against a reactive depression related to hearing loss [18]. Unfortunately, cases of elderly deaf persons taking anxiolytics or antidepressants are not uncommon in nursing homes. Thus we assume that preventing the deleterious consequences of auditory deafferentation, through an early screening and an effective rehabilitation, could significantly cut public health care spending [19]. For example, allowing presbycusis patients to better hear and communicate could delay the entry age into a retirement home and reduce expenditures for the care of deaf dependent elderly, some of whom suffering from associated cognitive impairment [10]. Indeed, solutions exist to improve the management of presbycusis patient.

3. Proposed solutions

In the face of serious consequences of presbycusis, early detection through vocal acoumetry, creating hearing circuits, audioverbal rehabilitation and caregiver training for helping the presbycusis patients are potential solutions to meet their individual needs and prevent hearing loss-induced complications [20].

3.1. Early detection through vocal acoumetry

The diagnosis of presbycusis is often too late and it is usually constrained and forced by his entourage that the presbycusis patient consults an ENT. At this point, the hearing loss is already advanced. This delay makes it more difficult to adapt to hearing aids and aural rehabilitation is much more laborious.

To enable an early screening, the Alzheimer Presbycusis Research Group (*GRAPsanté*) advises general practitioners and geriatricians to systematically practice a whispered vocal acoumetry during every consultation with an elderly patient over 60 years old. This voice test is a convenient, reliable and very sensitive tool (see Table I) that makes it easy to detect a hearing problem. The purpose of this screening is to refer the patient to ENT at the very beginning of the clinical onset of the disease [21]. The GP or geriatrician then becomes the initiator of a hearing care circuit that the patient will follow.

Table 1. Informational value of vocal acoumetry (VAcou) at whispered voice versus pure tone audiometry (TAudio) in an institutionalized elderly population

Thresholds	Results	Pathol. TAudio	Normal TAudio	Sen	Spe	PPV	NPV	Prev
RPT 15 dB HL VAS 75%	Pathol. VAcou	196	1	100%	91%	99.5%	100%	94.7%
	Normal VAcou	0	10					
RPT 21 dB HL VAS 75%	Pathol. VAcou	183	14	100%	41.7%	92.9%	100%	88.4%
	Normal VAcou	0	10					
RPT 30 dB HL VAS 75%	Pathol. VAcou	163	34	100%	22.7%	82.7%	100%	78.7%
	Normal VAcou	0	10					

RPT= reference pathological threshold for tonal audiometry; VAS= vocal acoumetry score; VAcou=vocal acoumetry; TAudio= tonal audiometry; Prev=prevalence of deafness in the experimental population; Sen=sensitivity; Spe=specificity; PPV=positive predictive value; NPV=negative predictive value

3.2 The hearing circuit

The different problems encountered around hearing disorders in elderly are such that they cannot be solved by a practitioner acting alone. However, if the practice is part of a care network, such as the hearing circuit, more favorable outcomes are possible for presbycusis patients. The presbycusis patient often has difficulty recognizing his deafness, deciding to purchase hearing aids and disciplining himself about hearing aids wearing and setting. If he is not followed regularly, by the different members of the hearing circuit, the risk of failure in the short to medium term is important [22].

Centered around the patient, the hearing circuit includes five indispensable partners:

- The geriatrician (or GP) detects deafness and follows patient's evolution.
- The ENT performs audiometric tests, makes the diagnosis and prescribes hearing aids and speech therapy.
- The hearing aid specialist then makes an individual adaptation of the hearing aids relative to the patient's hearing. After several adjustments, the benefit is obvious, in theory. In practice, difficulties in comprehension frequently persist among presbycusis patients, especially in noisy environment or challenging conditions. The degree of hearing loss is not necessarily proportional to difficulties of understanding, but the later the patient begins using the equipment, the more difficult adaptation and recovery will be. With equivalent pure tone audiogram,

patient's social impact may be more or less important, likewise for auditory rehabilitation. In 2011, building on a verbal comprehension test including sentences with high and low phonemic frequencies, called verbal "Acoutest," we showed that presbycusis patients wearing hearing aids, and despite correct adaptation, continued to misperceive high-pitched sentences even while they understood the low-pitched sentences quite well [23]. Wearing hearing aids is essential, but often not enough, and audioverbal therapy is then necessary.

- The speech therapist, last stakeholder of this hearing circuit, effects at the ENT's request a speech therapy assessment with rehabilitation if necessary. This assessment includes verbal "Acoutest" that allow to identify a lack of recognition of high pitched forms of speech in presbycusis patients wearing hearing aids. If the patient understands all the sentences, the speech therapist may focus the rehabilitation on another point. The goal is to make patients aware of aural rehabilitation possibilities, such as using lip reading in noisy environments, and of the importance of having a "caregiver". However, when the test indicates a failure of understanding, 5 to 15 speech therapy sessions are essential to enable the patient to regain full autonomy and to not feel social exclusion. In this context, accompanying patient by a caregiver, throughout his rehabilitation and beyond, is essential.

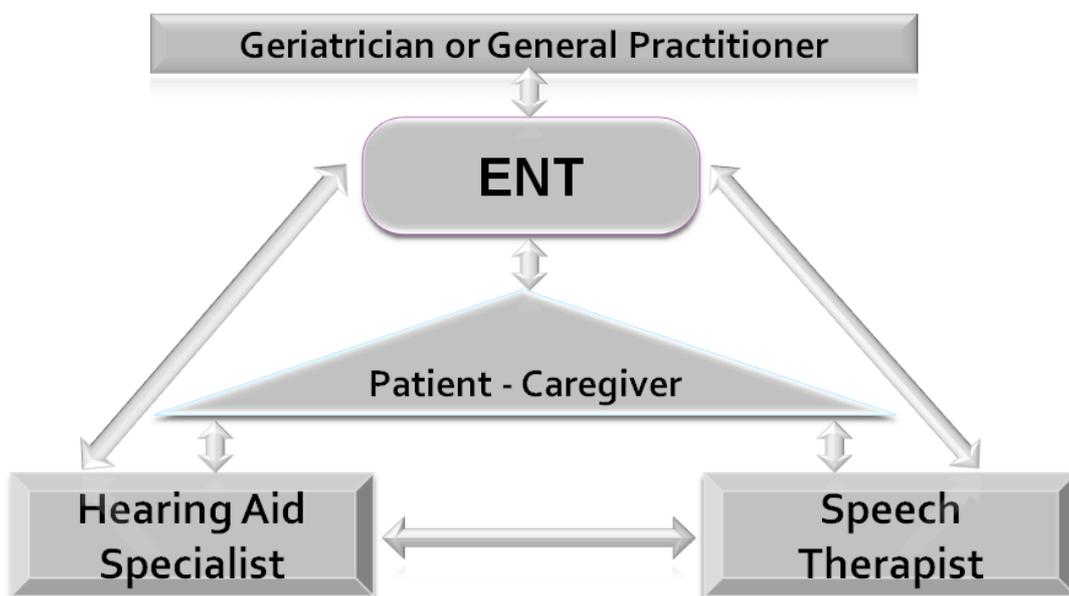


Fig. 1. The hearing circuit recommended by the Alzheimer Presbycusis Research Group (GRAPsanté) for presbycusis patients' health care management.

3.3. Audioverbal therapy

Without audioverbal therapy, the benefit of hearing aids is limited in terms of improving speech understanding. On the other hand, our central auditory system is able to reconstruct

recognition mechanisms for misunderstood words, through repetition-based training (perception of these words being already improved by hearing aids). Focusing rehabilitation on the automation of new sound form recognition, reconstructed from patient's residual and rehabilitated hearing, seems more efficient in real life than letting him persevere in using mental substitution mechanisms based on acoustic profiles previously stored but which will never be perceived again [24]. When it is still possible, mental substitution as the unique way of compensation for auditory confusion is also time consuming during verbal exchanges. The time spent on cognitive reconstruction does not allow presbycusis patients to follow a conversation over time, since the fluidity of exchange disappears, generating a large degree of fatigue. This guessing game, often punctuated by failures and teasing, does not generally pay off and as a result even patients wearing hearing aids may isolate themselves voluntarily. The main goal of the rehabilitation is to work from the patient's residual and rehabilitated hearing. For example, if a presbycusis still does not hear the "S" of "Suzie" and "F" of "Fusil" (rifle, in French), despite his hearing aids, audio-verbal training will consist in bringing out a relevant and beneficial difference for the patient, which becomes familiar enough to him to be easily noticeable. In the above example, the patient would focus on the "U" perceived more or less lowly depending on the word. Audioverbal therapy is therefore essential in presbycusis patient's rehabilitation, provided that all potential stakeholders –GP or geriatrician, hearing aid specialist and speech therapist– agree to interact in a hearing circuit!

3.3. Designation of the caregiver

The caregiver, who comes with the patient at each appointment in the hearing circuit, occupies a key role in the presbycusis's rehabilitation. It is therefore important to also educate him when entering in treatment protocol. Indeed, health professionals are often faced with a lack of cooperation and motivation on the part of the patient for his hearing rehabilitation. They are happy then to be allowed to speak with a "caregiver", a family member or other close acquaintance. The caregiver gives the professionals better insight into the situation and helps the patient to enter fully into the hearing circuit. Once educated by the various stakeholders, the caregiver can monitor the correct wearing of hearing aids and their good working order, guaranteeing good adaptation. The caregiver may also help the presbycusis patient in regaining a satisfactory hearing by assisting him during his audioverbal therapy. During speech therapy sessions, the caregiver is trained to exercise daily with the patient, adapting rehabilitation techniques to real-life and individual situations. The caregiver also helps to better inform professionals about the presbycusis's challenges. The hearing aid specialist adjusts the hearing

aids to the patient while the speech therapist adapts the patient to his hearing aids and to his surrounding world. Their joint action, resulting from collaborative observations, seems very synergistic and can significantly improve the immediate results and regular adjustment over time (based on the current study). Finally, having a personal caregiver enables the patient to receive a "home" and "free" audioverbal rehabilitation for life. The caregiver himself would benefit from this rehabilitation if he became presbycusis in his turn.

Conclusions and Perspectives

Presbycusis causes such extensive complications that it is essential to treat it, accepting its "complexity". Early approach and multidisciplinary management, organized in a hearing circuit, intend to help patients making better use of their hearing aids, by "amplifying" at the same time potential benefits of the standing technical progress. Compensation for the disability therefore is instrumental, functional and psychosocial.

The hearing circuit, which already exists for deaf children and adults with cochlear implants, is a logical addition to the health management of older persons with hearing loss who are often disregarded. Its purpose is to prevent the consequences of presbycusis and avoid as much as possible handicap situations and loss of patient autonomy.

In a society that wants to fight against the abuse of elderly, presbycusis, which features prominently, can and must be treated. An efficient compensation cannot be achieved without the active participation of presbycusis patient and his caregiver, the primary beneficiaries of the hearing circuit.

A comparative interventional study aiming at evaluating the benefits of an optimized management of older deaf subjects in this hearing circuit is currently under development. In this context, the hearing aid rehabilitation combined with audioverbal therapy will be compared to standard care with instrumental rehabilitation only, followed in a second stage by audioverbal therapy. A control group of patients refusing any treatment will also be established: they will benefit from a simple medical follow after which they will be re-offered an appropriate therapeutic management.

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References

1. X Perrot, "Neurosensory deficit in the elderly. Hearing disorders", *Rev Prat*, 62: 1311–1319, 2012.
2. L Vergnon, "L'audition dans le chaos", Elsevier Masson, Issy-les-Moulineaux, 2008.
3. D Bouccara, S Dhouib, L Vergnon, pour le GRAPsanté, "Hearing losses of the adult. Aging and hearing loss: the presbycusis", *Rev Geriatr*, 7:435-450, 2011.
4. L Van Laer, AL DeStefano, RH Myers, K Flothmann, S Thys, E Fransen, GA Gates, G Van Camp, CT Baldwin, "Is DFNA5 a susceptibility gene for age-related hearing impairment?", *Eur J Hum Genet*, 10:883-6, 2002.
5. MH Kemperman, EM De Leenheer, PL Huygen, E van Wijk, G van Duijnhoven, FP Cremers, H Kremer, CW Cremers, "A Dutch family with hearing loss linked to the DFNA20/26 locus", *Arch Otolaryngol Head Neck Surg*, 130:281-8, 2004;
6. M Tardy, "Réseau de santé audition et langage, Vieillesse et perte d'audition ou la perte du statut de « personne »", Journées de la Prévention 2009, INPES, Paris, France http://www.inpes.sante.fr/jp/cr/pdf/2009/session8/PPT_TARDY_Mireille.pdf.
7. M Prevel, S Dhouib, D Aubel, L Vergnon, "La presbyacousie : Signes, Diagnostic et conduite à tenir". *Rev Geriatr*, 10:807-820, 2003.
8. D Pouchain, C Dupuy, M San Jullian, S Dumas, MF Vogel, J Hamdaoui, L Vergnon, "Is presbycusis a risk factor for dementia? AcouDem study", *Rev Geriatr*, 32: 439–445, 2007.
9. Lin FR, Metter EJ, O'Brien RJ, Resnick SM, Zonderman AB, Ferrucci L, "Hearing loss and incident dementia", *Arch Neurol*, 68(2):214-220, 2011
10. C Petitot, X Perrot, L Collet, M Bonnefoy, "Maladie d'Alzheimer, troubles de l'audition et appareillage auditif : une revue des données actuelles", *PsycholNeuroPsychiatr Vieil*, 5(2):121-5, 2007.
11. Direction Générale de la Santé, Inserm. Rapport du GTNDO [Internet], Available from: http://www.eps-polelorraine.fr/actions/S0004/docs/observation_locale/rapport_gtndo.pdf, May p. 469–75, 2004.
12. A McCormack, H Fortnum, "Why do people fitted with hearing aids not wear them?" *Int J. Audiol*, 52(5): 360-8, 2013.
13. P Tran Ba Huy, E Sauvaget, B Azema, "La presbyacousie. Les surdités de perception", Masson, Paris, France, 2001.

14. S Leusie, T Rousseau, N Denni-Krichel, E Lambert, E Danel, J Guibert, D Aubel, L Vergnon, pour le GRAPsanté et Lurco-ERU 35, “Le réseau de l’audition. La place de l’orthophonie dans le traitement de la presbyacousie”, *L’Orthophoniste*, 314:19-26, 2011.
15. T.Y Ching, H Dillon, “A brief overview of factors affecting speech intelligibility of people with hearing loss: implications for amplification”, *Am J Audiol*, 2013.
16. M Prevel, S Dhouib, D Aubel, L Vergnon, “Évolution de l’audition au cours de la vie”, *RevGeriatr*, 9:735-740, 2003.
17. MH Kvam, M Loeb, K Tambs, “Mental health in deaf adults: symptoms of anxiety and depression among hearing and deaf individuals”. *Journal of Deaf Studies and Deaf Education*, 12:1; 1-7, 2007.
18. FB Chatatan, “Depression in old age”, *N Y State J Med*, 75:2505-9, 1975.
19. S Arlinger, “Negative consequences of uncorrected hearing loss. A review”, *International Journal of Audiology*, 42:2S17-2S20, 2003.
20. L Vergnon, X Perrot, JM Vétel, S Leusie, M Ferry, “Compte-Rendu : Le GRAPsanté et la Presbyacousie. Journées annuelles de la société de Gériatrie et de Gérontologie, 8 - 10 octobre 2013”, *RevGeriatr*, 38:779-784, 2013.
21. S Leusie, X Perrot, C Renard, D Aubel, L Vergnon, “Vocal acoumetry: A valid, easy and reliable tool for detecting, quantifying and following up hearing impairment in the elderly. AcoumAudio, a French institutionalized population study”, Cernobbio (Lake Como), Italy, June 2014, HEAL 2014: Abstract Book HEaringAcross the Lifespan, p43.
22. JM Vétel, M Prevel, Ph Taurand, S Leusie, M San Jullian, L Vergnon, pour le GRAPsanté. “The audition Network”, *RevGeriatr*, 36:549-554, 2011.
23. S Leusie, M Prevel, D Aubel, S Dhouib, M Ferry, P Taurand, L Vergnon, pour le GRAPsanté. Is hearing aid the only solution for presbycusis? *Rev Geriatr*, 36-37:50-55, 2011.
24. N Denni-Krichel, A Dumont, S Leusie, E Lambert, C Batchy, M Loustau, Vergnon L, pour le GRAPsanté. La place et le travail de l’orthophoniste dans le traitement de la Presbyacousie. *Rev Geriatr*, 36:529-539, 2011.