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Neurosurgery, a relatively young and very complex area of medical practice, has reached incredible successes over the 100 years of its development as an independent trend largely due to the integration of research achievements and the improvement of medical equipment and surgical methods. At the same time, neurosurgery itself has always been a source of basic knowledge on the nervous system, not only drawing information from areas such as genetics, biochemistry, and physiology but also enriching them with data about pathological and normal states, as well as about the functioning of the nervous system. This process of cross-fertilization, stimulated by the emergence of ever-newer technological opportunities, not only demonstrates the productivity of research that interfaces basic and practice-oriented disciplines but also holds out hope for increasing the positive statistics about the number of patients with various traumas and organic diseases saved and returned to normal life, in particular, by methods of neuroprotection and stimulation of neurogenesis, or at least for improving the quality of life in the case of irremediable diseases, including neuromodulation methods.

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Current Technologies and Basic Research in Neurosurgery

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In recent years, intensive development of new biomedical technologies has been progressing and achievements in basic sciences and the principles of evidence-based and personalized medicine have been introduced actively into clinical medicine [1–5]. Various subdisciplines of neuroscience—molecular and cellular neurobiology, neurogenetics, and neurophysiology—have been rapidly developing, significantly enriching clinical neurosciences, primarily, neurology and neurosurgery [6–10]. In turn, neuroscience has stimulated original technological solutions in neurovisualization, making possible the intravital study of brain anatomy and the structure of the pathways of interrelations between blood circulation, metabolism, and functional activity under normal and pathological conditions [11, 12].

Today, neurosurgery as a clinical specialty and a field of neuroscience, which includes the study of basic problems of vital activities of the brain, covers a wide range of socially relevant pathologies of the nervous system. These are primarily vascular pathology, neurocarcinology, neurotrauma, neurodegenerative diseases, congenital pathology, epilepsy, and hydrocephaly. Neurosurgery has obtained new data about brain functional anatomy, such as individual features of cortical and subcortical interrelations responsible for maintaining consciousness and higher psychical functions, and has discovered the multivariate representation of speech functions, memory, and sensorimotor acts [2, 13]. It studies the mechanisms of brain plasticity and the restructuring of functional interrelations during both acute and chronic diseases [14–18].

Introduction of high-tech methods into diagnostics and treatment. The successful development of neurosurgery in the past decades has become possible thanks to the appearance of methods of X-ray and magnetic resonance tomography (MRT), positron-emission and single-photon emission computer tomography (PET, SPECT), ultrasound dopplerography (USDG), and navigation systems, as well as thanks to the constant improvement of microscopes, endoscopes, and instruments for endovascular surgery, high-precision radiosurgery, and radiotherapy. Computer-aided surgery modeling methods; additive technologies in reconstructive neurosurgery; and new approaches to prosthetics, recovery, and modulation of impaired brain functions using brain–computer interface technologies, as well as robotized systems and devices, have been developed further [2, 16, 19–23].

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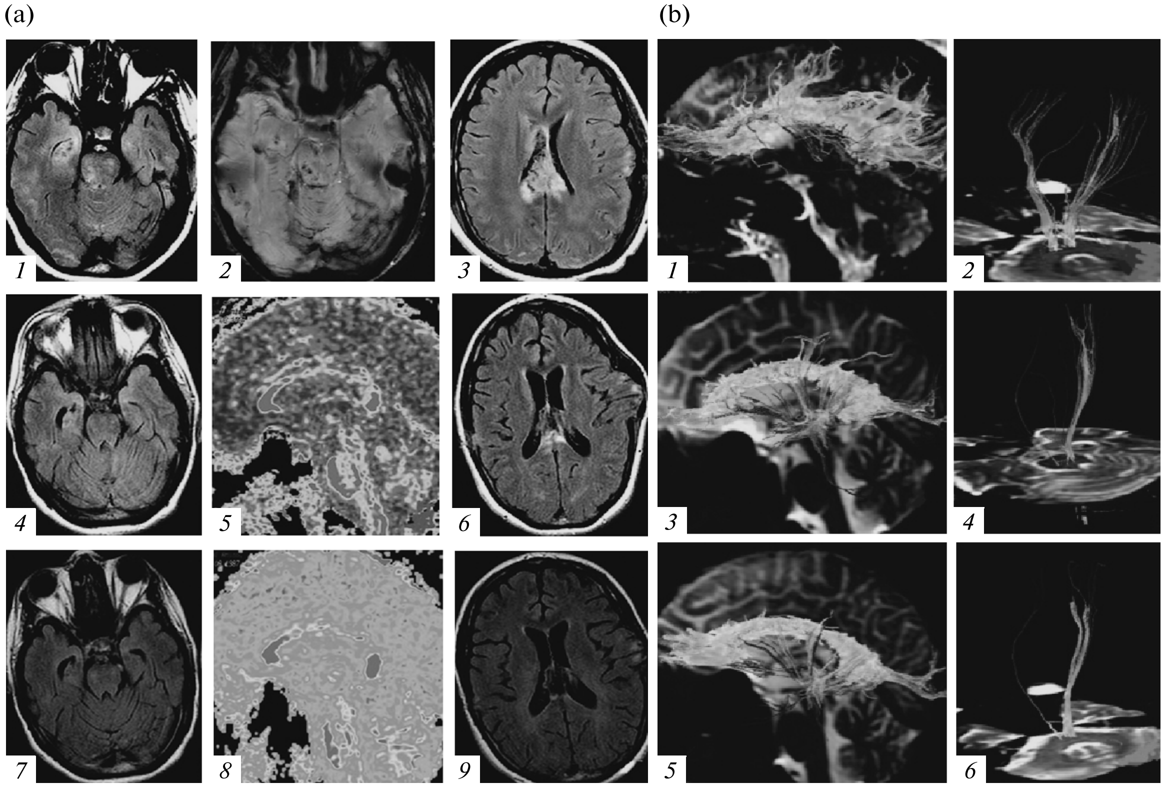

Fig. 1. Clinical case of a 22-year-old female patient with a diffuse axonal damage and unfavorable outcome (severe invalidism, tetraparesis).

(a) MRT examination results. During examination in modes T2-FLAIR (*1*, *3*) and SWAN (*2*) on the fourth day after the trauma, lesions were identified at the level of the mesolobus, pons, and midbrain; during examination on the 33rd day (*4*, *6*, T2-FLAIR; *5*, the map of fractional anisotropy in the saggital plane) and after four months (*7*, *9*, T2-FLAIR; *8*, the map of fractional anisotropy), atrophic changes in the cerebral hemispheres, pons, and mesolobus; (b) the dynamics of MR tractography data. Examination on the fourth day (*1*, *2*) determined the partial absence of visualization of fibers on the front third of the mesolobus, the corticospinal tracts being relatively symmetrical; examination on the 33rd day (*3*, *4*) visualizes only individual ascending fibers in the middle part, as well as in the genu and splenium of the mesolobus; the asymmetry of corticospinal tracts (CSTs), the thinning of fibers on the left; examination four months after the trauma (*5*, *6*) revealed only individual fibers in the area of the genu and splenium of the mesolobus, as well as severe asymmetric thinning of the CSTs.

Alongside applied effects, the introduction of new technologies into neurosurgery have stimulated basic research into the tissue, cellular, and molecular mechanisms of damage to and recovery of the nervous system under various pathologies. The concept of primary and secondary focal and diffuse brain damage under neurotraumas has made a step forward. The model of diffuse axonal damage helped to reveal the regularities of multidimensional brain splitting with the increasing degeneration of commissural (interhemispheric), associative (intrahemispheric), and projective (corticospinal) pathways of the brain [12, 24, 25]. Today we may state that a brain trauma, leading to diffuse axonal damage, is the cause, or, better, the trigger of a posttraumatic disease of brain pathways protracted in time (Figs. 1a, 1b). The severity of the posttraumatic disease, as well as its clinical progression and consequences, is predetermined by many factors: biomechanical specifics; aging and premorbid, including genetic, factors; individual features of secondary pathophysiological reactions; and the adequate selection of a personalized algorithm of diagnostic, curative, and neurorehabilitative measures [26].

The constant improvement and increased resolution of neurovisualization and neurophysiology methods have opened up new opportunities for the study of disturbances in the structural and functional integrity of the brain, which underlie various forms of disorders in consciousness and in cognitive, mnestic, sensorimotor, and other functions of the brain under various cerebral pathologies [14–16, 27, 28]. High-resolution modalities of magnetic resonance tomography have helped to obtain new data about neuroanatomic correlates of traumatic coma [29] and postcomatose states of impaired consciousness. For cases of severe brain traumas, first, the interrelation of the damage of certain sections of the brain stem (the pons in the projection of cholinergic nuclei, the central tegmental region of the midbrain) and the associated damage to the brain's subcortical structures (the neostriatum, paleostriatum, and thalamus) with the rate of consciousness recovery was shown for the first time; second, the clinical syndromes of dysfunction of the glutamatergic, cholinergic, and dopaminergic systems were singled out on the basis of theoretical concepts about neuromediators that participate in the physiology of motor pathways. The newly obtained data made it possible to develop a personalized approach to the selection of preparations for patients who were in a subconscious state, significantly improving the disease outcome [27, 28].

Perfusion computer tomography has revealed characteristic options of the voluminous cerebral blood flow in the hemispheres and stem structures of the brain under focal and diffuse damage and has established the critical levels of the blood flow in the brain stem under its primary and secondary disorders [12, 30–32].

Dynamic studies using diffuse tensor MRT, conducted at the Burdenko Research Institute of Neurosurgery, have shown not only the destruction and disintegration of pathways after a brain trauma with the development of coma and severe neurological disorders but also the possibility of their reintegration during the recovery of disturbed brain functions [31]. The topicality of human brain pathway research under normal and different pathological conditions is demonstrated by the following projects, unprecedented in the scale of high-tech support and in the amount of funding: Human Brain Connectome, launched in the United States in 2010, and Human Brain Project, kicked off in the EU countries in 2013 [33, 34].

Methods of presurgical planning and intrasurgical navigation. Neurovisualization using CT, MRT, PET, and SPECT data in various combinations has become an integral part of diagnostics and presurgical planning in neurosurgery. In addition to 2-D imaging of brain slices, 3-D reconstruction is used, providing a neurosurgeon with the opportunity to orient better during paraplasm removal and thus reducing the risk of damaging vital brain structures and vessels.

For more accurate and least traumatic access under maximally radical operations, especially when the boundaries between the healthy and pathological tissues are vague, as well as when the tumor is located in functionally critical zones, various intrasurgical visualization methods (CT, MRT, and unltrasonography), navigation systems, combinations of microscopic and endoscopic equipment, as well as neurophysiological and neurometabolic technologies began to be used [2, 13, 35, 36].

Various neurovisualization methods allow obtaining information not only about brain morphology and hemodynamics but also about the brain's functional and metabolic condition; in particular, the navigation method is important for determining the functionally critical zones, i.e., motor and speech centers localized before surgery using functional MRT and tractography. Data about the functional anatomy, obtained with functional and diffuse tensor MRT or intrasurgical neurophysiological mapping, have shown that the distribution of primary motor and sensory, as well as speech, centers is much wider and more variable than was assumed in the classical works by P. Broca, C. Wernicke, and K. Brodmann [2, 13].

Neurophysiological monitoring of the most crucial brain structures and functions is especially important for the atraumaticity of surgical operations. During operations on the brain hemispheres, it is the stimulation of the cortical motor zone and subcortical pyramidal tracts; during operations near speech centers, it is manipulations with patient awakening; and, during invasions on the brain stem, it is the determination of the position of motor nuclei by stimulating them and the use of hearing and sensorimotor induced potentials [2]. The use of electrophysiological methods of assessing the integrity of the main pathways is a precondition for operations on intramedullary tumors.

Promising fields in neurosurgery. Among the main vectors that form modern neurosurgery, we should, first of all, single out biophotonics, a new field that has been developed thanks to the cooperation of the Burdenko Research Institute of Neurosurgery with the Prokhorov Institute of General Physics, RAS, and the NIOPIK Science Center, where state-of-the-art methods of photodynamic diagnostics and therapy are developed and new fluorescent preparations are created [37–39]. For brain tumor surgery, the method of fluorescence diagnostics and biospectroscopy is widely used to raise both the radicality and the safety of operations [2, 35, 36, 40].

Another crucial component of modern neurosurgery is reconstructive neurosurgery to reconstruct the bone structures of the cranium and spinal column, brain tunics, the system of liquor and blood circulation in the brain and marrow, and the peripheral nervous system. Visualization methods and information technologies make it possible to obtain 3-D images of any anatomical structures and paraplasms, as well as to plan complex surgical operations in virtual models [2, 3, 22]. The most fruitful in this respect has been cooperation with the RAS Institute on Laser and Information Technologies, where the domestic technology of computer laser stereolithography was developed [19, 20]. As this technology has been enhanced, the quality of stereolithographic models, molds, and implants has improved substantially (Fig. 2). Unlike the CAD/CAM customized implant technologies practiced around the world, the domestic technology implies the participation of a surgeon in implant design, the use of biocompatible materials, and the precise plastic copying of an object under reconstruction and a mold. The possibility to manufacture implants before or during the operation significantly

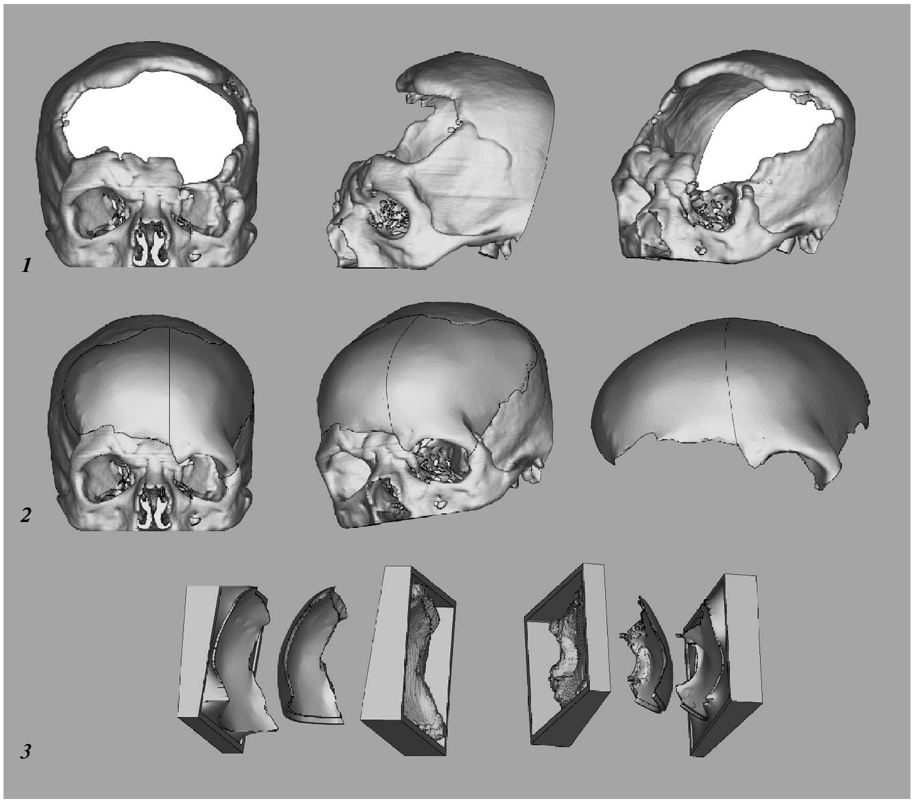

Fig. 2. Virtual model (based on spiral computer tomography) of a patient's cranium with a major defect of the frontal orbital area (*1*) before and (*2*) after reconstruction and (*3*) a virtual model of the press molds and implants.

reduces the time of surgical intervention and improves its cosmetic effect. Moreover, the manufacture of implants from biocompatible polymethyl metacrystals outside of the operative wound excludes negative consequences of exothermic reactions during polymerization. Constant improvement of information and additive technologies of high-precision copies of biological objects and structures of any complexity and individual implants from biocompatible materials open new horizons in reconstructive craniocerebral, craniofacial, and plastic surgery; vertebrology; and orthopedics [41].

Endovascular surgery is developing rapidly. It was founded by F.A. Serbinenko [42], and today it is actively being improved by his disciples. The experience of thousands of operations on brain vessels in adults and children, accumulated by them, is unique. Today the two main methods of treating brain vessel diseases, microsurgical and endovenous, complement one another effectively. It is very important that both fields are developing equally successfully at the Burdenko Research Institute of Neurosurgery, and this expands significantly the capabilities of treating various vascular pathologies of the central nervous system. At the current stage, the methods of endovascular neurosurgery make it possible to carry out low-invasive interventions on the brain and marrow vessels. The introduction of state-of-the-art microcatheters, microcoils, various stents, and adhesive glue compositions in combination with state-of-the-art angiographic equipment makes it possible to treat effectively patients with occlusal–stenotic damage to intracranial and extracranial arteries, arterial aneurysms, and arterial–venous malformations.

One of the most high-tech and promising development vectors in neurosurgery as a possibility to study individual neuroanatomy and to affect the brain's functional activity is functional neurosurgery. Currently the methods of functional neurosurgery and, primarily, neuromodulation, have found application in the complex treatment of Parkinsonism, various forms of torsion dystonia, infantile cerebral paralysis, spastic syndromes, epilepsy, chronic pain syndromes of neurogenic and visceral genesis, severe forms of obsessive compulsory disorders, depression, and other diseases [43]. The possibilities of brain neuromodulation in long-lasting unconscious states, including the persistent vegetative condition and the condition of minimal consciousness after a severe brain trauma, continue to be investigated [4, 16, 18].

We should stress that further development of neuromodulation methods is closely related to the use of high-resolution neurovisualization methods, mainly MRT; new knowledge of functional anatomy and optimal targets in various pathologies; the improvement of navigation systems; and the creation of more economical programmed implant systems. Experimental developments in gene engineering in combination with optical neurostimulation open new horizons in the development of the method of optogenetic neuromodulation [44].

A neuromodulation option is experimental developments of the brain–computer interface technologies. Today, the first promising clinical observations are conducted to control robotized prostheses and exoskeletons and to stimulate muscle groups and peripheral nerves to recover various motor acts, including limb movements, walking, and swallowing [21, 23].

Of great importance is research related to neuroprotection and neuroplasticity. A major strategy of treating acute phases of cerebral damages of various geneses is the prevention and elimination of the cascade of secondary brain disorders in the permeability of the brain–blood barrier, edematization, disorders in hemocirculation and liquorocirculation), which requires primarily adequate neuroprotection. An important element of treating a brain traumatic disease is to activate the mechanisms of regeneration of the neuro–glial–vascular complex. In recent years, it was possible to show the existence of genetic disposition to various degrees of intensity of secondary brain reactions in response to damage. In particular, as has been established, young patients with Apolipoprotein allele ε 4 in their genes exhibit worse outcomes than patients without this trait [6]. Analysis of the clinical and experimental data allows us to conclude that the very product of the APOE gene, Apolipoprotein E, plays an important role in the processes of neuroplasticity and recovery of the damaged brain.

At the same time, the plasticity of the nervous system is based on various mechanisms of adaptive restructuring; synaptic plasticity; and the ability to sprout, regenerate the glial–neuronal–vascular complex, form new structural–functional relations; etc. [17]. For example, experimental research has shown that the key role in neuroregeneration processes may be played by stem cells, which localize mainly in the subventricular zone and the hippocampus, as well as near the ependymal of the central canal of the spinal cord. In response to damage, the proliferating stem cells start migrating to the damaged zone, where they are differentiated into neuronal or glial cells, ensuring neuroregeneration processes [45]. However, the possibility to regenerate and recover the function of the central nervous system is very limited under clinical conditions. It may be possible to solve this problem in the future by stimulating neurogenesis using both endogenic and exogenic factors. Experimental data show the possibility to use different methodologies, including electrostimulation, antidepressants, and growth factors. However, the results of this work need more detailed translation into clinical medicine.

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The above overview of the main areas that comprise neurosurgery today and its technological status allows us to single out the following vectors of basic research and technological solutions:

- study of the functional anatomy of the human brain based on the integration of neurovisualization data and the 3-D mapping of structural, neurometabolic, neuromediator, and neurophysiological patterns;
- molecular diagnostics and biomarkers during vascular and tumoral diseases, as well as traumatic and radiative brain damages;
- study of the structural, metabolic, neuromediator, and neurophysiological mechanisms of brain plasticity and neurogenesis;
- the study of neurocarcinogenesis and the development of methods and technologies of the delivery of chemopreparations, antitumoral antibodies, and carcinolytic viruses;
- the search for a new class of neuro- and angioprotectors, as well as cellular and molecular technologies for the modulation of neuroregenerative processes;
- the development of new biocompatible materials; stable and reabsorbed implants and scaffolds for the reconstruction of bone structures, as well as brain shells and vessels; and liquor-conductive pathways with possible controlled bioreabsorption, as well as induction and conduction properties of cellular regeneration; the development of tissue engineering; and the creation of tissue equivalents and artificial organs; and
- new technological solutions in microsurgery; endoscopy; reconstructive, endovascular, and functional neurosurgery; high-precision radiosurgery; and robotics based on the achievements of physical optics, informatics, biophotonics, nano- and biotechnologies, and nuclear medicine; the continuation of developing the brain–computer interface; etc.

The Burdenko Research Institute of Neurosurgery is actively working in the above fields, and some of its research projects are supported by grants of the Russian Foundation for Basic Research, for example, "Analysis of Structural–Functional Mechanisms of Plasticity That Underlie the Recovery of Sensorimotor and Cognitive Functions in Patients with Traumatic Brain Damages" (grant no. 13-04-12061), "Intravital Molecular Diagnostics of Malignant Gliomas of the Human Brain Using State-of-the-Art Modalities of Magnetic Resonance Tomography, Intrasurgical Fluorescence Diagnostics, Combined Spectroscopy, and Histogenetic Studies" (grant no. 13-04-40201-N), and "Creation of a Biosensory

System of Laser Spectral Fluorescence Diagnostics of Neoplasms of the Central Nervous System" (grant no. 13-04-12066).

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The Development of Medicine and the Development of Big Science: Achievements and Common Problems

Paper Discussion

Opening the discussion, Academician **A.N. Konovalov** thanked the RAS Presidium for the opportunity to present and discuss the research results of the Burdenko Research Institute of Neurosurgery. According to him, this event is a logical continuation of Academician Yu.S. Osipov's initiatives aimed at integration of medical and big science. The mutual aspiration to find common goals and objectives yields, as practice shows, good results and refreshes itself by the specifics of the contemporary stage of the development of medicine, when problems that face it are solved at the cellular, molecular, and genetic levels. This opens prospects for cooperation between doctors and representatives of many disciplines; therefore, practically each of those present here, in the opinion of Konovalov, can take part in solving the objectives of medical science, including neurosurgery. This trend is also backed up, first, by the topics of human health being viewed as the highest priority, and, second, by the brain within this trend serving as a special object of study for penetrating into the secrets of the most complex processes of the organization of nervous activity.

Konovalov pointed to circumstances that concerned him as a researcher and a doctor. On the one hand, these problems of funding and determining research areas are common for all of academic science under reorganization; on the other hand, these are specific difficulties of medical science. Medicine, particularly neurosurgery, as a science relies on the vast clinical material and experience of treating tens and hundreds of thousands of patients. In addition, the technical and methodological level at medical facilities of the Russian Academy of Medical Sciences noticeably exceeds the corresponding level at other medical organizations of the country. Therefore, the fate of the institutes of the Russian Academy of Medical Sciences is decisive for the development of medicine in Russia. Here the potential that should be developed in close cooperation with other academic and nonacademic scientific establishments is concentrated.

Academician **V.Ya. Panchenko** singled out two aspects of neurosurgical development. The first is that new technologies are mastered by rank-and-file surgeons and thus are widely disseminated. This trend is observed in Russia and abroad. For example, the latest methods based on distant biomodeling and Internet information support for surgical operations are already becoming subjects of master classes. The second substantial fact is the active search for the most advanced methods and tools and their introduction into medical practice, i.e., an initiative that comes from scientists who have clinical practice, practical doctors. This particular work is a business card of the associates of the Burdenko Research Institute of Neurosurgery. Such broad research activity is a very rare phenomenon for a practicing clinic, which makes it even more valuable.

Panchenko also spoke about a trend in improving neurosurgical practice—the creation of biocompatible, as well as biodegradable, materials. To this end the domestic technology mentioned in this paper, i.e., stereolithography, which is an unquestionable achievement of academic science, is used. Other methods are the selective laser caking of biocompatible nanopowders and work with various mixtures that contain polylactides and saccharides, which, at a certain level of saturation with pluripotent cells, can contribute to the development and growth of the necessary tissues. Such research is conducted at the RAS Institute on Laser and Information Technologies, headed by Panchenko. In fact, a department of this institute cooperates directly with the Burdenko Research Institute of Neurosurgery.

The topic of converging various studies and disciplines was raised by Academician **I.A. Shcherbakov.** Although the very term *convergence* has been introduced into scientific use quite recently, the processes of interpenetration of methods, studies, and entire areas of scientific knowledge marked by it started to emerge much earlier. Such work at the Prokhorov Institute of General Physics was started right after the appearance of the first lasers, i.e., in the 1960s and 1970s, and today such research is characterized by the diversity of trends, including the one that is mastered in cooperation with the Burdenko Institute of Neurosurgery. A result of perennial cooperation, during which physicists and doctors were able to start speaking one language, is the development of photodynamic therapy in Russia.

Academician **M.V. Ugryumov** recalled that N.N. Burdenko, one of the founders of the Russian Academy of Medical Sciences and the Research Institute of Neurosurgery, which now bears his name, had advocated the idea of the need to develop neurosurgery in three directions: clinical–physiological, clinical–morphological, and clinical–biochemical. Although the terminology has changed, as well as the understanding of many phenomena and processes, the present status of neurosurgery confirms allegiance to the strategy of development of this area of medical science and practice suggested by Burdenko. It also illustrates the correctness of Academician L.A. Orbeli's words that pathology is the best model out of all the achievements of experimental models and studies. In addition, he meant primarily brain pathology, which "includes" some brain regions and makes it possible to study their functions.

The principle stated by Orbeli was implemented in the activities of prominent scientists who worked in the 1950s–1960s at the Research Institute of Neurosurgery, as well as outstanding specialists in the field of neurophysiology, dynamic physiology, morphology, psychology, etc. They all turned to the unique material for the study of brain operation, which had been accumulated within the walls of the institute, and this, in the opinion of Ugryumov, led to outstanding results. Thus, Academician V.S. Gurfinkel' dealt with modeling prostheses and was one of the first to speak about robotics, and A.R. Luriya contributed so profoundly to psychology that his works are still cited in the world literature equally or even more often than the works by I.P. Pavlov.

Ugryumov also paid attention to the decisive role in the development of neurosurgery that is played by technological progress. This paper reflected this dependence very vividly, in particular, by the example of various types of tomography, which, and this is important, supplement one another: while magnetic resonance tomography implements a microanatomical approach, positron emission tomography makes it possible to study the cellular–molecular mechanisms of brain operation.

However, against the backdrop of the brilliant achievements of the past and present, there are circumstances that cause grave concerns in Ugryumov about the future of Russian neurosurgery and Russian science in general; this is practically the complete absence of domestic equipment in scientific research laboratories and medical facilities. The causes are obvious: the destruction of applied and industrial science in the 1990s, which resulted in the fact that the developments of academic institutes had never reached the level of serial production. The Russian Academy of Medical Sciences finds itself in a better position in this respect, having preserved both basic and clinical institutes. This allows us to use basic knowledge without long delays, particularly by creating new technologies in medical practice on their basis.

In conclusion, Ugryumov stressed that it becomes obvious from visiting with foreign colleagues at various international meetings, conferences, and summits of large organizations that neurological and neurosurgical problems and all research in general are related one way or another to the brain and its functioning, being today a major vector of scientific endeavor. An illustration of this is, for example, the situation in the United States where in 2013, for the first time in ten years, the budget of the National Institute of Health (the analog of the Russian Academy of Medical Sciences) was not increased but, on the contrary, was reduced by $1.5 billion, but, despite this fact, the budget for brain research in 2014 increased by $800 million with an assumed growth in the following years.

RAS Corresponding Member **G.N. Vorozhtsov,** director general of the NIOPIK Science Center, continued the topic of the deficit of domestic equipment by the example of the above-mentioned methodology of photodynamic therapy. He demonstrated to the attendees a pricelist of instruments designed at the RAS Institute of General Physics and distributed not only in the Russian but also in the international market, as well as that of domestic preparations that have passed all the necessary tests from initial development to market entry as pharmaceuticals over the past 20 years. In addition, domestic developers have registered about 150 patents, some of them international. Therefore, Vorozhtsov concluded that applied research continues although it has suffered great damage in the post-Soviet period.

Vorozhtsov also called attention to the role of chemical studies and developments in neurosurgery. This is primarily the creation of relatively cheap domestic analogs of foreign preparations and original means of treatment and diagnostics. Thus, photodynamics makes it possible to designate tumor boundaries using a certain chemical compound. Therefore, the creation of a set of preparations for various tissues will allow us to expand significantly the capabilities of photodynamic therapy and diagnostics. Another field of research is the provision of magnetic resonance tomography with more effective diagnostic agents. In particular, a development based on the synthesis of aminolevulinic acid with markers of a carbon isotope, as estimated, will make it possible to increase by 10000 times the sensitivity of the MRT method. Catalytic therapy is promising for neurosurgery in the opinion of Vorozhtsov. It implies injecting two substances, inactive and harmless for the organism, that, concentrating in tumors, cause the death of cancer cells. Within this trend, teraftal is undergoing clinical tests.

The success of such studies, Vorozhtsov noted, depends on the productivity of joint activities of different organizations, such as academic institutes, agencies oriented at applied developments, and clinical facilities. The most fruitful way of organizing such work is studies according to single programs that integrate the activities of specialists from several research areas, which ideally have the status of federal target programs. Vorozhtsov expressed confidence that the united Academy of Sciences should be the initiator at a minimum and the supervisor at a maximum of such programs.

Academician A.A. Potapov's paper performed two key functions, demonstrating, first, the good level of Russian medicine and, second, the importance of experimental research for the solution of medical objectives, Academician **A.I. Grigor'ev** noted. The goal of these studies is to care for human health. Two scientific sessions of the RAS General Meeting, in 2003 (Science for Human Health) and in 2009 (The Brain: Basic and Applied Problems), were dedicated to medical problems in recent years. The 2009 session discussed a wide range of objectives related to brain studies. Their topicality has not decreased over the past several years. In particular, the urgency to counter various pathologies is supported by the following figures: 400000 strokes are annually registered in Russia; moreover, they increasingly more often strike not only elderly people but also quite young people. In a high-tech country like the United States, statistics registers four million patients with disorders of motor functions, i.e., with one of the possible results of nervous system disorders.

Despite the fact that the Academy pays great attention to solving the above and other problems of medical science, we should not ignore circumstances that do not exhibit positive dynamics. Grigor'ev's main concern was the notable deficit of domestic equipment, technologies, and diagnostic and therapeutic methods and preparations, which could not be overcome with the achievements mentioned in the addresses of the participants in the discussion. A number of developments that have reached the stage of prototypes cannot be commercialized because instrument making as an industry was destroyed all over the country, and the situation in the structures of the Russian Academy of Medical Sciences is not any better than the general situation. About 15 innovative developments are annually presented within the RAS Presidium program Basic Science for Medicine, but the Academy has no funds for their further promotion; the funding available is just enough to introduce one or two developments, Grigor'ev stressed. Appeals are heard at all levels to use innovative solutions and products, but the funding allocated by the government and business does not match at all the task put forward.

Grigor'ev agreed with Vorozhtsov that the establishment of a target program oriented at overcoming the current situation could really yield positive results. However, as far as he knew, only the executive authorities, i.e., ministries, can be the initiators of federal target programs. At the same time, the Academy is left with RAS Presidium's programs, and we should focus on them in order not to lose the groundwork we already have and to continue supporting, if not introducing into production, the development of new products. Today these programs should be changed taking into account the affiliation of the Russian Academy of Medical Sciences and the Russian Academy of Agricultural Sciences with the Russian Academy of Sciences, but the main point is that they should stay as the Academy's business and not as that of other institutions, for example, the Federal Agency for Scientific Organizations.

Academician **V.E. Fortov** backed up the idea of organizing a project aimed at the development of medical research within the united Academy of Sciences. This agrees with global trends, since now all developed countries are striving to obtain advanced results in this field. The RAS president noted that Russian Health Minister V.I. Skvortsova supported such initiatives. At the same time, the forthcoming reform of health care cannot but raise concerns because it is not clear how it will affect research at clinical facilities.

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