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Early management of presbycusis: recommendations from the French Society of Otorhinolaryngology and Head and Neck Surgery, the French Society of Audiology, and the French Society of Geriatrics and Gerontology

Recommandations de la Société française d'otorhinolaryngologie et de chirurgie de la face et du cou, la Société française d'audiologie et la Société française de gériatrie et gérontologie pour la prise en charge précoce de la presbyacousie

Hung Thai-Van[1-3]
Isabelle Mosnier[3,4]
François Dejean[5]
Emmanuelle Ambert-Dahan[4]
David Bakhos[6]
Joël Belmin[7]
Damien Bonnard[8]
Stéphanie borel[4]
Jean-Charles Ceccato[9]
Arnaud Coez[3]
Maxime Damien[1-3]
Matthieu Del Rio[10]
Mohamed El Yagoubi[11]
Arnaud Genin[12]
Auriane Gros[13]
Mélanie Harichaux[14]
Samar Idriss[1]
Eugen Ionescu[1,3]
Charles-Alexandre Joly[1,3]
Pierre Krolak Salmon[15]
Rémi Marianowski[16]
Mathieu Marx[17]
Thierry Mom[11]
Cécile Parietti-Winkler[18]
Morgan Potier[19]
Christian Renard[20]
Stéphane Roman[21]
Thomas Roy[5]
Sophie tronche[22]
Frédéric venail[23]
Christophe vincent[20]
Pierre Reynard[1- 3]
Le Réseau français presbyacousie

[1] Service d'audiologie et d'explorations otoneurologiques, CHU de Lyon, Hôpital Édouard-Herriot, Lyon, France
<hung.thai-van@chu-lyon.fr>

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Abstract. Introduction. *Presbycusis is the physiological decrease in hearing due to advancing age and begins well before the sixth decade. These recommendations recall the principles of early diagnosis of presbycusis and the means of optimal rehabilitation as soon as the first symptoms appear.* Material and methods. *The recommendations are based on a systematic analysis of the literature carried out by a multidisciplinary group of ENT physicians, audiologists, geriatricians and hearing specialists from all over France. They are classified as grade A, B, C or professional agreement according to a decreasing level of scientific evidence.* Results. *The diagnosis of presbycusis is more difficult at the beginning of its evolution but a certain number of tools are available for its early diagnosis and its face-to-face or remote management.* Conclusion. *In the case of a clinical profile suggestive of presbycusis in a young subject, especially if there are several family cases, it is recommended to propose a genetic investigation. Free-field speech audiometry in noise is recommended to measure intelligibility in a realistic environment. Questionnaires in addition to audiometric tests would allow the best assessment of the patient's disability. Hearing rehabilitation with a hearing aid or cochlear implant may slow or prevent cognitive decline. Combined auditory and cognitive rehabilitation should be offered regardless of the time since the hearing was fitting. It is recommended to integrate programs accessible via smartphones, tablets or the Internet, that include different training domains to complement face-to-face sessions.*

Key words: *recommendation, presbycusis, age-related hearing loss, hearing rehabilitation*

Résumé. *Introduction.* La presbyacousie correspond à la diminution physiologique de l'audition due à l'avancée en âge et commence bien avant la sixième décennie. Ces recommandations rappellent les principes du diagnostic précoce de la presbyacousie et les moyens de réhabilitation optimale dès l'apparition des premiers symptômes. *Matériel et méthodes.* Les recommandations sont basées sur une analyse systématique de la littérature réalisée par un groupe multidisciplinaire réunissant des médecins ORL, des audiologistes, des gériatres et des audioprothésistes provenant de toute la France. Elles sont classées en grade A, B, C ou accord professionnel selon un niveau de preuve scientifique décroissant. *Résultats.* Le diagnostic de presbyacousie est plus difficile en début d'évolution, mais un certain nombre d'outils sont disponibles pour son diagnostic précoce et sa prise en charge en présentiel, voire à distance. *Conclusion.* En cas de profil clinique évocateur de presbyacousie chez un sujet jeune, surtout s'il y a plusieurs cas familiaux, il est recommandé de proposer une enquête génétique. Il est recommandé de réaliser l'audiométrie vocale dans le bruit en champ libre pour mesurer l'intelligibilité dans un environnement au plus proche de la réalité. Les questionnaires en supplément de l'audiométrie permettraient d'évaluer au mieux le handicap du patient. Il est recommandé de considérer que la réhabilitation auditive par prothèse auditive ou implant cochléaire peut ralentir ou prévenir le déclin cognitif. Une

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[2] Claude-Bernard University Lyon 1

[3] Institut de l'audition, Institut Pasteur, Inserm, Paris, France

[4] ORL Department, Ile de France reference centre for cochlear and brainstem implants in adults, Pitié-Salpêtrière Hospital Group, Sorbonne University, AP -HP, Paris, France

[5] French Society of Audiology

[6] ENT Department, CHU de Tours, iBrain, Inserm U1253, Université François-Rabelais, Tours, France

[7] AP-HP, University Hospitals Pitié-Salpêtrière - Charles-Foix, Department of Geriatrics with a cardiological and neurological orientation, Ivry-sur-Seine, Sorbonne University, Paris, France

[8] ENT Department, CHU de Bordeaux, Bordeaux, France

[9] Institute for Neurosciences of Montpellier, Inserm U1298, Centre de recherche et de formation en audioprothèse, University of Montpellier, Montpellier, France

[10] École d'audioprothèse, Université de Bordeaux, Bordeaux, France

[11] ORL Department, CHU d'Estaing, Clermont-Ferrand, France

[12] SONUP, Montpellier, France

[13] ORL Department, Centre mémoire ressources et recherche, CHU de Nice, Institut Claude-Pompidou, Nice, France

[14] Hearing aid study coordinator, Marcq-en-Baroeul, France

[15] Department of Geriatrics, HCL, France

[16] ORL Department, CHU de Brest, Laboratoire de neurobiologie, UA 4685, Brest, France

[17] Department of Otology and Otoneurology, Hôpital Pierre-Paul-Riquet, CHU Toulouse Purpan, Toulouse, France

[18] ORL Department, CHU-Hôpital Central, Nancy, France

[19] Laboratoire d'audiologie clinique, Narbonne, France

[20] Department of Otology and Otoneurology, Salengro Hospital, University of Lille, Lille, France

[21] ORL Department, Hôpital de la Timone et de la Conception, Marseille, France

[22] French Society of ORL-Head & Neck

[23] Otology and Otoneurology unit, ORL Department, CHU Gui-de-Chauliac, Montpellier, France

Correspondence : H. Thai-Van

rééducation combinée auditive et cognitive devrait être proposée, quel que soit le temps écoulé depuis l'appareillage. Il est recommandé d'intégrer des programmes accessibles par smartphones, tablettes ou internet comprenant différents domaines d'entraînement en complément des séances en présentiel.

Mots-clés : recommandation, presbyacousie, surdité liée à l'âge, réhabilitation auditive

Introduction

Presbycusis is the physiological decrease in hearing due to advancing age. It is bilateral, symmetrical, insidious, and progressive, and its evolution varies from one subject to another [1]; it is considered the most frequent cause of sensorineural hearing loss [2]. Although presbycusis is often diagnosed after 60 years of age, it has been shown that it starts well before this age; a 2.9% degeneration of inner hair cells along with a 7.7% peripheral axonal degeneration of the auditory nerve fibers has been reported per decade, reaching up to 60% of fiber disconnections after 50 years of age [3]. In advanced forms, both the peripheral damage and the damage to the cortical and subcortical auditory pathways are present [4-6]. Although it is an intrinsic aging process, which is determined genetically, presbycusis can be increased by extrinsic factors [7-10], particularly by exposure to noise from a very young age [11-12].

The degeneration must exceed 80-90% to have an impact on hearing thresholds in silence [11]. Difficulty in understanding speech in noise is thus one of the first signs of hearing loss. Evaluating these difficulties in conditions close to those encountered in daily life would allow an early detection of presbycusis [13-14]. Moreover, presbycusis has been shown to be a cofactor in the development of neurocognitive disorders [15-19], possibly due to a reduction in stimuli linked to the isolation of the patient which would explain the deterioration in cognitive performances [15, 20]. In this context, early management of presbycusis could facilitate the preservation of cognitive functions in patients.

Technological advances in conventional hearing aids can improve the quality of life of patients with presbycusis [21-22], as these systems allow hearing rehabilitation [22-23]. Speech therapy, however, which can optimize the result of the hearing aid [24], is rarely performed in practice.

The French Society of Otorhinolaryngology and Surgery of the Face and Neck and the French Society of Audiology have not yet formulated guidelines for the management of presbycusis. Due to the aging of the population, presbycusis constitutes a real public health issue [7-9]. Although its diagnosis is more difficult at the beginning of its evolution, a certain number of tools are available for early diagnosis and management. The purpose of these recommendations is to recall the principles for diagnosing presbycusis as early as possible and to provide guidelines for implementing optimal rehabilitation at symptom onset.

Methods

These recommendations were developed on the basis of a systematic review of the international literature on presbycusis, validated by a multidisciplinary group of French otolaryngologists, gerontologists, audiologists, speech-language pathologists, and hearing aid specialists (https://www.sforl.

org/wp-content/uploads/2022/03/Reco-Parcours-de-soins-du-patient-presbyacousique_2022.pdf). A secondary systematic review, focused on the early management of presbycusis, was conducted through selecting the relevant articles from the initial review. For that purpose, the Pubmed database as well as Google Scholar were searched for the period 1950- December 2021. The equation used in Pubmed "Speech recognition in noise AND Hearing screening AND Auditory-cognitive training AND Speech therapy AND Hearing aid fitting AND Hearing loss questionnaire AND Remediation AND Teleaudiology AND [Cognitive disorders OR dementia] AND [Age-related hearing disorders OR presbycusis]" reported 2,198 results. Only English and French language publications were retained (1940). Articles dealing with the paediatric population were excluded (1,124). The review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [25]. The PRISMA flow chart is presented in *figure 1*. The proposed recommendations were classified as grade A, B, C, and expert opinion according to a decreasing level of scientific evidence from 1 to 4, in accordance with the guide for the analysis of the literature and the grading of recommendations published by the *Agence Nationale d'Accréditation et d'Evaluation en Santé* (ANAES) (https://www.has-sante.fr/upload/docs/application/pdf/analiterat.pdf).

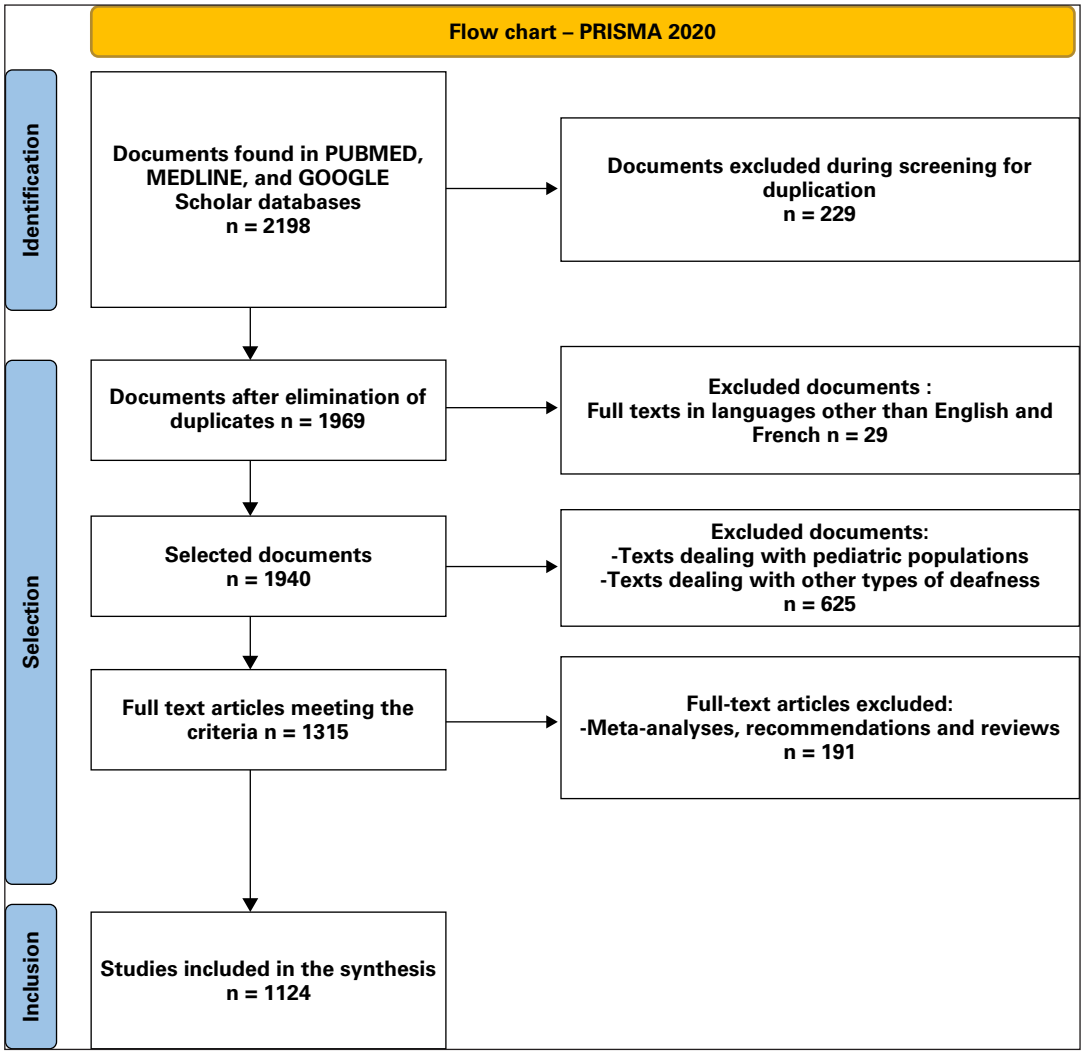

Figure 1. PRISMA 2020 flowchart for updated systematic reviews, including database searches and study selection. The search deadline was December 2021.
Figure 1. *Diagramme de flux. PRISMA avec critères de sélection. Ont été analysées les données publiées jusqu'en décembre 2021.*

Diagnosis

Positive and differential diagnosis

Presbycusis is defined by a progressive, irreversible, and symmetrical bilateral sensorineural hearing loss, classically from the 6th decade onward. The first frequencies affected are those above 2 kHz; lower frequencies may be affected secondarily [26]. Audiometry is performed during a medical consultation to evaluate the patient's discomfort, to search for an associated middle ear or retrocochlear pathology, to evaluate the impact of the hearing loss, and to explain the management strategies. The positive diagnosis is based on air and bone conduction (AC and BC) in pure tone audiometry and speech audiometry in silence. These tests may be normal in cases of early presbycusis. Since difficulty in understanding in noise is one of the first symptoms of presbycusis [3], a speech-in-noise audiometry should be performed. The latter is based on the measurement of speech understanding in the presence of noise, and often on the determination of the signal-to-noise ratio (SNR, difference between speech and noise presentation levels) at the 50% intelligibility threshold [14]. Tinnitus and hyperacusis can be indicative of presbycusis. The prevalence of tinnitus is 10-15% in adults but increases with age and deafness [27-28]. The prevalence of hyperacusis also increases with age and deafness [29].

The screening questionnaires are designed to be used in the primary care setting by treating physicians and geriatricians, but also by ENT specialists, speech therapists, and hearing aid specialists, and can even be used in a self-administered manner. They can be specific to deafness or more general [30]. The questionnaires enable to assess the hearing handicap felt by the patient, a handicap that is not always perfectly correlated with the audiometry results. They also allow evaluating whether the patient will be motivated to engage in a hearing rehabilitation project [30]. The appearance of a picture concordant with presbycusis in a younger patient (before 60 years of age) attracts attention with the essential complaint of poor comprehension in noisy environments. Neurophysiological examinations allow searching for an endocochlear origin other than presbycusis or for a retrocochlear origin of the deafness (electrocochleography, auditory evoked potentials, and acoustic otoemissions). Genetic susceptibility is then very likely [31-32]. A genetic investigation is desirable, since several genetic alterations have been found in early presbycusis [33-37]. Cochlear function testing may be offered to other family members [38].

The diagnosis of presbycusis is clinical but in case of uncertainty (asymmetric hearing loss, associated vertigo…) objective examinations are justified [39]. Although some authors have shown the diagnostic value of genetic tests and functional magnetic resonance imaging (MRI) in the resting state, these techniques are not feasible for large-scale screening [40-41].

- It is recommended that speech audiometry be performed in free field noise to measure intelligibility in a realistic environment (expert opinion).
- It is recommended to use questionnaires in addition to audiometry to best assess the patient's handicap (expert opinion).
- In the case of a clinical profile suggestive of presbycusis in a young subject, especially if there are several family cases, it is recommended to propose a genetic investigation (expert opinion).

Associated or differential diagnoses

Vestibular schwannoma is a retrocochlear pathology revealed in 94% of cases by a unilateral sensorineural hearing loss that can be brutal in 10% of cases and sometimes transient [42]. The diagnosis is established by MRI with gadolinium injection. Meningiomas and other tumors of the temporal bone or the cerebellopontine angle may be more rarely revealed by the same symptoms [42].

- It is recommended that MRI of the brain and cerebellopontine angles be ordered for:
- rotatory vertigo associated with presbycusis (Grade C)
- unilateral tinnitus associated with presbycusis (Grade C)
- auditory asymmetry ≥ 20 dB on two adjacent frequencies, or of 15 dB on 3 kHz or on two frequencies between 2 and 8 kHz (Grade C)

Central auditory processing disorder (CAPD) is mainly revealed by difficulties in comprehension in competitive listening situations (noise, dichotic conditions, etc.) [5] but also by difficulties in spatial localization. When CAPD is suspected, the evaluation is performed by specific tests (BIAP recommendations: www.biap.org/fr/archives/83-ct-30-processus-auditifs-centraux-pac).

Hidden hearing loss, a recently identified auditory disorder, is related to the alteration of acoustic fibers with high excitability threshold and low spontaneous discharge rate useful for understanding in noise [43]. The clinical expression may be delayed and mimic presbycusis. If there is a discrepancy between the tonal hearing threshold in silence and the discomfort reported by the patient in noise, a disorder of the auditory neuropathy spectrum may also be considered. In this case, cochlear function should be checked by means of acoustic otoemissions or microphonic cochlear potentials [44]. The disease affects young subjects sometimes up to the fourth decade [45-46]. Several genetic anomalies have been identified [47]. The hearing complaint may not be recognized until late and in this case may be confused with early presbycusis. Finally, we should mention multiple sclerosis (MS), which is diagnosed at a very variable age [48]. The auditory complaint is often atypical, with an impression of fluctuating intelligibility. The diagnosis of MS is based on a combination of clinical, electrophysiological, and radiological evidence [49-50].

In case of hearing loss, a pure tone audiometry in BC should be performed during the diagnostic phase to avoid ignoring middle ear pathology that may require specific management. The presence of a mixed hearing loss will lead to a CT scan of the temporal bones.

- In case of hearing complaints in noise and subnormal tonal audiometry in adults exposed to noise, it is recommended to carry out an exploration by high frequency audiometry, voice audiometry in noise, and electrocochleography to eliminate a hidden hearing loss (expert opinion).
- In the case of a disorder of the auditory neuropathy spectrum, it is recommended to ask for a genetic testing (expert opinion).
- It is recommended to systematically perform otoscopy and to measure the BC in pure tone audiometry when diagnosing presbycusis to search for a mixed hearing loss (expert opinion).

Hearing screening tracking using Smartphone or tablet applications

Numerous hearing screening apps that can be used on a smartphone or tablet have been developed (*table 1*). The choice of this format may limit the constraints of access to identification by enabling a self-test or an accompanied test to be carried out on general public equipment. However, very few have been clinically evaluated for their effectiveness and reliability.

Table 1. Key features of hearing screening apps.
Tableau 1. *Principales caractéristiques des applications de dépistage auditif.*

Screening app	Operating system*	Type of screening	Calibration and Transductors*	Maximum output level	Additional functions*	Availability
uHear (Unitron)	iOS	Pure tone	Headphones	90 dB	Environmental noise control	Free
Shoebox (Shoebox Ltd)	iOS	Pure tone	TDH-39, ER3A, B71 (vibrator)	90-115 dB	Environmental noise control, masking	Paid app (device must be purchased)
EarTrumpet (Ear Trumpet Labs)	iOS	Pure tone	Headphones: Apple, Bose QC15, Philips SHP	90-100 dB	Masking	Paid app
Hearscreen/Heartest (HearX group)	Android	Pure tone	Sennheiser HD202/HD280/HD300	40 dB	Environmental Noise control	Paid app
Audiogram Mobile (Vincenzo Cocciolo)	iOS	Pure tone	Heaphones Apple, Sennheiser HD-201, Panasonic RP- HTX7, Bose AE, Bose AE2, Bose SoundTrue, Sennheiser HDA 280	90 dB	Masking	Paid app
Hearing Test (Pieezo Hearsay Pte Ltd)	Android	Pure tone	Headphones Samsung, Motorola, Lexus	90 dB	Masking	Paid app
HearZA (HearX group)	Android/iOS	Digit Triplet in noise	Headphones Samsung, Motorola, Lexus, Apple…	NA	Environmental noise control	Paid app

*subject to modification

The identification strategy consists of using pure tones for different intensity/frequency combinations or speech in noise audiometry tests, which are more ecological [14, 51]. Different types of earphones and headphones have been used. Supra-aural headphones and inserts are preferable to other types of headphones [51-52].

Identification of cognitive disorders in relation to presbycusis

It is known that there are bidirectional relationships between cognitive decline and presbycusis, with presbycusis appearing to be a risk factor for the development of dementia (particularly Alzheimer's disease) [53-54]. Deafness in middle age is the main potentially modifiable risk for dementia [18, 55-56]. The association between even mild hearing loss and cognitive decline has been demonstrated in numerous studies [57-59]. It therefore seems that the early management of patients with presbycusis would be of particular interest in this context, since patients would be younger and prosthetic rehabilitation could thus be optimal.

Moreover, the association of CAPD and peripheral involvement may also increase the risk of dementia [7]. There is also an association between auditory performance in noise and cognitive functions, in particular working memory, inhibitory control, episodic memory, and processing speed, in patients with mild to moderate hearing loss [60-61].

Finally, communication difficulties increase the effort of listening and the cognitive effort at the origin of fatigue [62]. They may lead the patient to give up certain social activities and ultimately increase the risk of isolation and withdrawal [63]. A 2019 meta-analysis found an increased risk of depression related to deafness [8].

Hearing rehabilitation may itself be influenced by the patient's cognitive status [64]. Conversely, the presence of a mild neurocognitive disorder associated with hearing impairment may encourage the use of hearing aids in order to improve attentional abilities. To date, no large randomized prospective study has confirmed with a high level of evidence the impact of hearing rehabilitation on the incidence of dementia.

Identification consists of looking for cognitive impairment in people with cognitive symptoms reported by the patient himself or by his entourage [65]. It mainly concerns primary care, and in particular the general practitioner. The diagnosis is made in so-called memory centers or in the city (https://www.has-sante.fr/upload/docs/application/pdf/2018-05/parcours_de_soins_alzheimer.pdf). In the early stages of the disease, the positive and aetiological diagnosis of neurocognitive impairment must be made by experienced physicians. The choice of the diagnostic test is guided by the user's experience and the duration of the test (adapted to the clinical context).

- It is recommended that the impact of even mild presbycusis on cognitive functions be assessed by screening tests adapted to the deafness (Grade A).
- It is recommended that the presbycusis patient be screened for cognitive problems at the time of diagnosis or hearing aid fitting (Grade C).
- It is recommended that hearing rehabilitation with a hearing aid or cochlear implant be considered to slow or prevent cognitive decline (Grade B).

Management of the patient

Medical follow-up

Medical follow-up by the ENT is otoscopic and auditory. It allows to ensure that the patient adheres to the audiological rehabilitation with hearing aids, and that the tolerance and benefits of the hearing aid are maintained over time. The appearance of asymmetry should lead to a search for the existence of an additional retrocochlear pathology. A drop in comprehension performance allows the possibility of cochlear implantation to be considered when the intelligibility threshold in the free field is less than 60 dB in speech audiometry without lip-reading with the hearing aid and to refer the patient to a reference center for a pre-implant assessment [66]. During the various visits, the interviewer looks for evidence of anxiety and depression, mood disorders, and cognitive decline.

-It is recommended that the prescriber of a hearing aid performs a follow-up at least once a year for patients with presbycusis (expert opinion).
-It is recommended that these visits include otoscopic monitoring and speech audiometry in silence and in noise (expert opinion).
-It is recommended that objective examinations should not be performed in the follow-up of patients with presbycusis (expert opinion).
-It is recommended to refer the patient to a reference center to discuss the indication of a cochlear implant if the intelligibility threshold on both ears is < 60 dB in free field without lip-reading with a dissyllabic list and a hearing aid (expert opinion).

The general practitioner ensures the management of associated cardiovascular pathologies and risk factors identified as favoring the occurrence and aggravation of presbycusis [7, 67-68]. The patient's visual status, locomotor disorders, and nutritional status are also monitored.

- It is recommended to screen for comorbidities (cognitive deficit, anxiety and depression, visual or eating disorders, loss of autonomy) associated with presbycusis and to refer the patient to the appropriate practitioners (expert opinion).
- It is recommended to ensure that the patient's cardiovascular risk factors are managed (expert opinion).

Audiological rehabilitation with hearing aids

The decree of November 14, 2018 (https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037615111) supplemented by the decree of December 12, 2018 has modified the eligibility criteria for hearing aids. The delivery of the fitting is subject to a medical consultation and a hearing assessment carried out by a prescribing physician (ENT or the general practitioner).

The objective of rehabilitation is to improve the hearing-impaired listening, comprehension, and communication skills on a daily basis, thus avoiding social isolation. Patient satisfaction should be measured regularly by evaluating the time spent wearing the hearing aids [69]. The patient's adherence to the hearing aid project is crucial.

The assessment includes a history taking in the presence of the patient's family and friends. Several audiometric tests are then performed to evaluate the hearing loss and its impact on speech intelligibility [70]: a pure tone audiometry with separate ears in AC and BC; a supraliminal audiometry with the search for discomfort thresholds; a speech audiometry (in AC) ear by ear with measurement of intelligibility thresholds, in silence and in noise; and possibly a spatial sound localization test.

Presbycusis requires a bilateral fitting to take advantage of binaurality and to obtain better speech understanding in noise [71]. A monaural fitting is sometimes preferred in case of binaural interference [72]. The choice of the type of aid depends mainly on the hearing loss, the anatomy of the outer ear, the dexterity of the patient, the choice of a battery-operated product, and the esthetic concerns of the patient.

- A holistic approach that includes cognitive status is recommended to propose an appropriate fitting (expert opinion).
- It is recommended to use the daily wearing time as a criterion of compliance and as a method to evaluate patient satisfaction (Grade C).
- It is recommended that the prescribing physician ensures, or reinforces if necessary, the patient's motivation in the fitting process (Grade C).

The speech audiometry in noise is a more ecological evaluation tool than measurements in silence, highlighting the difficulties experienced [13, 73]. It has proven its value in monitoring overall hearing aid effectiveness, more specifically in quantifying the benefit of one listening program over another, the appropriateness of signal processing algorithms and directional microphones [14]. From the patients' point of view, self-evaluation questionnaires are available to monitor the improvement of their quality of life and overall hearing comfort, in particular the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire [74]; these questionnaires provide indispensable information [75], and their completion is mandatory in France according to the November 14, 2018 decree, on the terms of reimbursement of hearing aids and associated services.

Moreover, this decree recommends a prosthetic follow-up at 3 months, 6 months, and 12 months after the fitting. The use of *in vivo* measurement is essential to ensure the correct application of the chosen correction parameters [76] (professional agreement). Electroacoustic measurement chains allow precise control of the proper functioning of hearing aids and their compliance [77] (professional agreement). The permanent follow-up of the effectiveness beyond the first year includes all the elements of the previous controls. These visits also allow for the technical maintenance of the hearing aids.

-It is recommended that a stereophonic fitting be offered to allow the patient to benefit from binaural hearing (Grade B).
-It is recommended that *in vivo* measurement be used to accurately adjust amplification (Grade B).
-It is recommended that hearing aids be adjusted to optimize speech understanding as a priority (expert opinion).

The appearance of a sudden uni- or bilateral deafness less than three days old, in the absence of abnormalities of the external or middle ear, in a patient being followed for presbycusis or with no history of presbycusis justifies a specialized ENT consultation for a specialized assessment and management within 24 hours [78] (professional agreement). A sudden hearing loss that appeared in the 30 days preceding the consultation or that worsened rapidly over a period of 3 months should justify a consultation with an ENT physician within 2 weeks [78] (professional agreement).

-It is recommended that speech audiometry in noise be performed routinely to assess the prosthetic benefit in an ecological manner (Grade B).
-It is recommended that questionnaires be used in addition to audiometric measurements to provide a more complete picture of the hearing aid benefit (Grade B).
-Regular follow-ups with audiologists is recommended and should be tailored to the individual patient (Grade B).
-If there is a change in hearing status or in the patient's overall condition, a new medical opinion is recommended (expert opinion).

Communication aids include all devices designed to improve the communication and listening performance of the hearing impaired patient (FM system, Bluetooth, etc.). Their fitting should be considered in isolation or as a complement to a hearing aid, in order to respond to communication problems (restaurant, meeting, etc.). [79]. Teleaudiology is a positive step forward, especially for patients living in rural areas with limited access to hearing care professionals [80]. However, it remains relatively recent and not well developed [81-82]. Since studies on implanted patients show similar results between teleaudiology and face-to-face care [81-82], teleaudiology must remain a complement to face-to-face care.

Speech and language therapy techniques for auditory cognitive training

Aging is often accompanied by a reduction in the efficiency of sound processing due to the degeneration of the central auditory pathways and a decline in the cognitive functions that contribute to speech perception in unfavorable listening situations [60, 83]. Thus, speech therapy evaluation should include a cognitive assessment [84]. It has been demonstrated that deafness has an impact on the quality of life and the emotional state of patients with presbycusis [84].

The main axes of speech therapy follow-up are the development of lip-reading and auditory training combined with cognitive reinforcement [85]. This training includes a bottom-up approach (analytical identification of sounds) and a top-down approach (global comprehension of the message); the top-down approach or a combination of the two approaches is preferred [86]. Customization to the specific needs of the patient is recommended.

Auditory training is very effective for new hearing aid users and is still useful even after the period of habituation [86]. Twice-weekly training appears to be sufficient [87]. There is limited and conflicting data on the maintenance of the effects of auditory training after training cessation [86].

-It is recommended that combined auditory and cognitive therapy be offered regardless of the time since fitting (Grade C).
-It is recommended that cognitive, verbal, non-verbal, emotional, and lip-reading skills are assessed as part of the speech-language pathology assessment for the patient with presbycusis to optimize management (Grade B).
-It is recommended that therapy be individualized to the needs of the patient (Grade A).

Table 2. Online auditory training programs.
Tableau 2. *Programmes d'entraînement auditifs en ligne.*

Auditory training software	Hearing	Cognition	Free access	Web link
Auditico	Yes	Yes	No	www.happyneuronpro.com
Audiolog 4	Yes	No	No	www.editions-creasoft.com
Cogmed	No	Yes	No	www.pearsonclinical.fr
Cognifit	No	Yes	No	www.cognifit.com
FonctionsExecutives.com	No	Yes	No	www.fonctionsexecutives.com
HappyNeuron	No	Yes	No	www.happyneuron.fr
IFIC	yes	Yes	Yes	www.implant-ific.org
L'oreille en or	Yes	Yes	No	www.loreilleenor.com
Labiolecture	No	No	yes	www.labiolecture.fr
My Profonia	Yes	No	No	www.profonia.com

Telecare in speech therapy allows for remote evaluation and rehabilitation [88]. Digital technologies can be advantageously used in auditory-cognitive rehabilitation via digital tools [89-90], in particular on young subjects open to such technologies. These tools are available online or on applications for tablets and smartphones (*table 2*). They are generally organised in modules ordered by themes or increasing difficulty [91], sometimes self-adapting [87,92]. The feasibility and benefits of online training based on the principle of empowerment have been demonstrated [91-93]. The integration of these tools is conceived in association with rehabilitation in the presence of the speech therapist [88].

- It is recommended to integrate programs accessible via smartphones, tablets, or the Internet, integrating different training areas in addition to face-to-face sessions (expert opinion).
- It is recommended to carry out a regular follow-up to optimize self-training (expert opinion).

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