

## Organization of Research

# The Interdisciplinary Approach and New Technologies in the Scientific and Clinical Development of Otorhinolaryngology

N. A. Daikhes<sup>a,b,#</sup>

<sup>a</sup> National Medical Research Center for Otorhinolaryngology (NMRCO), Federal Medico-Biological Agency of Russia (FMBA),  
Moscow, Russia

<sup>b</sup> Pirogov Russian National Research Medical University, Ministry of Health of Russia, Moscow, Russia  
e-mail: otorhino1@yandex.ru

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**Abstract**—The experience of the FMBA NMRCO of Russia in implementing the concept of an interdisciplinary approach and the use of new technologies in the diagnosis, treatment, and rehabilitation of diseases of the ENT organs is discussed. It is noted that otorhinolaryngology is closely associated with a number of basic medical sciences and related clinical disciplines, which is reflected in the structure of the center: in addition to otorhinolaryngological departments, in which high-tech surgical interventions on ENT organs are performed, there are scientific and clinical departments: maxillofacial and plastic surgery, ophthalmology and neurosurgery, as well as the country's only center for professional pathology of ENT organs. Thus, in the general structure of the NMRCO's medical services, the share of medical care in specialties related to otorhinolaryngology is about 40%. Several departments deal with oncological diseases of the head and neck organs. Complex high-tech surgeries of cancer patients are performed by interdisciplinary teams of maxillofacial surgeons, oncologists, otosurgeons, and neurosurgeons, and interaction with the departments of phoniatics and physiotherapy and medical rehabilitation provides them with full-fledged postoperative rehabilitation. The NMRCO's experience shows that the widespread introduction of an interdisciplinary approach into clinical practice makes it possible to increase the efficiency of diagnostics, treatment, and rehabilitation of patients with otorhinolaryngological pathology.

**Keywords:** otorhinolaryngology, interdisciplinary approach, ENT organs, malignant neoplasms, diagnostics, surgery, rehabilitation.

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An interdisciplinary approach to the diagnostics, treatment, and rehabilitation of diseases of the ENT organs is the basis of the modern development of otorhinolaryngology, which is closely associated with other related medical disciplines. Large clinics in Europe and the United States specialize in the treatment of otorhinolaryngological diseases—head and neck surgery. An interdisciplinary approach to them became possible in the mid-20th century when new modern technologies appeared, making it possible to use microsurgical techniques in related anatomical areas [1].

The close relationship with basic medical sciences (immunology, virology, pharmacology, medical physics and chemistry, genetics, and pathological morphology) and related clinical disciplines (maxillofacial and plastic surgery, oncology, ophthalmology, neurosurgery, neurology, allergology, immunology, phoniatics, vestibulology, otoneurology, therapy, pediat-

rics, dentistry, cardiology, endocrinology, pulmonology, and occupational pathology) is the only correct way to develop otorhinolaryngology as a branch of medical science.

The concept of an interdisciplinary approach to the specialty is fully implemented at the National Medical Research Center of Otorhinolaryngology (NMRCO) of the FMBA of Russia, which is recognized as the largest leading Russian specialized scientific and clinical institution of otorhinolaryngology—head and neck surgery. In the center, specialists from different medical fields interact in the diagnostics, treatment, and rehabilitation of patients and in scientific research and the implementation of the results obtained in practice. More than 12000 high-tech surgeries are performed annually at the NMRCO with the participation of doctors of various specializations [2].

One of the important problems of otorhinolaryngology is the pathology of the auditory analyzer. Pathological processes in the ear and adjacent areas directly affect the physical condition of people, as well as their social and personal realization. An 80-bed

<sup>#</sup> RAS Corresponding Member Nikolai Arkad'evich Daikhes is Director of FMBA NMRCO of Russia.

otosurgery clinic has been established at NMRCO—one of the largest in the world, where a full range of surgical interventions on the structures of the ear and adjacent areas is performed, from sanitizing operations for chronic otitis media to the most complex surgical interventions on the structures of the base of skull. Specialists of the highest level and high-tech equipment (the latest motor, navigation, and micro-endoscopic systems; neuromonitoring of the facial nerve; and intraoperative angiography) allow performing surgical operations in complex pathological conditions, such as common cholesteatoma of the temporal bone pyramid, cochleovestibular disorders, congenital isolated anomalies of the middle uterine, congenital atresia of the external auditory canal with the absence of the auricle, and traumatic damage to the facial nerve [3].

A solution to the problem of high-grade sensorineural hearing loss and deafness became possible with the development of cochlear implantation. In Russia, it has been introduced into wide clinical practice since 2006. Our center performs such operations every day, correcting severe hearing impairment in patients of all ages. About 3500 cochlear implantations have already been performed, including those with a complicated course of the disease and in a previously inoperable group of patients [4].

An algorithm of surgical tactics with the use of a translabyrinthine approach has been worked out for the effective implementation of brainstem auditory implantation—restoration of hearing in deaf patients in whom it is impossible or impractical to carry out the operation of cochlear implantation. This is a large group of patients: children and adults with complete or significant ossification of the cochlea, with damage to the auditory nerves after tumor removal, with bilateral neuroma of the auditory nerve, and with the consequences of traumatic brain injury; children with aplasia or significant underdevelopment of the cochlea and/or auditory nerve; with auditory neuropathy. A brainstem auditory implant, unlike a cochlear one, is inserted not into the cochlea but into the subcortical centers of the brain (cochlear nuclei), which are located behind it and the auditory nerve, to stimulate them [5].

Diagnostics and rehabilitation of patients with hearing impairments of various origins are carried out by specialists of Russia's leading NMRCO Scientific and Clinical Department (SCD) of Audiology, Hearing Prosthetics, and Hearing—Speech Rehabilitation. More than 15000 people with hearing impairments of various age categories are registered at the SCD, of which more than 4500 are after cochlear implantation, including that performed in other institutions.

The NMRCO specialists have developed a system of complex hearing and speech rehabilitation, which is being actively introduced into the practice of medical institutions in Russia. Modern computer technolo-

gies, including programs using virtual reality, help to achieve good results in the rehabilitation of people with hearing impairments. Based on VR technologies, a program has been developed for training and complex hearing and speech rehabilitation for patients of different age groups. The presence of teachers for the deaf and hard-of-hearing and speech therapists in the structure of the department makes it possible to include medical and educational measures in the complex rehabilitation of adults and children with hearing and speech impairments.

NMRCO initiated the development of the program “Universal Audiological Screening of Newborns and Children of the First Year of Life,” which has been introduced into regional obstetric, outpatient, and polyclinic services and is a good help for audiologists and otorhinolaryngologists. The program is included in the national project Health, thanks to which the specialized services of the regions of Russia have received the appropriate equipment. The NMRCO specialists control its implementation and train personnel.

To prevent the development of genetic hearing loss, the audiologists of our center together with the Pirogov Russian National Research Medical University and the Kulakov National Medical Research Center for Obstetrics, Gynecology, and Perinatology conduct medical examination of families, preventing the possible development of genetic hearing loss and assist them in planning pregnancy using the *in vitro* fertilization method and in its follow-up.

Diseases of the nose and pharynx are among the most common in otorhinolaryngology, which are surgically treated by the SCD of Nose and Pharynx Pathology. Along with well-established operations (septoplasty, endoscopic sinusotomy, turbinate correction, and tonsillectomy), high-tech surgical interventions such as transnasal plastic closure of skull base defects, endoscopic operations on the maxillary sinuses using modern approaches, operations on the lacrimal ducts, elimination of postoperative cicatricial stenosis of the pharynx, and transnasal surgical interventions in the orbital area are performed [6, 7].

One of the most difficult endonasal surgeries is plastic closure of the perforation of the nasal septum. Over the past few years, more than 100 surgical interventions have been performed at the NMRCO using various methods of closing the defect (a flap on the anterior ethmoid and incisal arteries, modified free contralateral autografts), which help intraoperatively achieve almost 100% clinical effect and ensure a long-term functional result, while shortening the time of the operation.

In matters of allergic diseases of the upper respiratory tract, NMRCO actively cooperates with the State Research Center of Immunology of the FMBA of Russia.

Another problem associated with the pathology of the nose and pharynx in combination with somatic diseases is snoring and obstructive sleep apnea syndrome, which not only significantly reduce the quality of life but also often cause myocardial infarction, heart rhythm disturbances, arterial hypertension, stroke, and sudden death during sleep. To provide more effective assistance to these patients, a department of somnology has been created on the basis of the Scientific and Clinical Department of Nasal and Pharyngeal Diseases, which allows both a full range of diagnostics of snoring and obstructive sleep apnea syndrome and surgical treatment of this group of patients. The possibility of combining such treatment in one department makes SCD for Diseases of the Nose and Throat unique and the only one in Russia.

NMRCO pays much attention to the development and implementation of new methods of surgical treatment and rehabilitation of patients with laryngeal pathology. In many cases, this problem can only be solved by surgery. The center operates on the larynx using organ-preserving minimally invasive endoscopic surgical technologies and high-frequency artificial ventilation of the lungs, which significantly expands the possibilities of surgical intervention and makes it possible to abandon tracheostomy in almost all cases. For this purpose, the methods of radio wave, cold plasma, molecular resonance surgery, and CO<sub>2</sub> lasers are used, which almost completely eliminate the risk of injury of the vocal fold, ensure the preservation of anatomical structures, reduce blood loss and tissue trauma, and contribute to the fastest recovery of voice function.

Development and implementation of new methods of surgical treatment and rehabilitation of patients with congenital and acquired laryngeal stenosis are among the priorities. NMRCO has developed schemes for a personalized approach to this group of patients. For the first time in Russia, the endolaryngeal method of installing cartilage grafts for children and adults was used. This technique made it possible to shorten the duration of rehabilitation and prevent disability of patients.

NMRCO is one of the leaders in the study of the problem of laryngeal papillomatosis. We have developed new methods of surgical treatment of the disease and antirelapse therapy. A national registry of this category of patients is being created [8].

The leading Russian Scientific and Clinical Department of Pediatric Otorhinolaryngology, together with the SCD of the Upper Respiratory Tract, deals with laser surgery of the larynx for respiratory papillomatosis, as well as congenital and acquired stenosis of the larynx and trachea. The department also developed and introduced original methods of rhinoseptoplasty in children, taking into account the peculiarities of age-related development of the facial skeleton, including congenital clefts of the upper lip

and palate [9]. Authorial methods of reconstructive operations for congenital choanal atresia intended for children who have undergone cheilouranoplasty with perforation of the nasal septum are proposed. The terms and methods of surgical treatment of fractures of the nasal skeleton in children in the acute and long-term periods of trauma and methods of organ-preserving operations in adenoid vegetations have been determined and substantiated. A comprehensive approach to the treatment of adenoiditis in children with allergic and inflammatory diseases of the middle ear was introduced; an algorithm for the surgical treatment of children with PFAPA syndrome (periodic fever, aphthous stomatitis, pharyngitis, and cervical lymphadenitis) was developed.

Over the past decade, the center's pediatric otorhinolaryngologists have accumulated extensive experience in conservative and endoscopic surgical treatment of patients with chronic rhinosinusitis associated with hereditary diseases—cystic fibrosis and primary ciliary dyskinesia [10].

Currently, the SCD of Pediatric Otorhinolaryngology is actively working to improve further reconstructive operations for congenital and acquired malformations of the nose and intranasal structures and anomalies of the hearing organ, open reconstructive laryngotracheal surgery at the junction of otorhinolaryngology, and thoracic surgery.

One of the most important interdisciplinary problems today is oncology, in particular, ENT oncology. Six scientific and clinical departments deal with oncological diseases of the head and neck: oncology of the ENT organs, diseases of the upper respiratory tract, diseases of the nose and pharynx, pathology of the ear and skull base, maxillofacial and plastic surgery, and phoniatrics.

Thanks to the interdisciplinary approach, it has become possible to carry out the complete removal of benign neoplasms of the temporal bones (tumors of the facial nerve, glomus tumors) while preserving important and one-step reconstruction of destroyed structures (plasty of the facial nerve and cranial fossa defects, prosthetics of the auditory ossicles). Approaches through the middle cranial fossa to the base of the skull and the internal auditory canal were developed and mastered for performing operations with tumors of the internal auditory canal and cerebellopontine angle.

Thanks to modern technologies of intraoperative navigation control and the method of endoscopic transnasal surgery of the paranasal sinuses and the base of the skull, patients with juvenile angiofibroma of the nasopharynx, osteoma, inverted papilloma, and other benign and malignant neoplasms of the paranasal sinuses and the base of skull are successfully treated [11, 12].

Interdisciplinary teams of specialists, consisting of maxillofacial surgeons, oncologists, otosurgeons, and

neurosurgeons, have developed and perform complex high-tech operations, including surgical treatment of extensive defects in the head and neck area after various types of oncological diseases and radiation therapy. Among them are microsurgical operations to remove jaw ameloblastoma with subsequent rehabilitation of the function of chewing, swallowing, and speech; resection of the lower jaw affected by a tumor with a one-stage reconstruction with a peroneal graft on a vascular pedicle; operations to restore the integrity of the facial nerve in the temporal bone canal with simultaneous removal of the tumor; and removal of benign neoplasms of the cranial and maxillofacial region with simultaneous tissue restoration.

The most common malignant neoplasm of the ENT organs is malignant neoplasm of the larynx [13]. According to statistics, there are almost 6700 new cases of this disease every year. The overwhelming majority of newly diagnosed patients are patients with stage III–IV malignant neoplasm of the larynx. This also applies to groups of people working at enterprises with an increased risk of cancer, in whom, during preventive examinations, malignant neoplasms are detected only in 5% of cases.

The main task today is to ensure timely and effective diagnostics of malignant neoplasms. One of the promising methods is photodynamic diagnostics, which makes it possible to determine the edges of the tumor with high accuracy. The NMRCO specialists have developed and implemented photodynamic diagnostics for malignant and benign neoplasms of the larynx and benign nasal tumors.

Methods of early immunodiagnostics deserve special attention. Malignancy of the epithelial cells correlates with the concentration of heat shock proteins (molecules that appear during early cell damage by a tumor). Each type of human neoplasm has its own specific set of microRNAs. Researchers at the SCD of Oncology of ENT Organs have studied the expression of microRNA-21 in malignant neoplasms of the larynx; work is underway to create a base of microRNAs for various forms and types of malignant neoplasms of ENT organs.

In the case of submucosal neoplasms of the larynx and laryngopharynx, which are difficult to access for visualization and standard verification, NMRCO uses the technique of percutaneous harpoon biopsy of the larynx and laryngopharynx under the control of ultrasound, which makes it possible to obtain material for histological examination painlessly and safely [14].

The development of optical diagnostic methods based on fluorescence-Raman radiation, namely, on the express determination of the morphometric and functional state of biological tissues in patients with malignant and benign neoplasms of the larynx, is an important area of research at NMRCO. For the first time in Russia, a comparative analysis of the results of laser conversion express diagnostics of tissues in the

pre-, intra-, and postoperative periods was made for these patients [15].

The center conducts scientific and clinical work to improve early diagnostics, surgical treatment, and complex rehabilitation of patients with tumors of the upper respiratory tract together with colleagues from the National Medical Research Center of Radiology and the Blokhin National Medical Research Center of Oncology of the Russian Ministry of Health, as well as the FMBA oncological departments of medical institutions.

Interaction with other scientific and clinical departments, in particular with the SCD of Phoniatics and Physiotherapy and Medical Rehabilitation, makes it possible not only to achieve a good clinical result but also to ensure full postoperative rehabilitation of cancer patients with diseases of the larynx, pharynx, and related areas. The restoration of the patient's communicative function through the formation of substitutive phonation mechanisms is of great importance. The staff of the Scientific and Clinical Department of Phoniatics, the only one in Russia in this area, deals with these issues. Rehabilitation begins immediately in the postoperative period and lasts at least 1.5 months. For this purpose, personalized rehabilitation programs for laryngectomized patients are being developed and implemented, providing for the formation of an esophageal voice, the use of an electro-larynx, or restoration of voice function after laryngeal prosthetics.

For patients who have undergone surgery for benign neoplasms, papillomatosis, and cicatricial stenosis of the larynx, the stage of rehabilitation aimed at restoring the voice begins on the 7th–10th day and includes medical, physiotherapy, and pedagogical correction. Distance learning of laryngectomized patients has shown high efficiency. Rehabilitation of this group of patients is carried out jointly with patient organizations. Employees of the SCD of Phoniatics successfully apply differentiated algorithms for the treatment of voice disorders, including those associated with autoimmune rheumatic diseases. The SCD actively cooperates with the Nasonova Research Institute of Rheumatology.

The share of medical care in specialties related to otorhinolaryngology is at least 40% in the overall structure of the center's medical services. This is largely due to the possibilities of maxillofacial and plastic surgery. Together with otosurgeons, neurosurgeons, and employees of the department of microsurgery of the upper respiratory tract, complex high-tech operations are performed, including surgical treatment of extensive defects in the head and neck area and congenital malformations of the maxillofacial region. The interaction of maxillofacial surgeons with otosurgeons helps not only to eliminate a cosmetic defect in case of ear developmental anomalies but also to restore hearing at the same time [16].

Together with maxillofacial surgeons, operations are performed on the frontal sinuses with a combined approach, followed by reconstruction and obliteration of the frontal sinuses and open rhinoplasty. Close interdisciplinary interaction of pediatric otorhinolaryngologists with maxillofacial surgeons made it possible to substantiate the concept of age-related reconstructive rhinosurgery as a condition for the normal psychophysiological development of a child and prevention of concomitant and conjugate diseases.

As a result of interdisciplinary cooperation, it became possible for the first time to perform microsurgical reconstruction of a jaw defect with dental implantation, reconstruction of a defect in the lower third of the face using ectoprostheses obtained by 3D design on cranial implants, and orthognathic double maxillary surgery with reconstruction of an alveolar ridge defect in the upper jaw in a patient with a cleft upper lip, palate, and alveolar process of the upper jaw. Research in maxillofacial and plastic surgery is carried out in collaboration with the Central Research Institute of Dentistry and Maxillofacial Surgery and the Sechenov First Moscow State Medical University of the Russian Ministry of Health.

The interdisciplinary approach is also implemented in studies related to the problem of tissue engraftment after replacement of extensive defects of the face and neck in people who have undergone traumatic experiences. The experimental part of the research on the transplantation of large skin-musculoskeletal facial flaps on neurovascular anastomoses in laboratory animals (minipigs, primates) has been completed successfully. Now we are preparing for the clinical stage.

As a result of cooperation between otorhinolaryngologists and ophthalmologists of the center, it became possible to perform retinal implantation in deaf-blind patients. The world's first bionic eye installation operation took place at NMRCO in 2017. Our specialists developed a unique comprehensive method of postoperative rehabilitation of such patients, thanks to which the patients achieved a good level of adaptation, and bionic vision significantly improved their quality of life.

Now the center is actively developing the neurological direction of otorhinolaryngology. In the Russian Federation, the number of patients with cochleovestibular disorders is 13–14 per 10 000 of the population. The age aspect is also important: mainly young people of socially active and able-bodied age become patients of the otoneurological profile. The main problem of this group of patients is the late appeal to otoneurologists, including due to the insufficient number of specialists of this profile and complicated differential diagnostics. Routing of such patients is difficult due to the lack of interaction between doctors of different specialties. NMRCO treats patients with this pathology in close interaction of ENT specialists (vestibulo-

logists, otoneurologists, audiologists, otosurgeons, and rhinologists) with neurologists, neurosurgeons, psychiatrists, endocrinologists, therapists, and radiologists.

The center conducts scientific and applied research related to the development of a system for predicting the risk of developing vestibular disorders and the completeness of recovery after a previous vestibular attack in people working under barometric loads (including diving operations); systems for individual correction of the vestibular status of cosmonauts at the stage of preparation for flight, during the flight, and postflight rehabilitation; and a personalized approach to the treatment and rehabilitation of patients with otoneurological disorders.

A clinical study of cochleovestibular disorders against the background of changes in the bioelectrical activity of the brain began in cooperation with the Federal Center for Brain and Neurotechnology of the FMBA of Russia.

The connection of otorhinolaryngology with other medical areas, in particular with occupational pathology, is confirmed by the presence on the list of diseases of the ENT organs of a large number of diseases caused by the unfavorable action of occupational factors. For the effective provision of medical care to such patients, the NMRCO has created the country's only center for professional pathology of the ENT organs.

In the modern structure of occupational morbidity in Russia, indicators of occupational sensorineural hearing loss occupy the first place, underlying the occupational unsuitability of a significant number of highly qualified workers of fairly young working age (40–45 years). NMRCO conducts early diagnostics of occupational diseases of the ENT organs, determines the relationship of upper respiratory tract and ear diseases with the profession, and improves the issues of professional suitability and measures to prevent disorders and to return workers to their professions based on hearing conditions after surgical treatment [17, 18].

The work during the SARS-COV-2 pandemic became a confirmation of the concept of an interdisciplinary approach in otorhinolaryngology [19]. NMRCO turned out to be the only specialized otorhinolaryngological institution in Russia redesigned to provide medical care to patients with the new coronavirus infection. The center has deployed five infectious disease units and an intensive care unit. ENT doctors worked together with epidemiologists, infectious disease specialists, therapists, pulmonologists, endocrinologists, and anesthesiologists, which made it possible to treat more than 1000 patients effectively.

The results of the NMRCO research are reflected in leading Russian and foreign scientific journals. After 2000, the staff of the center published about 4000 works, including about 180 monographs, and received more than 90 patents for inventions. NMRCO's

Hirsch index, 32, is the highest among Russian scientific institutions in the field of otorhinolaryngology.

One of the main sections of the NMRCO work as the head institution specializing in otorhinolaryngology is the translation of modern scientific achievements into the clinical practice of healthcare institutions of the Russian Federation. Field teams of the center's specialists annually conduct more than 30 audits of otorhinolaryngological services in the regions of the Russian Federation, based on the results of which proposals are prepared for the introduction of modern methods of prevention, diagnostics, treatment, and rehabilitation, including telecommunication technologies used in world medical practice, into regional medical organizations. In 2020 alone, more than 400 telemedicine consultations took place.

Much attention is paid to the education of otorhinolaryngologists and doctors of related specialties, which follows specially developed programs of additional postgraduate education as advanced training cycles, on-the-job internships, and master classes with the participation of leading Russian and foreign specialists. Developed and included in the curriculum is a unique program for the advanced training cycle for otorhinolaryngologists, "Fundamentals of Diagnosis and Treatment of Tumors of ENT Organs." So far, this is the only cycle of advanced training in oncology for otorhinolaryngologists in the country.

Considering the insufficient staffing of the regions with personnel, NMRCO developed and implemented a professional retraining program in the specialty "audiology—otorhinolaryngology." Training classes and dissection classes were organized and equipped with modern simulators, including those with tactile feedback, allowing the most accurate transfer of sensations during manipulations on ENT organs. The equipment of the classrooms allows online lectures by leading experts, video broadcasting from operating rooms, and organizing teleconferences with Russian and foreign institutions.

In 2020, in connection with the introduction of compulsory primary specialized accreditation, by order of the Ministry of Health of the Russian Federation, NMRCO was assigned the function of the head center for the development of assessment tools and organizing and conducting accreditation in the specialties of otorhinolaryngology and audiology—otorhinolaryngology. For the accreditation procedure, the center created an accreditation platform equipped with world-class simulation equipment, which allows not only assessing the skills of a specialist but also providing practice-oriented training with realistic reproduction of the conditions of professional activity and the ability to assess objectively the readiness of a specialist to work with a patient.

Thus, Russian otorhinolaryngology is inextricably linked with other basic sciences and clinical areas and should develop as an interdisciplinary multiprofile

discipline. The experience of NMRCO shows that the widespread introduction of the interdisciplinary approach into clinical practice can significantly increase the efficiency of the diagnostics, treatment, and rehabilitation of patients with pathology of the ENT organs.

## REFERENCES

1. W. G. Edwards, "The versatility of the basic microscope system in otolaryngology," *Microsurgery* **1** (5), 387–393 (1980).
2. N. A. Daikhes, O. V. Karneeva, I. A. Kim, et al., "Scientific and Clinical Center of Otorhinolaryngology, FMBA of Russia: The timeline of an interdisciplinary approach in otorhinolaryngology," *Russ. Rinol.*, No. 4, 4–7 (2018).
3. N. A. Daikhes, Kh. M. Diab, and V. S. Korvyakov, *The Nuances of Otorhinolaryngology* (Izd. Moskva, Moscow, 2018) [in Russian].
4. Kh. M. Diab and K. D. Yusifov, "Complications of cochlear implantation and methods of their treatment," *Vestn. Otorinolaringol.*, No. 5, 21–25 (2018).
5. I. V. Koroleva, *Rehabilitation of Deaf Children and Adults after Cochlear and Brainstem Implantation* (KARO, St. Petersburg, 2016) [in Russian].
6. N. A. Daikhes, V. M. Averbukh, M. Z. Dzhafarova, and G. B. Bebchuk, RF Patent 2623648, *Byull. Izobret.*, No. 18 (2017).
7. N. A. Daikhes, V. M. Averbukh, M. Z. Dzhafarova, and G. B. Bebchuk, RF Patent 2644697, *Byull. Izobret.*, No. 5 (2018).
8. I. G. Guseinov, Kh. Sh. Davudov, T. I. Garashchenko, et al., "Photodynamic diagnosis of laryngeal papillomatosis using 5-aminolevulinic acid," *Med. Sovet.*, No. 11, 195–199 (2019).
9. A. S. Yunusov, N. A. Daikhes, and S. V. Rybalkin, *Pediatric Reconstructive Rhinosurgery* (Novye Izvestiya, Moscow, 2016) [in Russian].
10. D. P. Polyakov, O. V. Karneeva, and P. I. Belavina, "Chronic rhinosinusitis in children with cystic fibrosis: Current trends in diagnosis and treatment," *Russ. Rinol.*, No. 4, 17–25 (2018).
11. N. A. Daikhes, S. V. Yablonskii, Kh. Sh. Davudov, and S. M. Kuyan, *Benign Tumors of the Nasal Cavity, Paranasal Sinuses, and Nasopharynx in Children* (Meditsina, Moscow, 2005) [in Russian].
12. N. A. Daikhes, S. V. Yablonskii, Kh. Sh. Davudov, and S. M. Kuyan, *Juvenile Angiofibroma of the Base of the Skull* (Meditsina, Moscow, 2005) [in Russian].
13. *Malignant Neoplasms in Russia in 2018 (Morbidity and Mortality)*, Ed. by A. D. Kaprin, V. V. Starinskii, and G. V. Petrova (MNIOI im. P.A. Herzen, Filial FGBU NMITS Radiologii Minzdrava Rossii, Moscow, 2019) [in Russian].
14. N. A. Daikhes, V. V. Vinogradov, A. S. Korobkin, et al., "A case of early diagnosis of locoregional recurrence of laryngeal cancer using ultrasound-guided harpoon biopsy," *Russ. Elektron. Zh. Luch. Diagn.*, No. 2, 240–245 (2019).

15. N. A. Daikhes, V. V. Vinogradov, S. S. Reshul'skii, V. F. Prikuls, I. A. Kim, O. V. Karneeva, E. I. Trofimov, O. M. Sivkovich, and A. M. Khabazova, RF Patent 2729503, Byull. Izobret., No. 22 (2020).
16. Kh. M. Diab, D. N. Nazaryan, N. A. Daikhes, et al., "An interdisciplinary approach to the rehabilitation of patients with congenital atresia of the external auditory canal and microtia," Vestn. Otorinolaringol., No. 2, 17–21 (2018).
17. N. A. Daikhes, V. B. Pankova, I. N. Fedina, et al., "Occupational hearing loss treatment," Med. Tsel. Proekt., No. 29, 20–21 (2018).
18. N. A. Daikhes, I. V. Bukhtiyarov, G. A. Tavartkiladze, et al., "Key provisions of the clinical guidelines 'Noise-induced hearing loss,'" Vestn. Otorinolaringol., No. 5, 15–19 (2019).
19. N. A. Daikhes, O. V. Karneeva, A. S. Machalov, et al., "Audiological profile of patients with SARS-COV-2 virus disease," Vestn. Otorinolaringol., No. 5, 6–11 (2020).

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