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PRESBYACOUSSIS: JUSTIFICATION OF DIAGNOSIS IN SCREENING CONDITIONS

Abstract. Presbycusis as a manifestation of degenerative hearing loss that develops in the age category of the population is becoming more common. At the same time, it is necessary to take into account the possibility of late onset of presbycusis with early diagnosis. This review presents the results of studies on the effectiveness of presbycusis diagnosis in the conditions of screening at early stages and a comparative analysis with other forms of hearing loss. The relevance of using verified questionnaires for the early diagnosis of presbycusis is presented in the results of the analyzed studies. The main objective of the work is to determine the most effective form of presbycusis diagnosis in the conditions of screening to detect hearing impairment at early stages. An information search for relevant studies was conducted by keywords with the construction of strip lines and a stepwise analysis of the target orientation of the results of published studies. After selection and analysis, the results of 6 studies were taken into work, including 3 randomized clinical trials and 3 observational studies. Taking into account global trends, an analysis of the validity of the search for effective methods for diagnosing presbycusis was carried out. The situation of development of a screening scheme for effective diagnostics of presbycusis at early stages of its development in the age population is considered. The validity of using 3 types of questionnaires in conditions of early screening of presbycusis is established: HHIE, Hearing Impairment Inventory for the Elderly; HHIA, Questionnaire for persons with hearing impairment for adults; IOI-HA, International Outcomes Registry – Hearing Aids. The degree of optimization of specialized costly instrumental methods of diagnostics of presbycusis in the preliminary screening assessment by the survey method at the level of primary health care is also revealed.
Key words: hearing loss, presbycusis, quality of life, elderly, geriatrics, screening, questionnaire.

Introduction

Hearing loss in old age can disrupt the exchange of information, thereby significantly affecting daily life, causing loneliness, isolation, addiction and frustration, as well as communication disorders. Due to the aging of the population in developed countries, presbycusis is a growing problem that has been reported to reduce the quality of life. The progression of presbycusis cannot be treated [1]. Thus, the optimal treatment of this condition requires not only early recognition and rehabilitation, but also an assessment of the quality of life condition and its assessment [2].

The term "presbycusis" refers to hearing loss that is associated with the cochlear degenerative aging process. Age-related hearing loss (ARHL, formerly presbycusis) is caused by various lifelong damage to the auditory system and is characterized by bilateral sensorineural hearing loss, impaired speech comprehension in noise, and deficits in central sound processing. By definition, presbycusis is bilateral, symmetrical, and slowly progressing [3]. Presbycusis is the most common cause of hearing impairment in adults; It is considered the most common sensory disorder in older adults, affecting people aged 75 and older. As our society matures, more people are living into their 60s, 70s, 80s and older due to factors such as improved nutrition and health care [4]. In the United States, presbycusis is reported to affect 40% of the population over the age of 75, and in our aging society, it is becoming more common [5]. The most important aspect of geriatric practice in this area is to improve the tactics of early diagnosis and maintain a strategy of preventive measures that contribute to the preservation of the quality of life in the age population of the population.

Methods

We analyzed information on current areas of geriatric practice regarding the detection of presbycusis in the available literature for further adapta-

tion in clinical practice under the existing regulatory framework.

Objective: To determine the modern principles of diagnosing presbycusis in elderly patients with the social aspect of improving the quality of life.

Search criteria were formed according to the PICS methodology.

Inclusion Criteria:

Population/patient: Elderly patients with hearing problems.

Intervention/policy (study subject): Principles of presbycusis diagnosis.

Compare: Other methods of audio diagnostics.

Results: Efficiency

The type of study (study design) was also included in the search criteria: publications with RCT results and reviews were included in the evaluation of methods.

The criteria for restricting the search for information were also determined:

1. Limitations: Human
2. Publication date: From 2014 to 2024
3. Language: English

Based on the criteria, a search strategy was developed, which included the selection of verified databases, keywords and the creation of a search strip line. Based on the search, a qualitative analysis of the information obtained was carried out on the correspondence of the title of the article with the subsequent analysis of the abstract. The content of the selected information was evaluated using the PRISMA method.

Quality of the evidence: The quality of the body of evidence for each outcome was examined according to the GRADE criteria. Overall quality was defined as very low, low, moderate or high using a step-by-step structural methodology.

The study design was the first consideration; the initial assumption was that randomised controlled trials (RCTs) were of high quality, whereas observational studies were of low quality. Five more factors were then taken into account – the risk of bias, inconsistency, indirectness, inaccuracy and bias of the publication. Limitations in these areas have led to a decrease in the quality of the evidence. Finally, 3 main factors that may improve the quality of the evidence were considered: large effect size, intervention dependence gradient, and accounting for all residual confounding factors. For more information, see the latest GRADE article series. As indicated by GRADE, the final quality score can be interpreted using the definitions presented in Table 1.

Table 1 – Criteria for determining the degree of evidence

High	It's very sure that the true effect is close to the fact that the assessment of the effect
Temperate	Moderately confident in estimating the effect – the true effect is likely to be close to estimating the effect, but there is a chance that it is significantly different
Low	Confidence in the assessment of the effect is limited – the true effect may differ significantly from the assessment of the effect
Very low	There is very little confidence in the effect estimate – the true effect is probably significantly different from the effect estimate

Outcomes

After defining the criteria, a search strategy was developed. Studied sources to search for relevant peer-reviewed (scientific) literature. Table 2 provides an overview of the electronic databases searched for relevant peer-reviewed (scientific) literature.

These databases were searched by domain/aspect of the purpose of the review based on strip lines for search keywords. The search terms are presented in Table 3.

Subsequently, individual studies were selected based on the title and abstract. At this stage, we examined the titles and abstracts/abstracts of the identified literature to assess their relevance to our review.

Subsequently, a critical assessment of the evidence was carried out using the PRISMA methodology. Thus, 6 sources of information were selected to assess the effectiveness of presbycusis methods in the age category of patients.

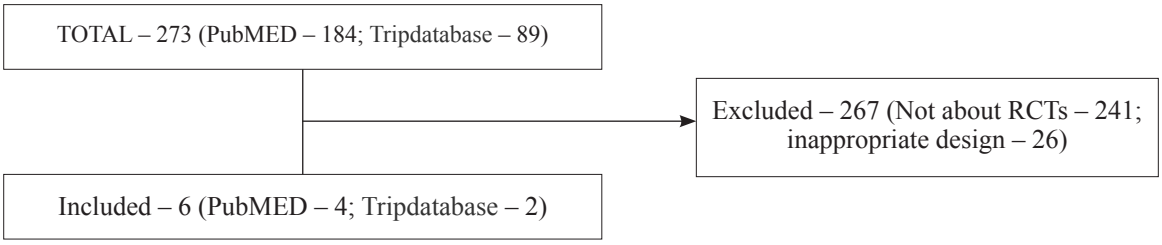
Table 2 – Validated specialized databases

Examined electronic databases to retrieve relevant peer-reviewed (scientific) literature	
Pubmed/Medline	http://www.ncbi.nlm.nih.gov/pubmed/
TripDataBase	https://www.tripdatabase.com/

Table 3 – Search terms

Search cases	Population/patient	Intervention	Comparative	Outcome	Study design
1	hearing loss, deafness, elderly patients, old age, presbycusis	diagnosis, quality of life, survey, interviewing, screening	Audio diagnostics of hearing, laboratory diagnostics, instrumental diagnostics	efficiency security, sociality	Review, RCT, Cohort Study

Table 4 – Selection flow diagram



Results of evidence-based analysis

A search of the databases yielded 273 citations published up to April 26, 2024 (with the removal of duplicates). Articles were excluded based on the information in the title and abstract. For further evaluation, the full texts of potentially relevant articles were received. Six studies (1 systematic review, 2 RCTs, 2 cohort studies, and 1 observational study) met the inclusion criteria. Reference lists of included studies were manually conducted to identify any additional potentially important studies. For each included study, the study design was identified and summarized in Table 5, which is a modified version of the Goodman study design hierarchy.

Characteristics of the included studies

6 studies were included in the evidence-based analysis. Studies were conducted from 5 different countries (Italy – 2, Spain – 1, Germany – 1, USA 1, China – 1). Study sample sizes ranged from 100 to 2059 patients.

The eTools methods used in each study were unique, as were the conditions under which they were applied. Some have been used to coordinate care between hospital and outpatient/community providers; some were used in social institutions to help coordinate care; the rest were applied in multi-assistance coordination efforts and/or did not indicate the coordination of their focal points. The quality of the evidence was assessed individually for each outcome. A general description of the assessment of sources is presented in Table 6.

Table 5 – Group of evidence considered in accordance with the study design

Study design	n
RCT	
Systematic review of RCTs	1
Big RCT	2
Small RCT	
Observational Studies	
Systematic review of non-RCTs with simultaneous control	
Non-RCTs with simultaneous control	
A Systematic Review of Non-RCTs with Historical Control	
Non-RCTs with historical control	
Cross-sectional database, registry or study	
Series of cases	2
Retrospective Review, Modeling	1
Research presented at the international conference	
Expert opinion	
Total	6

Table 6 – Characteristics of information sources

Author, year	Country, region	Study design	Continuation of the study	Population	Middle age, Years	Effectiveness
A. Ciorba et al., 2012	Italy, Ferrarra	Systematic review	1 year	Age population with presbycusis		Special tools for assessing the quality of life in presbycusis: HHIE, Inventory of Hearing Impairment for the Elderly; HHIA, Adult Hearing Impaired Questionnaire; IOI-HA, International Outcome Registry – Hearing Aids; QoL, quality of life
A. Rodríguez Valientea et al., 2015	Spain, Madrid	RCT	5 years	8 age groups (n=1175)	5-90 years	Hearing thresholds decreased slightly with increments of signal frequency up to 2000 Hz in the age range from 5 to 64 years. In the two older groups, the hearing threshold slightly increased to 2000 Hz in the group from 65 to 74 years old and to 1000 Hz in the group from 75 to 90 years old. At higher frequencies, hearing thresholds increased very dramatically The current ISO 7029 standard cannot be applied to persons under 18 years of age and does not apply to persons over 70 years of age. With the development of medicine and living conditions, the elderly population is increasing rapidly. The number of people aged 70 and over is growing. Therefore, it would be useful to have data on subjects over 70 years old.
H. J. Garringer et al., 2016	United States	Cohort Study. (Q8 survey, genetic study)	1 year	Male twins, born in 1917-1927. (n=2059)	Average age.= 74,3 года	Nonsyndromic hearing loss is distinguished into autosomal dominant, autosomal recessive, X-linked and mitochondrial forms of inheritance. The hearing loss gene is located at the DFNA18 locus. Men show a higher incidence of presbycusis than women in the general population. There was no evidence of linkage for any of the 4 chromosomal regions with LODs greater than 1.5 reported in the Framingham study
D.Cuda et al., 2021	Italy, Piacenza	Observational study.	3 years	Elderly people who received hearing aids for the first time (n=100)	≥ 65 Years	The AQoL-8D questionnaire “has the highest correlation with disease-specific measurements and the best compliance transformation properties.” The HHIE questionnaire has shown the extent to which hearing impairment affects emotional and social adjustment in everyday life. The MoHA questionnaire determined the cognitive abilities of the subjects. The use of the MoHA questionnaire in the before and after assessments excluded cognitive decline over time. The APHAB questionnaire was used to assess speech comprehension problems in various listening situations. The IOI-HA questionnaire was only in the Post App assessment. This gave an understanding of the difficulty and benefits of using the HA

Continuation of the table

Author, year	Country, region	Study design	Continuation of the study	Population	Middle age, Years	Effectiveness
Jianli Ge et al., 2023	China, Shanghai	Cross-sectional study	3 years	Participants who do not have hearing impairment at the initial self-assessment (n=401)	≥ 60Years	Among 401 elderly people, 29 (11.7%) participants from the high-risk group of stratified risk factors received referral; 37 (16.2%) HHIE-positive participants received referrals; 28 (17.5%) participants with positive results of multi-series screening testing received referrals; 38 (13.0%) participants with positive results of multiple screening parallel testing received referrals. The three-level and two-stage screening of hearing loss is highly effective and feasible, relying on the 1+10+100 medical consortium: from population screening to targeted screening, from suspect to diagnosis, from primary care to tertiary hospitals
D. Pürnerl., 2022	Germany, Munich	RCT	1 year	Пациенты с нарушением слуха	18-80 Years	All parts of the auditory pathway examined in the study show ARHL-related performance impairment associated in part with aging and partly with age-related hearing loss, with some overlaps not being completely ruled out. The independent central component of the ARHL, due to aging (not just peripheral hearing loss), is confirmed by the results of our CADP test. Age-related hearing loss leads to an additional significant deterioration in the function of the CTC and cochlear synapses, horizontal motion detection, speech comprehension in noise, and disruption of the central tonotopic organization.
TOTAL	5 countries: Europe – 4; America – 1; Asia – 1	6:1 SR; 2 RCTs; 1Cohort research; 1Observational research; 1cross-sec. study.	1-5 years			

Discussion

Dominik Pürner l., 2022 [6] in his study testifies to changes in the peripheral and central processing of sound by the auditory system during presbycusis. Age-related hearing loss is associated with a decrease in the level of Otoacoustic Emission Distortion Result (DPOAE). DPOAE thresholds represent the lowest level of stimulus causing measurable contraction of outer hair cells signal in both older groups when determining the auditory brainstem response (ABR). Possible mechanisms of these changes include: changes in brainstem auditory fibers and synaptic transmission; changes in homeostasis and the influence of fibroblast growth factor (FGF), leading to impaired myelination of the auditory pathways of the brainstem; loss of the neuropil of the cochlear nucleus, correlating with impaired interneuronal connections and auditory processing. Overall, the results suggest cochlear synaptopopathy in age-related hearing loss; Additional effects of aging on cochlear synaptic transmission appear to be possible, but cannot be proven. The results of the CADP test battery proved the differential aging of various parts

and functional aspects of the central auditory system. Overall, they provided further evidence for an independent central component of presbycusis (ARHL) not solely associated with peripheral hearing loss. Speech comprehension in noise, as measured by OLSA in the test battery, deteriorated significantly in both older groups. Even the highest level of hearing in Western older society will suffer from significantly lower understanding of speech in noise compared to younger people. The study provides further evidence for the multifocal aging process of the auditory system. All parts of the auditory pathway examined in the study show ARHL-related performance impairment associated in part with aging and partly with age-related hearing loss, with some overlaps not being completely ruled out.

Jianli Ge et al., 2023 showed in a study that the system for assessing risk factors for age-related hearing loss provides an evidence-based medical basis for building a screening regimen for hearing loss [7]. Influencing risk factors for presbycusis are age, BMI, overweight/obesity, divorce/widowhood, noise history, uneasy diet, exercise habits, hypertension, diabetes, hyperlipidemia, cardiovascular disease, hyperuricemia, and hypothyroidism. Noise history, heavy feeding, hyperuricemia are independent risk factors. Among the risk factors were 13 (72.2%) factors (uneasy diet, hypertension, diabetes, hyperlipidemia, cardiovascular disease, hyperuricemia, hypothyroidism, overweight, exercise habits, smoking, alcohol consumption and headphone wearing, as well as ototoxic drugs) that could be prevented, controlled, delayed and improved. The receiver performance curve (ROC curve), also known as the sensitivity curve, can be used to predict age-related hearing loss using cumulative risk factor estimates. Three-level and two-stage community-based screening for age-related hearing loss is appropriate and effective. The three-level and two-stage screening of hearing loss is highly effective and feasible, relying on the 1+10+100 medical consortium: from population screening to targeted screening, from suspect to diagnosis, from primary care to tertiary hospitals. With multiple screening, awareness of hearing loss and adherence can be raised in older adults. At present, the method of managing age-related hearing loss used by general practitioners is relatively poorly developed.

D. Cuda et al., 2021 notes the prospects of using the following questionnaires in practice: The AQoL-8D questionnaire "has the highest correlation with disease-specific measurements and the best compliance transformation properties" [8]. The HHIE questionnaire has shown the extent to which hearing impairment affects emotional and social adjustment in everyday life. The MoCA questionnaire determined the cognitive abilities of the subjects. The use of the MoHA questionnaire in the before and after assessments excluded cognitive decline over time. The APHAB questionnaire was used to assess speech comprehension problems in various listening situations. The IOI-HA questionnaire was only for the HA assessment.

H. J. Garringer et al., 2016 pointed out that despite the fact that in the study, the peak of cohesion in the DFNA18 locus indicates only an association according to the Lander and Kruglyak criteria (LOD score, 2.2-3.6), the results were reliable [9]. Despite the relatively small sample size (50 pairs), a robust association was observed when the analysis was limited to an even smaller number of pairs in which both twins reported bilateral hearing impairment. Genotyping of additional markers in the linkage region on chromosome 3 did not exclude evidence of linkage. The marker with the strongest evidence of peak linkage (D3S1292) prior to accurate mapping was the same marker at peak linkage in the family reported with the DFNA18 gene, and the phenotype represents progressive hearing loss that can develop over decades. There is a need to clone the DFNA18 gene. If confirmed, these results suggest that other variations in the sequence at the DFNA18 gene locus may be responsible for a significant percentage of hearing loss with aging in the general population. An analysis of hereditary hearing loss based on all Q8 responses of members of the NAS-NRC twin group (mean age 74.3 years) using the analytical analysis method showed that the heritability was 61%. The present study was conducted because of the moderately high heritability derived from the Q8 analysis, and also because, to the best of our knowledge, there are no other data on genomic screenings for the qualitative assessment of hearing loss with age in the general population.

A. Rodríguez Valientea et al., 2015, the study recorded normal hearing ranges according to age groups [10]. This data can help assess the degree of hearing loss not only in young patients, but also in older patients. The present study did not find any statistically significant differences in men and women in any age group or with any frequency. The current ISO 7029 standard cannot be applied to persons under 18 years of age and does not apply to persons over 70 years of age. With the development of medicine and living conditions, the elderly population is increasing rapidly. The number of people aged 70

and over is growing. Therefore, it would be useful to have data on subjects over 70 years old. The presence of standard values according to the age of the subject can facilitate the correct assessment of each subject individually, determining whether hearing damage is present or not. This study is a contribution to the still limited number of Hearing Threshold (HTL) surveys for otologic screening of the population, and may be useful in the upcoming update of ISO 7029, which is currently under revision.

A. Ciorba et al., 2012, in a systematic review, noted the importance of early diagnosis of presbycusis [11]. At the same time, she pays special attention to certified questionnaires that can be used in screening mode. These presbycusis screening tools are presented in Table 7.

Table 7 – Presbycusis screening tools

Tool	Aim	Elements
HHIE[12]	Measures the impact of hearing impairment on the emotional and social adjustment of older adults	25
HHIA[13]	Measures the impact of hearing impairment on the emotional and social adjustment of adults	25
IOI-HA[14]	Explores the perceived usefulness of hearing aids	7
Note: HHIE, Hearing Impairment Inventory for the Elderly; HHIA, Adult Hearing Impaired Questionnaire; IOI-HA, International Registry of Outcomes – Hearing Aids.		

These tools have been developed to provide the basis for evidence-based clinical guidelines for hearing rehabilitation; Clinical practice guidelines can minimize outcome variability, maximize treatment efficacy, reduce risks, reduce losses, increase patient satisfaction, and help raise awareness of the audiology profession among third-party payers, other healthcare providers, and most importantly, current and future patients. However, the main drawback of these tools, like other quality-of-life (QoL) scales, stems from the fact that the importance of different QoL measurements can vary between individuals and within individuals over time, which means that structured measurements may be inaccurate or insensitive. It would be helpful if primary care physicians regularly checked for hearing loss in adults and regularly referred people with hearing loss to tertiary level audiology centers. It was demonstrated that new hearing aid users experienced less anxiety and depression after using hearing aids. It has been demonstrated that users of binaural hearing aids can benefit from the ability of the central auditory system to integrate binaural information and enjoy benefits such as binaural volume summation, difference in masking level, localization and elimination of head shadow. Patients with symmetrical hearing loss should be more comfortable using binaural hearing aids. Therefore, it is recommended to introduce screening practices at the PHC level using the HHIE (Hearing Loss Inventory for the Elderly), HHIA (Adult Hearing Impaired Questionnaire), IOI-HA (International Hearing Aid Outcome Registry)).

Conclusion

Currently, for the early diagnosis of presbycusis in the age population, the use of verified and validated questionnaires HHIE, HHIA, IOI-HA, as well as AQoL-8D is relevant; OLSA audiometric test is recommended. The implementation of three-level screening: population screening to targeted screening, from suspect to diagnosis, from primary health care to tertiary hospitals is of practical importance. The use of these methods and tools will improve the quality of life and organize measures for the early diagnosis of presbycusis in the age population of the population. These measures will improve the communicative socialization of the elderly population with presbycusis, which, accordingly, will reduce the burden on the health care system. With the appropriate qualifications of primary health care nurses, the organization of the primary stage of screening will provide a high-quality approach to the diagnosis of presbycusis as a medical service. The high qualification level of specialists at all levels of screening contributes to high-quality early diagnosis of presbycusis.

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