Practice Oriented Science:
UAE – RUSSIA – INDIA

Materials of International University Scientific Forum
January 27, 2023

UAE, 2023

Materials of International University Scientific Forum

Practice Oriented Science: UAE – RUSSIA – INDIA

January 27, 2023

UAE

Proceedings of the International University Scientific Forum **“Practice Oriented Science: UAE – RUSSIA – INDIA”**.

(January 27, 2023. UAE)

ISBN 978-5-905695-87-5

These Conference Proceedings combine materials of the conference – research papers and thesis reports of scientific workers. They examines technical and sociological aspects of research issues. Some articles deal with theoretical and methodological approaches and principles of research questions of personality professionalization.

Authors are responsible for the accuracy of cited publications, facts, figures, quotations, statistics, proper names and other information.

ISBN 978-5-905695-87-5

CONTENTS

PSYCHOLOGICAL SCIENCES

MEDICAL SCIENCES

DOI 10.34660/INF.2023.56.80.050

ON THE ISSUE OF ENSURING THE ECONOMIC SOVEREIGNTY OF THE RUSSIAN FEDERATION IN THE CONDITIONS OF SANCTIONS PRESSURE[1*]

Kazantsev Sergey Vladimirovich
Doctor of Economic Sciences, Chief Researcher
Institute of Economics of the Russian Academy of Sciences,
Moscow, Russia
https://orcid.org/0000-0003-4777-8840

Annotation. *To ensure the sustainable progressive development of the country, qualified and motivated producers, favorable conditions for their work, advanced technologies and means of production, a reliable financial and credit system, well-established logistics, professional governance and management are needed. In the study of the strategic directions of the progressive development of the Russian Federation in the conditions of anti-Russian sanctions, four of these factors were investigated: producers, production conditions, means of production, a system of state governance. The results obtained are briefly summarized in this article*

Keywords: *the Russian Federation, strategic directions of socio-economic development, anti-Russian sanctions*.

Producers

Producers are people involved in the production process. Their numbers, professional skills, motivation, and well-being are important. And the first strategic task here is to increase the population of the count. The second strategic objective is to ensure a high level of education and professional training of those employed in public production. The dynamics of the working-age population in the Russian Federation is alarming: it, like the population as a whole, tends to decrease (Figure 1).

1 * *The paper was prepared according to the research plan of the Institute of Economics of the Russian Academy of Sciences, the topic of the state assignment reg. No. R&D 12030500096 – 5 "New challenges and threats to socio-economic security: measures of budgetary and financial regulation".*

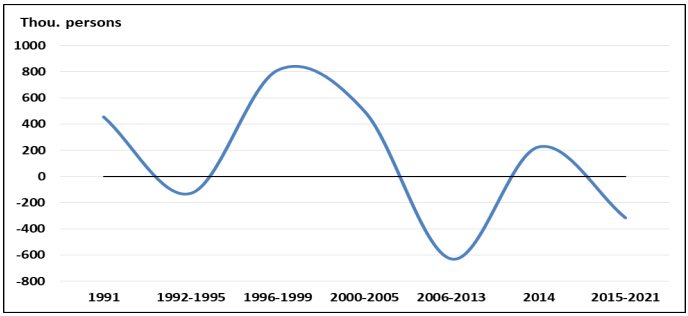


Figure 1. *Average annual growth of the population of the Russian Federation in working age in 1991-2021, thousand persons*[2].

Source: The figure is constructed by the author according to the statistical yearbooks "Russian Statistical Yearbook", "Regions of Russia. Socio-economic indicators".

It should be noted that for Russia with its vast territory (17.125 million square kilometers) of working population territorial settlement is important and not only the total number of workers. In this aspect, the dynamics of changes in the territorial structure of the working-age population in modern Russia is of concern. The population and labor resources are increasingly concentrated in several subjects of the Russian Federation, leaving an increasing number of regions[3] (Figure 2).

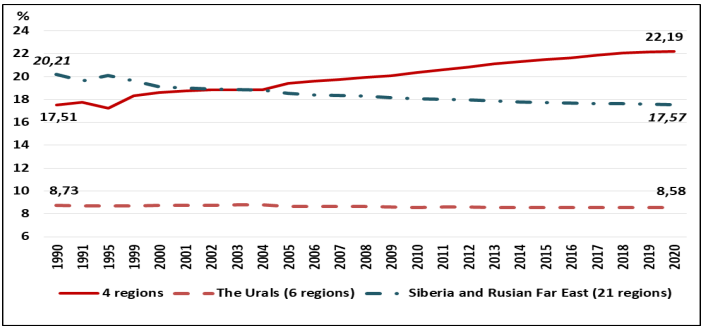


Figure 2. *The maximum and minimum (excluding Moscow and St. Petersburg) density of paved public roads in the subjects of the Russian Federation in 1990-2020 (end of year,* kilometers of routes per 1000 sq. km of territory).

2 In 2014, the Republic of Crimea and Sevastopol joined Russia (a total of 2.3 million people, including 1.3 million people of working age).

3 The terms "subject of the Russian Federation" and "region" are used as synonyms in the article.

Source: The figure is constructed by the author according to the statistical yearbooks "Russian Statistical Yearbook", "Regions of Russia. Socio-economic indicators".

The data shown in Table 1 illustrate the high rate of decline in the share of residents of the northern and eastern regions of Russia in the total number of Russians. In 2020, the average annual population of the Krasnoyarsk Territory was 12.5% less than in 1990, in the Kamchatka Territory – 40.8% less.

Table 1.

The rate of change in the working-age population in the regions with developed mechanical engineering of the Urals, Siberia and the Russian Far East in 1991-2020, %

Subjects of the Russian Federation	**%**	**Subjects of the Russian Federation**	**%**
Novosibirsk region	100,2	Irkutsk region	81,7
Krasnoyarsk territory	87,7	Primorsky Krai	76,8
Sverdlovsk region	87,1	Khabarovsk territory	76,3
Omsk region	86,7	Amur Region	72,4
Kemerovo region	83,0	Kamchatka Krai	59,2

Source: the table is compiled by the author according to statistical yearbooks "Russian Statistical Yearbook", "Regions of Russia. Socio-economic indicators".

It should be noted that in the Message of the President of the Russian Federation to the Federal Assembly of the Russian Federation dated 12.12.2013, the rise of Siberia and the Russian Far East is called a national priority for the entire XXI century. According to the President of the Russian Federation, he is "confident that Russia's turn to the Pacific Ocean, the dynamic development of all our eastern territories will not only open up new opportunities and horizons in the economy, but also give us additional tools for conducting an active foreign policy"[4]. The sanctions imposed on Russia in connection with the special military operation in Ukraine make such a reversal especially necessary to preserve the domestic economy, ensure its development, reorient business ties from the west to the east and maintain Russia's status as an active participant in the global world. But the absence of residents and producers undermines the opportunities for socio-

4 Message of the President of the Russian Federation to the Federal Assembly of the Russian Federation dated 12.12.2013 "On the situation in the country and the main directions of domestic and foreign policy of the state" // URL: http://www.kremlin.ru/acts/bank/38057/page/1 (accessed: March 19, 2022).

economic development not only of the Russian Far East, but also of other regions and the country as a whole, deepens the inequality of territories in many spheres of society, poses a serious threat to the security of society.

Conditions of production

The conditions of production are, first of all, a favorable environment for life, creation and activity. The most important elements of such environment necessary for the implementation of society activities are industrial relations, the welfare of the population, the regulatory and legislative framework, infrastructure, transport, logistics and information support, natural and climatic conditions, as well as security. Let's consider one of these elements, which is important for a country that occupies a huge territory. That is transport accessibility, whose development facilitates the population and labor resources displacement across the country.

At the end of 2020, the density of public roads with a hard surface (km of tracks per 1000 km^2 of territory) was, according to the Russian Statistical Research Agency (Rosstat), 2.8 times higher than at the end of 1990 - 23 and 64 km/1000 km^2. This is much lower than in many other countries. In Canada, this indicator is 104.4 km /1000 km^2, in Iran – 104.9, in Finland – 230.9, in China – 402.3, in USA – 675.5 km/1000 km^2 of the country's territory[5]. Moreover, in Russia, the transport accessibility of settlements for motorists is quite different in various regions of Russia (Figure 3).

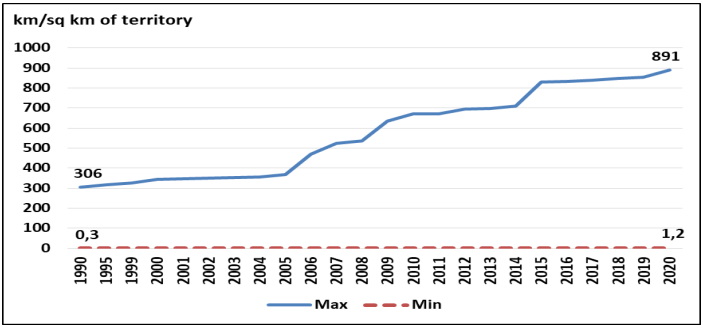


***Figure 3**. The maximum and minimum (excluding Moscow and St. Petersburg) density of paved public roads in the subjects of the Russian Federation in 1990-2020 (end of year, kilometers of routes per 1000 sq. km of territory).*

Source: The figure is constructed by the author according to the statistical collections "Russian Statistical Yearbook", "Regions of Russia. Socio-economic indicators".

5 URL: http://ru.worldstat.info/World/List_of_countries_by_Density_of_road_network (accessed: April 14, 2022).

The density of highways in Moscow and St. Petersburg is ten times higher than the national average (Table 2).

Table 2.

The ratio of the density of highways in Moscow and St. Petersburg to the average density in the Russian Federation in 2012-2020, times

Ratio to the Russia	2012	2014	2016	2018	2020
Moscow	39.1	40.6	39.9	40.1	40.4
St. Petersburg	39.9	38.2	39.5	39.5	39.5

Source: the table is compiled by the author according to statistical yearbooks "Russian Statistical Yearbook", "Regions of Russia. Socio-economic indicators".

Airplanes are the most important type of transportation of passengers and cargo over long distances. However, there are fewer domestic civil airliners produced in modern Russia than in the RSFSR: 134 aircrafts in 1980, 13 - in 2010 and 12 - in 2020[6]. Russia had 1,367 foreign aircraft at the beginning of 2022. Of these, 78 planes were arrested in foreign countries and will not return to Russia[7]. it's good that the Russian Government thought about this in advance. On January 12, 2022, Prime Minister of the Russian Federation Mikhail Mishustin signed three orders on additional financing for the development of the Russian aviation industry; and Federal Law No. 56-FZ allows registering the rights to foreign aircraft leased by Russian airlines, as well as issuing them Russian airworthiness certificates.

Means of production

For normal reproduction, in addition to the producers and labor, means of production are required. Long-term sanctions, bans and restrictions deprive the Russian Federation of free access to foreign markets, do not allow it to buy the goods it needs and sell its own. In these conditions, it becomes inevitable to create, maintain and expand own production of all necessary products and services, self-sufficiency with development resources.

Russia is not deprived of natural resources. It has water, forest, fuel and energy and many other types of minerals. In these conditions, production by us and for us requires, first of all, a developed industry for the creation of means of production for the production of means of production. That is to create modern technological lines and equipment, machine tools, apparatuses and tools, data processing

6 URL: http://superjet.wikidot.com/wiki:prod-by-type (accessed: March 15, 2022); URL: https://www.aviastat.ru/ (accessed: March 17, 2022).

7 URL: https://tass.ru/ekonomika/14143489?utm_source=yxnews&utm_medium=desktop (accessed: March 23, 2022).

systems, monitoring and control, software and etc. It is also necessary to have advanced technologies and knowledge.

It is necessary keep in mind that the development of the production of means of production in modern Russia highlights two problems that are directly related to ensuring the security of a country in international isolation. Firstly, the mass use of imported, rented, leased means of production, measuring instruments and tools. Secondly, the widespread distribution of foreign ownership of the means of production, technologies, enterprises, firms, corporations, commodity networks and marks used in modern Russia, trademarks, etc.

The interests of foreign owners are different from the interests of the state and the people of the country in which these owners are present in some form. In general, their own interests and goals are more important to them, and, if their achievement requires a refusal to be present in any country or field of activity, after assessing the benefits and damages, the owner will suspend or completely stop working.

State governance

Individuals and society control their actions to the extent that they consciously carry them out. When people act together, coherence and coordination of the persons involved in the activity are an important element of management. Coherence and coordination of actions are especially important for achieving common goals for a group of individuals and society as a whole. This, as is well known, is hindered by private ownership of the means of production. A private owner primarily pursues his own interests, which may not only not coincide, but also be diametrically opposed to the interests of society as a whole.

Working in modern Russia, foreign private owners eliminate Russian competitors; seek to take a monopoly position in the Russian economy and in the Russian market. Moreover, the realization of their desire for profit can cause damage to a foreign country in which they stay only temporarily (for example, to harm nature, lead to the depletion of non-renewable natural resources, change the worldview, destroy traditional values, etc.). Foreign owners, as is well known, lobby their interests, which do not coincide with national interests and even contradict them, in the authorities of the host country. All this can seriously slow down the development of the country, change the trajectory of its movement, worsen its position in the world economy.

Conclusion

Nowadays, in the economic sphere, the Russian Federation is not a serious opponent and competitor of either the United States, the EU, or the countries that have imposed anti-Russian sanctions. In 2021, the gross domestic product of the

Russian Federation (GDP) was 10.2% of the GDP of the European Union, 7.3% of the GDP of the United States and 3.0% of the GDP of unfriendly countries[8]. In 2022, these shares will probably be even smaller.

In these conditions, it is advisable for the Russian Federation to focus on the revival of its own economy, on solving internal issues. The regulatory and legislative acts of the Russian Federation adopted after 2014 and the research results presented here give grounds to propose the following strategic approaches to ensuring the sustainable development of the Russian economy in the conditions of unprecedented restrictions, prohibitions and sanctions imposed on Russia, in the conditions of growing uncertainty and instability of a rapidly changing world.

1. To create conditions for increasing the population of the country.
2. To train professional personnel for all spheres of society.
3. To develop the economy by ourselves and mainly for ourselves.
4. To determine the absolutely necessary set of products and strive to create them no less than necessary for the successful development of the economy and society, independent of interaction with foreign economic entities.
5. To look for business partners outside the Russian Federation and cooperate with them, first of all, to integrate into global production chains and partners' participation in Russian product creation chains; to expand scientific knowledge, to obtain information about the latest promising developments, technologies and products, about systems, techniques and management methods, and to gain access to them.
6. In the field of international financial settlement system: to strive to get away from the US dollar, develop our own payment system, and spread it around the world.
7. In the field of international cooperation; to strive to expand the representation of the Russian Federation in international organizations and bodies.
8. To create a favorablesocial, economic, regulatory, legislative, infrastructural and information environment for the implementation of the above-mentioned directions.

8 Calculated by the author according to the World Bank data (URL: https://data.worldbank.org/indicator/ (accessed: September 17, 2022)).

DOI 10.34660/INF.2023.70.70.051

OVERVIEW OF ONE LEADING AMERICAN STATE IN ESG

Emelianova Ellina Sergeevna
Candidate of Economic Sciences

Abstract. *The main topic of this article is the ESG principles implementation in one of the American states that is a leader in climate change legislation development – Connecticut. At the beginning of the article, the main benefits of implementing ESG principles in the European Union, China, and the United States are discussed. The following is a list of Connecticut organizations that adhere to the ESG principles. The article will deal with the issues of concern to ESG proponents. In conclusion, opportunities for business growth and sustainability in the event that companies have significant ESG risks will be formulated.*

Keywords: *ESG principles, ESG risks, ESG risk management.*

Some ideas for ESG development appeared at the beginning of the 20th century. In 1914-1920, Ford's social program applied the G – component of the ESG principle as a part of the business participation idea in providing social guarantees to the company's personnel [1]. The ESG principles (E-environment, responsible attitude to the environment; S-social, high social responsibility; G-governance, high quality) are currently quite widespread. Organizations are looking for new tools to influence the market and society in order to gain long-term competitive advantages.

The main benefits of implementing the ESG principles are differentiated, for example, in the EU, among the main benefits are:

- receiving tax preferences in terms of environmental fees and payments
- benefits and advantages of obtaining licenses for oil and gas production
- increasing the investment attractiveness of corporations, etc.

In China, these benefits include:

- reducing the frequency of state inspections
- tax incentives for the implementation of environmental standards and green investments
- reducing the cost of overcoming barriers when entering foreign markets with products or purchasing equipment or technologies
- getting priority in access to public tenders and purchases in the energy sector, etc.

In the United States, these benefits include:

- strengthening the competitive advantages of the oil and gas business in the global market
- impact on the market value of corporations and stock prices
- achieving the status of "market leadership" in the field of environmental friendliness and responsible use of natural resources
- formation of new technological standards of equipment and development of the "green technologies" transfer.

In the United States, the growing focus on ESG has so far resulted in voluntary, market-oriented responses, rather than new regulations. This contrasts with the European Union, where the European Commission has adopted specific prudential and conduct-based ESG directives [2]. However, the regulatory environment in the US is likely to change in the near future. In early 2021, President Biden issued an executive order requiring the federal government to "assess, disclose, and mitigate the effects of climate pollution and climate-related risks in every sector of our economy." [3] Then the U.S. Securities and Exchange Commission (SEC) announced an industry-wide approach to addressing climate change and other ESG risks and opportunities [4].

At the state level, more than a dozen have already introduced or are ready to introduce requirements to increase diversity on boards of directors, and some of them, including California, Connecticut, Illinois, New Jersey, New York, Oregon, and Washington, have increased regulation of their pension systems to promote sustainable investment [2]. Connecticut is a leader in the development of legislation on climate change: at the moment, more than 30 different types of regulations have been adopted contributing to the achievement of goals to reduce greenhouse gas emissions, as well as aimed at helping in the preparation and necessary response to climate change events [5].

The Connecticut Council for Sustainable Business [6] is an independent non–profit organization that brings together state leaders in the field of sustainable business, specialists in corporate social responsibility and occupational safety and health, social entrepreneurs, and investors. More than 30 companies are members of the council, and the founder and CEO is Heather Burns, who has been working on business sustainability since 1999. ESG principles are also used by the Office of the State Treasury: for example, the Connecticut Inclusive Investment Initiative ("Ci3") targets investments with emerging and diverse managers across both public and private asset classes and will provide a pathway for growth of the best emerging managers in the industry [7].

In Connecticut, on July 1, 2011, as part of State Law 11-80, the Connecticut General Assembly established the nation's first green bank, the Green Bank of Connecticut, which supports the Governor's and Legislature's energy strategy

to achieve cleaner, more affordable and reliable energy while creating jobs and supporting local economic development [8]. The Connecticut State university environment is also actively involved in promoting ESG principles: for example, the UConn Office of Sustainability leads the way for campus sustainability efforts by providing guidance, direction and support for sustainability in all sectors, from infrastructure to student outreach, and creating programs that enhance engagement and awareness around sustainable practices and behaviors at UConn and in the community [9]. In addition, the following ESG-compliant companies have their global headquarters in Connecticut, adhering to ESG (the list is not exhaustive):

- FactSet is a financial data and software company that helps more than 7,000 financial companies around the world solve various business problems, including the ESG investing field [10]

- Interactive Brokers is an American multinational brokerage firm that manages the largest electronic trading platform in the United States by the number of transactions with an average daily income. Using Interactive Brokers' suite of environmental, social and governance (ESG) tools, you can develop your own informed investment plan [11]

- AQR Capital Management (Applied Quantitative Research) is a global investment management company based in Greenwich, Connecticut. The company collaborated with UNPRI to create a framework of different approaches and conditions necessary for responsible investment [12]

- Cadenza Innovation Inc. is an American developer of lithium-ion battery technologies and energy storage solutions [13]. Partnership in the modern paradigm of energy storage and telecommunications provides superior security, reliability, energy density and cost-effectiveness, supporting the Sustainable Development Goals [14]

- Charter Communications Inc. is an American telecommunications and media company that provides services under the Spectrum trademark. With more than 32 million customers in 41 states, the company is the second-largest cable TV operator in the United States by a number of subscribers, just behind Comcast, and the third-largest pay-TV operator after Comcast and AT&T, as well as the fifth-largest telephone operator by a number of phone lines. [15] ESG efforts continue to be structured in a comprehensive three-part framework to reflect how the company's business delivers sustainable value in a beneficial economic cycle [16].

Despite significant advances in ESG by Connecticut and companies located in this state, there are currently issues of concern to ESG supporters.

1. The race for zero carbon emissions.

The ongoing transition to a green economy will open up new opportunities and risks for companies and investors as they seek to adapt to a low-carbon economy. Companies that are slow to implement can face serious financial consequences in

the form of distressed assets and incur reputational costs, as consumers continue to strive for sustainable development.

2. Disclosure of information for integration.

It is likely that the ESG disclosure standards will continue to converge over time, providing investors with standardized data that is useful for making decisions, necessary to identify ESG leaders and laggards. As part of this disclosure, companies, investors, and other stakeholders consider which metrics should require third-party verification or certification. Attention is also focused on ESG integration, which is likely to accelerate with improved disclosure, which will provide both companies and investors with greater clarity about ESG effectiveness.

3. Growing attention to human capital.

Human capital issues will continue to attract the attention of investors and stakeholders, as digitization, automation, and the growing global knowledge economy require companies to be more flexible and forward-thinking in shaping their future workforce. At the same time, companies will continue to meet inflated expectations for diversity and engagement in their workforce, especially in top-level management and on boards of directors.

4. Vigilant data protection.

Data and cybersecurity remain ESG priorities. Investors, companies, and other stakeholders continue to pay particular attention to the critical risks associated with this area.

5. Updating corporate goals.

The ongoing shift towards stakeholder capitalism has prompted companies to rethink their goals and how they can achieve value for all their stakeholders. Looking ahead, stakeholders and investors will seek to identify companies that have not progressed beyond the rhetoric.

6. Supply chain sustainability.

The COVID-19 pandemic has demonstrated the fragility of many supply chains, and companies may need to rethink how they combine supply chain efficiency with sustainability. The transition to a green economy, the effects of climate change, ongoing global trade tensions, and the need for reorientation have created new risks and uncertainties that companies need to address when rebuilding their supply chains after a pandemic.

7. Compensation linked to ESG results.

As the focus of investors and stakeholders on ESG effectiveness continues to grow, companies may face increased pressure to select and include appropriate indicators in their compensation incentive structures. Improved ESG disclosure and standardization of ESG metrics are likely to provide additional incentives to link compensation to ESG results.

The market for consulting firms that provide clients with data-based analysis and insights to help reduce the risks associated with ESG issues is now mainly represented by the Big four companies [17] and smaller specialized companies. However, the entry threshold for purchasing the services of listed companies is often extremely high and may be financially inaccessible to smaller companies that do not have large budgets allocated for ESG development.

Companies face numerous ESG risks related to climate change, working and safety conditions, respect for human rights, corruption practices, compliance with laws, regulations and policies, and judicial and reputational risks. Addressing significant ESG risks and reporting companies' progress in addressing them can provide significant opportunities for business growth and sustainability. These opportunities may include resource efficiency, cost reduction, innovation, the ability to capitalize on changing consumer and investor requirements, and even reduced government oversight [18].

The global scale of the issues laid down in the Sustainable Development Goals (SDGs) and the ESG principles encourages everyone to reconsider their views and rebuild their lives more and more every day, integrating ESG into every aspect of it.

References

1. *https://vuzlit.com/414790/osnovnye_polozheniya_sotsialnoy_programmy*
2. *https://iclg.com/practice-areas/environmental-social-and-governance-law/usa*
3. *https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/*
4. *https://www.sec.gov/spotlight/enforcement-task-force-focused-climate-esg-issues*
5. *https://portal.ct.gov/DEEP/Climate-Change/Connecticut-Legislation--Executive-Orders-on-Climate*
6. *https://www.ctsbcouncil.org/*
7. *https://portal.ct.gov/OTT/Pension-Funds/Doing-Business/CT-Horizon-Fund*
8. *https://www.ctgreenbankbonds.com/connecticut-green-bank-ct/i6126*
9. *https://sustainability.uconn.edu/#*
10. *https://www.factset.com/solutions/esg-investing*
11. *https://www.interactivebrokers.com/en/trading/sustainable-investing.php*
12. *https://www.aqr.com/Learning-Center/ESG/ESG-Glossary*

13. https://en.wikipedia.org/wiki/Cadenza_Innovation
14. https://cadenzainnovation.com/technology/
15. https://en.wikipedia.org/wiki/Charter_Communications
16. https://corporate.charter.com/esg-report
17. https://en.wikipedia.org/wiki/Big_Four_accounting_firms
18. https://www.ctcpas.org/news/a18434cd-2b11-483f-947b-e68bff29785c:connecticut-cpa-magazine-excerpt-integrating-esg-into-your-business-strategy

DOI 10.34660/INF.2023.64.17.052

THE REASONS FOR RUSSIA'S TECHNOLOGICAL LAG

Narimanova Olga Vladimirovna
Candidate of Economic Sciences, Associate Professor,
Head of the Department
Ryazan State Medical University

Narimanov Nariman Fariman oglu
Candidate of Economic Sciences, Associate Professor,
Academy of the FPS of Russia

Abstract. *The article is devoted to the analysis of the reasons for the technological lag of Russia. The need to overcome it is multiplied in a situation where Western countries openly declare their desire to inflict a strategic defeat on Russia. Overcoming the technological gap requires a deep understanding of its causes. The article considers two groups of such causes: 1) causes that have their origins in the socialist past of the country; 2) reasons due to the neoliberal economic course that has been implemented in Russia since 1992. In addition, new serious obstacles in the field of scientific and technological development of the country caused by anti-Russian sanctions are analyzed.*

Keywords: *technological development, technological lag, sanctions, innovation infrastructure, innovation activity, technological and cognitive sovereignty, mechanisms and incentives for innovation activity.*

Introduction. In the face of increased sanctions pressure and growing threats from the "collective West", one of the priority tasks for Russia is the achievement and maintenance of technological sovereignty. To solve it, it is important to have a clear idea of the scale and causes of Russia's technological lag.

The purpose of the study is to assess the level of modern technological development of Russia, to analyze the main reasons for its lagging behind the leading world powers.

Materials and methods. The study is based on scientific publications of experts in the field of economics, as well as statistical databases. General scientific research methods were used: analysis and synthesis, induction and deduction, a systematic approach, comparative analysis, economic and statistical analysis.

Results and discussion. The need for a technological breakthrough has long been clearly recognized at the highest state level, which is reflected in

the development and adoption of numerous policy documents, as well as the implementation of important measures in this direction. However, to date, Russia has not managed to close the gap with the world's technological leaders. In the current extremely unfavorable geopolitical and geo-economic situation, the solution of this problem becomes much more complicated, but becomes vital for the country.

The ratio of the productive forces of the fourth, fifth and sixth technological modes in Russia is 50%, 10% and 0.5%, respectively, while in the USA their shares are 20%, 60% and 5%. The third and fourth technological orders, which have reached the limits of economic growth, are still predominant in Russian industry. Russia is significantly behind the advanced countries in terms of the most important indicators of the new technological revolution: in terms of the number of start-ups - 30-35 times; by the number of platform companies - 15-20 times; in terms of high-tech exports - 15-20 times, and from China - 57 times; in terms of the number of issued patents - by 3-4 times, and in the USA and China - by 10 and 11 times, respectively; in terms of the share of R&D expenditures in GDP - 2-4 times. The share of innovatively active organizations in Russia is 9%, while in developed countries it is about 60%. The share of direct imports in the used finished products of the manufacturing industry is 38.7%, in 10 out of 18 industry segments of the manufacturing industry, the total import intensity exceeds 50% of the cost of products, and in certain sectors of engineering - 80-90% [1,2,3,4, 5].

Great hopes in overcoming the technological gap in Russia were placed on the implementation of the "Strategy - 2020", developed in 2011-2012, however, the real economic indicators turned out to be far from the target values. Thus, the share of industrial organizations implementing technological innovations in 2020 was only 9.1% instead of the planned 40%, the share of innovative products was only 11% with a target value of 25%, the share of innovative goods new to the world market increased compared to 2011 only by 0.2%. Russia should now be among the top ten countries in the field of digitalization of the economy, but remains in this area, according to various international ratings, only in 43-48 places [6].

The technological transformation of the Russian economy requires overcoming many obstacles, some of which have deep roots in the planned economy, while others were formed during the transition to the market.

The fact is that during the period of socialism in Russia, unlike in developed countries, an innovative infrastructure did not develop, there was no effective interaction between the real sector of the economy and the sphere of inventions and discoveries. The only exception was the military-industrial complex. The planned economy turned out to be absolutely immune to a significant part of innovative ideas and implemented only those that received support at the state level. Inventions and discoveries in the civil sector often remained outside the

scope of plans precisely because they cannot be predicted and planned, and, not being included in the plans, they did not receive the right to be implemented. Therefore, during the period of rapid industrial development, the country each time entered into the next technological modernization with a big delay compared to the advanced countries and only copied their achievements. The absence of natural mechanisms and incentives for the introduction of innovations led to the fact that the lag and modernization failures were always compensated by mobilization methods carried out from above.

The policy of "accelerating socio-economic development", initiated in the country in the late 1980s, was the last attempt to overcome the growing technological gap with developed countries within the framework of socialism. Its failure largely predetermined the transition to a market economy. It was expected that the market would not only help resolve the systemic crisis of "real socialism", but also eliminate the technological gap, increase the overall competitiveness of the domestic economy, and ensure sustainable economic growth. However, despite all the efforts made, it was not possible to solve the planned tasks for 30 years.

One of the main reasons for this is related to the persistence of the heavy and formidable legacy of the neoliberal course, the implementation of which began in the country in the 1990s in accordance with the recommendations of the IMF and the World Bank. Instead of a socially oriented market economy and technological modernization, this course led to the formation of an export-raw material model of the country's development, undermining the real sector of the economy, deindustrialization and increasing technological backwardness. The government's actions to liberalize foreign exchange transactions and the transition in 1992 to the internal convertibility of the ruble resulted in a strict binding of the size of the issue of the Bank of Russia to foreign exchange earnings from exports, while before that issue was determined by the volume of the entire economic turnover and the economic resources involved in it. Since the country's export opportunities were traditionally associated with the sectors of the energy and resource complex, the government's desire to ensure financial stability in the new conditions by maximizing foreign exchange earnings automatically turned on the resource type of development, caused a reduction in industrial production, primarily in technology-intensive industries. As a result, the state of the economy began to consistently deteriorate compared to 1992, when it had a powerful and fairly diversified industrial complex, although technically inferior to Western countries. After all, the main part of investments began to be directed to the export-raw material industries, since the profitability in them is 3-5 times higher than the profitability in industry. This has become the strongest barrier to the creation of a domestic innovation system.

Deindustrialization has generated many negative consequences: aging of the production base; undermining the scientific and technical potential of the country;

degradation of fundamental, applied and industrial science (for example, since 2010 the number of research organizations and design bureaus in Russia has decreased by more than a third, and design organizations by half); rupture of ties between fundamental science and the design and technological sphere; the outflow from the country of scientists, qualified scientific and technical personnel; threatening dependence on imports of machinery and technologies, reaching 80-90% in certain branches of engineering and creating a serious threat to national security (according to experts, if imports of a strategically important product exceed 25% in domestic consumption, then there is a threat to national security; a decrease in the competitiveness of domestic products industries in the world markets, including high-tech ones, and further deterioration of the indicators of innovative activity [7].

One of the most devastating consequences of deindustrialization was a serious undermining of the already weak motivational mechanisms for innovation activity. After all, a significant reduction in industrial production led to a drop in demand for technological innovation and undermined the material base for research and development.

Under the influence of the resource (raw material) rent distribution model, the ideology of an entire active generation, as well as the main part of the Russian elites, was formed, which is poorly compatible with the interests of the development of the domestic economy and with innovative motivation. We can talk about the loss during this period of not only technological, but cognitive sovereignty of the country [8]. Cognitive sovereignty means the country's ability to independent, independent of external influence and imposition from outside, awareness and upholding the meanings and goals of its existence and development, including in the field of economy, technology, science, education, culture, ideology, taking into account its identity, national and geopolitical interests. It seems that it was precisely as a result of the lack of cognitive sovereignty that a real chance to start the technological transformation of Russia two decades earlier was missed. Thus, since 2004, a significant part of the raw material rent (income from the export of energy resources) has been directed to the stabilization fund instead of serving the purposes of modernizing the economy. This significantly slowed down the growth of investment in capital, led to an increase in the degree of depreciation of fixed assets in the economy up to 46-51%, while in countries that are constantly updating technologies and fixed capital, this figure is no more than 30%, and the average service life of machinery and equipment twice less than in Russia [9].

The situation has not changed for the better after the 2008-2009 crisis. An attempt at an innovative breakthrough made in 2010 from above met with serious opposition from large Russian companies, which felt threatened by the usual "rental" way of life. In 2011, orders were sent from the Presidential Administration

to all large state-owned companies to form corporate venture funds, but in response they received replies that there was no need for such. In 2017, already as part of the implementation of the National Technology Initiative project, large Russian businesses were once again ordered to create venture funds, but most companies did not start their formation, and the rest formed them in a volume much lower than required. Thus, Russian technology leaders, like many representatives of the elites, have again demonstrated their unpreparedness for a decisive innovation breakthrough.

Meanwhile, world experience shows that corporate venture funds and venture companies are the most important tool for stimulating innovation in modern countries. They provide financial support for breakthrough projects and high-risk start-ups. International venture companies act as financial intermediaries that attract funds from various investors, including pension funds, insurance companies and other organizations, to implement innovations. Experienced "venturists" can judge the prospects of new projects only by indirect, often informal signs. In this case, faith in the team and its leader often becomes more important than faith in the idea and technology. Thus, the founders of pioneer companies themselves do not always realize what exactly they are inventing, but they get brilliant results. For example, Google developed a search engine, and as a result created a business tool for managing the market, marketing activity. Therefore, the most important quality of venture specialists is the ability to feel, pick up and support all viable and promising ideas generated by inventors. The ability and desire to capture and enhance the innovative potential of an idea form an innovative climate in the country.

Currently, most large companies in Europe, Japan, China have corporate venture funds, in the US every large firm has such a fund. Venture capital funds are created by companies voluntarily, as they allow the introduction of valuable technological inventions. It is important to emphasize that corporate venture funds begin to bring real returns only 10-15 years from the moment of creation, and during the first ten years they often lose all their funds. However, companies are willing to pay such a high price for learning how to play the game of innovation because they believe it is justified in the light of future developments. In the US, venture capital funds account for 25% of the venture capital economy [10].

As for Russia, its technological leaders and elites have found themselves quite comfortable with the old paradigm of rent-and-resource dependency, which ensures high profitability without any extra effort. Russian business is accustomed to the fact that servicing government contracts with clear and guaranteed remuneration is much more reliable and profitable than taking risks and investing in a new market.

To create innovative entrepreneurial motivation, among many other conditions, public administration reform, legal and judicial reforms, as well as

the solution of legal problems of intellectual property are necessary. After all, a healthy investment climate with a focus on innovation activity requires effective protection of the rights of entrepreneurs, the eradication of abuses and arbitrariness of corrupt government officials and representatives of law enforcement agencies.

We should not forget that the strongest obstacle to innovation activity is the absence in Russian legislation of a clear definition of the rights of various intellectual property owners, as well as the procedure and mechanism for distributing remuneration from its sale. As a result, investors experience great difficulty in making decisions about investing in research and development, in the purchase or implementation of new technologies. At the same time, the already high risks associated with innovation activity are unreasonably increasing. It is necessary to provide full legal certainty regarding the rights of all participants in the innovation process to intellectual property and income from its sale. Otherwise, a single "innovation chain" will not work out.

It is also important to take into account that about 70% of Russian scientific organizations are state-owned, so research and development is financed mainly from the state budget. About 90% of all intellectual property objects available in the country are created at the expense of budgetary funds. For a technological breakthrough in Russia, it is necessary to clearly regulate at the legislative level the procedure for the state to own and dispose of intellectual property, as well as the mechanism for its transfer from the state to other levels of government in the process of economic implementation. The problems of the country's most widespread mixed financing of research and development, which involves the allocation of funds from several different sources, also need a legal solution. Thus, it is necessary to put on a solid legal basis the actions of those subjects of the innovation process at all its stages, to develop a clear legal mechanism for the commercialization of intellectual property [11].

The development institutions that began to form in Russia in the mid-1990s to promote innovation, by analogy with foreign countries, could not significantly improve the technological situation in the country. This is how the Innovation Promotion Fund, the Industrial Development Fund, the Russian Venture Company OJSC (RVC OJSC), the ANO Agency for Strategic Initiatives (ANO ASI), the Russian Direct Investment Fund (RDIF), the Skolkovo Innovation Center, JSC RUSNANO ", JSC "SME Bank". The scope of their activities has extended to all types of innovation support, including venture financing and the infrastructure created with the transition to the market: investment funds and venture business, technology parks, technology transfer centers, innovative industrial complexes, centers for the collective use of scientific equipment, etc. The federal budget became the main source of funding for development institutions, but the effectiveness of the use of its funds and the overall performance of Russian

development institutions turned out to be extremely low. The business models they used did not correspond to either world practice or the pressing needs of the technological modernization of the Russian economy. In fact, it has not been possible to create a comprehensive network of institutions with a clear distribution of functions and areas of responsibility to provide financial support for promising innovative projects at all stages of their life cycle. The focus of attention of Russian development institutions was on projects of the late stages of the innovation cycle associated with the production of prototypes, when financial risks become minimal. At the same time, there is an acute shortage of funding for early-stage innovation projects and high-risk groundbreaking research. But it is precisely the support of promising projects in the early stages that leads to technological breakthroughs in the future. In many ways, this state of affairs is caused by the lack of a risk-based approach in the work of control and supervisory authorities when assessing the return on public funds.

In the course of checking the work of development institutions, the Accounts Chamber of the Russian Federation revealed many financial violations, facts of misuse of allocated budget funds, a significant part of which, instead of financing technological projects, was directed to deposit bank accounts. The development institutions have not coped with the task assigned to them of organizing the transfer of innovative technologies from the global market to Russia. Instead, they often invested in foreign companies solely for the purpose of enrichment, without any focus on importing advanced technologies.

Corruption and unreasonable overestimation of the salaries of top managers were also revealed in the work of development institutions. The reason for these violations was largely the special legal status initially assigned to the institutions, which ensured the low transparency of their activities. In fact, they got the opportunity to independently determine the goals of their work and evaluate its final results on the basis of standards and procedures developed by themselves. There were no unified state approaches to assessing the activities of development institutions. In the context of the traditional lack of healthy innovation motivation for representatives of Russian business and bureaucracy, this once again led to an open disregard for the national goals of technological development [12].

In March 2021, a major reform of development institutions began in the country, aimed at creating an effective public investment management system operating on the basis of uniform mechanisms and standards in accordance with national goals. The reform involved the reengineering of development institutions in order to focus their activities on creating a comfortable and effective regulatory environment for innovation and technological entrepreneurship.

New barriers to Russia's technological development arose in connection with the introduction of unprecedentedly tough sanctions against it against the

background of the extreme aggravation of geopolitical contradictions and the start of a special military operation in Ukraine on February 24, 2022.

The most painful for our country were the sanctions in the technological sphere, since their main goal is to completely undermine the scientific, technical and technological potential of the country, to strike at its strategically important industries, including the military-industrial complex, shipbuilding, the development of quantum technologies and artificial intelligence. The US, the EU and their allies are striving to limit high-tech imports to Russia as much as possible, primarily in the IT industry, microelectronics, mechanical engineering, and the aerospace industry. There is a curtailment of scientific ties, scientific and technical cooperation, joint projects of Russia with foreign universities and large companies. Russia is disconnected from international sources of scientific and technical information, deprived of the supply of foreign scientific equipment, components, reagents, software and literature, the training of Russian students abroad is reduced, unspoken restrictions are imposed on the publication of Russian authors in journals included in the international databases Web of Science and Scopus.

Thus, with the help of sanctions pressure, the United States and its allies seek to ensure the complete scientific and technological isolation of Russia, lower the "technological curtain" in front of it, create insurmountable barriers to import substitution and economic development, and increase the outflow of talented scientists and researchers from the country.

Conclusion

The technological lag of Russia is due to many serious reasons. Some of them have deep roots in the country's socialist past, while others developed in the 1990s during the transition to a market economy. From a planned economy, our country inherited the lack of an efficiently operating innovation infrastructure that ensures the rapid introduction of promising inventions and discoveries into the real sector of the economy. The only exception was the military-industrial complex. Two other reasons for the lag are the lack of formation of natural mechanisms and incentives for the development and implementation of inventions and discoveries, as well as the lack of clear legal mechanisms for the commercialization of intellectual property.

Another group of reasons for Russia's technological lag is associated with the neoliberal economic course pursued in the country since 1992 and its severe and difficult to overcome consequences. These included deindustrialization; formation of an export-raw material model of the economy; destruction of the industrial, scientific, technical and technological potential of the country; degradation of fundamental and applied science; the outflow from the country of scientists,

qualified scientific and technical personnel; threatening dependence on imports of machinery and technology; decrease in the competitiveness of domestic industry products in world markets. The disastrous consequences of these processes were the further undermining of the motivational mechanisms of innovation and the loss of not only technological, but also cognitive sovereignty by the country.

The weakening of the economic, scientific, technical and technological potential of Russia led to a change in the balance of power on the world stage, exacerbation of geopolitical contradictions and provoked the desire of the "collective West" to inflict a strategic defeat on our country. As a result, unprecedented anti-Russian sanctions followed, inflicting the main blow precisely on the scientific and technological potential of the country and creating new serious obstacles to overcoming the technological gap.

References

1. Uskov V.S. Development of the industrial sector of the Russian Federation in the context of a new technological revolution // Economic and social changes: facts, trends, forecast. - 2019. - T.12. - No. 2.- p.128-146.

2. Uskov V.S. Scientific and technological development of the Russian economy in the context of the transition to a new technological order // Economic and social changes: facts, trends, forecast. - 2020. - T.13. - No. 1. - p.70-86. https://doi.org/10.15838/esc. 2020.1.67.4.

3. Narimanov N. F, Narimanova O.V. Global technology space in the XXI century: formation of a bipolar configuration// Proceedings of the International conference "Science and innovations 2021: development directions and priorities" Part 1 (March 14, 2021. Melbourne, Australia). - Auspublishers, Infinity publishing, 2021. – p.19-27. https: // doi.org/10.34660/INF.2021.25.49.002

4. Narimanova O.V. The concept of "Century stagnation": what are the reasons for the slowdown in economic growth? // Proceedings of the annual scientific conference of RyazSMU named after Academician I.P. Pavlov, dedicated to the 65th anniversary of the university in the Ryazan land / under total ed. Honored Worker of Higher School of the Russian Federation, prof. V.A. Kiryushin. - Ryazan: Publishing house of RyazSMU, 2015. – p. 262-265.

5. Narimanova O.V. The main directions and results of the modern economic policy of Russia//Trends and prospects for the implementation of the financial policy of the state at the present stage: Sat. materials of the International scientific-practical. conf. (Ryazan, September 29, 2017) / ed. A. A. Gracheva; scientific ed. A. V. Shukaeva. - Ryazan: Academy of the Federal Penitentiary Service of Russia, 2018. - p. 20-23.

6. Russian statistical yearbook. 2020. / Stat.sb. / Rosstat. - M.: 2020 - 700 p.

7. Lenchuk E.B. Scientific and technological development of Russia under sanctions pressure // Economic revival of Russia. – 2022 - No. 3 (73) – p. 52-60. DOI: 10.37930/1990-9780-2022-3-73-52-60.

8. Peskov D. Island "Russia". Presidential Special Representative on the new digital strategy. [Electronic resource]. URL: https: //amp.rbc.ru/rbcnews/ opinions/economics/09/06/2022/62a0e95b9a79472d8b713207

9. Narimanova Olga Vladimirovna, Narimanov Nariman Fariman oglu. INVESTMENTS IN MODERN RUSSIA: PROBLEMS AND SOLUTIONS // Proceedings of the International Conference "Scientific research of the SCO countries: synergy and integration". Part 2 - Reports in English (March 9, 2022. Beijing, PRC). - p. 20-29. https: //doi.org/10.34660/INF.2022.12.97.003.

10. Lagging behind is a bond for us - 2035. Interview with Evgeny Kuznetsov (OJSC RVC). - [Electronic resource] : URL: http://2035.media/2018/03/21/ kuznetsov-interview/

11. Leontiev B.B. Problems of commercialization of intellectual property rights [interviewed by E.V. Zenkina] // Bulletin of the Russian State University for the Humanities. Series "Economics. Control. Right". - 2022.- No 3. Part 2. - p. 262–269. DOI: 10.28995/2073-6304-2022-3-262-269

12. Development institutions failed innovation // Vedomosti, March 2, 2021– [Electronic resource] : URL: https://www.vedomosti.ru/economics/ articles/2021/03/01/859742-instituti-razvitiya

DOI 10.34660/INF.2023.81.65.053

TECHNOLOGICAL SOVEREIGNTY OF RUSSIA: DIRECTIONS AND TASKS OF ACHIEVEMENT

Narimanova Olga Vladimirovna
Candidate of Economic Sciences, Associate Professor,
Head of the Department
Ryazan State Medical University

Narimanov Nariman Fariman oglu
Candidate of Economic Sciences, Associate Professor,
Academy of the FPS of Russia

Abstract*. The article analyzes the main directions and tasks of Russia's achievement of technological sovereignty in modern conditions. Three groups of tasks that must be solved in the country to ensure technological sovereignty are characterized: implementation of a set of urgent anti-crisis measures to maintain the technological integrity of the Russian economy; increasing the autonomy of the functioning of the main spheres of the country's life support; pursuing a scientific and technological policy aimed at achieving parity with countries that are technological leaders. The ways of solving the tasks set are considered taking into account the strict requirements dictated by the extreme aggravation of geopolitical contradictions and the growing military threats from the "collective West".*

Keywords: *technological sovereignty, national security, sanctions, import substitution, modernization of fixed assets, critical and end-to-end technologies.*

Introduction. In the new geopolitical conditions, the Russian leadership has recognized the achievement of technological sovereignty as the main strategic goal.

The purpose of the study is to determine the ways for Russia to achieve technological sovereignty in modern conditions.

Materials and methods. The study is based on scientific publications of experts in the field of economics, as well as statistical databases. General scientific research methods were used: analysis and synthesis, induction and deduction, a systematic approach, comparative analysis, economic and statistical analysis.

Results and discussion

Technological sovereignty is a high level of autonomy in the development of the country's technosphere, in which it has the ability to freely develop and apply advanced technologies in all critical areas of life support [1]. In an environment of unprecedented sanctions pressure, achieving technological sovereignty requires Russia to solve three groups of tasks:

1. Implementation of a set of urgent anti-crisis measures to maintain the technological integrity of the Russian economy.

2. Increasing the autonomy of the functioning of the main spheres of the country's life support.

3. Pursuing a scientific and technological policy aimed at achieving parity with countries that are technological leaders.

The first group of tasks includes:

1. Measures to neutralize risks and eliminate the negative consequences associated with restrictions on the activities of foreign companies in Russia.

2. Urgent measures for prompt import substitution and import of necessary goods in the parallel import regime.

In the pre-sanction period, about 5,000 foreign companies operated in Russia with a total staff of up to 600,000 people, which provided 11% of the total number of jobs in the country. During the first six months of the sanctions regime in Russia, 3,000 foreign companies suspended their work, about 500 of them were liquidated. Most of these companies have experienced direct pressure from the US leadership to stop all their activities in Russia. It should be noted that some foreign companies continued to operate in our country as before, but many decided to stop their activities or change their nature.

Taking into account the reaction of foreign companies to the sanctions, they can be divided into 5 groups: 1) companies that completely stop their activities in Russia or completely leave it; 2) companies that temporarily curtail all or most of their operations, but reserve the right to return; 3) companies that stop some important business operations, but retain others; 4) companies that continue their core business but postpone future planned investments; 5) companies that continue to operate in Russia as before [2].

The sanctions restrictions that apply to the activities of foreign companies have disrupted the usual organization of work in many segments and sectors of the Russian economy, led to the rupture of international cooperation and logistics ties, and damaged the technological integrity of the economy. In this regard, maintaining the health of those industries and sectors that have suffered due to the departure of foreign companies, as well as maintaining the organizational integrity of their assets, has become paramount.

For companies that have partially or completely stopped their work in Russia, the government has developed the following restructuring models: 1) continuation

of the activities of all structures of a foreign company when changing its trade name; 2) sale by a foreign company of its assets to Russian management while retaining control (RocaGroup, Electrolux, TetraPak, KONE, Michelin, Schneider Electric, etc.); 3) sale of assets to a Russian owner who continues to operate (Rosbank, Macdonalds, Valio, Fazer, Jotun, Mondi Syktyvkarsky LPK, etc.); 4) sale of assets to a Russian owner who continues to operate for a nominal price (sale of the Moscow Automobile Plant for 1 ruble, OBI for 600 rubles, etc.); 5) sale of assets to a Russian owner for a conditional price while maintaining the possibility of repurchase on pre-agreed conditions (sale of 68% of AvtoVAZ shares for 1 ruble); 6) directive transfer of rights associated with strategic assets to the ownership of a Russian entity in the course of carrying out further activities under a special agreement (Sakhalin Energy and others) [3].

As a result of sanctions restrictions on imports to Russia of a significant number of products in many sectors of the economy, there is a threat of a shortage of spare parts, components, and special types of raw materials. Therefore, urgent response measures were required to restore imports and search for replacement supplies from unfriendly countries. In this regard, already in April 2022, for the purpose of prompt import substitution, an online platform was created and began to operate on the basis of the State Information System of Industry for the selection and ordering of Russian analogues of imported goods.

At the same time, parallel imports were legalized, i.e. importation into the country of goods subject to sanctions without the consent of their manufacturer or copyright holder in parallel with the importation of similar products through official dealers. The volume of parallel imports by the end of 2022 is estimated at $20 billion.

The second group of tasks involves the implementation of the following activities:

1. Formation of a three-loop model of integration.

In response to the restrictive measures announced by the “collective West” in March 2022, the Russian government approved a list of 48 unfriendly states with the introduction of special regimes of interaction with them. This list included countries that initiated anti-Russian sanctions or actively participated in them.

It should be noted that technological sovereignty does not mean isolation or autarky. After all, technological progress is based on international technological cooperation, on partnerships between states. In this regard, it seems to be a constructive method for identifying three contours of countries, ranked according to the level of security of the technological and integration ties they provide [4].

The space of Russia, which is under sovereign protection from destructive foreign influence, is considered as the first contour. It should be noted that a similar protection regime already covers relations within the Union state with Belarus.

If the necessary political decisions are implemented, it is possible to form the same cooperative ties within the EAEU. For example, work is already underway in Kazakhstan to relocate 250 Western companies that left Russia. The second contour is the area of countries with which, on the basis of political, economic and other relationships, guarantees of security and reliability have been achieved in relations with their resident companies. Thus, in the Import Substitution 2.0 system, operating on the basis of the State Information System of the Ministry of Industry and Trade of the Russian Federation, products from China, India, Turkey, the United Arab Emirates, and South Africa are named as available for purchase. It seems that a similar circuit of reliable technological cooperation can also be formed on the basis of BRICS and SCO. The third circuit can be formed from neutral states whose cooperation with companies is dictated by economic expediency.

As for companies from unfriendly countries, relations with them are possible only on the basis of special technological security regimes. The problem is that the share of such countries in Russia's foreign trade turnover was more than 50%.

2. Implementation of a policy aimed at localizing value chains, import substitution, industrialization.

Domestic industry in the pre-sanctions period was deeply integrated into international value chains. The rupture of existing cooperative ties caused difficulties in supplying Russian enterprises with the necessary types of raw materials and components, as well as in marketing products to other countries, primarily those that did not go through the full processing cycle. Before the imposition of sanctions, about 80% of manufactured products supplied abroad were sent there for further processing, and only 20% - for final consumption. At the same time, about 42% of goods imported into Russia were represented by raw materials and components for further processing at Russian enterprises [5,6,7,8].

In this regard, forced import substitution becomes the most important task. It is necessary to adapt and rebuild value chains, localize various types of production, taking into account the missing links. Up to 80% of critical imports must be replaced, the remaining 20% must be redirected to friendly and neutral countries [9].

In areas directly related to ensuring national security, it is required to create complete independence from imports already in the short term. It is especially important to include a mechanism for centralized planning of the import substitution process. To this end, 25 sectoral import substitution plans have been developed in Russia, which are being implemented using the programs of the Agency for Technological Development. In this case, special investment contracts (SPIC and SPIC 2.0) are used, as well as other instruments of the Industrial Development Fund. Similar programs are already being used for the development

of Russian shipbuilding and small-tonnage chemistry. The implementation of high-tech projects involves a different approach - public-private partnership. On its basis, the production of high-precision machine tools, turbines, locomotives, telecommunications and medical equipment is localized [10].

3. Modernization of fixed assets on a sovereign technological basis. The priority in this area is the renewal of the fleet of machinery and equipment in the manufacturing industry, since it is the key to ensuring technological sovereignty.

To solve this problem, it is necessary to at least double the rate of renewal of fixed assets in the manufacturing industry, increasing them from 5.9% to 10-12%, which is now the norm for developed countries. Currently, the degree of depreciation of fixed assets in the manufacturing industries is 62.2%, and the share of completely depreciated funds is 27.3% [11,12,13].

4. Achieving autonomy of infrastructure solutions and digital sovereignty. We are talking about the security of using digital technologies and their localization at the national level.

Since 2014, important initiatives have been implemented in Russia in this area, which have significantly mitigated the consequences and threats of the 2022 sanctions measures [14,15,16,17]. The most important was the implementation of measures to improve the national payment system, which ensured the uninterrupted operation of financial settlement mechanisms in the domestic market, even after MasterCard and Visa completely stopped their activities in Russia in March 2022. This was an example of the successful localization of a global infrastructure solution, which made it possible to apply high-tech developments of foreign companies in combination with their autonomous use at the national level.

The successful experience of platform and infrastructure digital technological solutions needs to be developed and used in a variety of areas, primarily in information and finance.

5. Educational and personnel support of technological sovereignty. In Russia, there is a steady negative trend of an increase in the shortage of workers, which hinders the solution of the planned tasks. By the end of 2021, there was a shortage of 2.2 million workers, with more than 60% of them being workers. In this regard, rapid response measures are needed in the field of secondary vocational education. To overcome the shortage of personnel with higher education (primarily engineering specialties), the federal project “Advanced Engineering Schools” is being implemented as part of the state program “Scientific and Technological Development of the Russian Federation”. This state program aims at new forms of integration of education, science and production. It should be emphasized that the foundation of technological sovereignty should be domestic science, which ensures the reliable development of the country’s scientific and technological complex.

The third group of tasks is related to the implementation of the following areas of scientific and technological policy:

1. Development of critical technologies. Critical technologies are key areas of technological progress that form the basis of a new technological paradigm. Their list is developed and adjusted at the state level with the participation of experts from the scientific and technological complex of the country, representatives of the business community. For example, critical technologies include basic military and industrial technologies for creating advanced types of weapons, military and special equipment; biomedical, genomic, cellular technologies; computer simulation of nanomaterials and nanotechnology; bioengineering technologies, technologies for creating energy-saving systems for the transportation, distribution and use of energy, and others. Currently, more than 150 different instruments of state technological order have been directed to the development of critical technologies in our country. In 2022, only for the implementation of the state program "Scientific and technological development of the Russian Federation" budget funding in the amount of 464 billion rubles was allocated.

2. Development of end-to-end technologies. End-to-end technologies are the main directions of the national technology initiative, i.e. programs to support the development of promising industries. End-to-end technologies include artificial intelligence, big data, blockchain, quantum technologies, wireless communications, industrial internet, robotics, virtual and augmented reality, and new manufacturing technologies. The development of each end-to-end technology is assigned to companies leading in this high-tech area, as well as to the ministries in charge of them. So, "artificial intelligence" is in the area of responsibility of PJSC "Sberbank", JSC "MC RDIF", the Ministry of Economic Development of Russia and the Ministry of Digital Development of Russia, and "mobile communication networks of the fifth generation" - in the area of responsibility of PJSC "Rostelecom", the State Corporation "Rostec", the Ministry of Digital Development Russia and the Ministry of Industry and Trade. Such an organizational approach makes it possible to combine the most effective and promising projects and initiatives into a single end-to-end cycle of development of the direction, which covers all stages - from the development and implementation of technologies to the promotion of the results obtained to the markets [18].

3. Implementation of lighthouse projects. Beacon projects are strategic initiatives to create markets for high-tech products. Such activities allow obtaining the results of commercial testing of new technological solutions, identifying problems in their implementation, ensuring the scaling of projects, and reconciling the interests of all parties interested in them. Currently, as part of the "technological breakthrough" initiative, five beacon projects are being implemented in the country: "Unmanned logistics corridors", "Autonomous navigation", "Unmanned air cargo delivery", "Personal medical assistants", "Electric car and hydrogen car".

Financing of lighthouse projects is more than 140 billion rubles. from various sources.

4. National Technology Initiative (NTI) This state program was established in 2015 as a development institution and is now deeply integrated into the country's scientific and technological development system. More than 200 major projects are being implemented within the framework of NTI, in the implementation of which about 750 organizations participate. All leading universities of the country cooperate with NTI, on the basis of which the corresponding centers of competence are formed, and 3300 companies interact, which helps to coordinate the efforts of all structures involved in the development of end-to-end technologies [19].

Conclusion.

The negative scenario of the development of geopolitical events has put Russia in front of the need to solve the problem of achieving technological sovereignty in the face of the most severe sanctions pressure and growing military threats from the collective West. They can be solved only on the basis of a transition to a mobilization economy, which implies a significant strengthening of the role of the state in all spheres of the economy. Effective structures and mechanisms of state administration and regulation of intersectoral and regional economic relations are needed to ensure the concentration of the country's resources in priority areas of technological development.

References

1.Afanasiev A.A. Technological sovereignty: on the question of essence// Creative economy. - 2022. - No. 10. – pp.3691-3708.- doi: 10.18333/ se.10.16.116406.

2. Internet resource of the Yale School of Management, consolidating information about companies that have changed the nature of their activities in Russia in connection with the sanctions. [Electronic resource] URL: https: //som. yale. edu/stori/over-1000-companies-have-cirtailed-operations-russia-some-remain.

3. Vedomosti: how to encourage foreign companies to continue working in Russia. [Electronic resource] URL: https: //www. Vedomosti.ru//opinion/ articles/2022/05/24/923292/zarubezhnie-prodolzhit-rabotu

4. Afanasiev A.A. Technological sovereignty: the main directions of policy to achieve it in modern Russia//Issues of innovative economics. - 2022. - Volume 12. - No. 4. - pp.2243-2259. - doi: 10.18334/vinec.12.4.116433.

5. Afanasiev A.A. On assessing the impact of international sanctions on the conditions for the functioning of the domestic industry / / Economic relations. - 2022. - No. 2. - pp.179-194. - doi:10.18334/eo.12.2.114858.

6. Narimanov N.F. Import substitution as a factor of increasing national economic security// In the collection: Competitiveness of the territory: development priorities and strategic guidelines. Proceedings of the International scientific and practical conference. – Ryazan: Ryazan State University named after S.A. Yesenin, 2015. – P. 37- 41.

7. Narimanov N.F. The main directions of import substitution in modern Russia // In the collection: Ryazan State University named after S.A. Yesenin: a century-old history as a foundation for further development (dedicated to the 100th anniversary of S.A. Yesenin Ryazan State University). Proceedings of the scientific and practical conference of teachers of S.A. Yesenin Ryazan State University on the results of the 2014/15 academic year. Responsible editor M.N. Makhmudov; Ryazan State University named after S.A. Yesenin, 2015. – P. 48-54.

8. Narimanov N.F., Narimanova O.V. Import Substitution in modern Russia: types, methods of assessment, impact on the economy // Proceedings of the International Conference "Scientific research of the SCO countries: synergy and integration" (January 26, 2022. Beijing, PRC). – Part 2. Scientific publishing house Infinity, 2022. – P. 24–30. DOI 10.34660/INF.2022.64.14.004

9. Meeting of the Presidium of the Government Commission to improve the sustainability of the economy in the face of sanctions. [Electronic resource]. URL: http://government.ru/news/45119 (date of access: 01.10.2022).

10. Report by M.G. Reshetnikov on the forecast of socio-economic development for 2023 and for the planned period of 2024–2025 of the Ministry of Economic Development of the Russian Federation. Official Internet resource of the Federation Council of the Russian Federation. [Electronic resource]. URL: http://council.gov.ru/events/news/138446 (date of access: 09/29/2022).

11. Russian Statistical Yearbook. 2021. / Stat.sb. / Rosstat. - M., 2021. - 692 p.

12. Narimanova Olga Vladimirovna, Narimanov Nariman Fariman oglu.

INVESTMENTS IN MODERN RUSSIA: PROBLEMS AND SOLUTIONS // Proceedings of the International Conference "Scientific research of the SCO countries: synergy and integration". Part 2 - Reports in English (March 9, 2022. Beijin g, PRC). - P. 20-29. DOI 10.34660/INF.2022.12.97.003.

13. Narimanova O.V., Narimanov N.F. World practice of stimulating innovation activity// Proceedings of the International Conference "Scientific research of the SCO countries: synergy and integration" (January 26, 2022. Beijing, PRC). - Part 2. Scientific publishing house Infinity, 2022. – P. 31–36. DOI 10.34660/INF.2022.43.68.005

14. Bondarenko V.M. Possibilities and limitations of the application of the achievements of scientific and technological progress for the development of Russia // Economic security. - 2022. - No. 4. - pp. 1433-1450. doi: 10.18334/ecsec.5.4.116350.

15. Narimanova O.V. Blockchain technologies and their role in transforming markets // Topical areas of fundamental and applied research XIX: Proceedings of the Conference. North Charleston, 28-29.05.2019, Morrisville, NC, USA 27560: Lulu Press, Inc. 627 Davis Drive. 2019. Suite 300. - P. 201-207.

16. Narimanova O.V. Blockchain technologies and their implementation in financial markets. - In the book: Financial policy of the state: current trends and prospects: Proceedings of the All-Russian scientific-practical conference (Ryazan, September 29, 2018)/under total ed. A. A. Gracheva. - Ryazan: Academy of the Federal Penitentiary Service of Russia, 2018 . – P. 135-139.

17. Narimanova O.V., Narimanov N.F. Criptocurrency market: current state and developments trends// Proceedings of the International conference «Process Management and Scientific Developments» (Birmingham, United Kingdom, January 13, 2021). Part 2. – Scientific publishing house Infinity, 2021. – P. 30-35. https:// doi.org/10.34660/inf.2021.14.69.004

18. Eshtokin S.V. End-to-end technologies of the digital economy as a factor in the formation of the technological sovereignty of the country//Issues of innovative economics. - 2022. - Volume 12. - No. 3. – pp.1301-1314.

19. List of initiatives for the socio-economic development of the Russian Federation until 2030. Approved by the order of the Government of the Russian Federation of October 6, 2021 N 2816-r. Internet resources of the Government of the Russian Federation. [Electronic resource].

URL: http://static.government.ru/media/files/jwsYsyJKWGQQAaCSMGrd7q82RQ5xECo3.pdf (accessed 30.09.2022).

DOI 10.34660/INF.2023.11.97.054

ON THE DEVELOPMENT OF RENEWABLE ENERGY IN THE WORLD: PROSPECTS FOR RUSSIA AND COUNTRIES AFRICAN CONTINENT

Balashova Mariia Alexandrovna
Candidate of Economic Sciences, Associate Professor
Baikal State University

Svetnik Anastasia Vasilyevna
Student
Baikal State University

Abstract. *This article discusses the types of energy generation based on various resources, analyzes their advantages and disadvantages in the context of both existing and future global problems. Particular attention is paid to energy, as a promising area of cooperation between Russia and African countries, and the development opportunities for African countries in this area are outlined.*

Keywords: *energy, Russia, African countries, resources, global problems.*

As you know, traditional energy resources form the basis of hydrocarbon (fuel) energy and, despite the growing role of the atom and renewable sources in the world, they have the advantage of providing society with various types of energy (Fig. 1). This energy industry is based on the irreversible consumption of fossil energy carriers (oil, natural gas, coal, etc.), and it is distinguished by a number of disadvantages that create global problems, including environmental ones [1, p. 110].

Experts note that at the moment the development of modern fuel energy has almost reached its limit. This is due to the production process. In other words, it is automated, worked out and difficult to improve. In addition, in recent decades, the following trend has been observed: there is a decrease in the share of the industrial sector in developed post-industrial countries, which is reflected in a slowdown in the growth of energy consumption. The growing stagnation of energy consumption in developed countries does not contribute to the development of traditional energy, which provokes a structural change in the energy system or an energy transition [2, p. 28-29].

One of the proposed options for the partial replacement of hydrocarbon energy is the energy of the atom, which produces about 17% of the world's electricity. This is the most important sub-sector of global energy (Fig. 2), which already makes a significant contribution to global electricity production and has a clear advantage over hydrocarbon energy - the absence of such a phenomenon as the greenhouse effect and the cessation of aerosol emissions into the atmosphere [3].

France is the world leader in the field of nuclear energy. According to the World Nuclear Association for 2021, it uses 56 power units, producing about 70% of the world's electricity [4].

Nuclear power plants, due to their rhythm of operation, provide a constant and stable generation of electricity, which is a definite plus for French industrial enterprises. This allows for more efficient organization of technological processes and does not create storage tanks for energy carriers, as is required when using hydrocarbons. It is with the help of such a solution, according to French experts, that the country is able to provide itself with electricity. This confirms the high level of energy independence of the state, as well as the lowest cost of electricity in Europe.

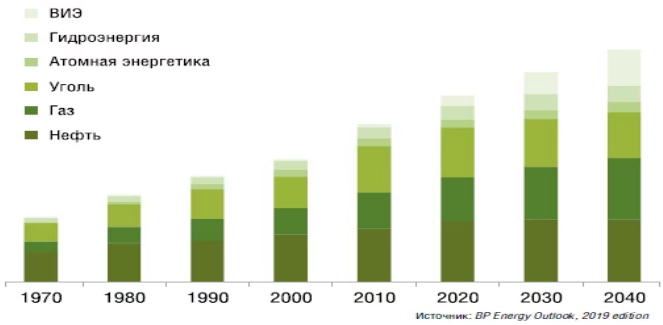


Figure 1. *Change in energy consumption from 2000 to 2040 [5]*

At the same time, one cannot deny the impact on the development of the world nuclear energy, which is exerted by the tasks of reducing the technogenic load on the environment. As a result, the EU sets as one of its goals the phase-out of nuclear energy and the transition to the so-called "green" economy, in which special attention is paid to "green" energy using alternative energy sources (AES) [6, p. 86].

The concept of "alternative energy" is based on renewable energy sources (RES): solar and wind energy, geothermal and hydraulic energy, as well as low-grade heat of the earth, water and air.

For many countries, energy based on alternative energy sources is one of

the most important components of energy supply. The attractiveness of RES is primarily associated with the inexhaustibility of the resources used, as well as independence from the price environment in the world energy markets. The prospects for the use of RES are directly related to both existing and future environmental problems [7, p. 133-134].

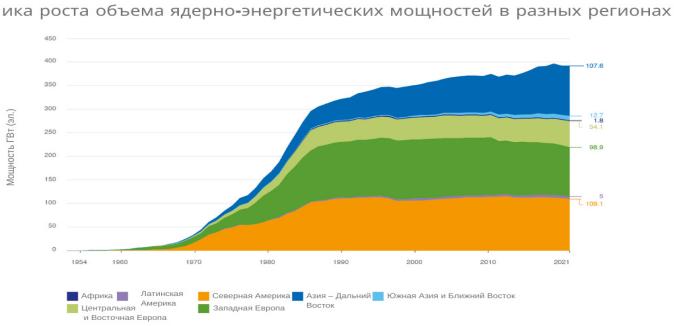


Figure 2. *Dynamics of growth in the volume of nuclear power capacities in different regions for 2021 [8]*

Despite the attractiveness of using alternative energy sources, the obvious question arises: can renewable energy sources replace non-renewable fossil energy resources and meet the world's demand for such essential energy?

Considering energy sources that are not associated with the irreversible use of mineral energy raw materials, first of all, hydropower is singled out [9, p. 790]. Thus, the share of renewable energy sources in the energy balance is high in countries where hydro resources are concentrated: Brazil, Canada, Sweden and Norway (more than 2/3 of the electricity generated in the country is provided by hydroelectric power plants) (Fig. 3) and others [10].

However, the concern of the world community with the issues and the state of the environment is the main obstacle to the use of the remaining world potential of water resources. An increase in water consumption for various needs and due to population growth may first slow down, and then completely limit the development of hydropower. There will be a reduction in the volume of water necessary for the operation of hydroelectric power plants.

The most promising alternative energy source at the moment is solar energy. According to V. S. Arutyunov and G. V. Lisichkin: "This is the only primary source of renewable energy coming to the Earth, which provides energy to all secondary sources, with the exception of geothermal energy, which does not have a significant global potential." Despite the advantages of this type of energy,

serious environmental problems are associated with it: the ambient temperature rises, during the operation of certain stations “a significant decrease in the ambient temperature is possible, causing condensation of water vapor with the formation of fog and, as a result, a decrease in the transparency of the atmosphere and a decrease in the efficiency of photoconverters” .

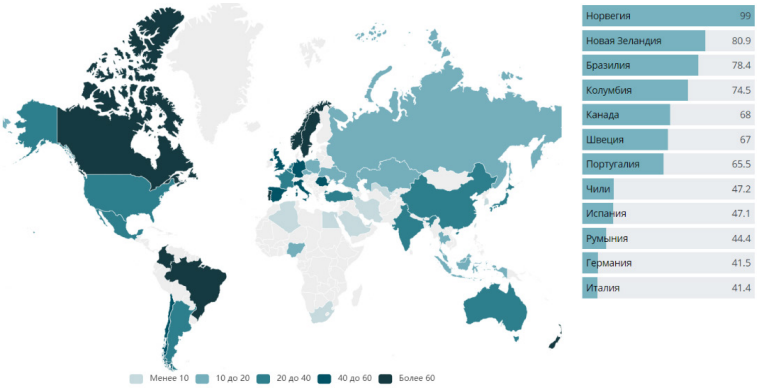


Figure 3. *Share of renewable energy sources in production electricity for 2021 in the world [10]*

Another significant problem of solar energy is the adverse effects of its industrial production. The production of silicon and arsenides is associated with a dangerous chemical manufacturing process, which in the future will cause the need to address issues of safe disposal of these materials.

With regard to wind power, in recent decades it has been the fastest growing way to generate energy using renewable energy. However, despite such advantages as the availability and inexhaustibility of wind energy produced by wind farms, there are the following technical and economic difficulties, the resolution of which is necessary for the introduction of the widespread use of wind energy. From a technical point of view, the variability of wind currents creates problems in the consistency of power generation, which is very unreliable. From an economic point of view, wind energy is one of the most expensive sources of energy.

It should be noted that, compared to nuclear or fuel energy, wind energy is more environmentally friendly, but only until the transition to large-scale electricity generation, which involves the construction of wind farms. Their construction will occupy significant land areas, there will be a need to create a new industry responsible for the manufacture of windmills, the production of windmills will directly affect the increase in the production of aluminum and other necessary materials. Ultimately, new production, as well as the disposal of obsolete

equipment, will somehow aggravate the ecological situation on the planet.

A more detailed examination of other RES currently at our disposal, one cannot help but notice the obvious: the incompatibility of the scale of global energy problems, world energy demands and proposed solutions based on alternative energy. So is it worth allocating significant resources and forces to unrealistic ideas that renewable sources can provide a long-term solution to the global problems of mankind, fully meet the demand for energy resources, and ensure the stable development of the world order [9 p.790-800] .

Considering the energy issues of Russia and the countries of the African Union, one cannot fail to note the similarity of their focus: focus on traditional resources that form the basis of hydrocarbon energy, as well as interest in the development of renewable energy sources.

In Russia, the interest is due to the fact that the global energy transition will provoke the threat of a decrease in production volumes, which in turn will affect the volume of investments. A change in the world course will call into question the expediency of the country's modern economic model, which is based on the goals of a further possible increase in energy exports. According to the calculations of the IES RAS, together with the "Skolkovo" MMS, the energy transition will significantly affect the export of energy resources, by 2040 it is expected to decrease by 16%. This will lead to a decrease in the average annual growth rate of country GDP by 1.1% per year [11].

In 2021, according to the ADRPG, the share of renewable energy generation in Russia's total energy consumption was about 0.5%. This is due to the fact that in most areas of the country there are no necessary conditions for the effective development and use of renewable energy sources. As noted earlier, for the large-scale use of renewable energy, a number of economic and technical problems must be solved: organization of mass production of generating equipment; the development of energy-saving technologies and energy storage technologies, as well as the availability of qualified personnel capable of applying them [12].

As for Africa, despite significant reserves of renewable and non-renewable energy sources, most of the countries in its territory face the problems of energy supply and distribution deficits on a daily basis. Fossil fuels are still the most important component of the energy mix in these countries.

Touching upon the issues of renewable energy, it is worth noting their huge potential and priority role in the strategy of the African Development Bank. Thus, according to the African Energy Commission (AFREC), the continent's hydropower potential is 13% of the world's. It is worth noting that the territories, due to their geographical location, are considered promising for the use and development of solar energy.

The priority role is determined by the fact that African countries are developing

countries, they need to develop the energy industry and solve the problem of energy poverty. By increasing energy capacity, African countries will be able to sell excess energy to countries in need, which will provoke domestic economic growth, as well as have an impact on solving the world's energy shortage problem.

For this, Africa, primarily due to the lack of a large energy infrastructure, needs support and cooperation from countries with strategic experience in the energy sector. As mentioned earlier, Russia and African countries have a similar development course, which opens up new prospects for cooperation for the initial implementation of new developments and projects, to which young qualified specialists can be attracted.

It is worth noting that the new explored world oil and gas reserves are mostly located in Africa. Thus, the found oil deposits at the end of 2020 in Africa amounted to 7.2% of the global volume (most of them are concentrated in Nigeria, Libya and on the shelf of West Africa), and natural gas - 6.9% (2.9% of located in and within the exclusive maritime economic zones of Nigeria).

Considering the nuclear potential of the continent and individual countries, it is necessary to mention the concentration of 20% of the world's uranium reserves, of which 5% is in Niger. Despite these opportunities, African civil nuclear power produces less than 2% of the world's energy.

The continent needs a significant increase in investment in the electricity sector in terms of generation and grids, for which it currently ranks among the lowest in the world. Africa is home to about 17% of the world's population, but accounts for only 4% of global energy investment. Without significant investment from outside, energy poverty and deep economic problems will remain for African countries an obstacle that will take decades to overcome, which will significantly affect the macroeconomic performance of these countries. It will be possible to achieve the planned economic and social development only with the full and competent use of the energy potential of states in accordance with national goals.

As a rule, the state is a monopolist in the energy sector or tightly controls it, therefore, for mutually beneficial cooperation, Russian companies need to establish ties with African state structures.

It is impossible not to deny the existence of unrealized potential in the field of energy, namely in the technological sphere. Russia is a leader in the development, implementation and use of peaceful nuclear energy. It will continue to develop cooperation in the field of energy security, focusing on the diversification of energy resources, the use of renewable energy sources, as well as the creation of joint projects in the field of civilian nuclear energy in African countries. African countries, due to the high cost of projects in this area, are not able to act as co-financiers. It is not easy to attract financing for them: it is extremely problematic for international development institutions to issue loans to countries with a

significant high public debt. Thus, it is Russia, with its experience and funding capabilities in the energy sector, that can play a decisive role for the development of African countries.

Also, the Russian Federation, as a country that has the necessary technologies and competencies in this area and is under the influence of Western sanctions on energy resources, can be a good example of African countries not selling their resources, moving away from the position of "preferential prices" and moving on to more competitive prices for based on supply and demand, as well as taking into account the weak position of Western countries during the energy and economic crisis [13, p. 114-119].

References

1. Klimovsky I. I. Disadvantages and advantages of hydrocarbon energy / I. I. Klimovsky // Alternative energy and ecology. – 2007. - No. 6. – P. 110-119.

2. Berezkin M. Yu. Geography of innovations in the field of traditional and renewable energy of the world / M. Yu. Berezkin, O. A. Sinyugin O. A., A. A. Solovyov // Moscow University Bulletin. Series 5. Geography. – 2013. – No. 1. – P. 28-32.

3. Atomic energy in the world / Atomenergomash. - URL: https://aem-group.ru/mediacenter/informatoriy/atomnaya-energetika-v-mire.html (date of access 10/25/2022).

4. The French authorities expect that the nationalization of the EDF will support the country's energy sovereignty / Neftegaz.RU business magazine. – URL: https://neftegaz.ru/news/nuclear/743273-vlasti-frantsii-rasschityvayut-chto-natsionalizatsiya-edf-podderzhit-energeticheskiy-suverenitet-str/ (date of access 10/24/2022).

5. Traditional hydrocarbon energy within the framework of sustainable development / Neftegaz.RU business magazine - URL: https://magazine.neftegaz.ru/articles/makroekonomika/551761-traditsionnaya-uglevodorodnaya-energetika-v-ramkakh-ustoychivogo-razvitiya/ (date of access 10/25/2022).

6. Sekacheva A. B. Trends, features and problems of development of nuclear power in France / A. B. Sekacheva // World of New Economics. – 2021. – V. 15, No. 3. – P. 85-96.

7. Rats G. I. Development of alternative energy sources in solving global energy problems / G. I. Rats, M. A. Mordinova // Bulletin of the Baikal State University. – 2012. – No. 2. – P. 132-136.

8. Nuclear power provided energy security through increased electricity generation in 2021 / International Atomic Energy Agency. - URL: https://www.iaea.

org/ru/newscenter/news/yadernaya-energetika-obespechivala-energeticheskuyu-bezopasnost-za-schet-povyshennoy-vyrabotki-elektroenergii-v-2021-godu (date of access 10/24/2022).

9. Arutyunov V. S. Energy resources of the XXI century: problems and forecasts. Can renewable energy replace fossil fuels? / V. S. Arutyunov, G. V. Lisichkin // Advances in Chemistry. – 2017. – V. 86 - No. 8. – P. 777-804.

10. The share of renewable energy sources in electricity generation / World Energy and Climate Data - Yearbook 2022 .2022).

11. The Fourth Energy Transition: Risks and Challenges for Russia / Vedomosti. – URL: https://www.vedomosti.ru/opinion/articles/2021/01/31/856101-chetvertii-energoperehod (date of access 10/24/2022).

12. Stable prospects in an unstable situation / Kommersant. – URL: https://www.kommersant.ru/doc/5318348 (accessed 24.10.2022).

13. Mobio D. Energy: a key area of cooperation between Russia and the ECOWAS countries / D. Mobio // Russian Foreign Economic Bulletin. – 2022. – No. 7. – P. 114-122.

DOI 10.34660/INF.2023.53.16.055

ETHICAL ISSUES AND RISKS OF DIGITAL TRANSFORMATION OF THE HIGHER EDUCATION INDUSTRY

Trofimov Valery Vladimirovich
Doctor of Technical Sciences, Full Professor, Head of Department
Saint Petersburg State University of Economics

Trofimova Elena Valerievna
Candidate of Economic Sciences, Associate Professor,
Associate Professor
Saint Petersburg State University of Economics

Abstract. *The implementation of the "Strategy for Digital Transformation of Science and Higher Education", carried out within the framework of national projects and strategic initiatives of the Government of the Russian Federation, on the one hand, is a prerequisite for achieving national goals formulated in the Decree of the President, on the other hand, requires the transformation of the classical education system, which can lead to a change in university ethics and the loss of the "spirit" of the university, and as a result, to the degradation of human morality, the substitution of the true goals, values and meanings of the university when replacing it with a "digital twin".*

Keywords: *Digital transformation, higher education, ethical issues and risks, morality.*

Introduction

The human mind is based on working with images, i.e. figurative thinking. "Slavic culture and language possess ways of conveying images. Words are made up of letters (symbols). A symbol is a sign with meaning, expressing a certain image. A word is also a symbol, like a sign expressing an image, but more complex! The Russian language dictionary contains more than 5 million words and is the largest in the world. The basic words of the language belong to the parent language and have a primary meaning!" [10]. For an unambiguous perception of the terms used below, let us consider their original meaning and the images embedded in them.

Transformation is the transformation (reengineering) of all processes (higher education): basic (science and education), auxiliary (providing the work of the

main ones), management (main and auxiliary processes) and development (strategic management) [1].

Digital transformation is the transformation (reengineering) of all processes (main, auxiliary, management and development) using digital (end-to-end) technologies in order to significantly increase both labor productivity and the quality of the result.

By the term "Digital technologies" we mean technologies that reduce cognitive limitations in the implementation of business processes and allow people and devices to perform their roles on an equal footing.

Education is the sculpting of a person's image by copying it from some standard. The creation of the image is carried out through education (nutrition axis) and training. What is the standard, such is the image. The result is an educated person. Higher education is part of education and an integral part of culture. Culture and Education are the basic words of our language, they belong to the parent language and have a primary (sacred) meaning!

"Culture (the Cult of RA, worship, following the Light of Truth, i.e. life according to the rules established by the Gods) is an ordered system, and the basis of its existence is self-preservation, i.e. the ability of culture bearers to have access to the original image (standard) and the ability to form and transmit this image without distortion" [5].

"The counterbalance to the term "Culture" is the term "Civilization". TSY (energy) + VILI (separation flow) + ZA (sequence, location) + TSY (energy) (I). Disconnected primary energy. CIVILIZATION strives for standard, equality and unification. CIVILIZATION is exclusively material." CULTURE is a deep and functional concept, it gives rise to diversity, implies inequality and uniqueness of the individual. CULTURE is a spiritual and material integrity. Man is a cultural phenomenon" [10].

Man is a complex multidimensional being (not only material, but also spiritual), therefore, it requires the organization of management of both spiritual and material components. A person (as an object of control) is also characterized as a purposeful system that carries out its activities in the direction of achieving its goals [3].

Learning is a process aimed at learning and applying ways to achieve goals and achieve an end result.

Education is the activity of all university staff, which is aimed at developing the student's personality and creating conditions for his/her self-determination and socialization (i.e., developing his/her skills to choose and set goals), based on university ethics and taking into account the principles of morality and morality [2 ,3].

"Ethics is a philosophical doctrine, the subject of which is morality, and the central problem is Good and Evil. Ethics studies the genesis, essence and

characteristics of human morality and morality, setting true goals, values and meanings; reveals their place and role in the life of society and man, reveals the mechanisms of moral regulation of human life, as well as the criteria for moral progress. Ethics is the basis for building a model of humane and fair relations in society, providing a high quality of communication between people, as well as a guideline for each person to develop their own strategy and tactics of the "correct life" [4].

Thus, education is a process, the purpose of which is the formation of an educated person (to educate a person) who observes moral and ethical standards; building its activities in the direction of achieving true goals, values and meanings; useful to his state and society; continuing its traditions and supporting its culture.

Decree of the President of the Russian Federation of July 21, 2020 No. 474 [11] formulates five national goals of the state for the period up to 2030. Digital transformation has been chosen as the main tool for achieving national goals, and its indicator is «achieving «digital maturity» in key sectors of the economy and social sphere, including education.»

To implement the Decree of the President, the Decree of the Government of the Russian Federation of October 6, 2021 No. 2816-r [6] approved the "LIST of initiatives for the socio-economic development of the Russian Federation until 2030" (Fig. 1), in which, in the areas of "Digital transformation" and " Technological breakthrough" within the framework of several initiatives provides for the training and education of IT specialists.

To implement these initiatives, the Ministry of Higher Education developed and adopted on July 14, 2021 the «Strategy for the Digital Transformation of the Science and Higher Education Industry» [8]. The digital transformation strategy of the Ministry of Higher Education is based on the following basic principles:

1. A practice-oriented approach should be implemented on the basis of digital tools that are aimed at scientific search and research.
2. Methods of predictive analytics should provide preventive management and improve the quality of education when making managerial decisions.
3. A single digital space should become the basis for combining the efforts of «science - education - business - the state» in solving the problems of the national economy.
4. Digital universities and the digital ministry (Ministry of Education and Science) should become the basis for the interaction of all participants in the educational process: applicants, students, scientists, teachers, the state, society, etc.
5. The digital transformation strategy for the science and higher education industry includes five areas and 7 projects: Datahab; «Architecture of

digital transformation»; «Digital University»; «Single service platform of science»; «Marketplace of software and equipment»; «Digital education»; «Service hub». The strategy also provides for seven indicators of achievement of goals for universities [7,8].

Ethical Issues of Digital Transformation of Higher Education

The digital transformation of higher education provides for the creation of digital universities and is aimed at introducing distance learning both on-line and off-line, developing and using educational materials in digital form, ensuring interaction between students and teachers in the virtual space, etc. All this leads to ethical issues. Recall that the problem is a mismatch between what we want and what we currently have. Ethical issues include:

1. the ratio of personal and working time of a teacher is catastrophically reduced due to a sharp increase in the time required to check the results of students' independent work, completed practical tasks, written abstracts, answers to test questions, holding consultations, etc.;

2. the role of the teacher's personality and its influence on students is sharply weakened due to the weakening of feedback in communication with students (the audience often perceives the teacher as a blogger);

3. substitution of live communication with the audience and the use of modern digital methods by monotonous reading from the screen;

4. replacement of the traditional educational space with a virtual (apparent) one with a distortion of its traditional moral content;

5. change in the digital reality of the boundaries of the personal space of the teacher and student;

6. the emergence of new forms of deception in the control of students' knowledge (for example, searching for answers to test questions using search engines on the Internet, unscrupulous borrowing of material when writing term papers and theses);

7. gross violations of etiquette and culture of communication during on-line classes.

Ethical Risks of Digital Transformation of Higher Education

In addition to the problems listed above, ethical risks are possible. Recall that a risk is a negative event that *can occur in the future* with a certain probability and cause damage. Ethical risks include:

1. change in the traditional university ethics, which determines the goals and meanings of the university, and on its basis, the reconstruction of the traditional system of university values;

2. virtual reality distorts a person's identity, formatting it as a digital file (digital footprint), deprives him of real interests, replacing them with virtual ones, which leads to a decrease in his creativity and intellectual collapse;

3. degradation of the norms of morality and morality, a decrease in the level of general culture and the culture of communication in particular;

4. distortion of the relationship between the main participants in the educational process «teacher-student», limiting the functions of the teacher, since the main role in managing this process is given to the organizer of on-line learning;

5. digital transformation can lead to distortion of the digital space of the university, its moral content and violation of the interests and rights of the teacher and student as a private person;

6. incorrect (incompetent) use of digital technologies in teaching can reduce the quality of education due to the combination of two functions by the teacher - the management of on-line learning and the actual interaction with students in the transfer of knowledge;

7. the transition to digital teaching methods may lead to the rejection of the services of teachers with experience who have rich experience in their subject area, but experience difficulties in using online education tools;

8. reduction in the number of teaching staff (replacing it with a «digital twin») due to the widespread introduction of video lectures and video materials for practical exercises, which leads to a decrease in the level of knowledge, skills and abilities of students.

Offers

During the forced transition of universities to distance learning due to the onset of the COVID-19 pandemic, the following was identified and tested:

1. The digital transformation of education leads to the emergence of a digital (virtual) university and cannot fully replace traditional education, just as a digital platform cannot replace a live teacher; the platform should and can become an additional tool for the teacher, expanding his capabilities and increasing the effectiveness of learning;

2. The digital transformation of education (in accordance with the requirements for new personnel in the digital economy) leads to the transformation of the basic meanings and goals of the classical university, which are the foundation of education, and to compensate for this distortion, additional study by students of such disciplines as «Ethics of artificial intelligence», « Ethics of digital technologies", "Digital etiquette", etc.;

3. The digital transformation of education requires the retraining of the teaching staff of the university, not only in studying terminology and mastering the skills of working with digital technologies, the features of teaching in an on-line format, but also in observing the norms and principles of professional ethics in the online learning environment;

4. The digital transformation of education should be accompanied by a strengthening of the role of the ethics commission, which forms and improves

not only the rules of its work, but also the code of ethics and rules of conduct, educational activities in the new conditions.

Findings

The implementation of the "Strategy for the Digital Transformation of Science and Higher Education" [8], on the one hand, is a prerequisite for achieving the national goals formulated in the Decree of the President [11], and for the transformation of the economy carried out by the Government of the Russian Federation [6], on the other hand, requires restructuring of the classical education system, which can lead to: degradation of university ethics; dehumanization of the learning process; increasing the time for studying tools by reducing the time for obtaining fundamental knowledge; loss of the «spirit» of the university (alma mater); substitution of the true goals, values and meanings of the university; degradation of human morality and its replacement by a "digital twin".

Conclusion

Thus, digital transformation is a powerful double-edged tool that affects ethics, transforms morality and morality, changes goals, values and meanings. Its use in capable hands can lead to welfare and prosperity, and in inept and malicious hands - to the degradation and destruction of both higher education and society as a whole.

References

1. Verzilin D. N., Doroshenko K. O., Maksimova T. G. et al. Modeling the management of economic processes (on the example of small and medium-sized enterprises): monograph under ed. of S. I. Shanygina. – M.: Megapolis Publishing House, 2022. – 225 p.

2. A single information space for the interaction of subjects of scientific and innovative activity / under ed. of Trofimova V.V., V.F. Minakov. (monograph). St. Petersburg: Publishing house of St. Petersburg State University of Economics, 2017. – 103 p.

3. Information and educational environment of an economic university / under ed. of prof. V.V. Trofimov (monograph). St. Petersburg: Publishing house of St. Petersburg State University of Economics, 2018. – 130p.

4. Ismoilova N., Muydinova M. Educational and methodological manual on philosophy (ethics, aesthetics, logic) for students of all specialties. Namangan, 2016.-188 p.

5. Ozhiganova A. A. Construction of tradition in the neo-pagan community of «lawyers». Journal COLLOQUIUM HEPTAPLOMERES. No. 2, 2015 – P. 30-38.

6. The list of initiatives for the socio-economic development of the Russian Federation until 2030, approved by the order of the Government of the Russian

Federation dated October 6, 2021 No. 2816-r. [Electronic resource] Access mode: http://government.ru/news/43451/. (date of access 12/26/2022)

7. System for the formation of research competencies and technological groundwork in scientific and educational activities. Monograph. / Ed. prof. Trofimova V.V., V.F. Minakov. St. Petersburg: Publishing house of St. Petersburg State University of Economics, 2019. - 180 p.

8. Strategy of digital transformation of the branch of science and higher education. Approved on 07/14/2021. [Electronic resource] Access mode: https://www.minobrnauki.gov.ru/upload/iblock/e16/dv6edzmr0og5dm57dtm0wyllr6uwtujw.pdf (date of access 12/26/2022)

9. Technological trends and knowledge-intensive economy: business, industries, regions: collective monograph / Under. ed. of prof. O.N. Korableva and others. St. Petersburg: Asterion, 2021. — 666 p. — DOI: 10.53115/9785001880134. - 1 CD-ROM. – Text: electronic. ISBN 978-5-00188-013-4.

10. Trofimov V.V., Trofimova L.A. Strategy for digital transformation of science and higher education in Russia. In the collection: Digital transformation in economics and management. collection of scientific papers. St. Petersburg, 2021, pp. 5-17. [Electronic resource] Access mode: http://elibrary.ru/item.asp?id=47577858 (date of access 12/26/2022)

11. Decree of the President of the Russian Federation of July 21, 2020 No. 474 «On the national development goals of the Russian Federation for the period up to 2030». [Electronic resource] Access mode: http://www.kremlin.ru/acts/bank/45726 (date of access 12/26/2022)

DOI 10.34660/INF.2023.23.55.056

STUDYING THE ISSUES OF MODERN PHYSICS IN A PROFESSION-ORIENTED SCHOOL

Dubitskaya Larisa Vladimirovna
Doctor of Pedagogical Sciences, Full Professor
State Social and Humanitarian University

Zolotova Svetlana Nikolaevna
Senior Lecturer
State Social and Humanitarian University

Sheshankov Ivan Nikolaevich
Director of the secondary school "Our Traditions", Voskresensk c.

Allenov Sergey Vladimirovich
Candidate of Physico-mathematical Sciences, Associate Professor
State Social and Humanitarian University

Abstract. *The article deals with the issue of forming students' ideas about the role and place of physics in the modern scientific picture of the world, understanding the role of metaphysical knowledge. Practical tasks are analyzed using digital services.*

Keywords: *physics, metasubjectivity, digital educational resources, educational content.*

Scientific discoveries of the 20th and early 21st centuries led to the accumulation of a huge amount of information in the fields of natural science, to the emergence of new ideas and theories that led to the creation of modern physics. "The main paradox of science is that, revealing to us solid and reliable knowledge about nature, it at the same time is rapidly changing its own ideas about reality," says Alexander Sergeev in his preface to the Russian edition of the book "Unreal reality. Journey through a quantum loop" by Rovelli Carlo, a global renown scientist physicist. The modern development of science is characterized by an ever-growing amount of knowledge and an extraordinary abstractness and complexity of discoveries, which leads to a significant gap between the current level of scientific knowledge and the content of school and university educational programs [1]. The most popular source of knowledge about modern scientific

achievements is not a school teacher, but the mass media, since modern physics is only with great difficulty included in the curricula and standards of general secondary education.

At the same time, in the Federal State Educational Standard of secondary (complete) general education, when describing the requirements for the subject, the results of the development of basic and advanced courses in physics, it is said that it is necessary to ensure the formation of students' ideas about the role and place of physics in the modern scientific picture of the world, understanding the role of metaphysical knowledge.

The process of obtaining knowledge about modern science at school allows you to solve a number of problems:

- forms an idea of the modern scientific picture of the world;
- makes students "react" to information about recently discovered physical phenomena, developing the need for its critical analysis;
- creates a need for self-education in physics;
- allows you to integrate knowledge from different areas of physics;
- generates dialectical thinking, the concept of inconsistency and relative truth of physical knowledge;
- reveals the area of applicability of school knowledge and their practical value in modern physical research;
- promotes professional orientation of students.

This process involves the solution of a large number of problem situations that require the productive nature of cognitive activity, as well as the implementation of educational and research, design and information and cognitive activities of students. The idea is emphasized that the model of critical thinking is maximally implemented in teaching natural sciences [2]. This and much more determines the educational potential of modern physics at school as an opportunity for the development of cognitive, motivational and creative personal spheres of students, in particular the development of dialectical and creative thinking, understanding, memory, cognitive and creative activity, etc.

It should be noted that the current educational standards, curricula of higher and secondary education do not meet the requirements necessary for the training of future specialists in the field of engineering and innovative technologies. In fact, schoolchildren and even students mainly study physical phenomena discovered before the beginning of the 60s of the XX century, as a result of which they form an erroneous opinion that physics is an inert system in which even small changes occur very rarely. And the elements of modern physics in traditional university and school textbooks, as a rule, are presented to a limited extent, or are completely absent. In this aspect, several areas of modern science are of particular interest in teaching physics, namely, certain issues of modern physics of the microcosm

and megaworld, the peculiarity of which is the relationship of modern physical research in these, at first glance, fields of science that are completely different in terms of the scale of the objects under study.

The absence of the compulsory discipline «Astronomy» for a long time in the standards led to the integration of a very limited range of astrophysical issues into the basic course of physics, but in modern conditions this material is often not connected in any way with the basic course of physics, which is not entirely correct from the point of view of modern science. The new standards again exclude the study of this subject at school, which will certainly have a negative impact on the formation of a holistic worldview of a school graduate. Therefore, at present, the most important, including from the point of view of solving the problem of integrating physics and astronomy, is to study the possibility of including issues of modern micro- and megaphysics in the school curriculum [3]. These issues can be studied in the sections «Quantum physics» and «Structure of the Universe» of the physics course of the profile level of education or «Quantum physics and elements of astrophysics» of the basic level of physics education.

The problem of the formation of schoolchildren's quantum ideas was one of the most difficult due to the specifics of the quantum description of the properties of matter, the limitations of experimental work in the school laboratory, and other reasons.

The issue of forming ideas about modern science in the field of micro- and megaphysics in dissertation research in pedagogy is presented, to a greater extent, by works devoted to the problems of studying astrophysics at school: Galkina T.A., Maksimenko E.V., Matartseva E.A., Nikitina G.A., Romas I.A., Rumyantsev A.Yu. and the problems of teaching students of pedagogical universities the issues of modern physics: Maksimenko E.V., Mikhailishina G.F., Pigarev A.Yu., Fedorova Yu.V. (particle-wave dualism, the statistical nature of the movement of microparticles, the discreteness of physical quantities). They do not contain methodological solutions to the problem of introducing modern (late 20th - early 21st century) research in this area into the school physics course.

In order to get an idea of modern research that is in the focus of attention of physicists, one can refer to the review by V.L. Ginzburg «the most important and interesting problems» of physics and astrophysics [4].

It should be noted that at the moment there are not enough integrated tasks in physics and astronomy, therefore, it is necessary to use information technologies and tools, the use of electronic resources of digital services. It is advisable to use digital tools for educational purposes to create interactive educational content [5]. To pay special attention to the development of skills to integrate interactive educational content into educational activities [6].

The influence of modern physics on the cognitive sphere of students was

revealed through the indicators of the dynamics of the subject results of students on the topics «Quantum Physics» and «Structure of the Universe» using tasks based on digital services, examples of which are given below.

Let's consider a practical work on the topic «Distances in the Solar System» using the 3D simulator of the Solar System «Solar System Scope».

Goals of the work:

Get practical skills in calculating astronomical distances.

To consolidate the theoretical material on the structure of the solar system.

Calculate the distances of the planets of the solar system relative to the sun and earth.

Get practical skills in working with the Solar System Scope program.

Task 1. Write down the definitions:

1. Astronomical unit –
2. Parsec –
3. Light year –

Task 2. Convert the following quantities to kilometers:

1. a.u. =
2. l. year =
3. pc =

Task 3. Follow the link https://mks.space/sss and study the interface of the computer program «Solar System Scope». List the main features of this program. Note. You can go to the website with the program using a QR code.

Task 4. Fill in the table below using the Solar System Scope program according to the following plan:

1. in front of the table, indicate the date when the measurements were taken;
2. click on the Sun, from the pop-up window, select the «distance» item;
3. Next, click on the planet you want to find the distance to;
4. The distance between them will appear in astronomical units on the straight line connecting the Sun and the selected planet. Record the resulting value in the second column «Distance from the Sun» in the «a.u.» column. In the «km» column, write down the distance found in kilometers.

5. Find out and write down the distance from the selected planet to the Earth in column 3 «Distance from the Earth»;

6. Write how the planet looks in the program, what shape it has, what color it is, etc in the column «Appearance of the planet».

7.Repeat paragraphs b-f for each planet in the solar system and Pluto.

Table 1.

For task 4 using the program «Solar System Scope»

Planet name	Distance from the Sun		Distance from Earth		Appearance of the planet
	a.u.	km	a.u.	km	
Mercury	0,46		1,08		The smallest planet in the solar system, round, gray.
Venus					
Earth					
Mars					
Jupiter					
Saturn					
Uranus					
Neptune					
Pluto					

Task 5. Analyze the results and draw a conclusion about the size in the solar system.

In a comparative experiment, the dynamics of the educational results of students in the experimental and control groups was revealed. The increase in educational results Δx was determined by the difference between the average result x2 in the test task for the educational minimum content for the profile level on the topics «Quantum Physics» and «Structure of the Universe» and the starting quality of knowledge x1. The starting value was determined as the average of two diagnostic tests of the StatGrad system implemented on personal computers in the classroom. The testing included tasks that included:

- understanding the physical meaning of phenomena, laws and concepts of quantum physics and astrophysics;
- knowledge and understanding of physical methods and ways of studying the microworld;
- the ability to navigate in the historical sequence of discovered laws and phenomena;
- ability to analyze, classify and systematize knowledge;

The above tasks made it possible to collectively assess the level of understanding and comprehension of the studied material, the level of development of mental processes underlying cognition, such as associations, identifying common features, classification, analysis, and more, as well as the ability to reproduce past experience and existing knowledge.

Thus, we can conclude that the inclusion of information about modern ideas in the field of physics in the curricula makes it possible to prepare a graduate with

broad natural science knowledge, understanding the «unity of nature», having an idea about the problems of modern physics, today's research methods and their prospects. development. A graduate who is ready and willing to multiply and use this knowledge in his/her further professional training.

References

1. Dubitskaya L. V. Training of a natural science teacher for a specialized secondary school in the conditions of a modern university // Uchenye zapiski Zabaikalskogo gosudarstvennogo universiteta, 2014. No. 6 (59). pp. 12-15.

2. Solodikhina M. V. Critical thinking in higher natural science education: definition and content of the concept: monograph. M.: Mos. Ped. State Un-ty, 2022. 164 p.

3. Dubitskaya L., Vlasenko A., Zhukov D., Zolotova C. About the need to study the theoretical foundations of wireless data transmission in a school physics course // Scientific research of the sco countries: synergy and integration. October 27, 2021. Beijing, PRC. part 2. Beijing, PRC. 2021. P. 79-85.

4. V. L. Ginzburg, "What problems of physics and astrophysics seem to be especially important and interesting now (thirty years later, and already on the threshold of the 21st century)," Uspekhi fizicheskikh nauk. 1999. V. 169. No. 4. P. 419–441.

5. Allyonov S. V., Znatnov S. Yu., Plekhanova M. V. Digital tools for educational purposes in the system of advanced training of teachers // Pedagogical education and science, 2022. No. 4. P. 65-68.

6. Allyonov S. V. Digital services for creating educational content in the system of advanced training of pedagogical workers // Collection of works on problems of additional professional education, 2022. No. 43. P. 44-50.

DOI 10.34660/INF.2023.83.72.057

WAYS TO DEVELOP POWER ENDURANCE OF KETTLEBELL LIFTERS

Badashkeev Mikhail Valeryevich
Candidate of Pedagogical Sciences, medical psychologist
Bokhansky district hospital

Badashkeev Valery Mikhailovich
student
Bohan Teachers College

Abstract. *In our research work, we consider the main ways to develop the power endurance of kettlebells in our opinion. A training process program has been developed to develop the power endurance of kettlebell lifters. Empirical research was carried out on the basis of the Bohan Children and Youth Sports School. Currently, a lot of kettlebell lifting coaches and kettlebell lifters themselves use the latest approaches and techniques in the training process. In our study, the main emphasis is on a combination of special and general physical training in the development of strength endurance of kettlebells.*

Keywords: *weight lifting, power endurance, weight lifting athletes, competitive activities, general physical training, round-robin training complex.*

In modern pedagogical science, the general physical fitness of kettlebell lifters is quite widely discussed, in our opinion, insufficient attention is paid to the development of strength endurance, and even more so with psychological factors affecting the motivational sphere of athletes. General physical fitness is a certain foundation for a kettlebell, but power endurance has a rather significant factor for a kettlebell athlete. In our opinion, the integral integration of the training process and psychological approaches, that is, the unification of the latest scientific knowledge with the classics of the physical development of the kettlebell lifting athlete, will make it possible to achieve the greatest achievements [5].

In modern kettlebell lifting, general physical fitness, strength endurance, and the strength of the athlete's will are of great importance. In our study, we consider the development of strength endurance, willpower of kettlebell lifters to be the main one, so the training process should be as optimal as possible, individual in the selection of means and training methods. Due attention must be paid to

the process of restoring the growing body of girls and boys. Individualization of the training process is important not only in strength endurance, but also in the development of willpower, where it is necessary to create motivating conditions in the educational environment of the youth school [1; 4; 5; 6]. The development of individual strong-willed qualities among kettlebell lifters is based on honing and improving technical and tactical skill, intellectual training. In the process of developing willpower among kettlebell-breakers, the main factors in our opinion are: the creation of a motivational sphere, adequate ambitions, goal-setting, adequate perception of one's own physiological capabilities [2].

An empirical study was carried out from September 2021 to January 2023 on the basis of the Bohan Youth Sports School, the kettlebell lifting section, coach D.A. Petrov, master of sports of Russia. The study involved 13 athletes - 10 young men, 3 girls with youth, adult sports categories, candidates for master of sports. At the first stage, a program of general physical training and power endurance was developed, at the second stage the program was implemented, control measurements were carried out, individual adjustments were made, at the third stage they paid more attention to the development of willpower, moral and psychological stability, honing technical and tactical moments, the fourth stage - summing up individual achievements, changes in general physical parameters, participation in competitions [3].

In modern pedagogical science, the general physical fitness of kettlebell lifters is quite widely discussed, in our opinion, insufficient attention is paid to the development of power endurance, and even more so with psychological factors affecting the motivational sphere of athletes. General physical fitness is a certain foundation for a kettlebell-lifting athlete, but power endurance has a rather significant factor for a kettlebell-lifting athlete. In our opinion, the integral integration of the training process and psychological approaches, that is, the integration of the latest scientific knowledge with the classics of the physical development of a kettlebell lifting athlete, will allow achieving the greatest achievements [7; 8].

In our opinion, one of the important problems in modern weight lifting is the problem of power endurance. Quite often we observe this at youth competitions. Therefore, our main goal is to set the most comfortable performance of kettlebell lifters at competitions, both physically and psychologically [2; 3].

An empirical study was carried out from September 2021 to January 2023 on the basis of the Bohan Youth Sports School, the kettlebell lifting section, coach D.A. Petrov, master of sports of Russia. The study involved 13 athletes - 10 young men, 3 girls with youth, adult sports categories, candidates for master of sports. We developed two round-robin training complexes.

Round-robin training complex №. 1. Aimed at developing strength endurance of leg muscles: 1. Shuttle Run, 2. Partner Transfer, 3. Jumping out of deep squat

with weights, 4. Half-cut with two weights of 16 kg., 5. Deadlift, rod weight 40 kg., 6. Jumping on a pedestal 1 m high, 7. Running at 200 m.

Round-robin training complex №. 2. Aimed at developing the power endurance of the back and press: 1. Flexion, extension of the arms in the resting position, 2. Plank in rest lying down, 3. Tilts with a bar of 20 kg., 4. Push along the long cycle of weights 24 kg., 5. Flexion and extension of the torso on the inclined bench, 6. Pulling up with a narrow grip, 7. Hyperextension.

Thus, the developed program for the development of general physical training and strength endurance allows: to increase the effectiveness of the training process, develop strength endurance, raise self-esteem, form competitive tactics, plan individual microcycles of training, as well as achieve higher sports results.

Thus, the complexes of exercises developed by us for the development of strength endurance of kettlebell lifters by the round-robin training method showed sufficient effectiveness. In general, all children and girls have increased results at competitions, confidence is felt and there is no fear of going to the platform.

References

1. Babintseva, M.A. Analysis of physical fitness of kettlebell lifting students and its influence on the performance of competitive activities/M.A. Babintseva. - Text: direct//Young scientist. - 2014. - № 18 (77). - P. 61-65. - URL: https://moluch.ru/archive/77/13133/ (accessed date: 09.09.2022).

2. Badashkeev, M.V. General physical training of kettlebell lifters of 14-17 years [Text] article/M.V. Badashkeev, V.M. Badashkeeva//mat. international scientific-practical conf. "The intellectual potential of society as a driver of the innovative development of science "/rel. ed. A.A. Sukiasyan - Irkutsk: Omega Sainz, - 2022. - P.109-111.

3. Badashkeev, M.V. Features of the development of power endurance of kettlebell lifters [Text] article/M.V. Badashkeev, V.M. Badashkeeva//mat. international scientific-practical config. "The intellectual potential of society as a driver of the innovative development of science "/rel. ed. A.A. Sukiasyan - Irkutsk: Omega Sainz, - 2022. - P.111-17.

4. Borisevich, S.A. Building the training process of high-qualification kettlebell lifters [Text]: Autoref. dis... cand. ped. sciences/S.A. Borisevich. - Omsk: SibGAFK, 2003. - 22 p.

5. Gutsu, V.F., Petrukhin I.V., Bondin V.I. Dynamics of physical fitness of kettlebell lifting athletes during many years of training//In the collection: Psychological, pedagogical and physiological aspects of building fitness programs and ensuring their safety collection of materials of the third international scientific conference. - 2016. - P. 113-118.

6. Musiyak S. A., Zamchiy T. P., Spataeva M. Kh., Matuk S. V. Relationship of physical fitness indicators with a competitive result among kettlebell lifters of various qualifications//Siberian State University of Physical Culture and Sports. - 2014. - №2. - P. 27-36.

7. Siemens V.P. Features of the means of sports training of kettlebells// Modern science-intensive technologies. -2017.-№5. S. 145-149; URL:https:// top-technologies. ru/ru/article/view? id = 36685 (accessed date: 13.01.2023).

8. Khomyakov, G.K. Integrated development of strength qualities as a means of achieving the peak of sports in kettlebell lifting [Text]/G.K. Khomyakov//Bulletin of Irkutsk State Technical University. - 2013. - № 5 (76). - P. 299-309.

DOI 10.34660/INF.2023.78.96.058

INSTITUTIONAL FORMS OF ENTERTAINMENT AND ART IN THE ETHNIC ENVIRONMENT OF THE ADYGS IN THE XVIII-XIX CENTURIES

Siyukhova Aminet Magametovna
Doctor of Cultural Studies, Full Professor
Maikop State Technological University

Tkhakushinov Aslancheriy Kitovich
Doctor of Sociological Sciences, Academician of the Russian Academy of Education, Full Professor
Maikop State Technological University

Abstract. *The article examines the institutional forms of entertainment and art in historical retrospect on the example of the ethnic group of the Adygs (Circassians). The introduction clarifies the essence of the concept of "social institution" in relation to art and ethnic rituals. The work used culturological research methods (diachronic, structural and functional), as well as methods of scientific ethnography. The system of the Adyghe traditional rites finally developed in the 18th and 19th centuries. An important element of many rites and rituals were artistic practices – singing, dancing, games, versification, theatricalization, instrumental music, etc. The rituals of "Chapsch" and "Girlish gatherings" are described in more detail. We show examples of the description of dances in the traditional epic of the Caucasian peoples «Narts». We have concluded that at present the institutionality of ethnic ritual has given way to the institutionality of art. However, art has also assumed a function that was previously characteristic of the ritual system – the function of ethno-cultural labeling, when ethnic communities are evaluated primarily by the artistic and aesthetic criteria of their creativity.*

Keywords: *Adygs, traditional culture, rituals, entertainment, art.*

Introduction

Starting to disclose the designated topic, let us recall that the concept of "social institution" ("social code") was introduced by one of the founders of scientific sociology, Herbert Spencer, understanding this concept as a stable organized type of activity and behavior of people that maintains its stability over a long period

of time, and being a condition for the sustainable functioning of society. Spencer and his followers identified the main social institutions - the state, religion, science, education, industry, trade, art, etc. A natural question arises: is the system of traditional rituals in the ethnic environment a socio-cultural institution? It is obvious that "yes", as evidenced by the following functions of a social institution defined by the classics of sociology.

Firstly, it is a function **of strengthening social ties** with the help of a system of institutional regulators that give people a standardized and regular character.

Secondly, it is an **integrative function** that provides: a) cohesion into a social group; b) combining the efforts of group members, causing a cumulative effect of a social institution.

Thirdly, it is a **socializing function**, the transfer of accumulated institutional experience from one generation to another and the formation of the type of people necessary for a given society.

The functionality of sociocultural institutions can be realized both explicitly and latently. Explicit functions are perceived by people when the activity within the institution is intentional (for example, in the economy or in health care). Latent (hidden) functions are presented through the activity of social institutions, the consequences of which are not realized by the participants or it is not intentional. The second type most often includes the system of traditional rituals of ethnic groups, religion, as well as most of the art as a sphere of spiritual creativity. In all these cases, institutional production is based on the mythological collective consciousness, which operates mainly not with logic and rationality, but with emotions, intuition and the ability to spontaneous symbolization.

Methodology. When developing the topic, reliance was placed on cultural research methods (diachronic, structural-functional), as well as on the methods of scientific ethnography.

Main part

The traditional culture of the Circassians approached its classical form by the 17th-18th centuries, when the mental traits of the character of the ethnic group finally took shape, the basic ethical principles of relationships, expressed in the unwritten code of honor "Adyghe Khabze", established forms of ritual (wedding, burial, calendar ritual, ritual at the bedside of a seriously ill/wounded person, girl gatherings, etc.), aesthetic artistic and stylistic signs of ethnic creativity (the epic Narts, gold embroidery, musical and choreographic art, etc.). Art organically fit into the system of rituals and functioned in the form of songs (comic, epic, heroic, later lyrical), dances, instrumental music, theatrical performances (mummers).

In ethnographic studies of the Adyghe traditional culture, various forms of gaming practices are considered in sufficient detail in various situations in the life of society - the time of the rite and the time of leisure (rest from everyday work

and military raids on neighboring settlements). S.Kh. Mafedzev, describing the traditions and customs of the Circassians, pays great attention to various games that were held, for example, in chapsch rites and girlish gatherings, weddings and funeral events. The researcher, in particular, describes the game «scenario, in accordance with which the action of the chapshch rite unfolded. To ensure order and general leadership, they elected a "king" (pashtykh), an "assistant" (beyguel) and a "horse for an assistant" (beiguelysh) and a "whipping boy" (klekyu) at the chapsche. At the beginning of all the games, the one who received the title of "king" ordered his assistant, under the general fun, to beat "klekyu" with a towel, belt or some other tourniquet. The "king" was engaged in the punishment of the guilty, sometimes asking for advice from an assistant. At the same time, both the "king", and his assistant, and the "horse" themselves took an active part in games, singing and other events. Along with the officials of the group of participants, the chapsha (male and female) elected its leader, which was reported to the "king". The leader had to be witty, resourceful and inventive, to exercise specific leadership over the members of his group. A similar parodic comic duplication of serious social relations between the authorities and the people is noted by M.M. Bakhtin, who studies the comic culture of the Middle Ages and the Renaissance [1].

S.Kh. Mafedzev divides chapsche games according to their functional and formal characteristics into two groups: the main, traditionally used, and improvisational games. At the same time, most often the games of both groups were in the nature of a theatrical spectacle with a predominance of comic content. An important link in the structure of the chapsch was games with the participation of mummers. E.M. Schelling reports that during the games they often used comic masks made of a pumpkin painted and sheathed with pieces of sheepskin [5]. N. Zhardetskaya describes the participation of mummers in the existence of chapscha at the beginning of the 20th century as follows. "From time to time here (into the room where the chapsch was held - S.A.) bursts a top of young people dressed up in masks specially made for the chapsch, depicting the head of a bear, wolf, old people, etc. The appearance of the mummers should be unexpected and produce as much as possible turmoil and noise. This is done in order to frighten off the uds (evil spirits), which, obviously, taking advantage of the helpless state of the patient, can cause him great harm, especially in a dream" [4].

The form of holding the chapscha remained stable for quite a long time. In chapsha, in addition to role-playing and competitive games, jokes, theatrical performances of mummers, playing musical instruments, dancing, singing special and comic songs, singing songs of a heroic and lyrical nature were obligatory. The genre of "kebzhech" stood out in particular, partly reminiscent of Russian ditties, taking the form of a theatrical dialogue [2]. Each group of chapsch participants tried to outdo the other in inventing means to entertain the sick [5].

The dzheguako, a professional in the field of musical and stage service for family and agricultural holidays, became an important organizing link in the structure of the chapsh rite. Dzheguako often became the initiator of laughter competition. Z.M. Naloev points out that poetic competitions between dzheguako and oriozem (lueryluedz - unprofessional "poet-witty person"), between oriozem and a girl, etc. were popular in chapsha. In these competitions, rivals ridiculed each other, trying to surpass the enemy with their ingenuity and wit and cause laughter the public, which, in turn, vividly responding to successful witticisms and resourceful answers, took sides, thereby becoming a participant in a verbal duel. "Everything was allowed here, accusations of imaginary and real shortcomings, the most salty curses and threats - it was only necessary to be able to defeat the opponent and silence him," writes Z.M. Naloev [6].

We can observe that the archaic Adyghe rite at the bedside is filled with artistic elements of art and forms of entertainment that are of an institutional nature, unfolding in the chronotope of the rite according to a strict scenario, i.e. institutional rules and regulations.

The category of traditional cultural practices of the Circassians includes the custom of youth gatherings (cheshdes). Until recently, this form of intra-ethnic interaction was of an institutional nature, the purpose of which was to create conditions for communication between potential marriage partners. This institution of acquaintance was balanced by the predominance of the spatially separate existence of men and women in everyday and ritual practice. S.Kh. Mafedzev writes: "In the past, Adyghe families had special girls' rooms (pshashche une) with a special separate entrance to meet the young, so that without meeting the girl's parents, one could go to her. Such visits by young people to girls were common and were not condemned" [5]. The so-called girls' houses «were in every family where girls of marriageable age grew up. These meetings were allowed only in the presence of the girlfriends of the girl in whose house these gatherings took place. Youth gatherings were of a casual leisure nature (there were games, jokes, playing musical instruments, wit competitions, etc.), but they had many ethical and etiquette subtleties, described in detail in historical and ethnographic literature [9]. Verbal duels were often used in the relationship between a guy and a girl, and the sharper they were, the more likely it was that some kind of sympathy would develop between the couple. L. Gutova notices that the girls' rooms became a place for testing the mind, ingenuity, and nobility of young people [3].

The exchange of cliched remarks of satirical content, mainly intended to put an opponent in a comic light, is one of the traditional types of game communication. In the light of modern culturological theories, laughter that is born in such situations has an obvious ritual character of "ragging", i.e. is the threshold of a significant initiation of the personality, in this case - the future status transition to the state

of a family person. Emotional openness was also facilitated by the musical and choreographic component of Cheshdes.

The nighttime gatherings also actualized the desire of young men to demonstrate prowess, heroism, and the ability to take risks. Authors of publications on cheshdes most often omit ethnographic descriptions of such actions, perhaps due to the fact that they are not consistent with modern concepts of criminal law. However, many informants do not hide the fact that well after midnight, when the participants had a feeling of hunger, the girls expressed their readiness to cook something if the guys brought prey for this. One of the young men went on a «raid» to someone's chicken coop (as a rule, it was the chicken coop of one of the guys who remained with the girls) and brought the chicken they got.

As we can see, the night tradition of girls' (youth) gatherings implements many archetypes of the collective unconscious, one of which is the archetypes of prey and night meal. In the same row, we can mention the archetype of the preservation of fire, because night vigils are very helpful. In the cultural space of gatherings, important functions of modeling the subsequent adult life of girls and boys are realized: the ability to conduct a dialogue, get out of conflicts, be responsible for the well-being of their loved ones, etc. in the origin of deep intimate experiences associated with the love of a man and a woman. All this ensures the integration of society into a single cultural ethnospace, distinguished by the integrity and stability of the life world.

In the traditional culture of the Circassians at the present stage, choreography plays a leading ethno-marking role. All Circassians, with rare exceptions, can perform at a high level technically quite complex Adyghe folk dances. Love for dancing has been characteristic of the Caucasian peoples since ancient times, and at first dance was an institutional element of rituals. Khan Giray writes: «... the ancestors of the current Circassians from the time of paganism, invoking the blessing of the objects they idolize or expressing their gratitude to them, danced.» Traveler Zh.B. Tavernier wrote: «When thunder rumbles, everyone immediately leaves the village, and all the youth of both sexes begin to sing and dance.» Cult dances, including «Shybleudzh» and «Thyashkhoudzh», have common features with the «Udzh-khurai» (circular round dance) that has survived to this day. The modern «Uj-khurai» is also performed «in a circle» and with a monotonous stamping of the feet. These performance features corresponded to the ancient ritual dance, where the rhythmically organized action in the form of monotonous stomping had a magical meaning.

In the future, new forms of Adyghe dance art appear. This can be seen in the example of «chakashyu» - the dance of the goat, which was performed at large festivities and became a new expression of folk art. «This traditional image embodies all types of ancient art: it easily reveals the ritual origins of the drama,

mainly direct folk satire and elements of onomatopoeia to birds and animals, as well as the beginning of theatrical mimicry and choreographic art» [7].

If we turn to the legends about the Narts - the heroic epic, we will see that they contain a lot of information about the dances of the Circassians. In the tales about the Narts, which reflect the forms of social life of the Circassians, their worldview, dance is presented as a relatively self-defined form of art. This is the legend of Batraz.

The brave sledges once gathered
On the Black Mountain, at the very top.
On the top of the mountain they started dancing.

A number of legends of Sosruko and Badynoko testify that the dance among the Narts is to a certain extent a means of physical education and hardening. He prepared young men for exploits, for the fight against the enemy. Skill, ingenuity and dexterity in dancing were valued by the Circassians no less than courage and bravery in battle. «At one of the Nart meetings (khase), the first dance was offered to Badynoko, who jumped onto the table and danced along the edge of the round table, without shaking it or overturning the wooden cups with gravy. Sosruko danced after him, but not along the edge of the table, but along the edge of the bowl standing on the table. The Nart Khamysh danced just as skilfully. After the dance of Batraz and Sosruko, Badynoko shows the impossible on the blades of swords: he drives his sword into the ground with the hilt and dances on his toes on the tip of the blade» [8].

One of the oldest circle dances of the Adyghe people is «Uj-khurai» - a dance-chanting, a hymn to a woman. And wherever it is performed - at holidays, weddings, festivities - the melody remains traditional. The meaning of the dance is also traditional, it reveals reverence, respect for a woman, utmost attention and courtesy. To be performed by the manager, the most beautiful, graceful girl is brought into the circle.

Conclusion.

We have mentioned only a small part of the traditional rites of the Adygs, as well as forms of art and entertainment in their space-time continuum, which had developed by the 18th century. However, in the XVII-XIX centuries. The Circassians were drawn into an almost 100-year bloody war (the First Caucasian War), were defeated, were squeezed out of their own territories of residence into regions that were unusual in terms of landscape and climate, which could not but affect the culture of the ethnic group as a whole. The need to preserve the remnants of the population and cultural identity led to a shift in the ideological system of the ethnic society from the heroic foundations of direct opposition to the enemy (Nart epic) to the dramatic line of accepting the situation of lack of freedom and finding ways to preserve one's own identity. As a result, the performance of heroic songs

goes out of existence in the structure of rituals, in their place come lamentation songs and love-lyrical songs. Instrumental music and choreography come to the fore in the artistic accompaniment of rituals. The balance in relation to the use of art and entertainment in traditional rituals is changing towards a decrease in gaming and verbal practices, with an increase in the share of non-verbal artistic and aesthetic forms of art (dance and instrumental music). Ritualism itself in the post-reform period was greatly transformed: the time for most rites changed from daytime to nighttime, some rites completely disappeared (chapshch, motion sickness of weak old people, many calendar rites). At the same time, the ethnos managed to largely preserve its identity and originality due to the emancipation of art from the boundaries of ethnic rituals. Already at the end of the XIX century. According to Z. Naloev, in the tradition of performing the ceremony at the bedside of the sick, the magical use of artistic practices was supplanted by carnival and concert competition, which are more characteristic of art as a socio-cultural institution. In the modern situation of holding a wedding ceremony, or other festive family and social celebrations, this principle has finally been strengthened.

Thus, the institutionality of ethnic rites has given way to the institutionality of art, primarily designed to give aesthetic pleasure to those who create it, and those who perceive it as an audience. However, at the same time, art also assumed the function that was previously realized in the system of rituals - the function of ethno-cultural marking, which today characterizes ethnic communities primarily according to the artistic and aesthetic criteria of their creativity.

References

1. Bakhtin M.M. Creativity of Francois Rabelais and folk culture of the Middle Ages and Renaissance. – M.: Fiction, 1990. – 541 p.

2. Gaeva L. Kapsh - a traditional Kabardian theatrical ritual at the bedside of the patient // Problems of national culture at the turn of the millennium: scientific-theor.conf. (Nalchik, April 1 - 4). – Nalchik, 2001. – P. 111-113.

3. Gutova L. The path of a woman in the light of Adyghe etiquette. Nalchik: Publishing House of M. and V. Kotlyarov, 2010. – 212 p.

4. Zhardetskaya N. Folk medicine and healing magic among the Circassians. // Religious remnants of the Shapsug Circassians: Materials of the Shapsug expedition of 1939 – M., 1940. – P. 58-65.

5. Mafedzev S.Kh. Rites and ritual games of the Circassians. – Nalchik, 1979. – 203 p.

6. Naloev Z.M. Etudes on the history and culture of the Circassians. - Nalchik: Elbrus, 2009. – 655 p.

7. Folk dances of the Adygs: history and meaning URL: https://aheku.net/news/culture/48

8. Narts. Kabardian epic. – M., 1957. – 526 p.

9. Soobtsokova N. Adygs and Circassians: people, customs, customs and traditions. – Maykop: GURIPP «Adygea», 2009. – 352 p.

DOI 10.34660/INF.2023.78.53.059

PUBLIC AND LITERARY ACTIVITY OF INDIAN WRITERS IN THE STRUGGLE FOR WOMEN'S EQUALITY IN THE LAST QUARTER OF THE XIX - EARLY XX CENTURY

Voloshina Ekaterina Evgenievna
Candidate of Historical Sciences, *Associate Professor*
Rostov State University of Economics (RINH)

Abstract. The article is devoted to the problem of the disenfranchised position of Indian women, which were solved by the writers not in social, but in moral terms. Literary and public figures believed that the liberation of a woman depends both on the humane attitude of men towards her, and on the woman herself, who must have great courage, will, and strong character. The women's question was an urgent problem in India, the awakening of national consciousness, the rise of the liberation movement in India, with all their acuteness, raised the question of ways and means of women's liberation.

Keywords: India, national consciousness, Indian women, Indian enlighteners, Rabindranath Tagore, women writers and poets, women's rights.

During the period of independent development of India (the last quarter of the 19th century - the middle of the 20th century), the women's issue was an urgent problem in India. The awakening of women is an important part of the process of social and political development in India. The rise of the national liberation movement in the countries of Asia and Africa stirred up millions of women who did not stand aside and took an active part in the liberation struggle of their peoples. Today in Asian countries much attention is paid to the position of women in society and in the life of the state, the constitutions of Asian countries ensure the equality of women and men, abolish discrimination based on sex in employment. It must be said that the adoption of constitutions in Asian countries was, in fact, the first important step towards attracting women to active work.

The women of India have made great strides in the struggle for their rights. The conquest of independence by India (1947) marked the transition of Indian society to a new stage of social progress, which entailed the expansion and democratization of women's rights. But by the time India gained independence, the age-old humiliation and backwardness of women had been preserved. This was

manifested in the limited personal rights in the family and society, discrimination against women in matters of marriage and divorce, the right to inherit, illiteracy and the general downtroddenness of women.

Particular attention is given to the work of N.R. Guseva [1, p.23-24] "India in the mirror of centuries", the author in his monograph pays attention to traditions, customs and the role of women in these traditions. The work of E.S. Yurlova "Social status and the women's movement in India" [2] is of invaluable interest in studying the problem under consideration.

The monographs of A.L. Beshem "The Miracle That Was India" [3] and G.M. Bongard-Levin "Ancient Indian Civilization" [4], which examines in detail the traditions and customs of ancient India.

The monograph by V. Balin "Literature of India" [5, p.99] provides extensive material on Indian leaders who fought for women's rights. A significant contribution to the emancipation of Indian women was made by Premchand (1880-1936), one of the greatest writers of the 20th century, the founder of the realistic trend, a classic of modern literature in Hindi and Urdu. As a realist and democrat, he could not remain indifferent to the plight of women in India. [6].

The awakening of national consciousness, the upsurge of the liberation movement in India, with all their acuteness, raised the question of ways and means of liberating women. The emancipation of women would be a serious blow to feudal remnants, because all the speeches in her defense were progressive and reflected the general growth of democratic tendencies in the Indian national liberation movement.

Release your dear friend
Release the captive woman,
The ancient force is strangling her fate -
former hard labor
And gilded fetters
from the body, tear her tender soul:
These are not decorations, but nets
her reclusive life!
And let our woman be glorified
Awakened to free life! [7].

These lines of the talented Indian poet Sumitranandan Pant (1900-1968) could serve as an epigraph to many works of Indian writers who were concerned about the problem of the disenfranchised position of Indian women during the period of colonial slavery.

One of the tasks of the educators was to free women from the fetters of age-old traditions and ideas, since it was in relation to women that the inhumanity and

cruelty of the social and everyday way of life of Indian society were most clearly manifested. First of all, the rise of women and the awakening of the masses, - wrote a representative of the progressive social thought of India in the 19th century. Swami Vivekananda (1863-1902) - and only then a true public good for the whole country, for India.

Ram Mohan Roy (1772-1833), the first Indian educator who initiated the social reform movement, is rightfully considered the pioneer of women's emancipation in India. He advocated radical reforms on the women's issue - giving women the right to education, to participate in public life, to remarry widows, etc. He devoted a lot of time and energy to the fight against the ancient custom of self-immolation of sati widows. By publishing accurate translations from the Sanskrit Vedas, he sought to prove that in ancient times a woman occupied a much higher position in society and that the custom of sati is not part of Hinduism, since there is not even a mention of it in Hindu sacred books. In modern India, brahmins and noble Rajputs considered sati a privilege of aristocrats. In Bengal alone, 500-850 widows were burned at the stake every year. Ram Mohan Roy's decisive struggle against this custom was crowned with success - in 1829 the Government banned it.

The theme of the struggle for the emancipation of women becomes the theme of the struggle for humanistic principles in Indian literature as well. Among the representatives of the Indian literature of modern times, one should note the outstanding Bengali writer Bochkimchondro Chottopadhyay (1838-1894) [8, p.101], in whose work the plight of the Indian woman was most clearly expressed.

The heroines of Chottopadhyay's works embody the writer's dreams and ideas about a woman. They are distinguished by their strength of character, purity of moral qualities and the will to fight. The writer protests against their humiliation and insult. A prominent public figure and educator, Chottopadhyay advocates changing the existing situation, the equality of Indian women. "There are many associations, leagues, societies, committees, clubs, etc. in the country," he wrote: interested in the advancement of women. We have societies even for the protection of animals, but no one cares about the well-being of the women of Bengal, who make up the majority of the population ... Our society is made up of men, women in it are nothing.

The writer believed that the emancipation of a woman is closely related to the granting of her right to work, since in India, according to an ingrained tradition, only women from lower castes could work, and then they were given the hardest and dirtiest work: "But what about widows from higher castes, when they are left without a livelihood and at the same time not entitled to perform the duties of a cook or maid? - the writer asks and answers this question himself: "If they had received an education in due time, they could have been successfully used in various areas of life and would have liberated the country from the multitude of foreigners who fill the Indian government offices."

In the middle of the 19th century, when the advanced public of India was just beginning to raise its voice for granting at least minimal rights to a woman, such statements by B. Chottopaddhaya sounded unusually strong and convincing.

The name of Bharetendu Harishchandra (1850-1885) [9, p.102], the founder of Hindi literature, is widely known and revered throughout India. The writer, of course, could not help but be concerned about the humiliating and powerless position of the Indian woman. Harishchandra fought for their rights. He set the freedom and activity of a European woman as an example of an Indian one, and at the same time, using the example of the historical past of his country, he proved that an Indian woman once played a big role in society.

In 1874, the writer founded the Balobodhini (Women's Education) magazine, on the pages of which leading representatives of the Indian public defended the rights of women to education and demanded radical changes in their existing situation.

Developing the ideas of his predecessors, the great Indian writer Rabindranath Tagore (1861-1941) showed in his work that a woman was humiliated and disenfranchised not only by medieval traditions, but also by newly emerging capitalist relations.

The civic pathos of Tagore's works is also manifested in the female images he created. In his early works, Tagore calls for abandoning the traditional view of a woman and seeing in her an equal girlfriend of a man ("Chitrongoda", 1892). In subsequent works of the writer, Tagore's views on the problem of the position of women in Indian society and its solution in the light of the writer's worldview are reflected. His heroines are different in character, but they are united by a thirst for useful activity, a desire to get out of the narrow confines of family relationships. The image of Lolita from the novel "The Mountain" embodies the author's ideas about a new woman who boldly challenges orthodox dogmas, defends her independence and awakens this desire in others. The heroines of Tagore are engaged not only in social activities, they boldly embark on the path of struggle for the liberation of their homeland.

"The mind of a woman, primarily limited by the narrow boundaries of the hearth, awakens from hibernation and begins to respond to the events of a wide life," Rabindranath Tagore wrote [10, p.336] in the article "Woman".

Like most other writers of India, Rabindranath Tagore considered ignorance to be the main reason for the plight of women, so he, first of all, called on them to acquire knowledge, to receive education: "Let her be cleansed of all the rubbish that has accumulated in her over the centuries! Let him open his heart, enlighten his mind and bow before the altar of knowledge!" [11, p.336] in the national school he created in Shantiniketon in 1901, girls studied together with boys, which was a new phenomenon for India.

A significant contribution to the emancipation of Indian women was made by Premchand (1880-1936), one of the greatest writers of the 20th century, the founder of the realistic trend and a classic of modern literature in Hindi and Urdu. As a realist and democrat, he could not remain indifferent to the plight of women in India. In one of his letters, Premchand, expressing his view on the role of women in society, wrote that his «ideal of a woman is self-sacrifice, service and integrity - everything is connected together. Self-sacrifice is unselfish, service is always generous and chastity is impeccable, like that of Caesar's wife!» in the works of Premchand there are no active heroines, as in the writers listed above. He believes that the dignity of a woman can be most fully revealed only in the family. But the attitude of the writer to a woman was based not on inert patriarchal precepts that completely deprived a woman of human rights, but not on noble humanistic ideals.

One of the works in which the share of the Indian woman is most clearly shown is Premchand's novel «Nirmala». The central theme of the novel is the tragic fate of a woman who has become a victim of traditional customs prevailing in society. The writer sharply criticizes the view of a woman based on medieval morality. He advocates that a woman from a cruelly exploited, deprived of rights, a miserable slave turned into an equal member of society. This shows the highest humanism of the writer.

The problem of the disenfranchised position of the Indian woman was solved by writers mainly not in social, but in moral terms. They believed that the liberation of a woman depends both on the humane attitude of men towards her, and on the woman herself, who must have great courage, will, strong character, etc. We find a similar way of liberating a woman in the prose works of Suryakant Tripatha Nirala [12 , p.134] (1960 - 1961), in which he creates many vivid, memorable images of Indian women.

As we can see, Suryakanta Tripathi Nirala also believes that education plays a big role in the liberation of a woman. However, the objective logic of many of Nirala's works ("Heavenly Maiden", "Alaka", etc.) is such that the reader understands the impossibility of changing the sad fate of an Indian woman by educational activity alone without social and economic transformations.

Life moves tirelessly, sweeping forward from its path the barriers erected from the ruins of the old world, firmly conquering new frontiers.

It must be said that broad democratic measures were taken to eliminate medieval traditions, to eradicate illiteracy and spread enlightenment and education among women, to involve women in industrial and social activities.

All this was of significant importance, both for improving the social position of women themselves, and for changing the traditional idea of the appointment of a woman, assigning her a secondary and dependent on a man role in the family and society. Many educated women now choose, contrary to tradition, to work for

hire, to marry of their choice, to pursue higher education, to live with their own separate family, and so on.

But the strength and stability of traditions are largely determined by the fact that it is the woman - the wife, mother and educator of the younger generation - who is the guardian of family customs, protects the purity of the caste and is responsible for observing the rituals prescribed by religion. Therefore, positive changes in the position of women, even the most insignificant at first glance, have far-reaching consequences for the entire Indian society.

References

1. *N. R. Guseva. India in the mirror of the ages. M., 1968.*
2. *E. S. Yurlova. Social status and women's status in India. M., 1982.*
3. *A. L. Beshem. The miracle that was India. M., 1977.*
4. *G. M. Bongard – Levin. ancient Indian civilization. M., 1973.*
5. *V. Balin. Literature of India. M., 1958.*
6. *"Overcoming the Indian tradition" // "India and prospects", 2000, No. 1.*
7. *Sumitranandana Pant. Free the woman! In the book: "Poems of Indian poets", Quoted from: V. A. Novikov. Bochkimchondro Chottopadhyay. Life and work, L., 1969.*
8. *Sumitranandana Pant. Free the woman! In the book: "Poems of Indian poets", Quoted from: V. A. Novikov. Bochkimchondro Chottopadhyay. Life and work, L., 1969.*
9. *V. A. Novikova. Bochkimchondro Chottopadhyay. Life and work, L., 1969.*
10. *Rabindranath Tagore. Coll.ed., vol. II, M., 1965.*
11. *Rabindranath Tagore. Coll.ed., vol. II, M., 1965.*
12. *A.L. Besh. The miracle that was India. M., 1977.*

DOI 10.34660/INF.2023.41.70.060

MOVING TOWARDS A MOBILISATION ECONOMY: LESSONS OF IMPORT SUBSTITUTION

Kharlanov Alexey Sergeevitch
Doctor of Economic Sciences, Candidate of Technical Sciences, Full Professor
Diplomatic Academy of the Ministry of Foreign Affairs of Russia, Moscow c.

Boboshko Andrey Alexandrovich
Doctor of Economic Sciences, Associate Professor
St. Petersburg State University of Architecture and Civil Engineering

Evans Julia Nailyevna
Master's degree Student
Diplomatic Academy of the Ministry of Foreign Affairs of Russia

Novikov Maxim Mikhailovich
Doctor of Economic Sciences, Doctoral Candidate
St. Petersburg State University of Architecture and Civil Engineering

Abstract: *The global digitalization of the world economy and all its industries leads to the fact that the costs of ongoing technological processes and redistribution are reduced, business strategies are simplified and indicators of profitability and capital productivity are specified, depending on the operation of existing funds and equipment involved in the innovative extraction of valuable components of various redistribution of raw materials or the creation of products with high added value, which gives advantages to markets and states in the struggle for competitiveness and better conditions for dominance in their sectors, in the remaining after total globalization, in their national, partially retained sovereignty, industries. The global transformation that happened to them and their corporatative reformatting under the chains of external involvement in post-industrial IER (international economic relations) and in the unifying market of IDL (international division of labor) of the robotic-humanoid mode of production of the urbanization world order.*

Keywords: *innovations, scientific and technological revolution, ADF, sanctions, import substitution, Russia, USA, China, Industry 4.0., AI, Big Data, national security.*

The scientific and technological progress, which is gaining more and more momentum, aims not only to improve the life of mankind itself and preserve the forms of the dominant forms of production and disposal of vital products, but also "de facto" solves the issues of our survival in the conditions of a climate catastrophe of global warming, nutrition problems, its quality , sufficiency and distribution of resources within countries and continents, and also purifies waste and chemically polluted waters, returning them to production cycles or giving them a second life from the standpoint of human drinking sources. And all these tasks of the upcoming 7th scientific and technological order are being solved from the standpoint of innovative restructuring, the digital transformation of the process of changing the paradigms of the technocratic attitude to the environment as part of the promoted philanthropic "green agenda" of "closed cycles" that guarantee the minimization of harm from human population activity and its collection within industrial zones and megacities, giving a multiplication of all specified economic effects for the qualitative and targeted use of resources per person [1]. The growth in the quality of living standards and security are compensated by the overcrowding and cell enclaves of multi-purpose cities for the tasks of direct development of the environment of such societies (like "smart cities", "smart houses", the whole complex of rational and aesthetic filling of each square meter with issues of efficiency and reasonable economy), which corrected by philosophy, but partially rejected by the biological chains of consumption of existing foods.

In particular, in Soviet times, in order to maintain a healthy and comprehensive diet, there were entire networks of walking distance products that made it possible to engage in separate meals and at the same time lead an automatically healthy lifestyle. Separately spaced from each other stores "vegetables and fruits", "meat" and "fish", as well as "dairy kitchen", "bread" and grocery stores, gave the potential buyer time to choose not only a uniform product search system, but also guaranteed nutrition according to the principles of compliance with the phased consumption of sufficient, and not excessive, flow of food on the tables and in the stomachs, which does not bring citizens to overeating and builds approximately the same diet. Taking into account the Soviet food shortage, the same distortions were observed, but they were more like fasting days ...

In the current metropolis, citizens have super- and hypermarkets, especially in times of unbridled and irrational consumption, a potential buyer grabs everything they need and is not in one place, and most often for a week in advance, and then eats it up chaotically and godlessly, saving on costs and completely undermining their own health and accompanying immunity. And therefore, according to statistics, during times of acute respiratory infections, and later covid shocks, the generations of Soviet childhood with a balanced diet have better indicators than young people who were initially unbalanced by pills and vaccines from foreign

pharmacologists (they injure and dull the activity of the thymus gland, which after 5 years of a baby's life goes away and leaves our body alone with all the bacteria and viruses that are not able to be adequately blocked and systemically destroyed by the defense systems of our organisms) and falling under the shocks of overeating and indigestion of products that have already lost their quality (this is a side effect of covid pandemics - people sitting on lockdowns already and they don't remember the reference quality of products, which are already becoming more expensive due to the logistics costs of the chains destroyed by the pandemic, and they don't realize the scale of the counterfeit influx in the mass copying of the previous product range, which the same innovations achieve by changing one chemistry to another, cheaper, but for then effective. So, for example, bread sourdough used to be ready according to Soviet GOST only within 21 days, and now the manufacturer spends 2-3 days on it massively, no more, while you can observe even more free manipulations with specifications for fish, some of which are simply floats abroad, and some varieties irretrievably left the tables of consumers back in the 1990s, having lost the ruble in the income / quality ratio race in favor of dollars, yen, yuan and won. All existing international surveys of the marine markets for crustaceans and aquatic bioresources of our partners or current opponents in ADF lead us to believe that our best fish and marine life is on the tables of Asian and European consumers, and the United States continues to take our majority of ocean exports , moreover, the types of bioresources themselves in such lists are growing and show our complete failure to return what was previously available to Soviet people [2].

As for the issues of parallel imports and the policy of import substitution, in general, with all the short-term and systemic successes of the ecosystems of industry and human goal-setting, it is extremely difficult to expect victories from an almost unchanged team of managers and owners of an oligarchic orientation who are interested in growing their incomes and insisting on the originality of their own businesses with various kinds of conglomerate formations: from space to the military-industrial complex, and even more so in food and pharmaceutical activities. Their stubbornness is understandable, because 76% of the world's TNCs (according to V. Volodin) [3] did not leave Russia with the beginning of the ADF, but simply changed their form of ownership and names, ceasing to be foreign agents and giving themselves better options for taxation and acquired ease in the export of capital abroad [4]. And with the Russian cross of our demographic winter, the departure of a significant number of most often trained and childbearing individuals makes us think about the real tasks of import substitution, which requires a whole range of professions and specialists capable of leveling off so slightly sagging domestic GDP in the shortest possible time only to -2.3 % [5]. The economic contraction of the national economy itself is not so catastrophic,

because the reorientation of our energy resources from Europe to Asia [10] gave us a temporary lag for a deeper structural adjustment and allows us to select our insurers and backups for our real entry into Industry 4.0. [3] At the same time, the Jesuitically declared paradigm of incomplete nationalization and the impossibility of transferring the economy to mobilization rails, the undesirability of Russia's withdrawal from the WTO (Maxim Oreshkin's 4 theses) and the failed people's revolution in finance - the return of the Central Bank of Russia to the mainstream of our civil society raises questions of the current problems of import substitution extremely problematic, devoid of deep personnel transformation and oligarchic cleansing in the polarizable field of emerging opportunities [1]. It is also not clear the resistance to the execution of the current state defense order, which is partially hampered by the incomplete federal laws that were not acceptable at all during the ADF - 44 and 223, the abolition of which only the lazy has not spoken out in the information field [5].

This state of affairs cannot be perceived as a temporary transition from the financial and credit dictate of the Yasinian elite of the Gaidar model of colonial development, leading Russia to the unrelenting grip of the hand of the "fifth column", variants of the "accidental" Chubais "miraculous rescue", delays in payments in various areas and on various territories that wholeheartedly support the President of Russia in his anti-colonial struggle. The trust rating for him at the end of January 2023 showed 76% of his support by the Russians. This means that the firmness and punitive measures of personal responsibility of the bureaucracy and the resignation of young volunteers with impunity in strategic areas of the children of the "right people" who did not leave should be put at the forefront both in personnel purges and in solving national security issues that still duplicate schemes and products of various countries on the so-called "non-alternative basis", as we have long observed in the oil and gas sector, and today it is squeezed out of the ICT industry with such difficulty [6].

The authors are far from malice and the policy of indiscriminate criticism of their own belligerent state, sensibly assesses the severity of the fighting of our armed forces in the ADF, but are determined to adequately assess the sabotage of the skillful steps of the Russian leadership to restore order and expect the end of the "liberal peacetime dreams" of the pseudo-elite, which is all by itself resolve and return back to normal [7]. Thank God, he will not return, and for the Victory over our years of timelessness we will pay the price of the revival of imperial Russia [8], which, like the military economy, will put an end to issues of betrayal and opportunism in the back of the howling heroes and new lands of Russia, who are waiting for a single ideological base and bringing the ADF to the level of complete denazification and demilitarization of Ukrainian Satanists [9].

Moreover, the formally discarded, but actually introduced mobilization economy manifests itself according to the following criteria:

- centralized management and planning (instead of the Soviet experience of the State Planning Commission and the actions of the main committees (glavkovs), a single decision-making center for the management of the ADF was adopted: the Coordinating Council under the Russian government to meet the needs of the RF Armed Forces);
- accelerated concentration and polarization of the required resources in priority areas (up to hidden and uncontested nationalization and the buyout of strategic assets from foreign capital and domestic business at market prices);
- proclamation of specific goals and "road maps" to achieve them by any methods and means of state structures (confiscation of assets acquired illegally, suppression of sabotage attempts and fight against clan lobbying of individual opposition oligarchs or those who left the country, including non-economic methods);
- labor mobilization of human resources, the introduction of preferences and benefits for a whole class of specialists, especially in nuclear energy, as well as in some highly intellectual areas of the MIC and Roscosmos, contracts for attracted resources from countries that support us for insourcing into our mobilized strategic industries);
- directive and planned management of commercial enterprises and regulation of scenarios for their involvement in the state defense order, when the owners cannot ignore the "defense order" issued to them by the Government of Russia;
- further nationalization and transfer to the principles of operational management or a full state-owned enterprise, on the principles of harmonizing a single activity in fulfilling the tasks of the defense industry and strategic industries, with their diversification and an increase in the share of state participation through a "golden share" or on the basis of regulated instructions of the Government of Russia in mobilization processes;
- monetary regulation of the banking and legal framework from the standpoint of mitigating access to long and cheap money through a network of authorized agents and banks that have preferences in the execution of the state defense order, fulfilling the mobilization order;
- use of the principle of discreteness (temporality of measures introduced by a more consolidated and high-quality execution of the state defense order);
- changing the regulations within the executive authorities, including the Government of Russia itself, speeding up the passage of documents and tightening the deadlines for the implementation of decisions made by the

Coordinating Council and the President and his administration / the Prime Minister and his cabinet.

Based on the described measures, there is a conviction that the process of reformatting and improving Russian society has been launched, now feedback and anti-corruption firmness in the determination to bring it to a victorious end are important [10].

References

1. CNews Analytics https://www.cnews.org/Index.aspx (Date of access: 01/20/2023).

2. Kharlanov A.S., The main trends in the evolution of the coming international transformation and the revenge of the amorphous dominance of the neo-Anglo-Saxons. Collection of scientific articles based on the results of the work of the International Scientific Forum - MODERN CONCEPTS – Moscow: Infiniti Publishing House, 2022. – 165 p.

3. Kharlanov A.S., Khairetdinov A.K., Boboshko A.A. Creation of a new civilizational way of planet Earth: transition to a «green economy» features and connections. Innovation and investment. No 10. P.18-23. 2021.

4. Statista https://www.statista.org/Index.aspx (Date of access: 01/20/2023).

5. IDC https://www.IDC.org/Index.aspx (Date of access: 01/20/2023).

6. Gartner https://www.gartner.org/Index.aspx (Date of access: 01/20/2023).

7. Trade statistics for international business development. Electronic resource. Access mode: https://www.trademap.org/Index.aspx (Date of access: 01/20/2023).

8. Customs statistics of foreign trade of the Russian Federation. Electronic resource. Access mode: http://stat.customs.ru/ (Date of access: 01/20/2023).

9. UN Comtrade Database. Electronic resource. Access mode: https://comtrade.un.org/ (Date of access: 01/20/2023)

10. Innovative development of Russia under sanctions. Import substitution experience. Kharlanov A.S. Interuniversity International Congress. Infiniti. Moscow. 2023. P. 124 -130.

DOI 10.34660/INF.2023.18.65.061

REPORTING FROM THE SMALL MOTHERLAND

Reshetnikov Mikhail
Doctor of Psychological Sciences, Candidate of Medical Sciences, Professor, Rector
East-European Institute of Psychoanalysis

Summary. *In this article, the author describes his impressions of the trip to the Lugansk People's Republic after its annexation to Russia. The period of fascist occupation, the heroism of the Soviet youth and the projection of past events on the current situation and the consequences of the Ukrainian policy of anti-Russianizm are analyzed.*

Keywords: *Psychology and sociology of war, blockade, heroes, traitors, future.*

1. Reflections on the future

When, without notifying my colleagues in advance, I went LNR, several messages followed me. Someone considered it necessary to write something kind, others simply stated: "Noble, but stupid"; or expressed incomprehension: "Why? You already have everything, don't you?"

I didn't have everything. I had no experience of communication with compatriots who had lived for eight years under continuous shelling, but survived. And now I have it. But this is only the very first experience - special studies and the most intense work are yet to come. And it is to include the work of our entire psychological community.

Let me make a small digression. Back in the 1980s I had a chance to work with a number of situations, extremely significant for military psychology, connected with the defense tasks of the Defense Ministry of the USSR. There were two deployments to the Afghan War in the period of the most active combat operations. Then there was a trip to Armenia after the Spitak earthquake in 1988, when some 100,000 people were killed in one day (the model of underground nuclear explosion). Then there was the crash of two passenger trains near Ufa in 1989 as a result of a gas explosion, accumulated in a low-lying area after a leak from a damaged gas main. The cars scattered dozens of meters, killing 645 people, including

181 children, and injuring and burning another 623. lt was a model of a nuclear explosion in the atmosphere. The consequences of the Chernobyl accident (1986) were also studied in detail, which was a real model of the "dirty bomb" deployment that has recently become a hot-button issue. There were other studies as well. lt was a unique experience to study mental trauma and PTSD.

Now neither I, nor anyone else in contemporary Russian psychology has an experience in working with the consequences of years of mental trauma, moreover, inflicted by a hostile and at the same time - the same ethnic group. Trauma accompanied by years of blockade, humiliation, torture, murders, terrorist attacks and shelling of residential areas, prohibition of the right to speak one's native language, and in the last stage, which was prevented by the special military operation, it was planned to cleanse vast territories of all Russian speakers and in fact to destroy them physically. The study of the consequences of all this and the development of a rehabilitation program for all age groups who managed to survive it are yet to be done.

When mass psychic trauma results from an environmental or even man-made disaster, it usually undergoes specific transformations and, regardless of whether the victims believe in God or not, such trauma is most often interpreted as "God is sending us new trials. They need to be lived through. And gradually, traumatic experiences pass as if in "off-line mode" over the course of 3-5 years.

Trauma caused by a hostile group provokes and starts up significantly different psychological mechanisms, the most essential of which are projection and projective identification. ln the most primitive form, this psychological phenomenon, which is expressed by the formula: "lt is not me who hates and persecutes X, it is he who hates and persecutes me". And such a "shift" in assessments of such situations can last for decades or even centuries. Examples of this kind among relatives are, for example, Arabs and Jews, Armenians and Azerbaijanis, English and lrish, ltalians and Catalans, Kazakhs and Uighurs, Tajiks and Uzbeks and many others.

Let me add that the negative development of all these (almost paranoid) mass processes is catalyzed by the "psychology of small differences" (or "narcissism of small differences"). The essence of this psychological phenomenology can be briefly formulated as follows: "lf someone is almost the same as I am - in history, in language, in traditions, culture, customs, etc., but slightly different - it is like a caricature of me. Naturally, a caricature of oneself (beloved!) is unpleasant and displeasing, and when combined with the mass trauma inflicted by a hostile group, it can become a source of irreconcilable hostility for an indefinite period of history.

There is another significant psychological factor that needs to be mentioned, namely "passing it on to the next generation". As it was substantiated in studies after World War II, the children of survivors of armed and interethnic conflicts form specific memories and specific attitudes toward tragic events in the history of their ancestors, which they did not and could not be witnessing. As a result, one of the psychological tasks for the next generations is to keep the memory of their ancestors' trauma alive and react to it.

The variants of such a response can be very different: from mourning for their fallen to the most tragic variants of individual and collective revenge. Any civilized resolution of such situations involves a powerful and sustained effort. I hope colleagues will understand what I wanted to say in this section.

I will conclude with another psychological phenomenon: in the sphere of hereditary ties nothing is forgotten. I can never forget that my father and mother were participants of the Great Patriotic War, both SMERSH officers, both communists. Father and mother are the very first figures of identification of any individual, carriers of language and culture, traditions and principles. But one must also recognize and understand that the opponents' descendants are bearers of different ("embedded" in them) parental images.

2. The Past

There are two other reasons for my trip. First, I was taught that both happy and difficult, and even dire times must be lived with one's own nation. Therefore, the Russian President's appeal to provide maximum assistance to Russians in the newly acquired territories is not an empty sound to me, but a guide to action. And secondly, LNR is my small Motherland.

I was born in the village Uspenka of Lutuginsky district near Lugansk (at that time Voroshilovgrad). My youth passed in legendary city Krasnodon, where on underground organization "Young Guard" was created in the city occupied by fascists during the Great Patriotic War.

On the night of September 29, 1942, not far from the central square, the Nazis buried alive

32 Communist miners in the ground, who had refused to mine coal for the invaders. Naturally, the entire small mining town knew about this atrocity. Several young boys and girls swore vengeance on the Nazis for the martyrdom of the heroic miners and created a Komsomol underground called the Young Guard. And then the number of members of the organization grew steadily.

Who were the Young Guard members? Recent school graduates, boys and girls 17-19 years old. They didn't manage to do much for our victory.

They distributed leaflets with texts of the Soviet information Bureau, put up red flags for the May holidays, helped a group of Red Army soldiers to escape from captivity, burned the stock exchange with the documents of the inhabitants to be stolen to Germany. Someone betrayed them. They were arrested and subjected to inhuman tortures: they put needles under their nails, cut off their ears, carved stars on their bodies, burned with hard iron, tortured. But they did not break, and then the fascists and their henchmen - policemen (from locals) – enraged by their firmness, threw them alive into the pit of Coal mine #5, which became their common grave. If anyone doesn't know, the drift is a vertical mine pit working-out 4-5 meters in diameter and 20-30-50 meters deep. As witnesses told us, the moans of the dying could be heard from the pit for several days.

When my generation was at school, the Russian literature curricula in all Soviet schools included Aleksandr Fadeev's novel "Molodaya Gvardiya" ("Young Guard"), which was written in 1946. Most of its protagonists, **Oleg Koshevoy, Ulyana Gromova, Lyubov Shevtsova, Ivan Zemnukhov, Sergey Tyulenin** and others, were real-life individuals who, for their courage and heroism, had been posthumously awarded the title of Hero of the Soviet Union in 1943.

The book was republished for more than 250 times, and its total circulation, including translations into almost all major world languages, was more than 26 million copies. ln 1948, based on this book, the outstanding Soviet director Sergei Gerasimov shot a film with the same title, which was watched by all schoolchildren of the country, and not only schoolchildren, but also by Krasnodon citizens - almost every year on a huge screen right on the town square. It is really an immortal classic of Soviet cinema. One of the main roles - of Ulyana Gromova - was played by our outstanding actress **Nonna Mordyukova,** who bore an almost photographic resemblance to her character. This was her first movie role, her debut, which became the basis of her entire future life and creative work. Later the series was filmed based on the same novel by A. Fadeev, but it made no impression either on the people of Krasnodon, or on the general audience.

Photos: Ulyana Gromova and Radik Yurkin.

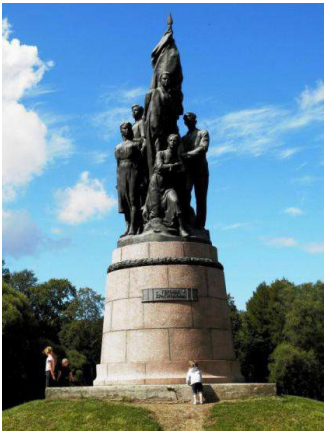
The house-museum where Oleg Koshevoy lived.

The whole country knew about Krasnodon and the Young Guard feat. Perhaps not everyone read it, but everyone went through the novel at school and participated in its discussion. And I was lucky enough to study at the same school and even with the same teachers who had taught the Young Guards before the war. And we did not just "read" the novel, we lived in it. In a way, our childhood and youth were a continuation of the novel, and we were all a bit of the Young Guard.

And how could it be otherwise. The mother of the Young Guard commander, Hero of the Soviet Union Ivan Turkenich lived with me on the same street opposite my parents' house. The mother of the commissar of the "Young Guard" Hero of the Soviet Union **Oleg Koshevoy** lived on the next street, and later - in the same house with us. The sister of the Hero of the Soviet Union **Sergey Tyulenin** worked as a secretary for my father. One of the few survivors of the Young Guard **Radik Yurkin** often came to our house, his son **Yuriy Yurkin** studied in the parallel class with me and we played together in the school orchestra - I played the trumpet, and he played the clarinet. There were Oleg Koshevoy's and Ivan Zemnukhov's classes and desks: the right to sit at them was given to the best pupils. These desks have been restored again and stand in the same classrooms now, as old as they were before the war, against the background of modern school furniture.

Thanks to heroism of the Young Guard, the city was rapidly growing and transforming. Almost all the prominent artists, cosmonauts, the capital's theaters and foreign delegations from all over the world came to visit us.

On September 12, 1954 I went with my parents to the opening ceremony of a monument to the Young Guardsmen in Krasnodon, which is now world famous - certainly an outstanding work of monumental sculpture. At the foot of this monument I was accepted in Pioneer's organization and was given my Komsomol card there. On all national holidays we were on honorary watch there and laid flowers at the monument and at the miners' grave, which was nearby at the entrance to the city park.



The monument to the Young Guardsmen (1954).

The Palace of Culture (1958)

In 1958, the Palace of Culture named after "Young Guard" was built, which could decorate any capital city. There was a unique art gallery, a beautiful library, sports halls, volleyball and basketball courts, a music school, and a beautiful concert hall with almost 600 seats.

In 1960, when I was ten years old, I was in this hall at the pubic trial of former policemen, who had long been hiding from retribution. They were all sentenced to the death penalty - execution. The sentence was carried out on the same day near the town market, in front of a huge crowd of people. Because of my age and small stature I could not see anything, but

I heard these traitors screaming and begging: "Don't kill! Forgive us, countrymen!". They did not.

I have visited my small Motherland more than once. The last time was about ten years ago, when they tried to "remake" it into Ukraine. I saw the abandoned grave of the heroes miners with the extinguished eternal flame, the garbage dump at Mine #5, the abandoned city with dark windows and deserted houses. To do anything with the monument to the Young

Guardsmen and the Museum of Oleg Koshevoy the new "masters of life" did not dare. Could I not go there now?

3. The present

On my way to the LNR I met a lot of people. Good people. Some were particularly memorable. A girl named Tanya in a roadside motel, about thirty years old. Her two younger brothers volunteered to go to the frontline. The middle one was the first, and then the elder one said he wouldn't let him go alone. The youngest is still at home, as he is under eighteen, but he will go too. She doesn't cry, says: "I am proud of my boys. And I pray". Together with her husband, they built a chapel near the motel to pray, because the church is too far. In another roadside cafe, I met two married couples and got to talking. They are brothers; one is the chairman of the local Communist Party branch, 32 years old. They were celebrating two years of the youngest's marriage, he was 23. And then both of them also went to the military registration office.

There are checkpoints and road-bocks at the entrance to the LNR. There isno border, but everyone's documents and cars are checked. The queue of cars lasts for four or five hours at least. We entered Krasnodon. The town is, to put it mildly, not well maintained. Approximately as we had in the 1990s. But then I walked around the memorials and was amazed: first of all, my countrymen put their effort in restoration of the most important thing - the memory.

Caption: And they were not thrown into the pit, but into our hearts!

New Obelisk above the pit of Mine # 5

There is a striking obelisk and an inscription on a waste heap at Mine No. 5. Not everyone knows what a waste heap is - it is such a mountain of rock extracted from the mines, some as big as the Egyptian pyramids. It is better to see than to tell. The grave of the hero-miners is well-kept, the eternal flame is burning. The guards from Tyumen wouldn't let me into the school. I was not allowed in, despite my ID as a colonel and war veteran - you can't do it without a permission, terrorist attacks can still happen.

Old – new monuments and Cathedral (2022)

The monument to the Young Guard members is clean and orderly (compare two photos from different years). And behind the monument there is a temple. In the center of the city on the pedestal again there is a tank, which was removed, repaired and fought over. The inscription on the pedestal has also been restored. If you can't read it in the photo, I'll translate it: "This combat vehicle is the monument to the civilian heroism of the Krasnodon citizens who, during the Great Patriotic War, donated

their personal savings for the construction of the Molodaya Gvardiya tank column."

Our family moved to Krasnodon in 1954. It was a small mining town with, as far as I remember, thirty or forty thousand inhabitants. We lived poorly. My father was a military officer, but they did not luxuriate either: a crust of black bread dipped in sunflower oil and sprinkled with sugar was the most delicious cake. I don't think they lived any richer there before the war. And these people raised money for a tank column! As I read it, I felt ashamed. Maybe we - the inhabitants of modern metropolitan areas - should also think about that?

Is it really not clear what is going on? There may not be a clash with NATO, but a joint army from "some" NATO countries is already forming in Ukraine, and it will be there for a long time. The political top of the "collective West," which is in death throes, does not allow the thought of losing and does not understand that it is going to perish anyway, so it will continue all the way. And we, too, cannot roll back, otherwise there will be no Russia and the Russian world.

At the exit from Krasnodon there was another tank on a pedestal, covered with wreaths and fresh flowers. It turned out that they had also removed it from the pedestal, but a young guy repaired and started the engine and found shells. His father-tanker, who had already been in the army, came to the rescue. Both died. That is why there were wreaths and flowers.

List of the Young guards men, who were pupils of Scholl #1 - Russians, Byelorussians, Ukrainians, Armenians, Jews...

From Afghanistan, I remember that the war doesn't make regular life stop, birthdays and state holidays are celebrated, weddings and ordinary feasts with songs and dances take place without any special occasion. There it is all right. But now when I am back I have no desire to watch the cheerful programs of our TV channels, where current events are not even remembered, as if they do not exist.

I gave lectures at Vladimir Dahl Luhansk State Pedagogical University and St. Luke's Luhansk State Medical University, at the Krasnodon Methodological Center for school teachers and psychologists, and met with students of 7-10 grades at my home school. The auditoriums for the flow lectures were crowded. And I don't think it's my merit - it's just that our fellow professors, students, and schoolchildren missed communicating with Greater Russia.

Vladimir Dahl Luhansk State Pedagogical University

St. Luke's Luhansk State Medical University

Krasnodon Methodological Center for school teachers and psychologists

A few more touches. When some of the tops of the Medical State University fled from Luhansk to Ukrainian-controlled territory after the formation of the LNR, not forgetting to take all the accounting and bills, the remaining teachers worked for several months without pay - it was impossible to abandon the students. They tell us about this without pride, "it was just the right thing to do. According to school psychologists, after eight years of shelling and living in basements, almost everyone has some form of PTSD, and speaking of that, they made no exception for themselves.

There is everything in the stores, the supply is excellent. Life is getting better, although there are still a lot of difficulties. Some asked: why did it take so long to come? But I did not meet those who are offended. They say: "That's all right. We can endure it. The main thing is that we are at home, in Russia.

These are all my impressions.

PLEASANT MEETINGS (Photos)

Lugansk State Medical University. At a meeting with the Vice-Rector for Science, Doctor of Medical Sciences, Professor ***Yuri Grigorievich Pustov*** *and Vice-Rector for International Relations, Doctor of Medical Sciences, Professor* ***Svetlana Valentinovna Vitrishchak.***

Meeting with psychologists and methodologists of *the LNR "Krasnodon Methodological Center. /n the center, to my left, - meeting organizer* ***Elena Viktorovna Poborchaya.***

Natalya Egorenko *(center}, principal* of *secondary school N*^{9} *1 named after M. Gorky, and her deputies* ***Victoria Yevgenyevna Demchenko*** *and* ***Anastasia Olegovna Levina.***

Meeting with the staff of *the lnstitute* of *Pedagogy and Psychology* of *Lugansk State Pedagogical University. To my right is the director* of *the Institute, candidate* of *pedagogical sciences, associate professor* ***Maria Valentinovn***

DOI 10.34660/INF.2023.27.95.062

THE ROLE OF REFLECTION OF AN ACT IN RESOLUTION AND CONFLICT PREVENTION

Vyazovova Natalia Vladimirovna
Candidate of Psychological Sciences, Associate Professor,
Head of Department
Moscow Psychological and Social University
Melekhova Viola Mikhailovna
Candidate of Psychological Sciences, Associate Professor
Derzhavin Tambov State University

Abstract. *the article is devoted to the actual problem of pedagogical conflictology. Theoretical and practical aspects of applying the technology of reflection of an act by schoolchildren and teachers to stabilize behavior in a conflict, its prevention and effective resolution are considered. The authors present the results of a study of conflict resistance and ontogenetic reflection of adolescents, the need to apply a psycho-prophylactic program aimed at teaching adolescents the ability to analyze conflict situations and use the acquired skills of reflection of an act both in the educational process of school and in other spheres of life is actualized.*

Keywords: *conflict, pedagogical conflict, reflection of an act, conflict resistance, conflict interaction.*

The formation of social and pedagogical psychology, as well as socio-pedagogical and psychological services, the significance of which is the provision of competent assistance to the population, the humanization of the pedagogical environment, the promotion of the social formation of personality, is taking place in Russia with the dominant role of social pedagogy, which considers pedagogical aspects social assistance and human protection.

Back in the 60s of the 20th century, attempts were made to introduce the rates of specialists directly oriented towards social and pedagogical work (organizers of extracurricular and extracurricular educational work, teachers of additional education, etc.), but at the turn of the 70s - 80s, public need brought the problem to a new level of its solution. In the practice of psychological and pedagogical services, specialists in the field of conflictology have become in demand, whose

activities are aimed at establishing a positive socio-pedagogical experience of interpersonal interaction, developing trends in social integration.

However, the development of these services in Russia was hampered by the lack of professionally trained personnel specifically oriented towards psychological and pedagogical work. The functions of a conflictologist were distributed among the traditionally acting subjects of the educational process - teachers and educators, as well as school administration. The present stage can be characterized as a transition to a qualitatively new level of development of practical psychology with a bright applied direction of activity.

The psychological and pedagogical literature has accumulated rich material on the problem of regulating conflicts in the pedagogical sphere: the psychological foundations of education have been developed (P. Ya. Galperin, V. V. Davydov, and others); the foundations of subjectivity as a person's ability to transform the external and internal world (K. A. Abulkhanova-Slavskaya, A. V. Brushlinsky and others); the importance of the educational environment in the development and formation of the personality is emphasized (V. A. Anufriev, L. P. Buev, etc.); the role of the environment, as a condition for the formation of personality, is considered in the works of V. V. Rubtsov, V. I. Slobodchikov; conflict regulation in the system of higher and secondary education was studied by R.M. Granovskaya, M. M. Kashapov, L. A. Petrovskaya and others.

Thanks to foreign studies (M. Sherif, D. Rapoport, M. Gil, M. Deutsch, etc.), the psychology of conflict emerged as a relatively independent branch of psychological science, and conflict management practice became the subject of research in the works of V. Horowitz and T. Boardman, C. Osgood, who developed psychological training programs aimed at teaching constructive behavior in conflicts. In the development of conflictological practice, a special place was occupied by the development of ways to resolve the conflict (D. Scott, W. Lincoln, L. Thompson, W. Urey, etc.).

Interpersonal conflict, according to many leading experts (A. G. Zdravomyslov, N. N. Shevandrin and others), can be considered as a social disease or a negative form of interaction relations between subjects associated with their psychological positions. Moreover, it is important to distinguish between psychological positions and social roles (N. N. Veresov), as well as to single out the category of "behavior".

Based on the key provisions of the works of domestic (A. A. Aleksandrov, V. V. Kovalev, V. F. Pirozhkov, V. G. Stepanov, etc.) and foreign scientists (S. Farrington, T. Shibutani, etc.), there were distinguished various types, forms and characteristics of behavior, including conflict and deviant.

The study of the problem of personality conflict acquires special significance, taking into account the various stages of ontogenesis. The data available in psychology make it possible to build a general concept of the development of

conflict in ontogeny. It is worth highlighting works that trace conflict as a characteristic of adolescence (I. V. Dubrovina, E. Erickson and others); the relationship of behavioral disorders and features of self-consciousness (R. Burns, I. I. Chesnokova, etc.); the problem of adolescent communication with adults and peers (A. M. Parishioners, E. V. Novikova, etc.), the problem of adolescents in relations with their parents (J. Dobson, S. N. Shakhovskaya, etc.). All this allows, on the one hand, to note the deep and comprehensive interest of psychological science in the problem of conflict research, and on the other hand, to note the insignificant arsenal of technologies, forms and methods of work focused on psychological and pedagogical practice that help reduce pedagogical conflict.

Thus, the relevance of our study is due to the following contradictions: between the need for practice in specific ways of working with conflict behavior and a limited number of such technological approaches; between the sensitivity of adolescence to mastering the reflection of actions and the absence in psychology of works that demonstrate to the psychologist the methods of reflective work with conflict adolescents.

These contradictions determined the problem of our article, the purpose of which was to study the psychological mechanism of the reflection of an act as a means of preventing conflict in adolescence.

The methodological basis of our study was the general provisions of the system-activity approach in psychology (L. S. Vygotsky, P. K. Anokhin, N. A. Bernshtein); the main conceptual provisions of the theory of personality development in ontogenesis (V. S. Mukhina, L. I. Bozhovich); the concept of self-consciousness of the individual (A.G. Asmolov, V.V. Stolin); psychology and pedagogy of non-violence (V. A. Sitarov, V. G. Maralov); methodological provisions on the unity of external and internal conditions in the formation of personality traits (S. L. Rubinshtein); foundations of reflective psychology (E. I. Isaev, I. N. Semenov, S. Yu. Stepanov, etc.).

Reflection means:

- the ability of a person to consciously pay attention to their thoughts, emotions and behavior, evaluate decisions and prospects;
- a mechanism for reflecting personal meanings and principles of action by establishing links between a specific situation and a person's worldview, which underlies self-control and self-regulation of a person in communication and activity;
- a mechanism that links the meanings of the subject's personality and the operationally objective side of his thinking (A.N. Leontiev);
- the process of communication, self-awareness and self-understanding, which determines the qualities of a person, the interaction of communication partners (insight, responsiveness, tolerance, etc. (B.F. Lomov, S.V. Kondratieva);

- the mechanism of self-regulation - personal assessment of a person (understanding the way of her thinking and behavior); understanding the meaning of an individual act, based on a specific situation (J. Anderson).

S. Yu. Smirnov expanded the interpretation of reflection in the process of communication, including in it not only a reflection of the inner world of other people, but also self-reflection.

Reflection is a multifaceted concept. This allows us to distinguish several types of reflection:

1) *socio-perceptual reflection*, aimed at rethinking by the subject of his/her own ideas about a person; personal, facilitating communication and interaction of subjects; communicative, consisting in the representation of the subject about how he/she is evaluated and perceived by others; meta-reflection - a person's ideas about himself (A. A. Bodalev);

2) according to the "temporary" parameter, three forms are distinguished:

a) *retrospective*, contributing to the analysis of the activities performed and the events that have already occurred.

b) *situational or actual,* which consists in the ability to be aware of oneself and one's state "here and now", comprehending the current situation, correlating one's actions and coordinating them according to changing conditions and one's own states;

c) *perspective*, providing planning by the subject of his/her future (V. N. Azarov, V. Ya. Butorin);

3) Considering reflection in communication as a complex system of relationships that arise and form in the course of interpersonal interaction, E. V. Lushpaeva identifies several components in the structure of reflection:

a) *personal-communicative reflection* (self-reflection) (A.V. Karpov, E.A. Selivanova and M.V. Khvatova);

b) *social-perceptual reflection* (reflection of another "I") (A. A. Pecherkina);

c) reflection of the situation, that is, *interaction* with the personality of another person (N. G. Ott);

4) specific forms of reflection are identified:

a) *introspection* (self-digging), associated with focusing on one's own experiences and states;

b) *systemic* reflection associated with self-determination and self-distancing;

c) *quasi-reflection*, aimed at an object that has nothing to do with the actual life situation, and occurring in isolation from the actual being in the world (E. N. Osin, D. A. Leontiev);

d) *areflexia* as a lack of self-control, concentration on an external intentional object of activity (E. N. Osin, D. A. Leontiev, etc.).

Realizing the role of reflection in the self-regulation of a person's behavior in conflict, we will consider conflict as a widespread phenomenon of social reality,

as *a collision of oppositely directed, incompatible with each other tendencies in the mind of a single individual, in interpersonal interactions or interpersonal relationships of individuals or groups of people associated with negative emotional experiences.* As a consequence, the basis of conflict situations in a group between individuals will be a clash of opposing interests, opinions, goals, as well as different ideas about how to achieve them. The basis of any conflict is the accumulated contradictions, objective and subjective, real and illusory.

Intragroup conflicts perform a number of functions: creating and maintaining a balance of power (authority); social control over compliance with generally accepted norms and rules; creation of new social norms, renewal of existing ones; adaptation and socialization of individuals and groups; group formation, establishment and maintenance of normative and physical boundaries of groups; establishing and maintaining a relatively stable structure of intragroup and intergroup relations; the establishment of an informal hierarchy in the group and society, including the identification of informal leaders [1; 3].

In conflicts, the positions, interests and goals of the participants in the interaction are revealed, a search is underway for a balanced solution to emerging problems, which, with the timely identification of contradictions, allows maintaining the social structure. And, despite the fact that potentially the conflict has a number of negative functions and all conflicts are considered negative that make it difficult to make the necessary decisions, lead to negative consequences and are unproductive, nevertheless, it should be recognized that the conflict is necessary and positive. in terms of the social dynamics of groups.

Unfortunately, most people are characterized by the inability to find a worthy way out of conflicts, as they are often guided by emotions, they experience tension that provokes stressful situations that damage the health of conflict participants. Therefore, *functional and dysfunctional* conflicts are distinguished, the first of which increase the effectiveness of the group and the individual, and the second reduce personal satisfaction, destroy group cohesion [4].

Taking into account the motivation of the conflict and the subjective perception of the situation by the conflicting parties, a number of conflicts are distinguished:

a) *false* - the subject perceives the situation as a conflict, without real reasons for this;

b) *potential* - having real grounds for the emergence of a conflict, but the situation is not perceived as a conflict by one of the parties or both parties;

c) *true* - a real clash of the parties (divided into constructive - arising on the basis of contradictions that actually exist between the subjects; random - arising due to a misunderstanding or a random combination of circumstances; displaced - arising on a false basis, when the true reason is hidden);

d) *an incorrectly attributed* conflict is a conflict in which the true culprit, the subject of the conflict, is not visible, and the participants involved in the conflict are not related to it;

e) an open form of conflict, or a clear *confrontation* arises when each of the parties seeks to achieve the maximum desired; regard their own resources as sufficient to escalate the conflict. In an effort to win, opponents develop actions whose task is to strengthen their own capabilities and force the opponent to make mistakes, which naturally reduces his/her chances of success.

Among them, a number of practically manipulative tactics of behavior can be distinguished:

A) *Demonstration* of the strengthening of one's own resources, when one of the parties informs the other about the real possibility of increasing one's own capabilities to such an extent that they will significantly block the opponent's potential. Such tactics are capable of evoking a variety of reactions on its part, from getting out of a conflict situation to mobilizing additional reserves and strengthening its own resources.

B) *Waiting*, holding the previous state - this is the lack of action on the part of one of the opponents, which creates a situation of uncertainty, tension. In this case, it is hoped that the opponent, subjected to additional stress due to the uncertainty of the situation, will not withstand the pressure and will take erroneous actions that inform the expectant about the real intentions of the opponent.

C) *Risk* is calculated on the effect of surprise, when one side undertakes a series of quickly following one after another, the most effective actions that force the opponent to respond. Given the lack of time and information, the opponent is forced to make blunders. Thus, the risky side achieves the goal.

D) *Coercion* is used by the stronger side in the conflict, which has the ability to strengthen its own resources, which puts the opponent in harsh conditions that do not allow mobilizing additional potentials. An analysis of conflict situations, opponents' behavioral strategies, and actions used shows that many participants in conflicts seek to lower the opponent's rank and always use this technique in emotional conflicts [5].

But no matter how deeply the conflict is analyzed, it can be very difficult to resolve it in the active phase, which is why the most important task of the practice of conflictology is the task of preventing unwanted, doomed to a destructive solution and consequences, conflicts. What should be prevented is not the conflict itself, which is already taking place, but those conditions, causes that can create potential conditions for the emergence of a conflict.

In a few studies of pedagogical conflicts, the authors (B. N. Almazov, M. M. Rybakova and others) draw attention to the contradictions that arise between the participants in educational activities. In the course of self-learning the basics

of pedagogical conflictology, the teacher has the opportunity to acquire applied knowledge of a fairly wide range: how to understand oneself and the student in conflict; what are the strategies and tactics of the teacher's activity in tense situations; what are the features of conflicts with pedagogically neglected students and schoolchildren of risk groups; what are the specifics of overcoming conflicts among high school students, in systems of relations horizontally and vertically; what are the specifics of conflicts with aggressive students; How can conflict be managed? what should be the behavior of the teacher as a manager in case of conflict; how to manage in a conflict the mental states of persons with an increased level of anxiety, lack of reflection of an act, and many others.

Summarizing the results of the review of modern literature in the field of pedagogical conflictology, there is reason to emphasize several circumstances:

1) pedagogical conflictology as a field of theoretical and applied knowledge is in its infancy, and the main condition for its formation is the accumulation of a mass of specific facts for their subsequent generalization and interpretation;

2) *the development* of pedagogical conflictology will be hampered under the condition of interscientific isolation of pedagogy, without the union of research efforts of teachers, psychologists, doctors, sociologists, lawyers, management specialists;

3) *pedagogical conflict* as a phenomenon of real pedagogical reality should be studied, evaluated, perceived taking into account practice, in connection with its consequences, mainly in connection with its most painful consequences - bullying, the destructive phenomenon of «Columbine», the culture of cancellation, suicide. Moreover, only the stressful characteristics of pedagogical conflicts are able to bring this problem into the field of humanization of the teacher's professional activity and his interactions with students, colleagues, and school leaders;

4) *The theory and practice of pedagogical conflicts*, in accordance with world experience and trends in the humanization of education in Russia, should be integrated into the content of pedagogical education, advanced training of teachers and specialists in the management of educational systems. "Given the fact that the responsibility for preventing and resolving conflict lies largely on the shoulders of the teacher, it should be assumed that his professional competence in the field of conflictology involves, first of all, knowledge of the psychological characteristics of the student, with whom relationships should be built only taking into account his individuality.» [2, p. 47].

The complex psychological world of pedagogical interaction between teachers and adolescents, accompanied by the emergence of nervous shocks on both sides, is made up of many contradictions. Some of the main ones include:

1. *Conflicts of discipline*. Evaluation of the typical actions of adolescents makes it possible to single out as the prevailing situations violations by students

of certain rules, without which the educational process is unthinkable. Among the facts of negative behavior, conflicts stand out, both unprovoked and caused by the actions of teachers. As is known, it is the actions of adolescents, in their individual and group forms, that often contradict common pedagogical sense, bringing the conflicting parties to a state of passion, when opponents do not give an account of their actions and deeds.

2. *Conflicts associated with didactic errors*, especially in the field of assessing the knowledge and skills of adolescents. It is known that only the application of pedagogy of cooperation develops for schoolchildren the criteria for evaluating the teacher's work in terms of the skill of teaching, the openness of the criteria by which he is guided when evaluating knowledge.

3. *Conflicts in the tactics of interaction between teachers and teenagers*. As the leading factors that determine the professionalism of a teacher, they consider his/her personal qualities and the ability to work with adolescents (skills for solving pedagogical problems). It is proved that the mental study of the realities of interaction between adults and schoolchildren, between which constructive and destructive contradictions are inevitable, certainly forms a stock of possible reactions and solutions demonstrated by the teacher.

4. *Conflicts of ethics*. The pickiness of teachers to their appearance, the suppression of individuality, insult and humiliation provoke adolescents to conflict. Such misconduct by teachers as vindictiveness towards students and discrimination against individual teenagers lead to serious consequences. Collisions with teachers who allow an open or masked violation of pedagogical ethics are more acutely perceived by students of middle school age [6].

R. M. Granovskaya described a number of behavioral manifestations in relation to stressful situations (to which conflicts can rightfully be attributed), and N. U. Zaichenko, in turn, outlined the types of personal reactions: *inhibitory* - slows down thinking, worsens minania; absent-mindedness is growing. All this increases a person's tendency to use stereotypical, often non-optimal solutions; *excitable* - the reaction makes a person fussy, irritable and quick-tempered, sometimes aggressive, which also does not contribute to making productive decisions; *suggestibility* - characterized by an increase in speech activity, a teenager in this state is ready to follow anyone who is able to give him clear instructions.

N. U. Zaichenko emphasizes that *success* in general and in conflicts is ensured by a certain level of *self-sufficiency*, and, therefore, if we want to form a self-sufficient person, then we need to provide him with the appropriate conditions for its manifestation and consolidation. And the wider the range of successful activities, the less the teenager will have the desire to assert himself in other areas of life (addictions, deviations, crimes).

Modern science offers a huge arsenal of diagnostic methods on the problem of assessing the level of a person's reflexivity, as the ability to evaluate one's

actions and states. In relation to the problem we are considering, the following methods have been identified: express diagnostics of resistance to conflicts; self-assessment of rational behavior in conflict; self-assessment of the level of ontogenetic reflection.

The study was conducted during the 2021-2022 academic year among students in grades 8-9 (84 people: 64 girls; 20 boys). The following diagnostic methods were used: Express diagnostics of resistance to conflicts; Self-assessment of the level of ontogenetic reflection (N. P. Fetiskin).

Diagnostics of *adolescents' resistance to conflicts* was carried out in order to identify self-assessment of attitudes towards conflict situations in general and such significant indicators as: *evasion in disputes; attitude towards a competitor; self-esteem in a dispute; taking into account the opinion of the opponent; susceptibility to provocations; concessions in disputes; feeling of guilt; correctness; emotional self-expression; attitude towards the conflict in general.*

Diagnostics showed that the audience we assessed cannot be classified as highly conflicting (0%). However, we can state that in general the audience is in conflict:

– 32% of respondents demonstrate the level of *pronounced conflict*,

– *the average level of conflict* 57.5% of the subjects,

– «*conflict-free*», that is, highly stable - only 10.5%.

Consequently, adolescents tend to behave impulsively and incorrectly in situations of disputes, do not listen to the opinion of opponents, and in any way strive to win, even at the cost of large losses. An analysis of individual tactical positions is presented in Figure 1.

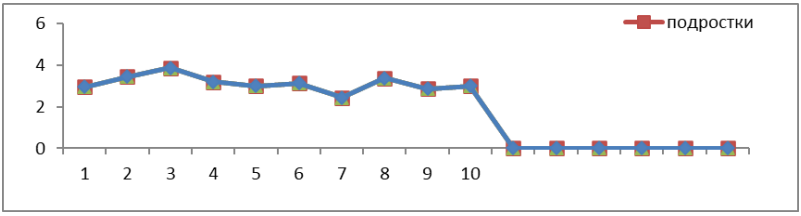


Figure 1. *The degree of severity of indicators of conflict resistance of adolescents*

1 - evasion in disputes; 2 - attitude towards a competitor; 3 - self-esteem in a dispute; 4 - taking into account the opinion of the opponent; 5 - susceptibility to provocations; 6 - concessions in disputes; 7- the presence of guilt; 8 - correctness; 9 - emotional self-expression; 10- attitude to the conflict in general.

A qualitative analysis of the results showed that despite a fairly *adequate assessment* of oneself in a conflict situation (3.88), a moderately pronounced *bias* towards the opponent (3.45), as well as relative *correctness in statements* (3.38), adolescents, nevertheless, However, they are not going to restrain themselves and *consider explosive reactions during arguments normal* (2.45), and therefore *do not experience feelings of guilt* for their actions.

Also, adolescents have little control over *negative emotions* at the moment of conflict, which, in their opinion, is natural to splash out on an opponent in order to show character (2.86). An unacceptable tactic for the majority of teenagers is evasion in conflict, the respondents eagerly *rush into battle* (2.95). Low conflict resistance indicates the need for prompt intervention by a specialist in the process of communicative interaction in order to eliminate negative behavioral tactics and increase the level of adequate assessment by a teenager of his own actions and the actions of another.

For a deeper analysis of the features of conflict behavior of adolescents, we need to determine how deeply they analyze their own behavior and whether there are internal reserves for reducing conflict. Self-assessment of the level of ontogenetic reflection should show us how deeply adolescents are able to assess their past communicative and conflict experience, what guides them when entering into social contact - emotions or reason, how do past mistakes and miscalculations in communication affect the construction of new social interactions? The survey results are shown in Figure 2.

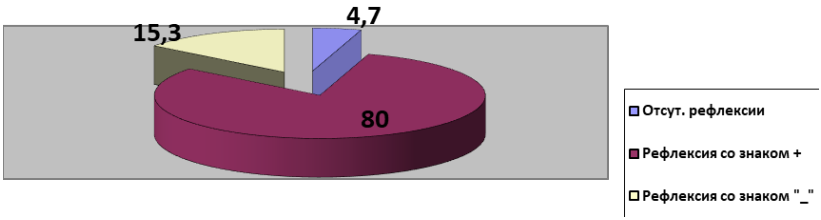


Figure 2. *Cyclogram of the levels of ontogenetic reflection of adolescents*

The complete lack of reflection of past experience at the ontogenetic level indicates an extremely high level of internal and external conflict of respondents, dissatisfaction with their own actions and decisions, as well as dissatisfaction with these actions of others.

Adolescents with a lack of reflection on past experience, without outside help, are not able to change their behavior (4.7%), since they do not have the skills of introspection and analysis of a specific situation; their behavior is inflexible, illogical and not business-oriented; actions performed by them are more aimed

at attracting attention to themselves and at self-affirmation in any, including destructive way.

Respondents with a level of ontogenetic reflection with a minus sign also often fail in situations of social interaction, primarily because they evaluate their past social experience as negatively conflicting and, entering into new social contacts, are afraid of repeating past mistakes. The presence of a vivid negative experience makes such adolescents avoid wide social contacts that multiply vital experience, they close themselves in a narrow circle of friends or relatives, and experience a feeling of loneliness and rejection (15.3%).

An attempt to reduce the risk of social failure by avoiding active social interaction only creates the illusion of «life success», but does not guarantee it, neither in the present, nor even in the future. Adolescents of this group need to be taught to draw the right conclusions from the reflected experience, to be taught to realize that they are already overestimating the negative past, that the conclusions made signal the changes taking place with them.

The third group - adolescents with reflection with a plus sign - shows us that schoolchildren are more able to realistically assess their past mistakes and successes, are able to draw the right conclusions, and therefore are able to plan their further actions and actions in accordance with an adequate assessment of the situation, themselves and another in it. This group of adolescents is characterized by social abilities to anticipate their own future, they are insured against destructive conflicts, as they are always able to offer ways acceptable for both sides to transfer the conflict into a constructive direction, they feel themselves the creators of their own lives and do not allow circumstances or opponents to completely seize the initiative.

Based on the results of this diagnostic study - an analysis of pedagogical conflict at school - and also taking into account the request of an educational institution, we recognized the need to organize psycho-prophylactic work aimed at preventing conflict among adolescents, which required us to find adequate methods for solving this problem.

In accordance with the provisions put forward, we determined the main ***goal of the program*** to carry out the prevention of adolescent conflict behavior by promoting the growth of his self-awareness and taking responsibility for his own activities and actions. An objective criterion for evaluating the effectiveness of the application of the program was the positive dynamics of the trained qualities.

The overall result for the sample showed a change in the situation for the better:

- 52% of respondents demonstrated that they have the skills of rational behavior in conflict situations (against 10.6% before);

- 36% - demonstrate an increase in rationality compared to the previously established (57.34%);

- and only 12% still do not have such skills (against 32%) and need in-depth behavior correction and training.

References

1. Voronin, G. L. Conflicts at school / G. L. Voronin. // Sociological research. – 1994. – No. 3. – P. 94 - 95.

2. Vyazova, N.V., Melekhova, V.M., Smolyarchuk, I.V. Features of the influence of character on the behavioral strategies of the subject of the conflict /N. V. Vyazovova, V. M. Melekhova, I. V. Smolyarchuk. //Psychological and pedagogical journal Gaudeamus. – V. 18, No. 2(40), 2019. – P.43-55. – P. 47.

3. Grishina, N. V. On the issue of predisposition to conflict behavior / N. V. Grishina. // Mental states / ed. A. A. Krylova and others – L., 1982. – P. 90-96.

4. Grigoryeva, T. G. Usoltseva, T. P. Fundamentals of constructive communication: Reader / T. G. Grigoryeva, T. P. Usoltseva. – Novosibirsk, M., 1997. – 196 p.

5. Druzhinin, VV et al. Introduction to the theory of conflict. /AT. V. Druzhinin, D. S. Kontorov. – M., 1989. – 288 p.

6. Zhuravlev, V. I. Fundamentals of pedagogical conflictology. /AT. I. Zhuravlev. – M., 1995. – 184 p.

DOI 10.34660/INF.2023.36.58.063

DIAGNOSTIC VALUE OF INFILTRATION OF TISSUE EOSINOPHILS IN THE STRUCTURE OF THE MUCOUS MEMBRANE OF THE GASTROINTESTINAL TRACT

Reva Ivan Vladimirovich
Candidate of Medical Sciences, PhD, Lecturer at the MEP, School of Medicine, Far Eastern Federal University, Vladivostok, Russia; International Center for Medical Research and Education, Niigata, Japan

Yamamoto Tatsuo
PhD, Professor, Director, International Center for Medical Research and Education, Niigata, Japan

Odintsova Irina Alekseevna
Doctor of Medical Sciences, Professor, Head of the Department of Histology, Cytology of Embryology, Military Medical Academy named after S. M. Kirov, St. Petersburg, Russia

Reva Galina Vitalievna
Doctor of Medical Sciences, MD, Professor, School of Medicine, Far Eastern Federal University, Vladivostok, Russia; Chief Scientist, International Center for Medical Research and Education, Niigata, Japan

Abstract. *The diagnostic value of tissue eosinophil infiltration of the mucous membrane of the human gastrointestinal tract was shown to develop criteria for early malignancy and prospects for the outcome of polyps. The revealed role of eosinophils in intercellular interactions in the structure of neoplasms of the gastrointestinal mucosa made it possible to recommend eosinophilic granulocytes as targets for targeted treatment in malignancy. In predicting the development and outcome of polyps, it is recommended to take into account the complete absence of eosinophils, as evidence of the malignancy of the emerging neoplasm. It is proposed to consider the presence of apoptosis and eosinophilic infiltration as a risk factor for malignancy. It was concluded that further studies of the induction of apoptosis by eosinophils and programmed death of the cambial epithelium are promising for revealing the mechanisms of carcinogenesis.*

Keywords: *human gastrointestinal tract, polyps, malignancy, mucosa, monocytes/macrophages, eosinophils, colon; gastrointestinal disease; neoplasms.*

Relevance

The prevalence of oncological pathology in Russia has reached 2.399% with an annual increase of 1.7%. In Primorsky Krai, only in 2016, stomach cancer was diagnosed in 493 people [1]. At the same time, a low level of diagnosis of malignant polyps in the early stages remains. Morphological confirmations in 91.3% of cases of malignancy indicate late diagnosis [2]. The possibility of saving the life of patients with early diagnosis of malignancy puts the main task of solving the problem of cancer prevention is endoscopic screenings [3], as well as the development of morphological criteria for malignancy of benign tumors to create a strategy for pathogenetically substantiated treatment of neoplasms. Actual problems that need to be addressed at the present stage are issues related to the nomenclature, diagnostic criteria, histological variants of polyps, the mechanisms of dysplasia and the criteria used in differential diagnosis [4].

The ability of eosinophils to induce tissue remodeling and their exceptional immunological properties are important to take into account in the destruction and disruption of cellular interactions in the system of epithelial-mesenchymal tissues during carcinogenesis [5, 6]. Cansiz Ersöz C., Kiremitci S., Savas B., Ensari A. (2020) recognize eosinophilia on the background of polyps in 88% with high sensitivity and specificity in predicting carcinogenesis [7].

The need to develop criteria for assessing the risk and predicting the outcomes of benign polyps dictates the conduct of clinical and morphological studies in the dynamics of the treatment of patients with polyps of the gastrointestinal tract and the provision of pathogenetically substantiated recommendations for practical healthcare.

The aim of the study was to characterize the localization of eosinophils in the structure of cell ensembles of myeloid phenotypes in the structure of polyps in various parts of the human gastrointestinal tract.

Material and research methods

Immunohistochemical methods were used to study 189 polyp biopsies from various parts of the gastrointestinal tract using monoclonal antibodies (MCA) (clone KP1, code No. M 0814, lot 119). Macrophages were also detected by the CD68 marker. Clone 10 D6, IgG1 immunoglobulin class, was used to label CD163. 10 mmol/l citrate buffer, pH 6.0 or DAKO TRS (Target retrieval solution, code No. S 1700) was used for antigen unmasking. Cooled preparations were washed in distilled water. Antibodies were used at a dilution of 1:50 and 1:100. Brown coloration indicated a positive reaction.

Results and its discussion

Our analysis of the clinical material is based on studies of the material of patients aged 40 to 90 years who were examined or treated in the surgical departments

of the FBGUZ of Primorsky Krai in the period from 2018 to 2020. Analysis of clinical material and case histories of patients in Primorsky Krai showed that against the background of cancer of various parts of the gastrointestinal tract, the stomach is in the lead, cancer of which in 2016 amounted to 199 cases per 100,000 of the population, which exceeded the standard data for Russia by 2 times (19.83 versus 9.73). The colon accounts for 451 cases, which amounted to 25.71 cases per 100 thousand of the population; rectal cancer was 294 cases (146 per 100 thousand population) [1]. In men, the number of patients with polyps in the group of 31-40 years old is 57%, 41-50 years old - 40%, 51-65 years old - 61%, 66-70 years old - 22%, 72-74 years old - 71%. In the examined women with clinical manifestations at the age of 40–50, polyps were found in 100%; in the group of 51–65 years, polyps are identified in 40%; at 66–70 years old - in 25%; there were no women with polyps in the group older than 70 among the examined patients.

The results showed that polyps were more often detected endoscopically, mainly in the large intestine, in both men and women. Cases of malignancy were established both during clinical diagnosis and confirmed histologically

Surgical interventions were performed in 95% of patients, conservative treatment - in 2% of patients, the outcome is favorable, the prognosis is positive in 93% of patients. The use of the fast track surgery (FTS) protocol - "accelerated recovery after surgical operations" in combination with laparoscopic access made it easier for patients to endure surgical treatment and leave the hospital 5-6 days after the operation.

The higher relative number of male patients among patients with pathology of the gastrointestinal tract indicates a higher incidence of pathology and mortality in the male population, with a smaller number of centenarians among the male population of Primorsky Krai. The distribution of patients in Primorsky Krai with clinical manifestations and identified pathology of the gastrointestinal tract is shown in Figure 1.

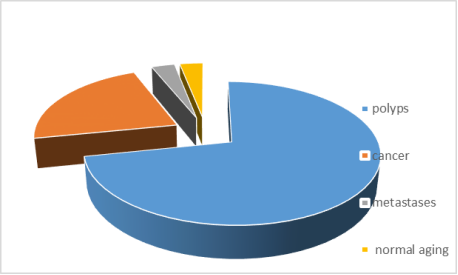


Figure 1. *Distribution of patients of older age groups who applied with complaints according to the presence of pathology. Neoplasms of the gastrointestinal tract*

Age-related changes in the structure of the CO TC are also characterized by the fact that almost all sections from biopsy specimens of the gastric mucosa, obtained for the purpose of diagnostic measures and in the absence of complaints about the symptoms of the gastrointestinal tract, showed the presence of leukocyte infiltration around the connective tissue vessels of the lamina propria and submucosa. At the same time, eosinophils were identified in large numbers in the infiltrates. In the area around the polyp, eosinophils are represented by various types of cells. In the first group, eosinophils have a clearly identifiable cytolemma, round, oval, or irregularly shaped nuclei. Another type of cells is represented by degranulating cells, has nuclei of two or one fragment. Eosinophils were identified not only in the lamina propria, but also penetrated into the basal epithelial layers.

When the structure of the epithelium of the mucous membrane changed in the structure of the polyp and its metaplasia, eosinophils were absent in our observations. Morphological findings were process-shaped eosinophils identified in the apoptotic epithelial plate with signs of degranulation. As part of the infiltrate, eosinophils are grouped near stem migrants, near vessels, and inside preserved blood vessels. In the area surrounding degranulating eosinophils, cells with signs of apoptosis are observed. In our studies, as well as in the work of Caruso R.A., Branca G., Fedele F. et al. (2014) also observed polyp cells, single or in small clusters, convoluted nuclei, irregularly condensed chromatin, loss of microvilli, and dilatation of the nuclear envelope [8, 9]. In these apoptotic cells, no fragmentation of the nucleus was observed, while the plasma membrane showed no signs of destruction. These ultrastructural findings represent intermediate aspects between apoptosis and necrosis and are compatible with apoptosis-like programmed cell death.

In addition, immunohistochemical study showed immunoreactivity to CD4, CD8, CD68, CD163, which were observed in all studied biopsy specimens of polyps and their surrounding tissue.

These results suggest that CD4, CD8, CD68, CD163 are key markers for the clinical diagnosis and prediction of polyp malignancy in the gastrointestinal tract, and that eosinophils are of unlimited value in the analysis and prognosis of polyp malignancy based on careful analysis of hematoxylin and eosin with immunostained sections.

Similar data were obtained by Moezzi J., Gopalswamy N., Haas R.J. Jr, (2000), who observed mild to moderate eosinophilia in 75% of all adenomas, especially pronounced in the tissue surrounding the polyp and their absence in the stroma of invasive adenocarcinomas [10]. Similar data obtained in our study suggest that the quantitative dynamics of tissue eosinophils can be taken into account in the development of a treatment strategy and influence the prognosis of polyp outcome in clinical assessment.

The migration of tissue eosinophils is necessary for adaptive tissue remodeling in the structure of the polyp and its environment. We noted that during the formation of a polyp on the surface of the mucous membrane, the morphological picture of the altered tissue is characterized by the disappearance of the basement membrane, apoptosis of epitheliocytes, and migration of migrant cells from the blood into the area of the altered tissue.

Ieni A., Branca G., Parisi A., (2015) in patients older than 72 years, a distinctive morphological variant of malignancy with an increase in neutrophil infiltration, although the true mechanism is also still unclear [11].

Conclusion

The mechanism of malignancy in the mucous membrane of the gastrointestinal tract still has no pathogenetic justification. In the integral assessment and comparative analysis of pathological changes in the gastrointestinal mucosa, there are still no specific comprehensive morphological markers of metaplasia of the epithelium of polyps and malignancy, and there is no explanation for the malignancy of only 1% of polyps, while tumors are often found next to polyps. These facts indicate that local immune homeostasis plays a role in malignancy, and it is necessary to focus on it when making a diagnosis, predicting the outcome of polyps, determining the extent of surgical intervention, and postoperative treatment strategies. An increase in the number of eosinophils in the total inflammatory cell spectrum in the malignant zone is an autonomous, antitumor mechanism, the decoding of which can contribute to the development of conservative methods for the treatment of gastrointestinal polyps. One of the targets of targeted treatment and prevention of malignancy is the eosinophilic pool of leukocyte infiltrate.

References

1. Ed. HELL. Kaprina, V.V. Starinsky, G.V. Petrova. Malignant neoplasms in Russia in 2016 (morbidity and mortality). - M.: MNIOI im. P.A. Herzen. - branch of the Federal State Budgetary Institution "NMITs Radiology" of the Ministry of Health of Russia. -2018. - 250 s.

2. Aubert A., Cazier A., Baglin A.C., Outters F., Dubertret M., Meduri B., Larche H., Fritsch J. Polypes fibro-inflammatoires du côlon (Inflammatory fibroid polyps of the colon). Gastroenterol Clin Biol. 1998 Dec;22(12):1106-9. French. PMID: 10051989.

3. Hamashima C., Narisawa R., Ogoshi K., Kato T., Fujita K. Optimal interval of endoscopic screening based on stage distributions of detected gastric cancers. BMC Cancer. 2017 Nov 9;17(1):740. doi: 10.1186/s12885-017-3710-x.

4. Chetty R. Traditional serrated adenoma (TSA): morphological questions, queries and quandaries. J Clin Pathol. 2016 Jan;69(1):6-11. doi: 10.1136/jclinpath-2015-203452. Epub 2015 Nov 9. PMID: 26553935.

5. Hillman Y.J., Hillman B.S., Sejpal D.V., et al. Effect of time of day and daily endoscopic workload on outcomes of endoscopic mucosal resection for large sessile colon polyps. United European Gastroenterol J. 2019;7(1):146-154. doi:10.1177/2050640618804724

6. McDuffie L.A., Sabesan A., Allgäeuer M., et al. β-Catenin activation in fundic gland polyps, gastric cancer and colonic polyps in families afflicted by 'gastric adenocarcinoma and proximal polyposis of the stomach' (GAPPS). J Clin Pathol. 2016;69(9):826-833. doi:10.1136/jclinpath-2016-203746

7. Cansiz Ersöz C., Kiremitci S., Savas B., Ensari A. Differential diagnosis of traditional serrated adenomas and tubulovillous adenomas: a compartmental morphologic and immunohistochemical analysis. Acta Gastroenterol Belg. 2020 Oct-Dec;83(4):549-556. PMID: 33321010.

8. Caruso R.A., Fedele F., Rigoli L., Branca G., Bonanno A., Quattrocchi E., Finocchiaro G., Venuti A. Apoptotic-like tumor cells and apoptotic neutrophils in mitochondrion-rich gastric adenocarcinomas: a comparative study with light and electron microscopy between these two forms of cell death. Rare Tumors. 2013 Jun 7;5(2):68-71. doi: 10.4081/rt.2013.e18.

9. Caruso R.A., Branca G., Fedele F., Irato E., Finocchiaro G., Parisi A., Ieni A. Mechanisms of coagulative necrosis in malignant epithelial tumors (Review). Oncol Lett. 2014 Oct;8(4):1397-1402. doi: 10.3892/ol.2014.2345.

10. Moezzi J., Gopalswamy N., Haas R.J. Jr, Markert R.J., Suryaprasad S., Bhutani M.S. Stromal eosinophilia in colonic epithelial neoplasms. Am J Gastroenterol. 2000 Feb;95(2):520-3. doi: 10.1111/j.1572-0241.2000.01778.x.

11. Ieni A., Branca G., Parisi A., Fedele F., Irato E., Venuti A., Caruso R.A. Neutrophil-rich gastric carcinoma in the integrated cancer registry of eastern Sicily, Italy. Anticancer Res. 2015 Jan;35(1):487-92.

DOI 10.34660/INF.2023.53.82.064

ADRENOREACTIVE MECHANISMS OF REGULATION OF MUSCLE BLOOD FLOW DURING COLD ADAPTATION

Ananiev Vladimir Nikolaevich
Doctor of Medical Sciences, Full Professor, Lead Research Officer
State Scientific Center of the Russian Federation – Institute of Biomedical Problems RAS

Ananiev Georgiy Vladimirovich
postgraduate
Moscow Pedagogical State University

Prokopyev Nikolay Yakovlevich
Doctor of Medical Sciences, Full Professor
Tyumen State University

Gurtovoy Elisey Sergeevich
student
Tyumen State Medical University

Abstract. *The article shows that the increase in blood flow during muscle contraction is carried out as a result of a temporary blockade of arterial alpha-adrenergic receptors. The authors proved that such a mechanism of hemodynamic regulation allows to increase the blood flow in the working muscles, while not changing the blood flow in the non-working muscles. In 30 days of modeling the cold adaptation of rabbits, the mechanism of increased blood flow in the working muscles was preserved, changing the quantitative characteristics.*

Keywords: *adaptation to cold, rabbit, limb arteries, working muscle hyperemia, adrenaline, adrenoreceptors.*

The relevance of research. The regulation of arterial blood flow in working muscles during dosed physical activity ensures their increased performance. Increased blood flow in working muscles helps to reduce blood pressure and is one of the most important mechanisms for the regulation and normalization of systemic arterial pressure [22, 23]. This mechanism of blood flow regulation in working muscles was named as working muscle hyperemia [6, 7], in the foreign press it is better known as functional sympatholysis [21, 24]. Adrenaline as a

neurotransmitter of the sympathetic nervous system [15] plays a significant role in the regulation of metabolic processes in the human body, especially in emergency situations and stress [5, 13].

When adapting to cold, adrenaline enhances heat production; animals with a damaged sympathetic nervous system do not adapt to cold and die fairly quickly at low temperatures [3].

During muscular work, the secretion of adrenaline from the adrenal glands into the blood increases, where adrenaline, stimulating the alpha-adrenergic receptors of the arteries, causes their dose-dependent reduction, thereby reducing blood flow in the muscles. It should be noted that in working muscles, adrenaline, like norepinephrine, significantly reduces its pressor effect, the mechanism of which was not known before our studies [2, 4, 6, 20].

Studies conducted in Russia have shown that living in areas with a cold climate leads to a strain of adaptive mechanisms, contributes to the risk of various diseases, including cardiovascular diseases [12, 16, 17]. In our country, much attention is paid to research on the processes of human adaptation to climatic conditions, including cold [1, 9, 10, 18]. At the same time, it has been convincingly proven that a person does not tolerate the period of incomplete adaptation, which lasts from about 1 day to 15–20 days of exposure to cold [2, 3]. During this period, pain in the heart area, headaches, insomnia, high blood pressure, and other health symptoms may disturb [1, 12]. In 25-30 days of adaptation to cold, people fully adapt to cold, since all the symptoms of diseases that were noted before the 20th day of cold disappear, and clinical analyzes also normalize [1].

It should be emphasized that the mechanisms of functional sympatholysis have not yet been fully studied, while various hypotheses of its regulation are put forward [21, 22, 24]. Due to the fact that a significant part of the territory of Russia is located in a cold climate, the scientific question arises of the effect of working muscle hyperemia in the conditions of adaptation of the human body to cold. It should be noted that there are practically no scientifically substantiated publications of domestic and foreign scientists containing studies of working muscle hyperemia during human adaptation to cold.

The purpose of the study was to study the adrenoreactivity of peripheral arterial vessels to the neurotransmitter adrenaline in the arteries of contracting muscles before and after 30 days of cold adaptation.

Research methods. Studies were carried out on 30 male rabbits (main group) weighing from 2.5 to 3.5 kg under general anesthesia in compliance with GOST 33216-2014 - "Rules for laboratory work with rodents and rabbits" and article 20 of the law "On the treatment of animals" . The control group also consisted of 30 rabbits kept at ambient temperature (+)18-220 C for 30 days [20]. Adaptation to cold was carried out daily [11, 14] for 6 hours in a cooling chamber at a

temperature of (-)100 C, the rest of the time the rabbits were at a temperature of (+) 18-220 C. This mode of adaptation to cold approximately corresponded to the mode of adaptation of people to cold during shift work in the North (6 hours of work in the cold, the rest of the time indoors). We studied the systemic pressure and vascular response of the preparation of the musculoskeletal region of the hind limb when perfused with the blood of the same animal using a constant-capacity pump. Working muscle hyperemia was simulated using an electrical stimulator, which ensured muscle contraction. Eight doses of adrenaline were administered intra-arterially before the pump inlet. Changes in systemic pressure and perfusion pressure in the arteries of the limb were recorded with a Motorola MPX5100DP electromanometer and, after conversion with a 12-bit ADC (ADS-1286), were recorded by a computer and simultaneously recorded by a chart recorder. Receptor reactivity was quantified in double inverse Lineiover-Burk coordinates [14, 19, 20].

Research results and discussion. The introduction of adrenaline in various increasing doses into the femoral artery (Fig. 1) before the pump in rabbits on the background of 30 days of cold before and against the background of muscle hyperemia caused an increase in perfusion pressure due to excitation of pressor postsynaptic adrenoreceptors. Against the background of muscle electrical stimulation with muscle hyperemia, the pressor effect of adrenaline was much less than without muscle hyperemia. Cold adaptation in rabbits led to the fact that the pressor effect of adrenaline on the arteries during muscular hyperemia increased and was greater by all doses than in rabbits without cold. In rabbits after cold adaptation against the background of muscle hyperemia, all doses of adrenaline had significantly ($p<0.05$) less pressor response of the arteries than without muscle hyperemia.

It should be noted that at a dose of injected adrenaline of 0.5 μg/kg into the femoral artery perfused with its own blood by a constant flow pump (6 ml/min) in animals in 30 days of cold, the pressure increased by 110 mm Hg from the initial level, in rabbits after 30 days of cold against the background of muscle hyperemia only by 7 mm Hg. We concluded that during muscle hyperemia, the pressor effect of adrenaline (at a dose of 0.5 μg/kg) decreased by 15.7 times.

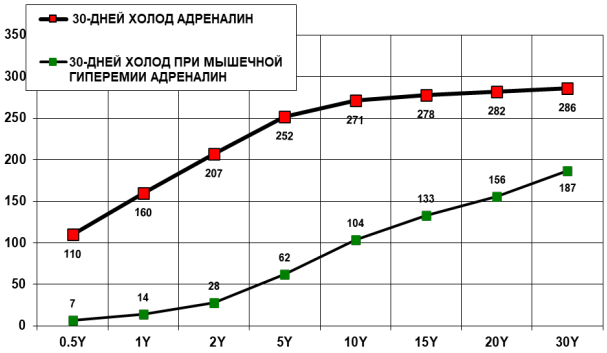


Figure 1. *All animals after 30 days of cold adaptation, one group of animals on the background of muscular working hyperemia. Y-axis: increase in perfusion pressure in mm. rt st. on adrenaline before and against the background of muscle hyperemia. Abscissa: doses of adrenaline in mcg/kg (Y) with intra-arterial administration ($p<0.05$).*

At a dose of adrenaline 1 mcg/kg (30 days of cold), the pressure increased by 160 mm Hg, and during muscle hyperemia increased by only 14 mm Hg, that is, it was 11.4 times less. At a dose of adrenaline 15 mcg/kg (30 days of cold), the pressure increased by 278 mm Hg and the addition of electrical muscle stimulation with muscle hyperemia led to the fact that the pressure in the arteries increased by only 133 mm Hg, that is, it became 2.1 times less. At a dose of adrenaline 20 mcg/kg (30 days of cold), the pressure increased by 282 mm Hg. Art., and during muscle hyperemia increased only by 156 mm Hg, that is, it became 1.8 times less. At a dose of adrenaline 30 mcg / kg (30 days of cold), the pressure increased by 286 mm Hg, and during muscle hyperemia increased by 187 mm Hg, that is, it was 1.53 times less.

Analysis of the pressor response of arteries to adrenaline against the background of 30 days of adaptation to cold with muscle hyperemia showed that at low doses of adrenaline, muscle hyperemia suppressed the pressor response of arteries much more strongly than at high doses of adrenaline. So, if the pressure response of the arteries became 15.7 times less at low doses of adrenaline with muscle hyperemia, then at a high dose (30 μg/kg) muscle hyperemia reduced the contraction of the arteries only 1.53 times.

Such changes in the reactivity of arteries to increasing doses of adrenaline after 30 days of cold with muscle hyperemia may be under the mechanisms of changes in the sensitivity and number of active arterial alpha-adrenergic receptors. To determine the sensitivity and number of arterial alpha-adrenergic receptors, dose-effect data are presented in double Lineweaver–Burk coordinates, where the

characteristics of the receptors are determined graphically and mathematically - their sensitivity and the number of active adrenoreceptors.

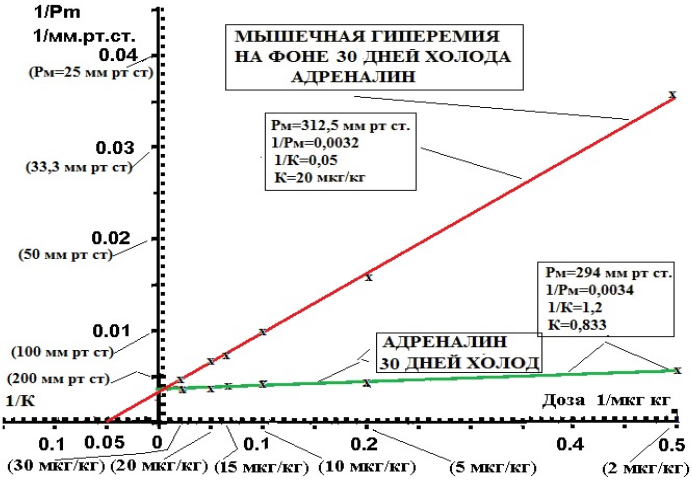


Figure 2. *Changes in the reactivity of arterial alpha-adrenergic receptors to different doses of adrenaline in double inverse Lineiover-Burk coordinates without and against the background of muscle hyperemia. Abscissa: reciprocal of adrenaline dose (1/Dose in 1/(μg/kg). Y-axis: reciprocal (1/Pm) of perfusion pressure increase in (1/mmHg) (P<0.05).*

An analysis of the mechanisms of interaction between adrenaline and arterial adrenoreceptors dose-effect in double reciprocal coordinates (Fig. 2) by Lineweaver–Burk showed that this was due to a decrease in the sensitivity (1/K) of alpha-1-2-adrenergic reactivity of arteries during muscle hyperemia by 24 times compared with the same muscle arteries without hyperemia (1/K=1.2 without hyperemia, 1/K=0.05 with muscle hyperemia ($p<0.05$). The number of active alpha-1-2-adrenergic receptors after working hyperemia (Pm = 312.5 mm Hg) for adrenaline increased little, by only 18 mm Hg, which did not differ significantly ($p> 0.05$), compared with without hyperemia (Pm = 294 mm Hg) Therefore, the number of alpha-1-2-adrenergic receptors in the arteries before and after hyperemia against the background of 30 days of cold was equal, and only due to the reduced sensitivity of these receptors to low doses of adrenaline, the blood flow during hyperemia is increased, with high doses of adrenaline it begins to approach the blood flow without hyperemia.

We believe that on the 30th day of cold, heat production is sufficient and adrenaline performs the function of a reserve hormone of the sympathetic system

that saves from hypothermia. In severe cold, the body must retain heat and large doses of adrenaline (the stronger the cold, the greater the concentration of adrenaline in the blood) contract the arteries more than at low doses, which helps to preserve body heat.

Conclusion. A study in rabbits on the background of 30-day cold adaptation of arterial reactivity to 8 increasing doses of adrenaline showed for the first time that muscular working hyperemia significantly ($p<0.05$) significantly reduces the pressor effect on adrenaline for all doses studied. This resulted in increased blood flow in working muscles compared to non-working muscles. Physiological analysis of the mechanisms of this study of dose-response parameters in dual Lineiweaver-Burk coordinates showed that this was due to a decrease in the sensitivity (1/K) of alpha-adrenergic reactivity of arteries with muscle hyperemia by 24 times compared with the same muscle arteries without hyperemia. The number of active alpha-adrenergic receptors after working hyperemia (Pm=312.5 mm Hg) on adrenaline did not differ significantly from the control.

References

1. Agadzhanyan N.A., Petrova P.G. Man in the conditions of the North. – M.: <KRUK>, 1996. – 208p.

2. Ananiev V.N. Reactivity of the systemic and regional circulation to adrenaline and norepinephrine // Fundamental research. – 2012. – No. 4-1. – P. 13-17.

3. Ananiev V.N. Cold adaptation and adrenoreceptors // Successes of modern natural science. – 2010. – No. 11. – P. 8-11;

4. Ananiev V.N., Ippolitov I.V., Anan'eva O.V. Influence of beta-blockers on the pressor action of adrenaline after 10 days of adaptation to cold // Natural and technical sciences. – 2011. – No. 3 (53). – P. 147-150.

5. Ananiev V.N., Prokopiev N.Ya., Ananiev G.V. Influence of long-term cold adaptation on adrenoreactivity of the cardiovascular system // Actual problems of physical culture and sports in the system of higher education: Collection of materials of the V All-Russian scientific and practical conference with international participation. – Omsk, May 19, 2022. – P. 92-97.

6. Ananiev V.N., Prokop'ev N.Ya., Anan'ev G.V., Anan'eva O.V., Gurtovoi E.S. Arterial reactivity to adrenaline in working muscle hyperemia against the background of incomplete cold adaptation // Natural and technical sciences. – 2020. – No. 2 (140). – P. 108-113.

7. Ananiev V.N., Prokopiev N.Ya., Ananiev G.V., Gurtovoy E.S., Anan'eva O.V. Physiological adrenergic mechanisms of the influence of working muscle

hyperemia on the regulation of systemic arterial pressure // Natural and technical sciences. – 2019. – No. 6 (132). – P. 62-66.

8. Ananiev V.N., Prokop'ev N.Ya., Anan'eva O.V., Anan'ev G.V., Gurtovoi E.S. Mechanisms of the multidirectional action of adrenaline and norepinephrine on systemic arterial pressure and regional arteries during adaptation to cold // Natural and technical sciences. – 2022. – No. 7 (170). – P. 110-116.

9. Vykhovanets Yu.G., Tetyura S.M., Andreev R.N., Chernyak A.N., Gabaraeva Z.G., Vykhovanets T.A. Influence of climatic factors on the functional state of the human circulatory system // Archive of Clinical and Experimental Medicine. – 2022. – V. 31. – No. 2. – P. 138-143.

10. Gruzdeva A.Yu., Yakovlev M.Yu., Datii A.V. Influence of climatic conditions on the human body // Bulletin of restorative medicine. - 2019. – No. 3 (91). – P. 25-28.

11. Cornish-Bowden E. Fundamentals of enzymatic kinetics. – M. Mir, 1979. – 280 p.

12. Krivoshchekov S.G., Okhotnikov S.V. Industrial migrations and human health in the North. – Novosibirsk, 2000. – 118 p.

13. Mamazhanova Z.K., Yuldasheva S.L., Abdullaeva K.A. Study of the balance of adrenaline and norepinephrine in the development of arterial hypertension in workers prone to stress // Economics and society. – 2022. – No. 11-1 (102). – P. 730-733.

14. Manukhin B.N. Analysis of ligand-receptor interactions at the level from molecular to organismal // Russian Journal of Physiology. THEM. Sechenov. – 2000. – V.86. – No. 9. – P. 1220-1232.

15. Maslov L.N., Vychuzhanina E.A. The role of the sympathetic-adrenomedullary system in adaptation to cold // Russian Journal of Physiology named after Sechenov. – 2015 – February; 101(2). – P. 145-162. PMID: 26012107

16. Meltser A.V., Polyakova E.M. Assessment of the combined occupational risk when performing labor operations in an open area during the cold season // Preventive and Clinical Medicine. – 2019. – No. 3 (72). – P. 4-12.

17. Narutdinov D.A., Rakhmanov R.S., Bogomolova E.S., Razgulin S.A., Potekhina N.N. Assessment of health risk in terms of cold exposure in the territories of the region with different types of climate // Occupational medicine and human ecology. – 2021. – No. 3 (27). – P. 109-123.

18. Saltykova M.M. Basic physiological mechanisms of human adaptation to cold // Russian Journal of Physiology named after Sechenov. – 2017. – V. 103. – No. 2. – P. 138-151.

19. Sergeev P.V., Shimanovsky N.L., Petrov V.I. Receptors of physiologically active substances. – Volgograd: Publishing house "Seven Winds". – 1999. – 640 p.

20. Ananiev V.N., Kichikulova T.P., Manukhin B.N. Alpha- and beta-adrenergic blood pressure response of the rabbit hind limb vessels during cold adaptation. // Dokl Biol Sci. 2000 Sep-Oct; 374: 448-451. PMID: 11103311

21. Heinonen I. *Muscle-specific functional sympatholysis in humans. //*Exp Physiol. 2014. Feb; 99(2): 344-345. PMID 24487247.

22. Horst J., Møller S., Kjeldsen S.A.S., Wojtaszewski J.F.P., Hellsten Y., Jepps T.A. *Functional sympatholysis in mouse skeletal muscle involves sarcoplasmic reticulum swelling in arterial smooth muscle cells. //*Physiol Rep. 2021 Dec; 9(23): e15133. doi: 10.14814/phy2.15133

23. Joyner M.J., Casey D.P. Regulation of increased blood flow (hyperemia) to muscles during exercise: a hierarchy of competing physiological // Physiol Rev. 2015. 95(2). P. 549-601.

24. Segal S.S. *Enhanced functional sympatholysis through endothelial signalling in healthy young men and women. //*J Physiol. 2016 Dec 15; 594(24): 7149-7150. doi: 10.1113/JP273454.PMID: 27976390

DOI 10.34660/INF.2023.40.48.065

THE ROLE OF NEUROGLIA IN THE ANGIOGENESIS OF NEURAL STRUCTURES

Reva Galina Vitalievna
Doctor of Medical Sciences, Full Professor
Far Eastern Federal University
International Medical Research and Education Center, MD
Chief Researcher (Niigata, Japan)

Sadovaya Yana Olegovna
postgraduate
Far Eastern Federal University

Shahariar Islam
postgraduate
Far Eastern Federal University

Zhibanov Pavel Vitalievich
postgraduate
Far Eastern Federal University

Bondar Evgeny Nikolaevich
postgraduate
Far Eastern Federal University

Introduction

Using the method of immune histochemistry, the processes of angiogenesis in neural structures in human prenatal ontogenesis were studied. It has been established that under conditions of ischemia and macrophage and neuroglial induction, vasculogenesis occurs in the neural structure of the retina. However, CSF-dependent structures maintain trophic supply due to CSF dynamics. This trend persists in postnatal ontogenesis and is important in ischemia of neuronal structures.

Actuality

In the vascularization of neural structures, an important role is played not only by macrophages secreting endothelial growth factor [1, 3], but also by the interneuronal matrix [5, 9, 11]. In the structures of the human eye, this role is played by the interphotoreceptor matrix, which retains its properties in postnatal

ontogenesis and compensates for hypoxia under conditions of developing ischemia, facilitating the adaptation of neurons to oxygen deficiency [4, 7, 12]. The organ of vision as a part of the brain, brought to the periphery, is the most important indicator of the state of the organism. One of the morphological criteria for assessing the visual functions and health status of patients is the study of the posterior wall and transparent media of the human eye. One of the clinical manifestations of pathological abnormalities in the system of the peripheral part of the visual analyzer is a change in the choroidal and retinal microcirculation or the appearance of vessels in the transparent structures of the eye [6, 8]. Assessment of the state of blood vessels does not resolve the issue of the mechanism of pathogenetic processes in the human eye and makes it possible to prescribe only symptomatic treatment [2]. At the present stage, the issues of sources of germination of blood vessels into the vitreous body, as well as the launch of ingrowth of vessels from the sclera into the cornea, have not been resolved [10]. The solution to the issue of launching the angiogenesis cascade into the transparent media of the human eye requires a deeper study in order to develop a targeted effect with inhibition of pathological angiogenesis, which determined the direction of our research.

Purpose of the study

The aim of the study was to study the interaction of cell ensembles in vasculogenesis and angiogenesis in the structures of the developing human eye.

Material and methods

156 eyes of human embryos and fetuses were studied by classical morphological and immunohistochemical methods to study the processes of vasculogenesis and angiogenesis in the human eye during the formation of eye structures, histogenesis and specialization.

Results

These early stages were not chosen by chance, but due to the fact that it is during the period of early embryonic development that the most significant deviations in the development of the visual system occur, which require surgical correction in the early postnatal period. Dysgenesis can be associated either with the absence or insufficiency of developing vessels, such as in aniridia, or with persistent remnants of uninvolved vessels in the human eye.

It is known that the features of the functional maturity of the transparent structures of the human eye is the involution in them of temporarily functioning vascular systems. In pathological conditions, such as diabetes mellitus, these empty, non-functioning vessels, and newly formed vessels, lead to reduced vision, blindness and disability.

We found that at the border of the opaque sclera and the transparent cornea in the early period of embryonic development, the cause of angiogenesis inhibition is the presence of a wide range of cellular phenotypes belonging to different

differons, the main of which is neuroglia migrating from the neural retina in the prevascular period along the intercellular spaces of the ectomesenchymal vitreous body. This cellular neuroglial phenotype is a precursor to fibroblasts that produce crystallins in the retina, cerebral cortex, cornea, lens, and vitreous. Signal interactions for the migration of neuroglia in the area of inhibition occur in the prevascular period, and by the time of angiogenesis, a cellular barrier is created in this zone, at the border of the sclera and cornea. We found that during the period of vasculogenesis, the differentiation of ectomesenchymal cells into endothelial cells and vasculogenesis are influenced by macrophages of the CD163 phenotype secreting VEGF. Angiogenesis occurs under the inducing influence of existing blood vessels, due to endothelium, CD34 positive. During the period of involution of blood vessels in the transparent media of the human eye, like the vitreous body, the vascular capsule of the lens, occurs with an increase in antigen-presenting cells of the CD68 phenotype, a slight increase in CD163-positive cells. This fact indicates that during pathological angiogenesis in the structures of the human eye, not only involution with phagocytosis of the endothelium occurs, but also the desolation of vessels capable of returning to adaptive rearrangement in response to developing hypoxia to the mechanisms of embryonic induction of angiogenesis under conditions of eye ischemia.

Conclusions. Therefore, cellular responses, changes in the spectrum of cell ensembles under conditions of vascular restructuring, and involvement of neuroglia in the inhibition of temporary vascular systems in the developing human eye are promising targets for the development of targeted therapy in the treatment of retinopathy in newborns and patients with diabetes mellitus.

Features of vascularization of neuronal structures and their trophic supply in human prenatal ontogenesis plays an important role in damage to the brain and neural part of the retina during ischemia. To a lesser extent, those structures that retain cerebrospinal fluid trophic supply in the postnatal ontogenesis of a person suffer less.

References

1. Baranov P, Michaelson A, Kundu J, Carrier RL, Young M. Interphotoreceptor matrix-poly(ϵ-caprolactone) composite scaffolds for human photoreceptor differentiation. J Tissue Eng. 2014 Oct 1;5:2041731414554139. doi: 10.1177/2041731414554139.

2. Chowers I., Tiosano L., Audo I., Grunin M., Boon C.J. Adult-onset foveomacular vitelliform dystrophy: A fresh perspective.//Prog Retin Eye Res. 2015 Jul;47:64-85. doi: 10.1016/j.preteyeres.2015.02.001

3. Ezequiel M. Salido , Visvanathan Ramamurthy. Proteoglycan IMPG2 Shapes the Interphotoreceptor Matrix and Modulates Vision. //J. Neurosci. – 2020.- May 13;40(20):4059-4072. doi: 10.1523/JNEUROSCI.2994-19.2020.

4. Felemban M, Dorgau B, Hunt NC, Hallam D, Zerti D, Bauer R, Ding Y, Collin J, Steel D, Krasnogor N, Al-Aama J, Lindsay S, Mellough C, Lako M. Extracellular matrix component expression in human pluripotent stem cell-derived retinal organoids recapitulates retinogenesis in vivo and reveals an important role for IMPG1 and CD44 in the development of photoreceptors and interphotoreceptor matrix.//Acta Biomater. 2018 Jul 1;74:207-221. doi: 10.1016/j.actbio.2018.05.023.

5. Garlipp MA, Gonzalez-Fernandez F. Cone outer segment and Müller microvilli pericellular matrices provide binding domains for interphotoreceptor retinoid-binding protein (IRBP).//Exp Eye Res. 2013 Aug;113:192-202. doi: 10.1016/j.exer.2013.02.003.

6. Gupta MP, Brodie SE, Freund KB. UNUSUAL EARLY-ONSET VITELLIFORM DYSTROPHY POSSIBLY LINKED TO THE INTERPHOTORECEPTOR MATRIX PROTEOGLYCAN-1 P.LEU154PRO MUTATION. Retin Cases Brief Rep. 2019 Jan 25. doi: 10.1097/ICB.0000000000000843.

7. Ishikawa M, Sawada Y, Yoshitomi T. Structure and function of the interphotoreceptor matrix surrounding retinal photoreceptor cells.//Exp Eye Res. 2015 Apr;133:3-18. doi: 10.1016/j.exer.2015.02.017.

8. Hauck SM, Schoeffmann S, Deeg CA, Gloeckner CJ, Swiatek-de Lange M, Ueffing M. Proteomic analysis of the porcine interphotoreceptor matrix. Proteomics. 2005 Sep;5(14):3623-36. doi: 10.1002/pmic.200401223. Erratum in: Proteomics. 2005 Nov;5(17):4637.

9. Hollyfield JG. Hyaluronan and the functional organization of the interphotoreceptor matrix. Invest Ophthalmol Vis Sci. 1999 Nov;40(12):2767-9.

10. Hollyfield JG, Varner HH, Rayborn ME. Regional variation within the interphotoreceptor matrix from fovea to the retinal periphery.//Eye (Lond). 1990;4 (Pt 2):333-9. doi: 10.1038/eye.1990.45.

11. Kwon W., Freeman S.A. Phagocytosis by the Retinal Pigment Epithelium: Recognition, Resolution, Recycling.//Front Immunol. 2020 Nov 13;11:604205. doi: 10.3389/fimmu.2020.604205.

12. Zeng S, Zhang T, Madigan MC, Fernando N, Aggio-Bruce R, Zhou F, Pierce M, Chen Y, Huang L, Natoli R, Gillies MC, Zhu L. Interphotoreceptor Retinoid-Binding Protein (IRBP) in Retinal Health and Disease.//Front Cell Neurosci. 2020 Nov 19;14:577935. doi: 10.3389/fncel.2020.577935.

DOI 10.34660/INF.2023.68.28.066

PRIMARY LABILE ARTERIAL HYPERTENSION IN CHILDREN: MOLECULAR GENETIC ASPECTS

Ignatenko Grigory Anatolyevich
Doctor of Medical Sciences, Full Professor, corresponding member of NAMSU, Head of Department, Rector
M. Gorky Donetsk National Medical University, Donetsk
ORCID: 0000-0003-3611-1186

Lastkov Dmitry Olegovich
Doctor of Medical Sciences, Full Professor, Head of Department, vice-rector for scientific work
M. Gorky Donetsk National Medical University, Donetsk
ORCID: 0000-0002-9566-8745

Dubovaya Anna Valerievna
Doctor of Medical Sciences, Full Professor, Head of Department, Director of the Accreditation and Simulation Center
M. Gorky Donetsk National Medical University, Donetsk
ORCID: 0000-0002-7999-8656

Naumenko Yulia Vladimirovna
Doctor of Medical Sciences, Associate Professor
M. Gorky Donetsk National Medical University, Donetsk
ORCID: 0000-0002-6829-0371

Summary. *The article presents the results of a comparison of clinical and molecular genetic data on the study of the role of polymorphism of the genes of the renin-angiotensin system - ADD1, AGT, AGTR1, AGTR2, CYP11B2, GNB3, NOS3 in children with essential arterial hypertension, taking into account the results of daily monitoring of blood pressure. The main group consisted of 16 children (13 boys and 3 girls) aged 13 to 17 years with essential arterial hypertension. This study indicates a significant contribution of genetic factors to the development and progression of arterial hypertension in children.*

Keywords: ***c****hildren, essential arterial hypertension, gene polymorphism, ADD1, AGT, AGTR1, AGTR2, CYP11B2, GNB3, NOS3.*

The problem of preventing and predicting the course of essential arterial hypertension in children and adolescents remains relevant [1]. This is primarily due to the high prevalence of the disease, as well as a significant risk of its transformation into coronary heart disease and hypertension, which are the main cause of disability and mortality in the adult population [2, 3, 4]. Arterial hypertension is observed in 2.4-18% of children and adolescents, depending on age [2]. The pathogenesis of arterial hypertension is very complex and includes many aspects that require further study. The mechanisms involved in the development of essential arterial hypertension and participating in the process of its primary compensation are diverse.

Along with the dominant neurogenic theory since the 1950s, the membranous, neurohumoral, renal and a number of other concepts of the pathogenetic mechanisms of the formation of essential arterial hypertension have received wide recognition. At the same time, despite the statement about the multipathogenicity and polyetiology of the disease, many scientists recognize the leading role of the genetic component [5, 6]. Currently, great importance is attached to the study of molecular genetic aspects of arterial hypertension, in particular, the analysis of polymorphism of the genes of proteins of the renin-angiotensin cascade [4]. However, most of these studies were conducted in the adult population, when the onset of pronounced neurohumoral changes makes it difficult to establish relationships between gene polymorphism and the clinical picture [7].

The aim of this work was to study the polymorphism of the genes of the renin-angiotensin-aldosterone system (RAAS) in children with essential arterial hypertension.

Characteristics of children and research methods

We examined 16 children (13 boys and 3 girls) aged 13 to 17 years with essential arterial hypertension (main group), who were treated in the Department of Pediatric Cardiology and Cardiac Surgery of Institute of Emergency and Reconstructive Surgery named after V.K. Gusak. Symptomatic arterial hypertension was excluded based on a combination of clinical, instrumental and laboratory studies. In all children, information was collected on the presence of arterial hypertension and coronary heart disease in relatives by the method of questioning. To verify the diagnosis, all children with elevated blood pressure underwent ambulatory blood pressure monitoring (ABPM) using an apparatus for 24-hour ECG and blood pressure monitoring "Cardiotechnika 4000AD" (Inkart, St. Petersburg) according to the standard method. ABPM allows not only to verify the presence and severity of arterial hypertension, but also to determine the severity of vascular tone disorders. The severity of hypertension was determined based on the magnitude of pressure load in accordance with the National Guidelines for the Diagnosis, Treatment and Prevention of Arterial

Hypertension in Children and Adolescents [1]. The distribution of children into subgroups was carried out taking into account the severity of arterial hypertension (1st-2nd subgroups), as well as depending on the manifestations of arterial hypertension and coronary heart disease in relatives of I (parents) and II (grandparents) degree of kinship. Taking into account this indicator, 2 subgroups of children were identified: 1st - children with labile arterial hypertension, when an increase in blood pressure was recorded during 25-50% of the study time (11 people); 2nd subgroup - children with stable arterial hypertension, with an increase in blood pressure within > 50% of the entire study time (5 children).

The control group consisted of 20 healthy peers (15 boys and 5 girls). In this group, blood pressure was measured using the auscultatory method (method of N.S. Korotkov). For the analysis, we used the arithmetic mean of 3 measurements taken with an interval of 3 minutes, in the position of the subject sitting, on the right hand, after a 5-minute rest. Cuff selection and blood pressure assessment were carried out in accordance with the National Guidelines for the Diagnosis, Treatment and Prevention of Arterial Hypertension in Children and Adolescents [1].

Using the detecting amplifiers "DT-96" and "DTprime" (Russia), all children underwent genetic studies of the polymorphism of the RAAS genes: α-adductin ADD1:1378G>T , angiotensinogen AGT:704T>C and AGT:521C>T, angiotensin II receptor type 1 AGTR1:1166A>C, angiotensin II receptor type 2 AGTR2:1675G>A, aldosterone synthase CYP11B2:344 C>T, guanine-binding protein GNB3:825 C>T, nitric oxide synthase 3 NOS3:786 T >C and NOS3: 894G>T.

Statistical processing of the results of the study was carried out by the methods of variational and alternative statistics using the licensed software package for statistical analysis MedStat. The $\chi 2$ test and the Shapiro-Wilk test were used to test the data distribution for normality. The signs obeyed the law of normal distribution, therefore, parametric criteria were used: to compare quantitative signs, the Student's test was used, pairwise comparison - the Scheffe test. When comparing the frequency of manifestation of signs, the $\chi 2$ test was used. The critical level of significance in testing statistical hypotheses was taken equal to 0.05.

Results and discussion

When studying the representation of genotypes and alleles of the RAAS gene polymorphism in the examined children, taking into account the hereditary history of arterial hypertension, significant differences were found. Thus, in 7 (43.75%) patients, changes in the ADD1:1378G>T gene were detected: the T allele was detected. Patients with these changes have an increased risk of developing salt-sensitive hypertension [8]. When prescribing therapy to

patients with G/T genotypes, one should take into account the fact that calcium channel blockers may not be effective, positive dynamics is observed in the treatment with thiazide diuretics [9]. In 9 (56.25%) children with essential arterial hypertension, we identified the G/G genotype, which was statistically significantly more common than in the control group (2 adolescents, 10.0%, $p<0.01$).

The following changes were observed in the AGT:704T>C gene: allele C was detected in 11 (68.75%) children, which in the future can lead to the development of target organ damage: left ventricular myocardial hypertrophy, carotid artery damage [8]. It has been proven that the AGT:704T>C polymorphism increases the risk of myocardial infarction in patients with multivessel coronary artery disease and coronary heart disease [10]. Patients with this nucleotide variant have an increased risk of developing nephritis with a progressive decline in renal function and the development of chronic renal failure [9]. When comparing the frequency of alleles and genotypes of the AGT:704T>C gene in children and adolescents with varying degrees of severity of arterial hypertension (according to ABPM data), a significant increase in the frequency of the T allele was noted with a stable form of arterial hypertension [11]. In the study of G.A. Ignatenko et al. [10] proved the association of the T-allele of the AGT gene and predisposition to arterial hypertension. G.I. Exemplary et al. [11] established a relationship between the carriage of the T allele and a higher level of blood pressure. In the study of polymorphic variants of the angiotensin gene in children with arterial hypertension with a aggravated family history of arterial hypertension, the predominance of the T allele was also noted. According to the results of our study, 5 (31.25%) adolescents with stable arterial hypertension revealed a normal variant of the polymorphism in the homozygous T/T form.

In 5 (31.25%) children, we detected a heterozygous form of the AGT:521C>T polymorphism with a predominance of the T allele whose grandparents had normal blood pressure). Children with stable arterial hypertension predominated (60.0%).

We performed a similar analysis in the AGTR1:1166A>C gene: in 8 (50.0%) patients, the A/C genotype associated with arterial hypertension (changes in the functional activity of the receptor) was detected, which was statistically significantly more frequent than in healthy peers (3 adolescents, 15.0%, $p<0.01$). Patients with this polymorphism have an increased risk of dysregulation of vascular tone and proliferation of vascular wall elements. Thus, in diabetes mellitus, the risk of developing these changes increases by 3.6 times, there is a 2-fold increase in the risk of developing diabetic nephropathy, progression of interstitial nephritis to the stage of chronic renal failure [6]. 7 (43.75%) children with labile arterial hypertension and 1 (6.25%) adolescent with stable arterial hypertension had disorders of vascular

tone of varying severity according to ABPM data in our study. In 8 (50.0%) children in AGTR1:1166A>C, the A/A genotype was detected, not associated with arterial hypertension. When analyzing the allele frequency and distribution of genotypes of the AGTR1:1166A>C polymorphism in the group of children with arterial hypertension, taking into account the hereditary predisposition to arterial hypertension and coronary heart disease, it was found that in children with relatives with arterial hypertension and coronary heart disease, AGTR1:1166A >C, the A/A genotype was detected, which was statistically significantly more frequent ($p<0.05$) than in children without a burdened family history.

Analysis of the AGTR2:1675G>A gene in 8 (50.0%) patients revealed the G/A genotype associated with arterial hypertension, which increases the risk of coronary heart disease. 4 (25.0%) patients had stable arterial hypertension, 4 (25.0%) adolescents had labile arterial hypertension. In 2 (12.5%) children, the G/G genotype, not associated with arterial hypertension, was determined.

In 9 (56.25%) children, changes in the CYP11B2:344 C>T gene were observed: the T allele, which is associated with the development of arterial hypertension, predominated (increased gene expression, increased basal aldosterone production). Patients with the C/T genotype have a higher risk of developing and progressing to renal failure. An association of the C/T genotype with an increase in myocardial mass and dilatation of the left ventricular cavity has been described [9]. The C/T genotype for the CYP11B2:344 gene was observed in 5 (31.25%) children with stable arterial hypertension and 4 (25.0%) adolescents with labile arterial hypertension. The C/T genotype increases the risk of developing hypertensive complications of pregnancy and placental insufficiency [4]. In 5 (31.25%) children with labile arterial hypertension, the T/T genotype for the CYP11B2:344 gene was detected, which is also associated with arterial hypertension. In 2 (12.5%) adolescents with arterial hypertension and in 2 (10.0%) healthy children, the C/C genotype was found not associated with arterial hypertension.

In 9 (56.25%) patients, we found changes in the GNB3:825C>T gene: the T allele predominated, which can lead to a change in the protein structure and its functional activity. These changes are associated with low renin activity in arterial hypertension [9]. Patients have an increased risk of postprandial distress syndrome, left ventricular myocardial hypertrophy, and type 2 diabetes mellitus increases the risk of developing diabetic nephropathy [6]. Among the patients, children with stable arterial hypertension predominated 9 people (56.25%). In 7 (43.75%) patients with labile arterial hypertension and in all healthy children, no changes in the GNB3:825C>T gene were detected.

In 7 (43.75%) patients with stable arterial hypertension, changes in the NOS3:786 T>C gene were detected: the predominance of the C allele was revealed, as a result of which in this group of children there is an increased risk of coronary spasm,

vasospastic angina, myocardial infarction, increased tone of the coronary arteries [11]. In the control group, these polymorphic changes in the NOS3:786 T>C gene were absent.

Conclusion

This study indicates a significant contribution of genetic factors to the development and formation of essential arterial hypertension in children. Polymorphism of genes of the renin-angiotensin-aldosterone system was statistically significantly more often observed in children with essential arterial hypertension in comparison with healthy peers. Thus, the heterozygous form of the T>C polymorphism in the AGT AGT:704T>C gene was found in 11 (68.75%) patients, the heterozygous form of the AGT:521C>T C polymorphism in this gene was found in 5 (31.25%), A/ C-genotype for the AGTR1:1166 gene - in 8 (50.0%), G/A-genotype for the AGTR2:1675G>A gene - in 6 (37.5%), C/T-genotype for the CYP11B2:344 gene – in 9 (56.25%), C/T genotype for the GNB3:825 gene – in 9 (56.25%), T/C genotype for the NOS3:786 gene – in 7 (43.75%). These changes were more often noted in children with stable arterial hypertension, in patients with hereditary burden of arterial hypertension and coronary heart disease. This suggests that with a timely study of gene polymorphism, it is possible to select adequate treatment tactics and reduce the progression of arterial hypertension and the risk of complications.

References

1. National guidelines for the diagnosis, treatment and prevention of hypertension in children and adolescents. - Recommendations of the IOC, the Russian medical society for arterial hypertension and the Association of pediatric cardiologists of Russia. Kardiovaskulyarnaya terapiya i profilaktika 2015; 8(4): 1-36. (in Russ.)]

2. Rotar O. P. Prevalence of metabolic syndrome in different cities of the Russian Federation. Rossiyskiy kardiologicheskiy zhurnal 2012; 2: 55-62. (in Russ.)

3. Edleyeva A. G., Khomich M. M., Volkov N. Yu., Leonova I. A., Yuryev V. V. Assessment of body composition as a way to identify predictors of metabolic syndrome in children. Profilakticheskaya i klinicheskaya meditsina 2010; 3-4 (36-37): 183-186. (in Russ.)

4. Glotov A. S. Vashukova E. S., Kanaeva M. D., Dvoeglazova M. O., Danilova M. M., Pakin V. S. et. al. Study of Association of polymorphism of APOE, LPL and NOS3 genes with risk of vascular pathology in children and pregnant women. Ekologicheskaya genetika 2011; 9(4): 25-34. (in Russ.)

5. Baudin B. Polymorphism in angiotensin II receptor genes and hypertension. Experimental Physiology 2005; 90(3): 277 – 282. DOI: 10.1113/expphysiol.2004.0284566

6. Kuznetsova T.Yu. Gavrilov D.V., Dudanov I.P. Effect of polymorphisms of the gene of endothelial NO-synthase and NADPH-oxidase on the development of complications of arterial hypertension. Kardiologiya 2008; 48(3): 27-33. (in Russ.)

7. Speicher M.R., Antonarakis S.E., Motulsky A.G. Vogel and Motulsky's Human Genetics: Problems and Approaches (Re-post). Springer, 2010; 981-983. DOI: 10.1186/1479-7364-5-1-73

8. Williams J.S., Hopkins P.N., Jeunemaitre X., Brown N.J. CYP4A11 T8590C polymorphism, salt-sensitive hypertension, and renal blood flow. J Hypertens 2011; 29: 1913 – 1918. DOI: 10.1097/HJH.0b013e32834aa786

9. Porto P.I., Garcia S.I., Dieuzeide G. Renin-angiotensin-aldosterone system loci and multilocus interactions in young-onset essential hypertension. Clin Exp Hypertens 2015; 25(2): 117 – 130. DOI: 10.1081/ceh-120017932

10. Ignatenko G.A., Dzhodzhua R.A., Muhin I.V., Ignatenko T.S., Gavrilyak V.G. Clinical course of hypertensive syndrome in young patients with genetic polymorphism. Problemy ekologicheskoj i medicinskoj genetiki i klinicheskoj immunologii 2019; 4(154): 60-66. (in Russ.)]

11. Obrazcova G.I., YUr'ev V.V. Genetic aspects of the formation of arterial hypertension in children. Molekulyarnaya meditsina 2013; 3: 32-35. (in Russ.)]

Conflict of interest:

The authors of this article confirmed the lack of conflict of interest and financial support, which should be reported.

DOI 10.34660/INF.2023.39.38.067

THE IMPORTANCE OF HAND HYGIENE OF MEDICAL PERSONNEL IN THE PREVENTION OF HAI

Smetanin Viktor Nikolaevich
Candidate of Medical Sciences, Associate Professor
Ryazan State Medical University named after Academician I.P. Pavlova

Summary. *The article presents the results of a study aimed at substantiating hand hygiene in medical organizations as the most effective measure for preventing HAI in the framework of the implementation of the National Concept for the Prevention of Infections Associated with Medical Care (approved by the Chief State Sanitary Doctor of the Russian Federation on November 6, 2011). It was found that healthcare-associated infections (HAIs) are an urgent problem of modern Russian healthcare. The main causes of HAI are insufficiently effective infection control methods in medical organizations and the overuse of antimicrobials. In the course of the study, such methods as content analysis, literature review, ranking, hypothetical-deductive method, generalization, formalization were used. The materials used were articles published in international bibliographic and abstract databases (Scopus, PubMed); official documents of the Russian Federation, as well as international documents (legislative acts, programs, conventions, etc.) on the issues of infections associated with the provision of medical care. The performed systematic literature analysis suggests that one of the main measures to prevent HAI is hand hygiene. It was found that the maximum result in the prevention of HAI can be achieved through the implementation of a multimodal approach. Based on available scientific research, 5 key points have been identified when hand hygiene is mandatory for healthcare professionals. It was concluded that HAI prevention should be multimodal, with successful implementation of HAI prevention requiring cultural shifts at the hospital level, and coordination at the national level is needed to address the serious threat posed by HAI.*

Keywords: *healthcare-associated infections, hand hygiene, prevention, room cleaning, infection prevention concept*

Relevance of the problem

Health care-associated infections (HAIs) are infections that a patient gets while being treated in a health care setting, such as a hospital, or as a result of an

infection from a healthcare worker, such as a doctor or nurse. Health care-acquired infections can enter the body through portals such as the bloodstream, lungs, skin, urinary tract, or digestive tract, causing serious illness. These infections are difficult to treat and can persist in the body for a long time. In the worst cases, infections of this group lead to death [1, 2].

The main causes of HAI are insufficiently effective infection control methods in medical organizations and the overuse of antimicrobials. In the long term, the reduction of HAI levels depends on the implementation of multimodal prevention strategies that require behavioral and cultural changes. Key components of such strategies include identification of carriers of multidrug-resistant organisms, elimination of environmental reservoirs, measures to control cross-transmission, and evidence-based use of antimicrobials. These measures must be implemented within the framework of individual responsibility, strong administrative support and access to up-to-date national and local surveillance data [3].

Treatment of HAI is exacerbated by rising levels of antimicrobial resistance. Health care workers and contaminated hospital environments are increasingly causing the transmission and persistence of multidrug-resistant organisms, as well as other pathogens such as Clostridium difficile. This determines the relevance of focusing on a number of measures for the prevention of HAI.

The purpose of this study is to substantiate hand hygiene in medical organizations as the most effective measure for preventing HAI in the framework of the implementation of the National Concept for the Prevention of Infections Associated with Medical Care (approved by the Chief State Sanitary Doctor of the Russian Federation on November 6, 2011).

Materials and methods

To achieve this goal, such methods as content analysis, literature review, ranking, hypothetical-deductive method, generalization, formalization were used.

The materials used were articles published in international bibliographic and abstract databases (Scopus, PubMed); official documents of the Russian Federation, as well as international documents (legislative acts, programs, conventions, etc.) on the issues of infections associated with the provision of medical care 20 domestic and foreign sources were cited.

Results

The main components of HAI prevention have been found to include:

1. antimicrobial management to reduce overuse of antimicrobials and ensure evidence-based use of antimicrobials;

2. Infection prevention strategies to control multi-resistant to - especially methicillin-resistant Staphylococcus aureus, vancomycin-resistant Enterococcus spp. (VRE organisms) and, more recently, multiresistant gram-negative bacteria;

3. cleaning and disinfection of hospitals;

4. Development of prescription guidelines and standards of care [4, 5, 6].

At the same time, the main preventive measures recommended for patients in order to avoid infection are:

- Mandatory hand washing by the patient himself or the use of liquid, gel hand sanitizers.
- Handwashing by healthcare workers prior to handling or use of liquid and/or gel hand sanitizers;
- Taking antibiotics only as prescribed by a doctor;
- Taking antibiotics strictly according to the doctor's instructions, while completing the course it is necessary strictly in accordance with the purpose;
- When taking antibiotics or painkillers, care must be taken to protect the digestive tract from side effects;
- Knowledge of the rights of the patient [7, 8].

Available studies suggest that Clostridium difficile is one of the most common causative agents of HAIs, with an annual incidence of 3.65 per 10,000 bed-days and a relative mortality rate of 6–7% per 30 days. The profile of Clostridium difficile has increased in recent decades. Between 1999 and 2013 a hypervirulent strain of C. difficile (ribotype 027), which causes high morbidity among the elderly, has become endemic in hospitals in North America and the Great Britain. The factors of its appearance were the poor practice of prescribing antibiotics, especially fluoroquinolones, inadequate environmental and hand hygiene, these shortcomings are also characteristic of modern Russian healthcare [9, 10, 11].

Complicating the epidemiology is that, according to experts and available research data, up to 1/3 of new infections caused by Clostridium difficile occur outside the home; only 35% of inpatient cases of Clostridium difficile infection were associated with other hospital cases when examined by whole genome sequencing [12, 13].

Available research data indicate that viable HAI spores have been isolated from 49% of surfaces surrounding patients in healthcare settings, including high-touch areas such as call buttons and bed rails, reflecting the ability of pathogens to resist drying out and survive on hard surfaces. At the same time, other factors, including aerosolization of spores after flushing in toilets and the release of asymptomatic carriers, further contribute to the environmental pollution of medical organizations [14, 15].

Patients admitted to a room previously occupied by C. difficile patients have an increased risk of acquiring HAI despite proper cleaning. For asymptomatic carriers of viable C. difficile spores, the pathogen has been found to contaminate 29% of surrounding surfaces, it is currently unclear whether standard bleach cleaning and standard contact precautions should be implemented in such cases, or whether a special specialized algorithm is needed [16].

C. difficile spores, the main causative agent of HAIs, have now been found to be resistant to standard hospital decontamination methods, including alcohol-based hand rubs and common disinfectants (quaternary ammonium compounds). To minimize pathogen transmission, patient care packages should include contact precautions, use of special patient equipment, regular bleach cleaning, and hand hygiene using soap and water [17].

The performed systematic literature analysis suggests that one of the main measures to prevent HAI is hand hygiene. At the same time, the maximum result in the course of HAI prevention can be achieved through the implementation of a multimodal approach.

Hand hygiene is a fundamental principle of quality health care. While interventions are often multimodal and direct causal relationships are difficult to prove, epidemiological evidence exists to support the role of hand hygiene in reducing HAI.

For example, between 2002 and 2013 S. aureus bacteremia (SAB) (MRSA and MSSA) with initial manifestations in the hospital decreased by 63%, and a similar decrease was demonstrated in many countries around the world. This decline in HAI has occurred in parallel with national initiatives, leading to the widespread adoption of successful hand hygiene programs. Proper hand hygiene is a core principle in HAI prevention packages and remains a key indicator of hospital safety and quality systems [18].

Infection with HAI pathogens occurs in nosocomial settings through cross-transmission, so hand and environmental hygiene are the main prevention strategies. Health care workers, patients and visitors should be aware of the importance of strict hand hygiene, especially after going to the toilet.

Based on available scientific research, 5 main points have been identified when hand hygiene is mandatory for healthcare workers [19, 20].

1. Before patient contact. Hand hygiene is performed to protect the patient from pathogen colonization and, in some cases, from exogenous infection, harmful microbes carried on the hands. Situations that are included in this paragraph: handshake; assisting the patient in self-care; assistance and other non-invasive therapeutic procedures: applying an oxygen mask, massage, etc.; performing a physical non-invasive examination: measurement of pulse, blood pressure, chest auscultation, ECG recording, etc.

2. Before clean / aseptic procedures. Hand hygiene is performed to protect the patient from being exposed to harmful germs, including his/her own germs entering his/her body. Situations that are included in this paragraph: brushing the patient's teeth, instilling eye drops, performing a digital vaginal or rectal examination, examining the mouth, nose, ear with or without instruments, inserting a suppository/pessary, suctioning the mucosa; wound dressing with or without an

instrument, application of ointment to the vesicle, injections/punctures; introduction of an invasive medical device (nasal cannula, nasogastric tube, endotracheal tube, urinary tube, catheter, drainage); cooking, drugs, pharmaceutical products, sterile materials.

3. Contact with biological fluids. Hand hygiene is performed to protect the healthcare worker from colonizing or infecting the patient with harmful microbes and to protect the healthcare environment from the spread of germs. Situations that are included in this paragraph: contact with the mucous membrane and with intact skin; performing an injection or puncture; introduction of an invasive medical device (vascular access, catheter, tube, drainage, etc.); removal of an invasive medical device; removal of any material that provides protection (napkin, bandage, gauze, sanitary napkin, etc.); dealing with a sample containing organic matter after cleaning excrement and any other biological fluids after cleaning any contaminated surface and contaminated material (dirty bedding, dentures, tools, urinal, bedpan, toilet bowls, etc.).

4. After contact with the patient. Hand hygiene is performed to protect the healthcare worker from infection with pathogenic microbes and to protect the environment of the healthcare facility from the spread of germs. Situations that are included in this paragraph: after shaking hands, stroking the child on the forehead; after helping the patient in self-care; after assistance and other non-invasive treatment; after a non-invasive examination: measurement of pulse, blood pressure, chest auscultation, ECG recording, etc.

5. After contact with objects surrounding the patient. Hand hygiene is performed to protect the healthcare worker from colonization by disease-causing microbes that may be on surfaces/objects around the patient, as well as to protect the environment of the healthcare facility from the spread of pathogens. Situations that are included in this paragraph: after physical contact with the patient and his/her environment; after the provision of medical care, for example, after setting up equipment; after contact with surfaces or other objects, bed, bedside tables and so on.

When considering hand hygiene, the wearing of gloves deserves special attention. Wearing gloves does not replace the need for good hand hygiene. Hand hygiene should be performed at all times and in other situations, regardless of the indication for the use of gloves. After each use of gloves, throw them away and wash your hands. Gloves are required only when indicated according to established standards – otherwise they become a major risk for germ transmission.

Conclusion

Successful implementation of HAI prevention requires a cultural shift at the hospital level, and national coordination is needed to address the serious threat posed by HAI. Prevention of HAI should be multimodal, with hand hygiene being the most effective intervention.

References

1. Edwards VR. Preventing and managing healthcare-associated infections: linking collective leadership, good management, good data, expertise, and culture change. J Hosp Infect 2016; 94: 30– 31.

2. Abstracts of presentations at a conference with international participation of specialists in infection control associated with the provision of medical care «risk-based technologies for ensuring the epidemiological safety of medical activities» September 27-29, 2017, Perm // MediaAl Journal. 2017. No. 2 (20). URL: https://cyberleninka.ru/article/n/tezisy-vystupleniy-na-konferentsii-s-mezhdunarodnym-uchastiem-spetsialistov-po-kontrolyu-infektsiy-svyazannyh-s-okazaniem-meditsinskoy (Date of access: 01/17/2022).

3. Pakyz AL, Moczygemba LR, VanderWielen LM, Edmond MB, Stevens MP, Kuzel AJ. Facilitators and barriers to implementing antimicrobial stewardship strategies: results from a qualitative study. Am J Infect Control 2014; 42:257–263.

4. Kuzin A.A., Svistunov S.A., Zharkov D.A., Belov A.B. Theoretical ideas about the epidemiology of infections associated with the provision of medical care // Perm Medical Journal. 2017. No. 4. pp. 10-17. URL: https://cyberleninka.ru/article/n/teoreticheskie-predstavleniya-ob-epidemiologii-infektsiy-svyazannyh-s-okazaniem-meditsinskoy-pomoschi (date of access: 01/19/2022).

5. Grayson ML, Macesic N, Huang GK, Bond K, Fletcher J, Gilbert GL et al. Use of an innovative-mindset profiling tool to guide culture-change strategies among different healthcare worker groups. PLoS One 2015; 10: e0140509.

6. Entesari-Tatafi D, Orford N, Bailey MJ, Chonghaile MN, Lamb-Jenkins J, Athan E. Effectiveness of a care bundle to reduce central line-associated bloodstream infections. Med JAust 2015; 202:247–250.

7. Brusina E.B., Zueva L.P., Kovalishena O.V., Stasenko V.L., Feldblyum I.V., Briko N.I., Akimkin V.G. Health Care Associated Infections: The Modern Doctrine of Prevention Part 2. Key Points. Epidemiology and vaccination. 2018. No. 6 (103). URL: https://cyberleninka.ru/article/n/infektsii-svyazannye-s-okazaniem-meditsinskoy-pomoschi-sovremennaya-doktrina-profilaktiki-chast-2-osnovnye-polozheniya (date of access: 01/19/2022).

8. Zueva N.G. Ways to improve the quality of anti-infective treatment and protect the hands of obstetric hospital staff: Abstract of thes. Cand. of Medical Sciences. Sciences. Perm 2012; 24.

9. Mitchell BG, Ware C, McGregor A, Brown S, Wells A. ASID (HICSIG)/ AICA position statement: preventing catheter-associated urinary tract infections in patients. Healthcare Infection 2011; 16: 45– 52.

10. Bode LG, Kluytmans JA, Wertheim HF, Bogaers D, Vandenbroucke-Grauls CM, Roosendaal R et al. Preventing surgical-site infections in nasal carriers of Staphylococcus aureus. N Engl J Med 2010; 362: 9– 17.

11. Perl TM, Cullen JJ, Wenzel RP, Zimmerman MB, Pfaller MA, Sheppard D et al. Intranasal mupirocin to prevent postoperative Staphylococcus aureus infections. N Engl J Med 2002; 346: 1871– 1877.

12. Harris AD, Pineles L, Belton B, Johnson JK, Shardell M, Loeb M et al. Universal glove and gown use and acquisition of antibiotic-resistant bacteria in the ICU: a randomized trial. JAMA 2013; 310: 1571– 1580.

13. Abad C, Fearday A, Safdar N. Adverse effects of isolation in hospitalised patients: a systematic review. J Hosp Infect 2010; 76: 97– 102.

14. Freedberg DE, Salmasian H, Cohen B, Abrams JA, Larson EL. Receipt of antibiotics in hospitalized patients and risk for Clostridium difficile infection in subsequent patients who occupy the same bed. JAMA Intern Med 2016; 176: 1801– 1808.

15. Abreu AC, Tavares RR, Borges A, Mergulhão F, Simões M. Current and emergent strategies for disinfection of hospital environments. J Antimicrob Chemother 2013; 68: 2718– 2732.

16. Rubin ZA, Murthy RK. Outbreaks associated with duodenoscopes: new challenges and controversies. Curr Opin Infect Dis 2016; 29: 407– 414.

17. Otter JA, Burgess P, Davies F, Mookerjee S, Singleton J, Gilchrist M et al. Counting the cost of an outbreak of carbapenemase-producing Enterobacteriaceae: an economic evaluation from a hospital perspective. Clin Microbiol Infect 2016; 23: 188– 96.

18. Leffler DA, Lamont JT. Clostridium difficile infection. N Engl J Med 2015; 372: 1539– 48.

19. Колозян Д.А., Гусаров В.Г., Стойко Ю.М., Левчук А.Л., Максименков А.В. профилактика и терапия гнойно-септических осложнений у колопроктологических больных. Вестник Национального медико-хирургического Центра им. Н. И. Пирогова. 2019. №2. С.105-114. URL: https://cyberleninka.ru/article/n/profilaktika-i-terapiya-gnoyno-septicheskih-oslozhneniy-u-koloproktologicheskih-bolnyh (дата обращения: 19.01.2022).

20. Eyre DW, Cule ML, Wilson DJ, Griffiths D, Vaughan A, O'Connor L et al. Diverse sources of C. difficile infection identified on whole-genome sequencing. N Engl J Med 2013; 369: 1195– 205.

DOI 10.34660/INF.2023.10.78.068

THE ROLE OF DIET OF ATHLETES IN MAINTAINING THE QUALITATIVE AND QUANTITATIVE COMPOSITION OF THE MICROBIOME

Kobelkova Irina Vitalievna
Senior Researcher, Candidate of Medical Sciences
Federal Research Center for Nutrition, Biotechnology and Food Safety, Moscow, Russia
Associate Professor
Federal Scientific and Clinical Center of the Federal Medical and Biological Agency of Russia, Moscow, Russia

Korosteleva Margarita Mikhailovna
Senior Researcher, Candidate of Medical Sciences
Federal Research Center for Nutrition, Biotechnology and Food Safety, Moscow, Russia
Associate Professor
RUDN University, Moscow, Russia

Nikityuk Dmitry Borisovich
Academician of the Russian Academy of Sciences, Director
Federal Research Center for Nutrition, Biotechnology and Food Safety, Moscow, Russia

Annotation. *The nature of the diet has a great influence on the microbial diversity of the gastrointestinal tract. The results of studying the actual nutrition of 25 students-basketball players by the frequency method are presented. The energy value of the diet was 3166±484 kcal/day, proteins accounted for 16% of the daily calorie content, fats - 44%, carbohydrates - 40%. A high consumption of saturated fatty acids was noted against the background of a low content of polyunsaturated fatty acids n-3 in the diet. The frequency of consumption of bakery products, potatoes, vegetables, fruits and fish was low, meat and meat products were in line with the recommended, and confectionery products were excessive. Optimization of the diet by reducing the amount of fats, increasing carbohydrates, including dietary fiber, will positively affect the composition of the intestinal microbiome, and the high species diversity of microflora, in turn, will contribute to the formation of adaptation to training and improve sports performance.*

Keywords: *nutrition, athletes, adaptive potential, microbe, lipid component, dietary fiber*

The microbial diversity of elite athletes is positively correlated with levels of protein intake and physical activity. A high-fat, carbohydrate-restricted diet leads to an increase in ketone body synthesis and can affect the composition of the gut microbiome, disrupting the balance of pro- and anti-inflammatory markers. Consumption of saturated and monounsaturated fatty acids is associated with a decrease in microbiome diversity. Excess consumption of simple carbohydrates and a suboptimal fructose-to-glucose ratio cause gastrointestinal distress. Lactose contributes to a positive effect on the intestinal microbiome: an increase in Bifidobacterium and Lactobacterium. Polyunsaturated fatty acids (PUFAs) reduce the Firmicutes/Bacteroidetes ratio, Coprococcus and Faecalibacterium levels, but increase Bifidobacterium, Lachnospiraceae and other butyrate-producing microorganisms that can have an anti-inflammatory effect through their influence on prostaglandin synthesis. Plasma levels of ω-3 PUFA are positively correlated with the content of Lachnospiraceae, which produce short-chain fatty acids - substrates for oxidation. ω-3 PUFAs modulate the composition of the gut microbiome and it has been proposed to classify them as prebiotics [1].

In elite sports, the correction of the parameters of the intestinal microbiome and adaptive potential by optimizing the diet seems to be extremely relevant. A comprehensive examination of highly qualified athletes on the basis of the Federal State Budgetary Institution “Federal Research Center for Nutrition and Biotechnology”, Moscow, Russian Federation, included the study of actual nutrition, indicators of nutritional and basic parameters of the microbiome, and genetic markers of alimentary-dependent diseases. This publication only considers data obtained from the evaluation of the main diet, without taking into account specialized foods that were not consumed by all athletes.

To assess the nature of the fat component, the actual nutrition of 25 basketball players, students of the Moscow State Academy of Physical Education and Sports (age 20.9 ± 1.8 years) was studied by the frequency method using a computer program.

Table 1

Results of studying the actual nutrition of basketball players by the frequency method (M±m, n=25)

Indicators	Absolute, M±m, kcal(g)/day	kcal(g)/kg BW*/day	Norms of physiological need
Energy value	3205±520	39±7	3250÷3800
Proteins	135±36	1,6±0,5	102÷114

Fats	155±25	1,9±0,4	108÷127
Carbohydrates	317±72	3,8±0,9	467÷551
Dietary fiber	5,4±1,7	-	20-25

*BW - body weight, kg

The nutritional and energy value of the diet, including the content of vitamins, macro- and microelements, depends on the variety and quantity of the main food groups in the athlete's diet. It was found that the average consumption of some food groups differed significantly from the recommended levels (RU) **(Order of the Ministry of Sports of Russia (Ministry of Sports of the Russian Federation) dated October 30, 2015 No. Federation"). The total bread intake compared to the recommended levels of 150 g/d wheat and 150 g/d rye bread was low at 54±23 g/d, as well as a fruit content of 76±34 g/d (RD 450 g/d), fresh vegetables and herbs, not counting potatoes - 167±55 g/day (RU 300 g/day) and fish 11±9 g/day (RU 70 g/day).

The main sources of fat and protein were sausages, meat and chicken eggs. More than half of the carbohydrates consumed came from sugary sodas, confectionery, juices and fruits. A low dietary fiber intake can impair gastrointestinal motility, and these nutrients are prebiotics and help optimize gut microbiome diversity, which in turn affects an athlete's adaptive capacity and professional performance. It should be noted that the consumption of confectionery products containing added sugar is quite high, which can cause sharp fluctuations in blood glucose levels, and the onset of fatigue associated with its subsequent drop [2].

An assessment of the actual nutrition of basketball players for the month preceding the survey showed a moderate level of energy value of the diet of 3166±484 kcal/day, while proteins accounted for 16%, fats - 44%, carbohydrates - 40% of the daily calorie content.

Representatives of various sports do not have exact recommendations on justifying the physiological need for nutrients, but most literature sources indicate that fats should not exceed 30% of the energy value of the diet (EC). We have found that the recommended level of fats in the diet of basketball players is 1.4 times on average, and maximum 1.7 times. An excessive intake of cholesterol (560±292 mg/day) was revealed, which subsequently, with a decrease in the level of physical activity and the preservation of eating habits, can become a risk factor for the development of metabolic syndrome and cardiovascular diseases [3].

It was found that the content of saturated fatty acids was higher than the recommended norms of physiological need and amounted to 16.6% of the EC of the diet (RU < 10%), the content of polyunsaturated fatty acids, incl. ω-3 of the family was low 6% EC, but within the RR (5-8% EC) and 3 ± 0.9 g/day or 0.8% of the EC (RR 1-2%). Thus, the fatty acid profile of the diet of the examined

basketball players is extremely unbalanced and creates prerequisites not only for the development of cardiovascular diseases and metabolic syndrome, but also for dysbiotic changes in the intestinal microflora.

It is known that a dysbiotically altered profile of the intestinal microbiome is associated with common non-communicable diseases. The "Western" type of diet, characterized by a high content of saturated fats and simple sugars against a background of a low amount of dietary fiber, is associated with an increase in the Firmicutes / Bacteroidetes ratio and an increase in Proteobacteria, Mollicutes and Bilophila wadsworthia, a decrease in Akkermansia and Faecalibacterium. The athlete microbiome is characterized by an increase in Bacteroidetes (Prevotella), and a decrease in Firmicutes (Veillonellaceae), as well as Methanobevibacter and Akkermansia.

Conclusions: It is necessary to correct the lipid and carbohydrate components of the diet by reducing the frequency of consumption of foods high in saturated fats (meat deli, sausages) and added sugar (carbonated/non-carbonated sweet drinks and confectionery), while increasing the consumption of fish, vegetable oils and vegetables will increase the species diversity of the microbiome and optimize the adaptive potential of athletes. It is possible to optimize the diet by introducing specialized food products and biologically active food supplements - sources of ω-3 PUFAs into the diet in order to improve health and professional performance.

References

1. Wolters M, Ahrens J, Romaní-Pérez M, Watkins C, Sanz Y, Benítez-Páez A, Stanton C, Günther K./ Dietary fat, the gut microbiota, and metabolic health - A systematic review conducted within the MyNewGut project.// Clin Nutr.- 2019. - №38(6. – P. 2504-2520. doi: 10.1016/j.clnu.2018.12.024.

2. Davis JK, Oikawa SY, Halson S, Stephens J, O'Riordan S, Luhrs K, Sopena B, Baker LB. In-Season Nutrition Strategies and Recovery Modalities to Enhance Recovery for Basketball Players: A Narrative Review. Sports Med. 2022 May;52(5):971-993. doi: 10.1007/s40279-021-01606-7.

3. Kobelkova I V, Korosteleva M M, Nikityuk D B. The main deviations from the principles of balanced nutrition of athletes of some kinds of sport. Proceedings of the International University Scientific Forum "Practice Oriented Science: UAE – RUSSIA – INDIA". (October 12, 2022. UAE) ISBN 978-5-905695-87-5 P 79-83

DOI 10.34660/INF.2023.94.79.069

EXPERIENCE IN THE TREATMENT OF PROSTATE CANCER IN PATIENTS OF THE FEFU MEDICAL CENTER USING HIFU THERAPY

Pronyagin Sergey Viktorovich
Head of the Department of Oncourology
Center for Surgery, Medical Center, Far Eastern Federal University

Grebneva Anastasia Viktorovna
Urologist
Center for Surgery, Medical Center, Far Eastern Federal University

Lonshakov Konstantin Andreevich
student
Far Eastern Federal University

Reva Galina Vitalievna
Doctor of Medical Sciences, Full Professor
Far Eastern Federal University

Abstract. *The work is devoted to the study of prostate cancer and the development of optimal effective methods of treatment with the prediction of relapses. It has been established that the results of the treatment of prostate cancer in patients of the FEFU Medical Center using HIFU therapy against the background of conservative treatment of patients with the use of antiangiogenic drugs make it possible to obtain a higher treatment efficiency, accompanied by a decrease in the complications of prostate cancer. It has been established that the applied HIFU-therapy for localized tumors allows not only to reduce the duration of treatment, is aimed not only at the death of cancer cells, but also contributes to the inhibition of angiogenesis in tumors.*

Keywords: *Prostate cancer, angiogenesis, malignancy, HIFU therapy, anti-angiogenic drugs, treatment.*

Relevance

Job Analysis Karwacki J., Kiełbik A., Szlasa W., Sauer N., et al., (2022) [1], Shoji S., Koizumi N., Yuzuriha S., Kano T., et al., (2001) [8] и 6. Schatten H. (2018) [6], showed that the level of blood supply significantly affects the

progression of tumor growth in various visceral systems of the human body. In the structure of the pathology of cancer of the prostate, it ranks third in terms of the number of oncological diseases in men, yielding the leading position only to lung cancer, which indicates the high relevance of studying this problem [1, 2, 4, 9]. Although the IARC notes a decrease in mortality from prostate cancer in some developed countries, nevertheless, the overall global trend observed in the whole world of a steady increase in the number of prostate cancers from 2008 from 9452 deaths to more than 1500 in 2021 requires that the search for scientific solutions to this problem be directed to develop new effective strategies with exhaustive pathogenetic substantiation [5].

Sebesta E.M., Anderson C.B. (2018) [7] consider that prostate cancer is a heterogeneous disease with a variable course, in which optimal treatment is a challenge. Aggressive local therapy and radical prostatectomy are associated with a reduction in mortality and metastasis, which offers advantages over radiation therapy. However, it should be borne in mind that any aggressive prostate cancer therapy negatively affects erectile function and urinary retention. Deciding which treatment to choose, which should include collaborative decision making and take into account cancer risk and severity in addition to patient preference, has shaped the direction of our research.

Purpose of the study

To study the results of treatment of prostate cancer in patients of the FEFU Medical Center using HIFU therapy against the background of conservative treatment of patients with the use of antiangiogenic drugs in order to increase the effectiveness of treatment and reduce complications of prostate cancer.

Material and methods

The analysis of the results of HIFU therapy using the Sonablate 500 apparatus in the treatment of prostate cancer in 35 patients over 60 years of age in combination with antiangiogenic therapy against the background of the use of antibacterial and anti-inflammatory nonsteroidal drugs was carried out.

Results and its discussion

The methods of conservative treatment of prostate cancer using inhibitors of endothelial cell proliferation with antiangiogenic drugs that are available in the modern arsenal of oncourology lead to a temporary cessation of the growth of not only primary tumors, but also metastases, since due to long-term therapy, endothelial cells acquire tolerance to the action of antiangiogenic drugs. A new approach to the treatment of prostate cancer using antitumor HIFU - therapy (High Intensity Focused Ultrasound), based on high-intensity focused ultrasound, showed a decrease in the number of relapses of prostate cancer and complications during the treatment. In the case of a localized tumor, a high efficiency of treatment was achieved, aimed not only at the death of cancer cells, but also at the destruction

of the blood vessels of the tumor. In those cases when malignant cells were not only located in the perivascular spaces, but also appeared in the blood, and also metastasized to the lymph nodes and other organs with the formation of secondary tumors, HIFU therapy was necessarily combined with antiangiogenic and immunotherapy, which showed this method as the most effective and promising strategy in the conservative treatment of prostate cancer.

Mazzucchelli R., Scarpelli M., Cheng L., (2009) defined ablation with focal prostate therapy to eradicate monofocal cancer as a treatment for low risk of recurrence while preserving unaffected surrounding prostate tissue and therefore higher later on. quality of life [3]. The main arguments against focal therapy are related to the possible error in staging and multifocality. The under-staging argument highlights the importance of the occasional but unpleasant finding of a large extra-prostatic or high-grade tumor in about 25% of radical prostatectomy cases. Analysis of study data shows that 83% of all prostate cancers are multifocal, suggesting the need for additional testing. with repeated biopsy and magnetic resonance imaging (MRI) of the prostate. Ultrasound-guided high-intensity focused ultrasound (HIFU), photodynamic therapy using newly developed photosensitive agents, and MRI-guided HIFU are promising new tools.

It is assumed that such combined therapy will not only counteract immune tolerance to self antigens and resistance to antiangiogenic drugs, but also promote the elimination of endothelial cells under conditions of tumor angiogenesis due to the activation of immunocytes/macrophages. It has been established that the density of microvasculature vessels (MCR) correlates with the malignant potential of tumors and the survival of patients. Vascular endothelial growth factors (VEGF)-A, VEGF-C and VEGF-D can modulate MCR. Therefore, one of the strategies for the treatment of malignant neoplasms should be aimed at suppressing angiogenesis through the inhibition of endothelial growth factors, not only with the help of drugs, but also with physical methods.

Conclusion

Our results show that the study of the features of MCB in prostate cancer biopsies are promising criteria for choosing postoperative management and treatment strategies for patients with prostate cancer. Activation of angiogenesis, as a response to hypoxia, can be suppressed by non-steroidal anti-inflammatory drugs, antihistamines, progestogens, calcium channel blockers, anticoagulants, antibiotics that have an antiangiogenic effect through a direct effect directly on angiogenesis mediators, or indirectly, realized through a decrease in inflammation. The advantages of this method are their less aggressiveness in comparison with the use of chemotherapy treatment of cancer patients, reducing the length of stay in the hospital.

References

1. Karwacki J., Kiełbik A., Szlasa W., Sauer N., Kowalczyk K., Krajewski W., Saczko J., Kulbacka J., Szydełko T., Małkiewicz B. Boosting the Immune Response-Combining Local and Immune Therapy for Prostate Cancer Treatment. Cells. 2022 Sep 7;11(18):2793. doi: 10.3390/cells11182793.

2. Lopez W., Nguyen N., Cao J., Eddow C., Shung K.K., Lee N.S., Chow M.S.S. Ultrasound Therapy, Chemotherapy and Their Combination for Prostate Cancer. Technol Cancer Res Treat. 2021 Jan-Dec;20:15330338211011965 doi: 10.1177/15330338211011965.

3. Mazzucchelli R., Scarpelli M., Cheng L., Lopez-Beltran A., Galosi A.B., Kirkali Z., Montironi R. Pathology of prostate cancer and focal therapy ('male lumpectomy'). Anticancer Res. 2009 Dec;29(12):5155-61.

4. Nguyen-Nielsen M., Borre M. Diagnostic and Therapeutic Strategies for Prostate Cancer. Semin Nucl Med. 2016 Nov;46(6):484-490. doi: 10.1053/j.semnuclmed.2016.07.002.

5. Prostate cancer. Nurs Stand. 2016 Jun 1;30(40):17. doi: 10.7748/ns.30.40.17.s20.

6. Schatten H. Brief Overview of Prostate Cancer Statistics, Grading, Diagnosis and Treatment Strategies. Adv Exp Med Biol. 2018;1095:1-14. doi: 10.1007/978-3-319-95693-0_1.

7. Sebesta E.M., Anderson C.B. The Surgical Management of Prostate Cancer. Semin Oncol. 2017 Oct;44(5):347-357. doi: 10.1053/j.seminoncol.2018.01.003.

8. Shoji S., Koizumi N., Yuzuriha S., Kano T., Ogawa T., Nakano M., Kawakami M., Nitta M., Hasegawa M., Miyajima A.. Development and future prospective of treatment for localized prostate cancer with high-intensity focused ultrasound. J Med Ultrason (2001). 2022 Jan 15. doi: 10.1007/s10396-021-01183-2.

9. Wang G., Zhao D., Spring D.J., DePinho R..A.. Genetics and biology of prostate cancer. Genes Dev. 2018 Sep 1;32(17-18):1105-1140. doi: 10.1101/gad.315739.118.

DOI 10.34660/INF.2023.89.68.070

THE ROLE OF VITAMIN D IN THE DEVELOPMENT OF MENSTRUAL DYSFUNCTION IN THE JUVENILE AGE

Trushina Oksana Vladimirovna
Candidate of Medical Sciences, Associate Professor
Saratov State Medical University named after V.I. Razumovsky

Khvorostukhina Natalia Fedorovna
Doctor of Medical Sciences, Full Professor, Head of the Department
Saratov State Medical University named after V.I. Razumovsky

Ovakimyan Diana Vageevna
Student
Saratov State Medical University named after V.I. Razumovsky

Summary. *The results of the study of vitamin D levels in 130 adolescent girls with menstrual dysfunction aged 11 to 18 years are presented. Depending on the provision of vitamin D in adolescents, two groups were identified: group I (n=116) – with an inadequate level of 25 (OH)D and II (n=14) – with adequate provision. Group I was divided into two subgroups: with insufficiency 25(OH)D – IA (n=42) and vitamin - IB deficiency (n=74). Definition 25(OH)D in blood serum was performed on the ARCHITECT analyzer by chemiluminescent immunoassay on microparticles, using the 25-OH Vitamin D Abbot test system. For statistical analysis, the programs "Excel MS Office Professional" and "Statistic 6.0" were used. A high prevalence of hypovitaminosis D was found among adolescent girls with menstrual dysfunction (89.2%), which in 63.8% is in the deficit range. It was revealed that the probability of developing hypomenstrual syndrome against the background of hypovitaminosis D is 66.4%, abnormal uterine bleeding – 23.3%, dysmenorrhea – 10.3%. In group II, hypomenstrual syndrome and abnormal bleeding occurred with a frequency of 57.1% and 42.9%, respectively. Violation of the D-status is more associated with overweight and obesity (81.9%). Levels 25(OH)D in 130 girls with menstrual dysfunction were inversely dependent on body mass index (r=-0.137; p=0.01). The data obtained clearly demonstrate that the period of formation of menstrual function should be considered as a risk factor for the development of D-deficient conditions, increasing against the background of disorders of fat metabolism.*

Keywords: *teenage girls; vitamin D deficiency; menstrual dysfunction.*

Vitamin D deficiency has a high prevalence worldwide and in all age groups, including among adolescents [1-4]. The leading role in the regulation of homeostasis belongs to two isoforms of vitamin D that are similar in chemical structure and have similar stages of metabolism – ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3) [5]. The source of vitamin D2 is food. Vitamin D3 metabolism begins in the malpighian and basal layers of the epidermis of the skin, where, as a result of a non-enzymatic UV-dependent photolysis reaction, provitamin D3 is formed from a derivative of cholesterol 7-dehydrocholesterol. As a result of thermal isomerization, provitamin D3 is converted into cholecalciferol, binds to vitamin-D-binding protein (VDBP), is transported to Kupffer liver cells and undergoes biological activation, undergoing two hydroxylation processes. The first hydroxylation with the participation of the mitochondrial enzyme 25-hydroxylase (CYP2R1) leads to the formation of the inactive metabolite calcidol (25(OH) D). Related to VDBP 25(OH)D is transferred to the cells of the proximal tubules of the kidneys, in which, with the participation of the mitochondrial enzyme 1α-hydroxylase (CYP27B1), a second hydroxylation occurs with the formation of the active metabolite of vitamin D – calcitriol (1,25 (OH)2D). 1,25(OH)2D is metabolized into an inactive, water-soluble form of calcitroic acid in target cells with the participation of the enzyme 24-hydroxylase (CYP24A1), whose activity is regulated by the feedback principle of 1,25(OH)2D itself. The genomic effects of 1,25(OH)2D are mediated by binding to a specific nuclear receptor (VDR), one of the members of the nuclear receptor superfamily that perform the functions of classical endocrine receptors. On the other hand, 1,25(OH)2D, like other steroid hormones, implements its biological effect through rapid non–genomic mechanisms - membrane receptors and secondary messengers.

The main biological effect of vitamin D is to maintain phosphorus-calcium homeostasis optimal for bone mineralization. In recent decades, the results of numerous clinical and fundamental (in vitro and in vivo on experimental models) studies have radically changed the view of vitamin D as an active steroid hormone, directly or indirectly regulating more than 200 genes involved in a wide range of homeostatic functions [6-8]. It has been established that the active metabolite of vitamin D participates in autocrine and paracrine regulation of cellular differentiation and proliferation, regulates innate and adaptive immune responses, neutralizes the adverse endothelial effects of the end products of non–enzymatic protein glycation (AGE) - the epigenetic mechanism of posttranslational structural modification of chromatin, altering the availability of genes for transcription and the main cause of spontaneous irreversible loss of structure and function of intracellular and extracellular proteins of various physiological systems. To date, the expression of VDR mRNA and metabolizing enzymes (CYP27A1, CYP27B1) have been detected in various types of cells of the body, including cells of the

female reproductive system – the eutopic endometrium, fallopian tubes, granulosa cells of the ovaries, pituitary gland, hypothalamus and placenta. The results of numerous studies confirm the participation of 1.25(OH)2D in the mechanisms of folliculogenesis, steroidogenesis, but many aspects of causal relationships between D-status and pathology of the reproductive system remain the subject of discussion [9-11]. Antiproliferative, anti-inflammatory and immunomodulatory effects 1,25(OH)2D suggested the role of D-deficient conditions in the pathogenesis of endometriosis and uterine fibroids. The assumption about the effect of vitamin D on the structure and receptivity of the endometrium through the regulation of endometrial expression of the HOXA10 gene critical for the implantation process and participation in the regulation of reactions by the immune system of the mother and embryo during implantation allowed us to consider the status of vitamin D as a predictor of the success of outcomes of assisted reproductive technologies. Vitamin D deficiency, which is involved in the regulation of the functions of the fetoplacental complex, becomes one of the risk factors for adverse gestational outcomes - fetoplacental insufficiency, preeclampsia and premature birth [12]. The placenta controls the passage of vitamin D metabolites in such a way that 25(OH)D freely penetrates through the hemochorial placentas, whereas the passage of 1.25(OH)2D is blocked, therefore, the level of 25(OH) D in umbilical cord blood is from 75% of maternal values, whereas 1.25(OH)2D is 25-40% [13]. Maternal hypovitaminosis D during gestation is associated with impaired lung development in 6-year-olds, neuro-cognitive difficulties at the age of 10, and an increased risk of eating disorders in adolescence [14]. Sensitive to the effects of adverse exogenous factors, adolescence becomes a risk group for the development of dyselementosis and hypovitaminosis, including hypovitaminosis D. The intensity of informational training loads, inversion of circadian rhythms, inactivity, quantitative and qualitative eating disorders in modern adolescents reduce the time of availability of adequate natural insolation and increase the risk of obesity – the leading controlled risk factors for the development of a D-deficient condition [15].

The purpose of the study: to study the vitamin D content in adolescent girls with menstrual dysfunction living in the Saratov region, which, like other regions of the Russian Federation, is located north of the 35th parallel, which is associated with an insufficient level of insolation most of the year, an acute angle of incidence of UV rays and their dispersion in the atmosphere, making it difficult adequate level of endogenous vitamin D synthesis.

Materials and methods. A study of vitamin D levels was conducted in 130 adolescent girls aged 11 to 18 years (average age 15.04 years) who applied for outpatient treatment for menstrual dysfunction for the period 2018-2019. All the surveyed were comparable in terms of the impact of climatic factors (indigenous

women of the region). Inclusion criteria: gynecological age at the time of examination 2 years or more; virgo intacta; voluntary informed consent to the examination received from patients or their legal representatives. Exclusion criteria: the presence in the anamnesis and/or at the time of examination of inflammatory diseases of the reproductive system and surgical interventions on the pelvic organs, acute (exacerbations of chronic) infectious and inflammatory diseases, therapy with sex steroid hormones and vitamin D preparations. Gynecological examination was performed according to the current profile standards. To assess menstrual function, the method of interviewing was used according to a developed questionnaire reflecting the characteristics of puberty from its debut and menstrual function from menarche. To assess the trophological status, the absolute body mass index (BMI) was used, calculated as the ratio of body weight (kg) to height (m2), and its standard deviation from the average (SDS). The values of SDS BMI were interpreted in accordance with the Federal Clinical Guidelines for the Diagnosis and Treatment of Obesity in Children and Adolescents (RAE, 2014): malnutrition – with a value of SDS BMI less than -2.0 SD, low nutrition – with a value of SDS BMI from -2.0 to -1.0, normal body weight – with a value of SDS BMI from -1.0 to +1.0, overweight – with a value of SDS BMI from +1.0 SD to +2.0, obesity – with a value of SDS BMI more +2.0. The vitamin D content was studied by determining the serum level of its intermediate metabolite 25(OH)D, which most adequately reflects the total amount of exogenous and endogenous vitamin D [15]. The study was performed on the ARCHITECT automatic analyzer (ABBOT, USA) by the method of chemiluminescent immunoassay on microparticles (CHIAM), using the Abbot 25-OH Vitamin D test system. Level 25(OH)D in the range from 30 ng/ml to 50 ng/ml was regarded as adequate, the level of 25(OH)D from 20 ng/ml to 30 ng/ml – as vitamin D deficiency, level 25(OH)D below 20 ng/ml – as vitamin D deficiency [7]. Taking into account the provision of girls with vitamin D, the following groups were identified: group I (n=116) – with inadequate levels of vitamin D and group II (n=14) – with adequate provision. Group I patients were divided into two subgroups: IA (n=42) included girls with vitamin D deficiency, subgroup IB (n=74) – those with vitamin deficiency.

When calculating the indicators, the percentage frequencies of observations (%) were calculated, represented as the median (M) and ± standard deviation. For statistical analysis, the programs “Excel MS Office Professional” and “Statistic 6.0” were used. The reliability of the differences between the parameters was assessed by the Student’s t-test (the differences were considered statistically significant at $p<0.05$).

Results and discussion. Average level of 25(OH)D in serum among 130 examined adolescent girls was 20.02 ng/ml (range from 5.40 ng/ml to 49.40 ng/ml). Adequate provision of vitamin D was found in only one out of ten surveyed

adolescent girls (10.8 ± 2.7%). At the same time, it is noteworthy that the median (38.08 ng/ml) and the range (from 31.7 ng/ml to 49.4 ng/ml) of the level of 25 (OH) D in girls with adequate vitamin D provision were close to low-normal values. The vast majority of the surveyed (89.2±2.7%) had a level of 25(OH)D was below the accepted physiological value of 30 ng/ml. Hypovitaminosis D in 36.2±4.5% of cases was registered at the level of insufficiency (level range 25(OH)D from 20.70 ng/ml to 29.60 ng/ml; median 24.34 ng/ml), in 63.8±4.5% of cases – at the level of deficiency (level range 25(OH)D from 5.40 ng/ml to 19.90 ng/ml; median 14.16 ng/ml). Statistically significant dependence of level 25(OH)D from the age of the examined was not detected (r=-0.1158; p>0.05). The leading cause of vitamin D deficiency, in our opinion, is a decrease in its synthesis in the epidermis against the background of a regional, seasonal or situational inadequate level of insolation. An analysis of the dependence of vitamin D availability on the seasonality of the examination of girls (Table 1) showed that D-hypovitaminosis occurred in the vast majority of cases throughout the year – in 97.0% of those surveyed in winter, in 95.2% of those surveyed in spring, in 80.0% of those surveyed in the summer months and in 80.0% of those surveyed in autumn.

Table 1

Vitamin D availability of adolescent girls, taking into account the seasonality of the survey

Level of 25(OH)D in serum		**winter (n=33)**	**spring (n=42)**	**summer (n=30)**	**autumn (n=25)**	**p**
		abs %±SD	**abs %±SD**	**abs %±SD**	**abs %±SD**	
		1	**2**	**3**	**4**	
Reduced level including:	5	32 97,0±3,0	40 95,2±3,3	24 80,0±7,3	20 80,0±8,0	p_{1-3}=0,04
- insufficiency	6	9 28,1±7,9	10 25,0±6,8	13 54,2±10,2	10 50,0±11,2	p_{1-3}=0,05
- deficit	7	23 71,9±7,9	30 75,0±6,8	11 45,8±10,2	10 50,0±11,2	p_{1-3}=0,05
Physiological level	8	1 3,0±3,0	2 4,8±3,3	6 20,0±7,3	5 20,0±8,0	p_{1-3}=0,09
p		p_{5-8}<0,001 p_{6-7}=0,001	p_{5-8}<0,001 p_{6-7}<0,001	p_{5-8}=<0,001 p_{6-7}=0,66	p_{5-8}<0,001 p_{6-7}=1,0	

Among girls with hypovitaminosis D, the level of deficiency was registered 3 times more often than its insufficiency in those examined in winter (71.9 and 28.1%, respectively; p=0.001) and in spring (75.0 and 25.0%, respectively; p<0.001). With the same frequency – almost every second girl, vitamin D deficiency and deficiency were found among children examined in summer (54.2 and 45.8%,

respectively) and in autumn (50.0% and 50.0%, respectively).

Two clinical groups were identified for further data analysis. Group I (n=116) included girls with inadequate vitamin D levels (level range 25(OH)D from 5.4 to 29.6 ng/ml; median 17.84 ng/ml). Two subgroups were identified in this group. Subgroup IA (n=42) included girls with vitamin D deficiency (level range 25(OH) D from 20.70 to 29.60 ng/ml; median 24.34 ng/ml), in subgroup IB (n=74) – girls with vitamin D deficiency (level range 25 (OH)D from 5.40 to 19.90 ng/ml; median 14.16 ng/ml). Group II (n=14) is represented by girls with adequate provision of vitamin D (level range 25(OH)D from 31.7 to 49.4 ng/ml; median 38.08 ng/ml).

Interviewing 130 respondents showed that in the structure of menstrual dysfunction, more than half of the cases of treatment were associated with hypomenstrual syndrome (n=85; 65.4%), every fourth patient suffered from abnormal uterine bleeding (n=33; 25.4%), almost every tenth – dysmenorrhea (n=12; 9.2%). The analysis of variants of menstrual function in girls of each clinical group and subgroups was carried out (Table 2).

Table 2

Characteristics of menstrual function in adolescent girls depending on the level of vitamin D provision

A variant of menstrual dysfunction		**I group (n=116)**	**IA subgroup (n=42)**	**IB subgroup (n=74)**	**II group (n=14)**	**p**
		abs %±SD	**abs %±SD**	**abs %±SD**	**abs %±SD**	
Hypomenstrual syndrome	1	77 66,4±4,4	27 64,3±7,4	50 67,6±5,4	8 57,1±13,2	$p_{I\text{-}II}$=0,67
Abnormal uterine bleeding	2	27 23,3±3,9	10 23,8±6,6	17 23,0±4,9	6 42,9±13,2	$p_{I\text{-}II}$=0,16
Dysmenorrhea	3	12 10,3±2,8	5 11,9±5,0	7 9,5±3,4	0	
p		$p_{1\text{-}2}$<0,001 $p_{1\text{-}3}$<0,001 $p_{2\text{-}3}$=0,01	$p_{1\text{-}2}$<0,001 $p_{1\text{-}3}$<0,001 $p_{2\text{-}3}$=0,17	$p_{1\text{-}2}$<0,001 $p_{1\text{-}3}$<0,001 $p_{2\text{-}3}$=0,03	$p_{1\text{-}2}$=0,46	

As follows from the presented data, against the background of hypovitaminosis D (group I), menstrual dysfunction was represented by hypomenstrual syndrome in more than half of cases (n=77; 66.4%), in almost every fifth case – abnormal uterine bleeding (n=27; 23.3%). All patients with dysmenorrhea had inadequate D-status. The structure of menstrual dysfunction, depending on the degree of hypovitaminosis D, practically did not differ. The frequency of hypomenstrual syndrome prevailed over the frequency of abnormal uterine bleeding among girls with vitamin D deficiency (IA subgroup) by 2.7 times (64.3 and 23.8%, respectively) and among patients with vitamin D deficiency (IB subgroup) by 2.9

times (67.6 and 23.0%, respectively). Every tenth patient with vitamin D deficiency and deficiency suffered from dysmenorrhea (11.9 and 9.5%, respectively). Among girls with adequate vitamin D (group II), menstrual dysfunction by the type of hypomenstrual syndrome and abnormal uterine bleeding occurred with almost the same frequency (57.1 and 42.9%).

Currently, a multifactorial relationship between the amount of subcutaneous fat (from the total body weight) and steroidogenesis has been proven – accumulation, intensive aromatization of sex steroid hormones and their secretion occur in adipose tissue. In adolescence, both weight loss and significant weight gain can equally lead to impaired sexual development and menstrual dysfunction. When assessing the trophological status, it was found that among the examined girls with menstrual dysfunction, only one in five had normal BMI (22.3%). In the vast majority of cases, the physical development of girls was disharmonious, mainly due to excess body weight (66.2%). Obesity (6.9%) and a reduced level of nutrition (4.6%) were significantly less common. It is established that the levels of 25(OH)D in the blood serum of 130 examined girls with menstrual dysfunction were inversely related to BMI ($r=-0.137$; $p=0.01$).

The dependence of vitamin D provision and the trophological status of patients was analyzed (Table 3). Among girls with hypovitaminosis D (group I), only 14.7% had harmonious physical development. In the overwhelming majority of cases among the patients of this group there was an increased trophological status – overweight (74.1%) and obesity (7.8%), in isolated cases – a reduced level of nutrition (3.4%). This statistically significantly ($p<0.001$) differed from patients with adequate vitamin D status (group II), who in the vast majority of cases (85.7%) had harmonious physical development and only one of seven (4.3%) had a reduced nutritional status. There were no overweight patients in this group.

Table 3

Characteristics of the trophological status in adolescent girls, depending on the level of vitamin D provision

Trophological status (SDS BMI)		**I group (n=116)**	**IA subgroup (n=42)**	**IB subgroup (n=74)**	**II group (n=14)**	**p**
		abs %±SD	**abs %±SD**	**abs %±SD**	**abs %±SD**	
Malnutrition (SDS less than -2,0)	1	0	0	0	0	
Reduced nutrition (SDS from -2,0 up to -1,0)	2	4 3,4±1,7	2 4,8±3,3	2 2,7±1,9	2 14,3±9,4	$p_{I-II}=0,34$ $p_{IA-IB}=0,68$
Normal body weight (SDS from -1,0 up to +1,0)	3	17 14,7±3,3	11 26,2±6,8	6 8,1±3,2	12 85,7±9,4	$p_{I-II}<0,001$ $p_{IA-IB}=0,03$

Increased nutrition (SDS from +1,0 up to +2,0)	4	86 74,1±4,1	27 64,3±7,4	59 79,7±4,7	0	p_{IA-IB}=0,36
Obesity (SDS more than +2,0)	5	9 7,8±2,5	2 4,8±3,3	7 9,5±3,4	0	
p		p_{2-3}=0,01 p_{2-4}<0,001 p_{2-5}=0,18 p_{3-4}=0,11 p_{3-5}<0,001 p_{4-5}<0,001	p_{2-3}=0,02 p_{2-4}<0,001 p_{2-5}=1,0 p_{3-4}=0,001 p_{3-5}=0,02 p_{4-5}<0,001	p_{2-3}=0,21 p_{2-4}<0,001 p_{2-5}=0,13 p_{3-4}<0,001 p_{3-5}=0,77 p_{4-5}<0,001	p_{2-3}<0,001	

It is characteristic that among girls with harmonious physical development, vitamin D deficiency was 3.2 times less common than its deficiency (p=0.03). When comparing the frequency of various degrees of hypovitaminosis D among girls with increased nutrition, it was found that insufficiency and deficiency occurred with almost equal frequency (64.3 and 79.7%, respectively).

The existence of a pathogenetic relationship between a decrease in the level of circulating blood 25(OH)D and obesity are beyond doubt [16, 17]. Adipose tissue has a high level of VDR and CYP27B1 mRNA expression, thus being a site of local vitamin D metabolism and a target for it. Most often in the literature hypovitaminosis D in obesity is explained by volumetric dilution of lipophilic vitamin D molecules and its sequestration in adipose tissue [18]. Hypovitaminosis D can cause secondary hyperparathyroidism and a subsequent increase in intracellular calcium in adipocytes, which can cause increased lipogenesis and decreased lipolysis. In turn, 1,25(OH)2D plays a central role in adipocyte metabolism by inhibiting adipogenesis during early adipocyte differentiation. The violation of glucose homeostasis associated with obesity further complicates the unfavorable metabolic scenario. Hypovitaminosis D can determine the development of obesity with metabolic disorders and negative effects on the reproductive system already in childhood [19, 20].

Conclusions. 1. A high prevalence of hypovitaminosis D was revealed among adolescent girls in the Saratov region (89.2%), which in more than half of cases is in the deficit range (63.8%).

2. The probability of developing hypomenstrual syndrome in juvenile age against the background of hypovitaminosis D increases to 66.4%, abnormal uterine bleeding – up to 23.3%, and with dysmenorrhea, inadequate vitamin D provision was traced in 100% of adolescent girls.

3. Violation of the D-status in juvenile age is more associated with overweight and obesity (81.9%).

The data obtained clearly demonstrate that the period of formation of the function of the reproductive system should be considered as a risk factor for

the development of D-deficient conditions, increasing against the background of disorders of fat metabolism. And timely correction of hypovitaminosis D can make a significant contribution not only to general somatic health, but also to a favorable reproductive prognosis.

References

1. Holick M.F. The vitamin D deficiency pandemic: Approaches for diagnosis, treatment and prevention // Rev. Endocr. Metab. Disord. – 2017. – Vol. 18(2). P. 153-165. doi: 10.1007/s11154-017-9424-1.

2. Palermo N.E., Holick M.F. Vitamin D, bone health, and other health benefits in pediatric patients // J. Pediatr. Rehabil. Med. – 2014. – Vol. 7(2). – P. 179-92. doi: 10.3233/PRM-140287.

3. Vitamin D status in adolescent girls with menstrual dysfunction / O.V. Trushina, D.A. Novichkov, N.F. Khvorostukhina [et al.] // Gynecology, Obstetrics and Perinatology. – 2019. – Vol. 18, № 5. – P. 95-101. doi: 10.20953/1726-1678-2019-5-95-101.

4. Vitamin D deficiency in children and adolescents of the Russian Federation: modern approaches to correction. National Program / T.E. Borovik, O.A. Gromova, I.N. Zakharova [et cetera.]. – Moscow, 2021. (2nd edition, revised and expanded). – 116 p.

5. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline / M.F. Holick, N.C. Binkley, H.A. Bischoff-Ferrari [et al.] // J. Clin. Endocrinol. Metab. – 2011. – Vol. 96(7). – P. 1911-30. doi: 10.1210/jc.2011-0385.

6. Wacker M., Holick M.F. Vitamin D-effects on skeletal and extraskeletal health and the need for supplementation / Nutrients. – 2013. – Vol. 10. – P. 111-148. doi: 10.3390/nu5010111.

7. Vitamin D: Metabolism, Molecular Mechanism of Action, and Pleiotropic Effects / S. Christakos, P. Dhawan, A. Verstuyf [et al.] // Physiol. Rev. – 2016. – Vol. 96(1). – P. 365-408. doi: 10.1152/physrev.00014.2015.

8. Gil A.J., Plaza-Diaz J., Mesa M.D. Vitamin D: classic and novel actions // Ann. Nutr. Metab. – 2018. – Vol. 72(2). – P. 87-95. doi: 10.1159/000486536.

9. Lerchbaum E., Rabe T. Vitamin D and female fertility // Curr. Opin. Obstet. Gynecol. – 2014. – Vol. 26(3). – P. 145-50. doi: 10.1097/GCO.0000000000000065.

10. Subramanian A., Gernand A.D. Vitamin D metabolites across the menstrual cycle: a systematic review // BMC Womens Health. – 2019. – Vol. 19(1). – P. 19. doi: 10.1186/s12905-019-0721-6.

11. Low levels of 25-OH vitamin D in women with endometriosis and associated pelvic pain / E. Anastasi, E. Fuggetta, C. De Vito [et al.] // Clin. Chem. Lab. Med. – 2017. – Vol. 55. – P. e282-e284. doi: 10.1515/cclm-2017-0016.

12. Association between maternal serum 25-hydroxyvitamin D level and pregnancy and neonatal outcomes: systematic review and meta-analysis of observational studies / F. Aghajafari, T. Nagulesapillai, P.E. Ronksley [et al.] // BMJ. – 2013. – Vol. 346. – P. f1169. doi: 10.1136/bmj.f1169.

13. Kovacs C.S. Maternal vitamin D deficiency: Fetal and neonatal implications // Semin. Fetal. Neonatal. Med. – 2013. – Vol. 18(3). – P. 129-135. doi: 10.1016/j.siny.2013.01.005.

14. Vitamin D in fetal development: findings from a birth cohort study / P.H. Hart, R.M. Lucas, J.P. Walsh [et al.] // Pediatrics. – 2015. – Vol. 135(1). – P. e167-73. doi: 10.1542/peds.2014-1860.

15. Endocrine Society. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline / M.F. Holick, N.C. Binkley, H.A. Bischoff-Ferrari [et al.] // J. Clin. Endocrinol. Metab. – 2011. – Vol. 96(7). – P. 1911-30. doi: 10.1210/jc.2011-0385.

16. Obesity and hypovitaminosis D: causality or casualty? / S. Migliaccio, A. Di Nisio, C. Mele [et al.] // Int. J. Obes. Suppl. – 2019. – Vol. 9(1). – P. 20-31. doi: 10.1038/s41367-019-0010-8.

17. Abbas M.A. Physiological functions of vitamin D in adipose tissue // J. Steroid. Biochem. Mol. Biol. – 2017. – Vol. 165(Pt B). – P. 369-381. doi: 10.1016/j.jsbmb.2016.08.004.

18. Decreased bioavailability of vitamin D in obesity / J. Wortsman, L.Y. Matsuoka, T.C. Chen [et al.] // Am. J. Clin. Nutr. – 2000. – Vol. 72(3). – P. 690-3. doi: 10.1093/ajcn/72.3.690.

19. Kelishadi R, Farajzadegan Z, Bahreynian M. Association between vitamin D status and lipid profile in children and adolescents: a systematic review and meta-analysis // Int. J. Food. Sci Nutr. – 2014. – Vol. 65(4). – P. 404-10. doi: 10.3109/09637486.2014.886186.

20. Çığrı E., İnan F.Ç. The Relationship between Anthropometric Measurements and Vitamin D Levels and Insulin Resistance in Obese Children and Adolescents // Children (Basel). 2022. – Vol. 9(12). – P. 1837. doi: 10.3390/children9121837.

DOI 10.34660/INF.2023.98.95.071

ANALYSIS OF THE CAUSES OF CERVICAL RUPTURES DURING URGENT LABOR COMPLICATED BY PREMATURE RUPTURE OF FETAL MEMBRANES

Khvorostukhina Natalia Fedorovna
Doctor of Medical Sciences, Full Professor, Head of the Department
Saratov State Medical University named after V.I. Razumovsky

Bakhmach Vladislav Olegovich
Assistant of the Department
Saratov State Medical University named after V.I. Razumovsky

Chupahin Ruslan Vladimirovich
Assistant, postgraduate
Saratov State Medical University named after V.I. Razumovsky

Abstract. *The results of studying the causes of cervical ruptures during urgent labor complicated by premature rupture of fetal membranes (PRFM) are presented. The 1st group included 49 patients with prenatal gestation, whose labor was complicated by a rupture of the cervix of varying degrees, in the 2nd group (n=166) – women with prenatal labor during urgent labor and the absence of birth trauma of the mother. The prevalence of primiparous women in the 1st group was revealed: 57.1% versus 40.4% in the 2nd (p=0.04), whose pregnancy occurred against the background of anemia 1.8 times more often (51.0%). It has been established that cervical ruptures during prenatal and full–term gestation are associated with the lack of biological readiness of the birth canal (“immature” and “insufficiently mature” cervix - 75.5%), the development of labor anomalies (28.6%), the use of surgical aids during delivery (vacuum extraction of the fetus, episiotomy – 32.4%). The negative impact of obstetric traumatism of the mother during urgent labor complicated by PRFM on the morbidity of newborns was proved: the frequency of cephalohematoma increased in group 1 by 5 times, natal cervical trauma – by 5.7 times.*

Keywords: *urgent delivery; premature rupture of fetal membranes; ruptures of the cervix; risk factors; morbidity of newborns*

Premature rupture of the fetal membranes (PRFM) continues to be one of the urgent problems of modern obstetrics, since this pathology associates with

high frequency of unfavorable pregnancy outcomes. According to the literature, the proportion of PRFM in preterm labor reaches 38-51%, negatively affecting the indicators of perinatal morbidity and mortality [1-4]. At the same time, it is known that PRFM in full-term pregnancy increases the likelihood of not only the realization of purulent-septic infections in the mother and newborn, but also refers to risk factors for obstetric injuries [5-7].

It should be noted that the problem of injuries of the soft tissues of the birth canal has not lost its importance in obstetrics for many years [8, 9]. Despite the widespread introduction of modern clinical recommendations, improvement of the tactics of labor management in various obstetric situations, the frequency of cervical injuries during labor has no tendency to decrease [6, 10, 11].

At the same time, many scientists agree on the direct connection of birth trauma of the cervix with numerous disorders in the functioning of the female genital organs, the most frequent manifestations of which are cervical pathology, infertility and habitual miscarriage [12-14]. The negative impact of cervical ruptures during childbirth on the quality of life and reproductive health of women [12, 13, 15] pushes researchers to search for new solutions to this medical problem.

The purpose of the study: to study the causes of cervical ruptures during urgent labor complicated by premature rupture of the fetal membranes (PRFM).

Materials and methods. A single-stage cohort comparative study was conducted according to the data of the Perinatal Center of the Saratov City Clinical Hospital No. 8 for 2019. During this period, a total of 5586 births were registered, of which the frequency of PRFM was 21.5% (n=1203). The 1st group included 49 patients with full-term gestation, whose urgent labor was complicated by a rupture of the cervix of varying degrees, in the 2nd group (n=166) – women with emergency labor and the absence of birth trauma of the mother. Criteria for inclusion in the 1st and 2nd groups: a single pregnancy that ended at the gestation period of more than 37.1 weeks with urgent delivery through the natural birth canal, complicated by PRFM and rupture of the cervix (group 1), and in the absence of injuries of the soft birth canal (group 2). Exclusion criteria: premature birth, complicated by PRFM, multiple pregnancy or as a result of assisted reproductive technologies, completion of labor by cesarean section, episiotomy in childbirth due to the threat of perineal rupture, isolated abrasions and tears of the vaginal mucosa. The study was conducted with the approval of the Ethics Committee of the Saratov State Medical University named after V.I. Razumovsky and after receiving the voluntary informed consent of women. Examination and treatment of pregnant and maternity women in groups was carried out in accordance with the standards approved by the Ministry of Health of the Russian Federation. Anamnestic data, peculiarities of the course of pregnancy, childbirth and main parameters of the health status of newborns were studied in detail.

The programs "Excel MS 2013" and "Statistica 6.0" were used for statistical analysis. The hypothesis was tested for the normality of the initial data using the Kolmogorov-Smirnov criterion. The results were presented in the form of mean values (M) and standard deviation (SD). When evaluating qualitative indicators, absolute and relative frequencies of observations (n, %) were calculated. Differences between the two average values of the parameters were evaluated by the Student's t-criterion, qualitative – by the Fisher criterion $\chi 2$ (differences at $p<0.05$ were considered statistically significant).

Results and discussion. The age of the patients included in the study was in the range from 19 to 46 years, with no statistical difference in the mean age values in the groups (Table 1). A detailed study of anamnestic data showed a significant predominance in the 1st group of primiparous women: 57.1% versus 40.4% in the 2nd ($p=0.04$). At the same time, the first pregnancy in the groups was traced with almost the same frequency: in the 1st group - in 34.7% (n=17), and in the 2nd – in 30.1% (n=50) ($p=0.54$). It should be noted that in terms of the frequency of induced abortions and spontaneous miscarriages, we did not reveal statistical differences in the groups (Table 1). There was also no significant difference in the frequency of occurrence in the 1st and 2nd groups of chronic inflammatory diseases of the genitals, cervical pathology, uterine fibroids, genital endometriosis and infertility. However, in group 1, benign ovarian neoplasms were diagnosed 2.6 times more often in anamnesis or during a real pregnancy ($p=0.04$) in comparison with the indicators of group 2. The absence of genital pathology was found by us only in 14.3 and 17.5% of pregnant women in groups 1 and 2 ($p=0.60$). It is necessary to note the wide variety of concomitant extragenital diseases in pregnant women with PPO at full-term gestation. Diseases of the circulatory system (vegetative–vascular dystonia, chronic arterial hypertension, varicose veins) prevailed among somatic pathology - in total in 44.9% in group 1 and 38.0% in group 2; pathology of the visual organs (in every second woman of the 1st group and in a third - in the 2nd), diseases of the gastrointestinal tract (chronic gastritis, cholecystitis, pancreatitis – in every fourth and fifth pregnant woman, respectively), other foci of chronic infection in the form of upper respiratory tract diseases (rhinitis, tonsillitis, pharyngitis, bronchitis – in every fifth in both groups) and the urinary system (cystitis, chronic pyelonephritis – in every seventh patient), in the absence of significant differences when comparing the indicators between the groups (Table 1). The data obtained are consistent with the opinion of many scientists about the significant significance of the low index of women's health, concomitant genital and somatic pathology in the development of complicated pregnancy and childbirth [16-18].

Table 1

General characteristics of groups

Parameters	1-st (n=49)		2-nd (n=166)		p^{1-2}
Age, years - M (SD)	33,2 (5,1)		32,7 (5,7)		0,95
Obstetric and gynecological anamnesis					
	n	%	n	%	
Primiparous	28	57,1	67	40,4	0,04
Multiparous	21	42,9	99	59,6	0,04
Abortions	14	28,6	50	30,1	0,84
Spontaneous /failed miscarriage	8	16,3	30	18,1	0,78
Inflammatory diseases of the genitals	4	8,2	24	14,5	0,25
Cervical pathology	31	63,3	119	71,7	0,26
Ovarian neoplasms	7	14,3	9	5,4	0,04
Uterine fibroids	4	8,2	8	4,8	0,37
Genital endometriosis	3	6,1	4	2,4	0,20
Infertility	2	4,1	1	0,6	0,07
Absence of genital pathology	7	14,3	29	17,5	0,60
Extragenital diseases					
Diseases of the circulatory system	22	44,9	63	38,0	0,38
Diseases of the gastrointestinal tract	12	24,5	34	20,5	0,55
Diseases of the visual organs (myopia, astigmatism, hypermetropia)	25	51,0	64	38,6	0,12
Chronic rhinitis, tonsillitis, pharyngitis, bronchitis	9	18,4	31	18,7	0,96
Diseases of the urinary system	7	14,3	23	13,9	0,94
Diseases of the thyroid gland	7	14,3	25	15,1	0,89
Overweight, obesity	6	12,2	31	18,7	0,30
Osteochondrosis	4	8,2	8	4,8	0,37
Absence of pathology	4	8,2	33	19,9	0,06

When analyzing the features of the course of this pregnancy, we did not establish significant differences in many of the parameters studied, but found statistically significant differences in the frequency of occurrence of isthmic-cervical insufficiency and anemia, the proportion of which in group 1 significantly exceeded similar indicators of group 2 (Table 2). The leading positions among other complications of gestation were occupied by signs of threatening termination of pregnancy, placental insufficiency with disorders of uteroplacental blood flow (in one third of patients), acute respiratory viral diseases, inflammatory processes and disorders of the microbiota of the genital tract suffered at various stages of pregnancy. It can be assumed that the development of anemia during pregnancy in combination with inflammatory diseases of the external genitalia and hemodynamic

disorders of the utero-placental complex contribute to morphofunctional changes in the tissues of the birth canal, which increases the risk of cervical injury by almost 2 times.

Table 2

Features of the course of pregnancy and delivery in groups

Parameters	**1-st (n=49)**		**2-nd (n=166)**		**p^{1-2}**
	n	**%**	**n**	**%**	
Features of the course of pregnancy					
No complications	6	12,2	19	11,4	0,88
Toxicosis of the I half	5	10,2	10	6,0	0,31
Threat of termination of pregnancy	20	40,9	74	44,6	0,64
Disorders of uteroplacental blood flow	15	30,6	65	39,2	0,28
Fetal growth retardation	0	0,0	3	1,8	0,34
Polyhydramnios	1	2,0	10	6,0	0,27
Olygoamnios	1	2,0	3	1,8	0,92
Isthmic-cervical insufficiency	2	4,1	0	0,0	0,01
Edema, proteinuria	7	14,3	17	10,2	0,43
Gestational hypertension	5	10,2	20	12,1	0,72
Moderate preeclampsia	2	4,1	1	0,6	0,07
Gestational pyelonephritis	2	4,1	7	4,2	0,97
Gestational diabetes mellitus	2	4,1	2	1,2	0,19
Colpitis	8	16,3	21	12,7	0,51
Bacterial vaginosis	2	4,1	16	9,6	0,22
Anemia	25	51,0	47	28,3	0,004
Acute respiratory viral diseases	15	30,6	48	28,9	0,82
Features of delivery and complications of labor					
The degree of maturity of the cervix (Bishop) Immature (0-5 points)	19	38,8	26	15,7	<0,001
Not mature enough (6-7 points)	18	36,7	53	31,9	0,53
Mature (8-9 or more points)	12	24,5	87	52,4	<0,001
Using Mifepristone	8	16,3	36	21,7	0,41
Duration of anhydrous interval up to 12 hours	24	49,0	94	56,6	0,35
more than 12 hours	25	51,0	72	43,4	0,35
Anomalies of labor activity	14	28,6	29	17,5	0,09
Discoordination of labor activity	7	14,3	15	9,0	0,29
Quick delivery	1	2,0	7	4,2	0,48
Weakness of labor activity	6	12,2	7	4,2	0,04
Acute fetal distress	3	6,1	0	0,0	0,002
Hyperthermia	1	2,0	1	0,6	0,36

The threat of rupture of the perineum	6	12,2	0	0,0	<0,001
Episiotomy	11	22,4	0	0,0	<0,001
Vacuum extraction of the fetus	5	10,2	0	0,0	<0,001
Rupture of the perineum and cervix	12	24,5	0	0,0	<0,001
Rupture of the cervix					
1 grade	38	77,6	0	0,0	<0,001
2 grade	11	22,4	0	0,0	<0,001

When assessing the state of the cervix at the time of the initial examination of women with PRFM and full-term gestation, we found significant differences in the groups (Table 2). “Immature” cervix on the Bishop scale was 2.5 times more often recorded in pregnant women of group 1, while in group 2, in every second observation, the degree of maturity of the cervix corresponded to the criterion of “mature” - by 8-9 or more points. At the same time, despite the absence of signs of biological readiness for childbirth in most women of group 1 (75.5% in total against 47.6% in group 2), the use of mifepristone for the preparation of the birth canal and labor excitation was noted only in 16.3% of pregnant women in group 1 and 21.7% in group 2 (p=0.41). The duration of the anhydrous interval over 12 hours in frequency of occurrence in the 1st group slightly exceeded the indicator of the 2nd group (p= 0.35). And anomalies of contractile activity of the uterus were more often recorded in group 1, but statistically significant differences were found only when comparing the frequency of occurrence of weakness of labor activity. It should be emphasized that according to the literature, the probability of occurrence of various disorders of contractile activity of the uterus with an “immature” cervix, even with the use of mifepristone, can reach 20-28% [19-21].

In addition, according to our data, in group 1, during labor, the risk of acute fetal distress and the threat of perineal rupture significantly increased, which contributed to an increase in the frequency of the use of surgical aids in this group (vacuum fetal extraction, episiotomy) (Table 2).

When studying the perinatal outcomes of urgent labor complicated by PRFM, we did not reveal any connection between cervical trauma and anthropometric data and the sex of the newborn (Table 3). The frequency of birth of children in a state of mild asphyxia in group 1 slightly exceeded the same indicator of group 2 (55.1% vs. 42.8%; p=0.13). However, in the structure of perinatal pathology in group 1, the probability of diagnosis of cephalohematoma (5 times) and natal cervical injury (5.7 times) significantly increased. At the same time, the chance of the birth of a healthy child even in the event of birth trauma of the mother reached 75.5%.

Table 3

General characteristics and morbidity of newborns in groups

Parameters	1-st (n=49)		2-nd (n=166)		p^{1-2}
Weight, g - M (SD)	3424,8 (455.4)		3314,2 (403.9)		0,86
Height, cm - M (SD)	51,83 (2,15)		51,27 (1,95)		0,85
	n	%	n	%	
Distribution of newborns by gender					
Boys	25	51,0	80	48,2	0,73
Girls	24	49,0	86	51,8	0,73
Assessment of newborns on the Apgar scale					
8-9 points	21	42,9	94	56,2	0,09
6-7 points (mild asphyxia)	27	55,1	71	42,8	0,13
4-5 points (moderate asphyxia)	1	2,0	1	0,6	0,36
Morbidity of newborns					
Healthy	37	75,5	136	81,9	0,32
Cerebral ischemia	12	24,5	25	15,1	0,13
Kefalogematoma	3	6,1	2	1,2	0,05
Malnutrition and stunted growth	2	4,1	6	3,6	0,88
Neonatal jaundice	1	2,0	1	0,6	0,36
Natal cervical injury	5	10,2	3	1,8	0,01
Intrauterine pneumonia	1	2,0	1	0,6	0,36
Congenital malformations	1	2,0	7	4,2	0,48

Conclusions. 1. Injuries of the cervix during urgent labor complicated by PRFM increases in primiparous women with a burdened obstetric and gynecological history and concomitant somatic pathology, whose pregnancy took place against the background of anemia in combination with acute respiratory viral infections, inflammatory diseases of the genital tract.

2. Ruptures of the cervix in prenatal and full–term gestation are associated with the lack of biological readiness of the birth canal (“immature” and “insufficiently mature” cervix - 75.5%), the development of labor anomalies (28.6%), the use of surgical aids during delivery (vacuum extraction of the fetus, episiotomy – 32.4%).

3. Obstetric traumatism of the mother during urgent labor complicated by PRFM increases the probability of occurrence in newborns of cephalohematoma (5 times) and natal cervical trauma (5.7 times).

References

1. Outcomes of pregnancy and delivery preterm in women with premature rupture of membranes / N.V. Artymuk, N.N. Elizarova, V.I. Chernyaeva, S.V. Rybnikov // Mother and Baby in Kuzbass. – 2015. – Vol. 2(61). – P. 98-102. https://elibrary.ru/item.asp?id=25096659.

2. Features of the course of puerperium in preterm birth with a long anhydrous interval / N.F. Khvorostukhina, N.N. Stepanova, D.A. Novichkov, A.A. Silkina // Medical Council. – 2021. – № 3. – P. 82-88. doi: 10.21518/2079-701X-2021-3-82-88

3. The effects of latency period in PPROM cases managed expectantly / E. Baser, D. Aydogan Kirmizi., D. Ulubas Isik [et al.] // J. Matern. Fetal Neonatal Med. – 2020. – Vol. 23. – P. 1-10. doi: 10.1080/14767058.2020.1731465.

4. Cellular immune responses in amniotic fluid of women with preterm prelabor rupture of membranes / J. Galaz, R. Romero, R. Slutsky [et al.] / J. Perinat Med. – 2020. Vol. 48(3). – P. 222-233. doi: 10.1515/jpm-2019-0395.

5. Dolzhenko E.S., Kositsina E.K. Imapct of course of pregnancy and labor on obstetric trauma // Alley science. – 2019. – Vol. 1, № 12(39). – P. 206-209.

6. Selikhova M.S., Ababekyan N.V. Optimal treatment of bacterial vaginosis before delivery // Doctor.Ru. – 2020. – Vol. 19, № 6. – P. 36-39. doi: 10.31550/1727-2378-2020-19-6-30-35

7. Cohen W.R., Friedman E.A. The assessment of labor: a brief history // J. Perinat. Med. – 2018. – Vol. 46(1). – P. 1-8. doi: 10.1515/jpm-2017-0018.

8. Reducing perineal lacerations through team-based simulation / E.K. Marko, M.B. Fausett, S. Deering [et al.] // Simul. Healthc. – 2019. – Vol. 14(3). – P. 182-187. doi: 10.1097/SIH.0000000000000378.

9. Restrictive versus routine episiotomy among Southeast Asian term pregnancies: a multicentre randomised controlled trial / U. Sangkomkamhang, K. Kongwattanakul, C. Kietpeerakool [et al.] // BJOG. – 2020. – Vol. 127(3). – P. 397-403. doi: 10.1111/1471-0528.15982

10. Orazov M.R., Kampos E.S. Perineal injury risk factors in second birth // Research'n Practical Medicine Journal. – 2017. – Vol. 4, № S2. – P. 75. EDN: YMWXPN.

11. Cervical lacerations in planned versus labor cerclage removal: a systematic review / G. Simonazzi, A. Curti, M. Bisulli [et al.] // Eur. J. Obstet. Gynecol. Reprod. Biol. – 2015. – Vol. 193. – P. 19-22. doi: 10.1016/j.ejogrb.2015.06.032.

12. Manukhin I.B. The last outpost of the cervix as the "gate" of the reproductive system: a contribution to the mechanism of premature birth. The condition is getting worse // Status ratings. Gynecology, obstetrics, infertile marriages. – 2019. – Vol. 1(54). – P. 89–96. https://www.elibrary.ru/item.asp?id=39240595.

13. Khvorostukhina N.F., Novichkov D.A., Mikheeva Y.V. Ectropion of the cervix. – Saratov: Publishing Center of Saratov State Medical University, 2020. – 144 p. https://www.elibrary.ru/item.asp?id=44646340.

14. Intrapartum cervical lacerations and their impact on future pregnancy outcome / B. Hamou, E. Sheiner, T. Coreanu [et al.] // J. Matern. Fetal. Neonatal. Med. – 2020. – Vol. 33(5). – P. 883-887. doi: 10.1080/14767058.2018.1505852.

15. The impact of cryotherapy for symptomatic cervical ectropion on female sexual function and quality of life / S. Yildiz, I. Alay, E. Eren [et al.] // J. Obstet. Gynaecol. – 2021. – Vol. 41(5). – P. 815-820. doi: 10.1080/01443615.2020.1803243.

16. Guseynova G.E., Khodzhaeva Z.S. Clinical and anamnestic features of women with preterm premature rupture of membranes // Obstetrics and Gynecology. – 2019. – № 8. – P. 54-62. doi: 10.18565/aig.2019.8.54-61.

17. Preterm delivery: an overview on epidemiology, pathophysiology and consequences for the individual and the society / B. Jacobsson, K. Pettersson, D. Modzelewska [et al.] // Lakartidningen. – 2019. – Vol. 116. – pii: FR6F.

18. Acute pancreatitis of pregnancy / N.F. Khvorostukhina, I.A. Salov, D.A. Novichkov // Clinical Medicine. – 2015. – Vol. 93, № 2. – P. 61-66. https:// elibrary.ru/item.asp?id=23058621

19. The effectiveness of cervical preparation and induction of labor using the antiprogestin mifepristone regimen / O.R. Baev, O.V. Tysyachniy, V.P. Rumyantseva, E.A. Usova // Medical Council. – 2015. – № 9. – P. 72-77. https:// elibrary.ru/item.asp?id=24292325

20. Experience with the use of mifepristone in cervical preparation for childbirth at term of pregnancy / N.F. Khvorostukhina, A.M. Leonova, D.A. Novichkov, D.S. Yatsenko // Modern problems of science and education. – 2016. – № 1. – P. 14. https://elibrary.ru/download/elibrary_25509261_23054177.pdf

21. Study of effects of mifepristone on full-term pregnancies / P. Sharma, K. Pathania, U.B. Rana // Journal of Obstetrics and Gynaecology. – 2020. – Vol. 40, № 2. – P. 188-189. https://elibrary.ru/item.asp?id=43380695

DOI 10.34660/INF.2023.90.70.072

ASYMMETRY OF DEPTH AND VOLUME OF JUGULAR FOSSA OF THE SKULL

Rozhkova Victoria Petrovna
Assistant
RUDN University

Tsvetkova Tatiana Yurievna
Candidate of Medical Sciences, Associate Professor
RUDN University

Kokoreva Tatiana Valeryevna
Candidate of Medical Sciences, Associate Professor
RUDN University

The dimensions and morphological features of the jugular fossa (JF), which is the receptacle of the superior bulb of the internal jugular vein, are of interest to otolaryngologists and neurosurgeons. These data must be taken into account during operations on the temporal bone.

Many authors cite data on the great variability in the size of the JF and jugular foramen [Сперанский; Iswarkumar S.; Knoof; Buckwalter J.A.; Xiaoqin Wu; Khanday S.; Skrzat J., Marawy S.M.; Rich Philip M.].

So, for example, the following types of jugular foramina are randomly distinguished: small foramina (up to 0.5 cm), medium (up to 1 cm) and large (more than 1 cm) [Knoof. Y]. Unfortunately, the authors do not indicate which dimension of jugular fossa is on the basis of such classification.

Purpose of study.

The purpose of the study was to evaluate the morphological features of the JF of the temporal bone of the skulls of N.I. Anserov collection (XVIII - XIX century) and of skulls of XX century.

Objectives of research.

The shape, volume of JF, and also the depth of the fossa along its anteromedial and posterolateral walls were determined.

Materials and methods.

The JF in 79 skulls of the XVIII – XIX centuries (1 group) and 35 skulls of the XX century (2 group) were investigated. The volume was measured by filling the JF with foil, then further submerging the foil impression into a syringe with liquid and determining its level displacement.

The walls of the JF were measured by needle, which was being set into the deepest point of the JF.

From the edge of the examined wall of JF, a perpendicular was drawn to the needle by means of wire and a mark was made on the needle. The distance from the tip of the needle to the mark was the required value.

Results.

As can be seen from Table 1, the JF depth projection on its anteromedial wall, on average, prevailed on the right side in both groups. Moreover, index decrease was observed on both sides of the skulls of the XX century (2 group). There was no significant difference between the depth of the JF along the posterolateral wall, both between the symmetrical indices and between the groups of skulls. Our study reported mean JF depth along the anteromedial wall of the skulls of 1 and 2 groups to be 13.5±1.2 mm and 10.1±0.8 mm on the right side (p=0.008, t) and 12.4±1.0 mm and 8.9±0.6 mm (p=0.02, t) on the left side, respectively. The mean JF depth along the posterolateral wall appeared to be about 14.0 mm on the right and left sides. There was a statistically significant decrease, on average, in the depth of the JF along the anteromedial wall and a slight increase in the depth of the JF along the posterolateral wall on both sides in skulls of the 2nd group (XX century).

Table 1

Depth of jugular fossa along the anteromedial and posterolateral walls , mm

Depth of JF	**Anteromedial wall of JF, mm**		**Posterolateral wall of JF, mm**	
	Right	**Left**	**Right**	**Left**
1st group, n=79 skulls	13.5 ± 1.2	12.4 ± 1.0	14.4 ± 0.9	13.7 ± 0.6
2nd group, n=35 skulls	10.1 ± 0.6** (p=0.008)	8.9 ± 0.5** (p=0.002)	14.9 ± 0.8	14.6 ± 0.5

Notes: JF – jugular fossa, ** - result is statistically significant compared to the corresponding indicator of the 1st group. Data represent mean ± standard deviation (p value - Student t test).

Individual examination of the depth of the JF along the anteromedial and posterolateral walls in the skulls of 1 and 2 groups showed a greater indicator of both walls on the right side in most cases. The number of skulls of the 2nd group with anteromedial wall depth on the right side prevailed over the same indicator on the left side is increased; but there was no difference between the right and left depth along the posterolateral wall (Table 2).

Table 2

Interrelationship of the depth of the jugular fossa along the anteromedial and posterolateral walls, %

	1st group, n=79 skulls			2nd group, n=35 skulls		
Depth of jugular fossa	**More on the right**	**More on the left**	**Equal**	**More on the right**	**More on the left**	**Equal**
Anteromedial wall	45.3% (36)	39.2% (31)	15.5% (12)	54.3% (19)	31.4% (11)	14.3% (5)
Posterolateral wall	50.6% (40)	41.8% (33)	7.5% (6)	48.6% (17)	45.7% (16)	5.7% (2)

The volume of the right JF in 1 and 2 groups rank within wide limits in comparison with the volume of the left JF. The mean volume of the JF of the skull of the 1st group was 0.6±0.0 ml and 0.5±0.0 ml on the right and left sides, respectively, while the same indicator of the 2nd group skulls was 0.4±0.0 ml and 0.3±0.0 ml on the right and left sides, respectively. In general, the volume of JF from the N.I. Anserov (1st group) skull collection varied between 0.1 and 1.5 ml on the right side and between 0.1 and 1.3 ml on the left side; the skulls of the XX century performed the same indicator range from 0.1 to 0.8 ml and from 0.1 to 0.7 ml on the right and left sides, respectively. When the volume of the right JF was more than 0.4 ml, the indicator, as a rule, exceeded the volume of the left JF in both groups (Figures 1 and 2). The difference between symmetrical volumes averaged 0.4 ml (p=0.001, t). If the volume of the right JF was lesser than 0.4 ml on the skulls of the 1st group, the volume of the left JF exceeded the symmetrical index (p=0.003, t). The mean volume of the left JF of the 2nd group skulls also showed the same peculiarity (p=0.078, t) (Fig. 1).

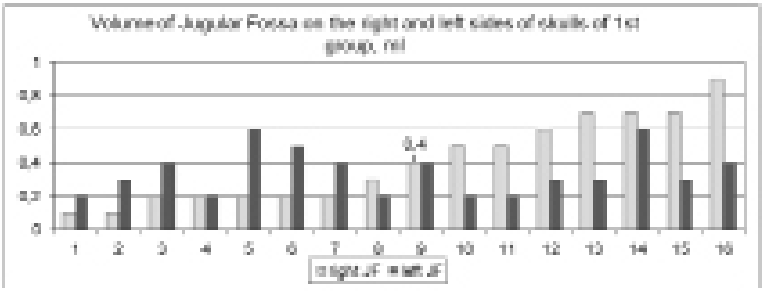


Figure 1. *Volume of jugular fossae of N.I. Anserov (1st group) skull collection (XVIII – XIX century). The volume of the right JF (jugular fossae) is arranged in ascending order of their volume.*

The interrelationship of the volumes of the fossae performs 16 skulls from this group (the parameters of the volumes of the symmetric JF of the remaining skulls corresponded in most cases to one of the 16 given variants).

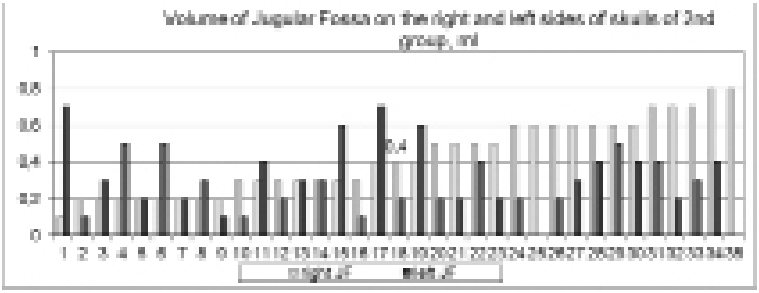


Figure 2. *Volume of jugular fossae of skulls of XX century (2nd group). The volume of the right JF (jugular fossae) is arranged in ascending order of their volume (volume of JF of skulls 25 and 35 was not able to measure).*

The bony septation of the JF was seen in 2 skulls of the 2nd group and in 3 skulls of the 1st group (2 septa – on the right side, and 1 septa – on the left side) (Fig. 3).

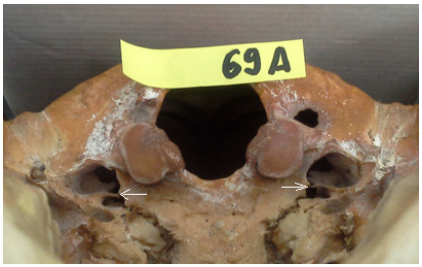


Figure 3. Right and left JF of the skull from N.I. Anserov collection (XVIII – XIX century) with bony septa (white arrows)

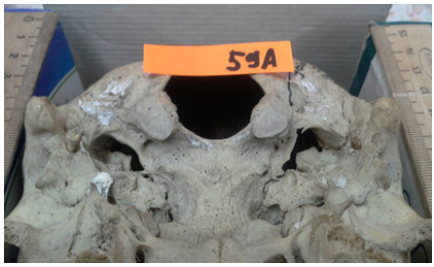


Figure 4. Right JF (is greater, triangular shape) and left JF (oval shape) from N.I. Anserov collection (XVIII – XIX century) without bony septa

Different shapes of jugular fossa were seen which depends predominantly from the position of its deepest point and the shape of the entrance to the fossa (jugular foramen) [Kosyagina]. E.B. Kosyagina (1988) described the following entrance shape (jugular foramen) as oval, bean-shaped, round and irregular. In this paper we added the additional triangular shape of the jugular foramen (Fig. 4).

Conclusion.

Over a time interval equals to 100-200 years, there was a change in the configuration and volume of the JF due to a pronounced decrease in the depth of the JF along the anteromedial wall and a slight increase in the indicator along the posterolateral wall both on the right and on the left sides. Decrease of the volume

of JF was observed in the skulls of the XX century (2nd group) compared with older skulls (1st group). There is some borderline volume indicator equals to 0.4 ml, above which the volume of the JF on the right side, as a rule, exceeded than that on the left side. This regularity is preserved in the skulls of both groups. The data performed in this paper allowed us to suggest a hypothesis about change in the structure of the superior bulb of the internal jugular vein over a short evolutionary period, as well as the configuration of the transition "sigmoid sinus - internal jugular vein", which in turn can lead to hemodynamic peculiarities in this region and differences between the right and left internal jugular veins.

References

1. *Косягина Е. Б. Строение яремной ямки / Е.Б. Косягина // Архив АГЭ. – М., 1988. - №1. – С. 58-62*
2. *Сперанский В.С. и Зайченко А.И. Форма и конструкция черепа, М., Медицина, 1980*
3. *Buckwalter J.A. Pulsatile tinnitus arising from jugular megabulb deformity: a treatment rationale / J.A Buckwalter, C.T. Sasaki, C.Virapongse, N.Bauman // Laryngoscope 93 – 1983. – p. 1534-1539*
4. *Iswarkumar S. An osteometric evaluation of the jugular foramen / S. Iswarkumar, N. Naidoo, L. Lazarus, P. Pillay, Satyapal K.S. // Int. J. Morphol. – 2015. - № 33(1). – p. 251-254*
5. *Khanday S. Morphological and morphometric study of jugular foramen in south Indian population / S. Khanday, Subramanian R.K., Rajendran M., Hassan A.U., Khan S.H. // Int. J. Anat. Res. – 2013/ - Vol. 1(3). - p. 122-27*
6. *Knoof. Y, Gigant jugular fossa with brief notes on the anatomical variations of the jugular fossa. Amer. J. Roentgenol., 1946, v. 55, N 3, p. 333-336*
7. *Marawy S.M. Study of anatomical variation of the jugular foramen in Egyptian dry skull (Morphological and Morphometric studies) / S.M. Marawy, El-Sawaf E.A. // Journal of American Science/ - 2019. - 15(5) – p. 17-25*
8. *Rich Philip M. The jugular foramen in complex syndromic craniosyostosis and its relationship to raised intracranial pressure / Philip M.Rich, Cox Timothy C.S., Hayward Richard D. // Am J Neuroradiol. – 2003. - № 24 – p. 45-51*
9. *Skrzat J. Morphology, topography and clinical significance of the jugular foramen / J. Skrzat, Mroz I., Spulber A., Walocha J. // Follia Medica Cracoviensia – Vol. LVI, 1. – 2016. – p. 71-80*
10. *Xiaoqin Wu Jugular foramen and venous collaterals may help to discriminate congenital from post-thrombotic jugular stenosis // Wu Xiaoqin, Yuchuan D., Xumming Ji, Ran M. // European Journal of Medical Research. – 2022. - № 27 (10). – doi: 10.1186/s40001-022-00636-9.*

DOI 10.34660/INF.2023.84.82.073

FEATURES OF THE ORAL MUCOSA DEVELOPMENT IN HUMAN ONTOGENESIS

Machina Natalya Mikhailovna
graduate student
Far Eastern Federal University

Reva Galina Vitalievna
Professor
Far Eastern Federal University and Chief Scientific Officer IMERC (Niigata, Japan)

Baranovskaya Irina Anatolyevna
graduate student
Far Eastern Federal University

Reva Ivan Vladimirovich
PhD, lector of the School of Medicine
Far Eastern Federal University (Vladivostok, Russia), IMERC (Niigata, Japan)

Ichenko Stanislav Vladimirovich
graduate student
Far Eastern Federal University, Head of Department of ENT diseases

Sementsov Igor Valeryevich
PhD, professor
Far Eastern Federal University

Abstract. *In the study, a comparative characteristic of the human oral mucosa in pre- and postnatal ontogenesis was obtained. Classical morphological and immunohistochemical research methods were used. Qualitative and quantitative features of changes in local immune homeostasis of the oral mucosa have been established. The data obtained characterize the age-related features of epithelial-mesenchymal interactions and can be used to predict the outcomes of adentia treatment. Violations of epithelial-mesenchymal interactions in the prenatal period are inducers of malformations, in the postnatal period they lead to pathological processes, including malignancy.*

Keywords: *adentia, prosthetics, treatment, implantation, ontogenesis, oral mucosa, embryonic development, local immune homeostasis*

Relevance

Disturbances in the system of epithelial-mesenchymal interactions induce various pathological processes, such as precancerous lesions, including leukoplakia, tumors, and psoriasis, while knowledge of these patterns will allow therapeutic manipulation of target cell signaling pathways in the system of interacting ensembles of mesenchymal and epithelial differons with preventing rejection of dental implants. Ferguson M.W. (1988) the most studied age characteristics of the oral mucosa (OM) in various representatives of the evolutionary ladder [1]. Semchenko Iu.P, Kovbyk L.V. (1995) on based on the revealed differences in the biological properties of the epithelium, an assumption is made about the different genetic origin of the epithelial tissues of the mucous membranes of the soft palate of the oral and pharyngeal surfaces [4].

Sharpe P.M., Ferguson M.W. (1988) it was shown that mesenchymal tissue: cells, matrix and soluble factors affect the morphogenesis, proliferation and differentiation of various embryonic epithelium, as well as mesenchymal derivatives that support these processes in postnatal ontogenesis through their influence on the local proliferation rate and cytokeratin composition of the oral mucosa [5].

Changes in epithelial-mesenchymal interactions in the age aspect depend on the presence of concomitant pathology and affect the assessment of a person's biological age, which is one of the most difficult tasks in the auxological sciences [2, 3]. Wertz P.W., Squier C.A. believe that at the present stage, the fundamental platform of ideas about the features of the structure of the oral mucosa in different age groups of a person is insufficient, which affects the development of the applied methods of conservative and invasive treatment [6]. New possibilities are opened up by the assessment of the developmental features of the oral mucosa in order to predict the outcomes of the treatment of adentia and dental prosthetics, which served as the basis for choosing the direction of our research.

Purpose and objectives of the study

To study the features of the oral mucosa in pre- and postnatal ontogenesis.

Material and methods of research

The study was carried out taking into account the provisions of the Declaration of Helsinki (2000, 2013) and with the permission of the ethics committee of the Far Eastern Federal University. OM biopsy specimens were obtained in accordance with the order of the Ministry of Health and Medical Industry of the Russian Federation dated April 29, 1994 N 82 "On the procedure for conducting pathoanatomical autopsies" and in accordance with the nomenclature of clinical laboratory studies of the Ministry of Health of the Russian Federation (order of February 21, 2000 No. 64). Clinical material for the study was obtained at the Kolot Medical Center (Vladivostok) during 2019-2021.

The biological material of 10 human embryos and fetuses was studied, the age of which was determined according to ultrasound data and the Haase rule. 54 OM biopsies obtained from patients (22 men and 32 women) aged 10 to 85 years had periodontal disease, with teeth to be extracted. The control group included 9 patients aged 25 to 30 years with fractures and dislocations of teeth in intact dentition, somatically healthy, with a period of treatment of no more than one hour after injury.

Research results and discussion

We found that on the 3rd week the wall of the oral fossa of the embryo is covered with a single-layer multi-row epithelium. The bottom of the oral fossa is covered with two-layer low prismatic epithelium, the roof is covered with ciliated epithelium. We have noted that CD34-expressing mesenchymal cells in the developing oral mucosa (OM) are detected as early as the 3rd week of human embryonic development.

In comparison with the prenatal period, in the postnatal period of human development, OM is characterized by a decrease in the thickness of the mucous membrane as a whole, the appearance of granular layers of cells on the surface of the stratified squamous non-keratinized epithelium. Children are characterized by basophilia in the basal and on the entire surface of the cut of the spinous layer. With age, the number of cambial cells in the spinous layer decreases significantly, remaining in the form of single proliferating cells in the older age groups after 65 years. The dynamics of the decrease in proliferative activity in the basal layer is not so pronounced; proliferative activity in single cells per 1 mm2 of the area of the OM cut remains until old age. In general, the dynamics of changes in the morphometric parameters of the oral mucosa of patients in the control group in the age aspect is shown very low.

Gerontological features of OM In patients of the gerontological group in the layers of the epidermis, they were characterized by the fact that a violation of intercellular contacts was identified, pronounced in the spinous layer. Intercellular connections in some cases are preserved, however, intercellular gaps with clear contours of the cytoplasm of spiny cells towards the apical surface are defined. The initial background of immunocytes/macrophages of the oral mucosa in the subgroup of patients with somatic pathology, especially with gastrointestinal pathology, was statistically significantly different from the data of the control and the first group of the study in all respects. With prolonged absence of teeth, regardless of age, desquamated epitheliocytes contaminated with microflora, dendritic cells, lymphocytes, and in the case of prolonged use of metal prosthetic structures, metal nanoparticles, sometimes freely located in the oral fluid, sometimes phagocytosed by epitheliocytes, were found on the surface of the OM. The regeneration of the epithelial layer in the control group proceeds in accordance with the processes

of differentiation of keratinocytes, despite the processes of apoptosis, and in patients with somatic pathology there are violations of differentiation, which is accompanied by a decrease in the protective properties of the epithelium. We also noted age-related positive dynamics of epithelial apoptosis not only in the surface layers, but also in the cambial and spiny layers, desolation of capillaries in the lamina propria; increased lymphocytic infiltration.

Conclusion

The data obtained indicate a decrease in immune control in terms of local immune homeostasis in older age groups, especially those over 65 years of age. Therefore, we proposed to consider patients at risk for implantation of teeth over 65 years of age, predisposed to the development of inflammatory processes, the development of implant rejection, and allergic reactions when installing dentures of any chemical composition.

Prevention of implant rejection should be carried out against the background of a thorough sanitation of the oral cavity, accompanied by monitoring of the state of the oral mucosa.

References

1.Ferguson M.W. Palate development. Development. 1988;103 Suppl:41-60. doi: 10.1242/dev.103.Supplement.41.

2. Litwiejko-Pietryńczak E. Variability of electrophoretical mobility of nuclei in human ontogenesis. Rocz Akad Med Bialymst. 2001;46:225-30.

3. Novak N., Gros E., Bieber T., Allam J.P. Human skin and oral mucosal dendritic cells as 'good guys' and 'bad guys' in allergic immune responses. Clin Exp Immunol. 2010 Jul 1;161(1):28-33. doi: 10.1111/j.1365-2249.2010.04162.x.

4.Semchenko Iu.P., Kovbyk L.V. Gistogeneticheskie osobennosti épitelial'nykh tkaneĭ slizistykh obolochek glotochnoĭ i rotovoĭ poverkhnosteĭ miagkogo neba v ontogeneze i v éksperimental'nykh usloviiakh [The histogenetic characteristics of the epithelial tissues of the mucosa of the pharyngeal and oral surfaces of the soft palate in ontogeny and under experimental conditions]. Morfologiia. 1995;108(2):54-6.

5.Sharpe P.M., Ferguson M.W. Mesenchymal influences on epithelial differentiation in developing systems. J Cell Sci Suppl. 1988;10:195-230. doi: 10.1242/jcs.1988.supplement_10.15.

6. Wertz P.W., Squier C.A. Cellular and molecular basis of barrier function in oral epithelium. Crit Rev Ther Drug Carrier Syst. 1991;8(3):237-69.

DOI 10.34660/INF.2023.27.21.074

THE PROBLEM OF NEW-ONSET AFFECTIVE DISORDERS IN THE POST-COVID PERIOD: A FOCUS ON MANIA

Dmitriev Maxim Nikolaevich
Candidate of Medical Sciences, Associate Professor
Rostov State Medical University
Glushchenko Yana Yuryevna
Resident of the Department of Psychiatry
*Rostov State Medical University***,**
Rostov-on-Don, Russia

Abstract. *A significant level of neuropsychiatric disorders has been reported worldwide in patients who have undergone COVID-19. The emergence of a wide range of psychopathologies is most often attributed to a complex of biological and socio-stress mechanisms of brain damage. However, clinical observations of first-onset manic psychoses have been reported in the world literature, calling into question previous views on the etiopathogenetic basis of affective disorders associated with COVID-19. It is likely that coronavirus infection may potentiate the exacerbation of previously unexpressed primary psychopathologies or influence their development de novo. This article finds a pattern indicating a relationship between SARSCoV-2 ingestion and the development of autochthonous psychiatric nosologies.*

Keywords: *COVID-19, post-covid affective disorder, first-time mania, first-time depression, new-onset mania, autochthonous psychiatric disorders.*

Since the emergence of the COVID-19 pandemic, many countries around the world have reported an increase in the incidence of psychiatric morbidity. In a study by Taquet M. et al. (2021) of 62 000 patients diagnosed with COVID-19, psychiatric disorders were observed in 18% of patients within 3 months of infection. These were newly detected mental disorders in 5.8% of cases [1].

Affective pathology was the most frequently found. Signs of depression and anxiety in the post-covid period were recorded in 30-40% and 28-42% of patients, respectively, according to various sources [2-6]. Disorders that have occurred for the first time in life deserve special attention. It have been found in patients with varying severity of respiratory and intoxication disorders due to Sars-CoV-2 lesions [3,15,16].

Various articles on this topic have provided examples of similar clinical cases in which, after a mild or moderate course of COVID-19, patients with a favorable psychiatric history showed signs of affective disorders, including mania [7,14,17,18,20]. Emotional problems were also reported in people who did not have clinical manifestations of infection.

Meeder R. et al. (2020) described cases of the development of manic psychoses in patients with asymptomatic COVID – 19 and who did not express concerns about their somatic health. They came under medical supervision after the manifestation of symptoms such as psychomotor agitation, acceleration of the pace of thinking and speech, excessive talkativeness, grandiosity of delusion ideas, insomnia, mood lability [8].

These facts reflect the complex formation of biological, psychological and social factors in the origin of mental pathology.

Many researchers state a particular disorder, limit themselves to typing a syndromic model, or back up their conclusions with indicators of psychometric scales [3, 9-12].

The analysis of clinical cases reveals that a single syndrome can be a manifestation of formally different diseases, according to the current classifications of mental disorders [7,13]. Dorozhenok I. (2021) describes the variance of affective disorders on the example of clinical cases of post-covid depressions [13]. They were represented by a depressive variant of an adjustment disorder, an exacerbation of a previously existing recurrent depressive disorder and the appearance of new-onset dysthymia [13].

According to the views of the domestic school of psychiatry, affective pathology can be a manifestation of endogenous, exogenous and psychogenic diseases. Mood disorders can be classified as manifestations of three groups of psychiatric pathology - intrinsic affective disorders (block L1-6A6), disorders specifically related to stress (block L1-6B4) and secondary affective syndrome (6E62), based on the implementation of ICD-11 [14], This dispersion of clinical variants may be true for depression and anxiety in both the new and old classifications.

Manic manifestations are quite rare of all the affective disorders associated with COVID-19. Psychiatric disorders were found in 39 out of 125 patients with confirmed COVID-19 in a study conducted by Varatharaj A. et al. (2020). Of these, there was 1 case of mania [24]. There are difficulties in the identification and standardised typing of such pathology. While studying this problem in Russia, we were able to find only 2 publications [15, 25] describing mania in COVID-19.

There are no specifications from the category of psychogenic or stress-induced illness for manic manifestations. References to the experience of patients during the COVID-19 pandemic due to quarantine measures, information exposure, or other stressful events before the onset of mania suggest only a temporal relationship [15-17]. It is not possible to find K. Jaspers criteria for psychogenic disorders with a careful study of the presented clinical cases. In all cases no connection was found

between the content of psychiatric symptoms and the direction of psychogenic influences. There is no causal relationship between manic or hypomanic symptoms and stressful situations. Therefore, socio-psychological risk factors may play a significantly lesser role in the development of mania. The main mechanisms for the development of mania are related to biological factors.

Affective disorders are not among the classical manifestations of exogenous reactions by K. Bonhoeffer. In ICD-10 and ICD-11, the general rule for including affects in the group of organic or secondary lesions is the presence of reliable data from anamnesis, medical examination, laboratory or instrumental studies, indicating direct causal relationships with cerebral or somatic pathology. Affective symptoms should not be a manifestation of other psychopathological disorders (for example, delirium) and cannot be explained by a psychologically understandable reaction of the patient to a severe health disorder.

An analysis of known clinical cases shows that these criteria are not present in examples of post-COVID mania or they are very rare. Iqbal Y. et al. (2021) provide a rather large sample of their own observations of such patients [18].

Only 20% (n=3) showed moderate ischemic white matter changes on brain imaging. The rest did not have obvious structural brain disorders. At the same time, 66% of patients had no clinical symptoms of COVID-19, 13% had minor symptoms of the upper respiratory tract. Only 20% had non-severe pneumonia, and 53% had no inflammatory markers. Our own clinical case [15] described the onset of mania in a patient 2 weeks after COVID-19 in the absence of neurological symptoms and normal brain MRI parameters.

In an extensive systematic review of 963 reports of mania in Sars-Cov-2, M. Russo et al (2022) were able to identify only 23 clinical cases of first episodes meeting the current DSM-5 criteria for a manic episode. Only 5 patients had MR positive findings in the brain. They indicated chronic small vessel disease in three persons, and only 2 patients presented acute abnormalities. Only 2 patients had positive findings cerebrospinal fluid.

These and other examples show a very low probability of the development of mania as a secondary psychopathological disorder due to damage to the brain substance due to Sars-CoV-2 [15,17-20] and indicate the preference for the point of view of the manifestation of autochthonous mental disorders.

When considering primary (autochthonous) psychiatric disorders, great importance is given to individual and family history. Many publications [15,18-20] provide examples of new-onset episodes of post-COVID mania without a previous psychiatric history.

Also among the clinical cases described are examples of no personal psychiatric history, but the presence of a family history of bipolar disorder or other mental disorders [17,18]. Mania in COVID-19 can be a recurrent psychotic episode in a patient who has a previously history of depression or mania [16, 18, 19]. Mania in

COVID-19 can be a recurrent psychotic episode in the patient himself, who was preceded by depressive or manic manifestations [16,18,19]. At the same time, these patients did not have obvious mental symptoms before the development of coronavirus infection.

Presumably, the occurrence of mental disorders associated with coronavirus infection may be mediated by biological mechanisms that are implemented by activating the general immune response, the marker of which is the basic index of systemic immune inflammation [2, 19].

So, in some scientific papers it is reported that in patients with severe COVID - 19, the level of pro-inflammatory cytokines IL-6, IL-10 and TNF-a is significantly increased. [21], compared with the control group [22]. It is noteworthy that with careful analysis, overlaps can be found between the cytokine profile in coronavirus infection and confirmed cases of primary affective disorders. Thus, interleukin-6 (IL-6), interleukin-8 (IL-8) and tumor necrosis factor (TNF-a) are found in large quantities in patients diagnosed with Bipolar affective disorder [23], as well as in manic states [18]. Immune disorders may be the mechanisms through which Sars-CoV-2 [19, 22] induces the development of de novo bipolar disorder or its recurrence after prolonged euthymia.

An additional problem in the study of mania in COVID-19 is understanding the boundaries of mood disorders and their typing. This also applies to manifestations of the depressive spectrum [26]. There is a tendency to broadly treat some types of acute mania as a bipolar affective disorder spectrum. Cases of delirious mania have been described in COVID-19 [19, 27, 28]. Criteria for this syndrome include acute agitation, severe emotional lability, delusions with grandiose ideas, insomnia, disorientation and altered consciousness, and the addition of catatonic symptoms [29]. In the Russian psychiatric school, such disorders are typified as oneyroid syndrome and traditionally referred to as manifestations of schizophrenia spectrum disorders. Delirious mania can account for up to 15% of all acute mania. Such discrepancies make it difficult to accurately diagnose and account for such patients.

Conclusion

First-time affective disorders and especially mania represent an underestimated clinical picture of COVID-19. The reported cases illustrate a number of possible pathogenetic mechanisms by which COVID-19 may induce mania or hypomania. The presence of new-onset mania during Sars-CoV-2 infection indicates the likely development of bipolar disorder. Further cohort studies with more stringent criteria are needed to determine the incidence, etiology and prognosis of COVID-19-associated affective disorders.

.

References

1. Taquet M., Harrison P. J. Why is COVID-19 associated with mental illness? Med. 2021. T. 2, Vol. 8, pp. 899-902. DOI: 10.1016/S2215-0366(20)30462-4

2. Mazza M. G., De Lorenzo R., Conte C., et al. COVID-19 BioB Outpatient Clinic Study group; Benedetti F. Anxiety and depression in COVID-19 survivors: Role of inflammatory and clinical predictors. Brain Behav Immun. 2020 Oct., Vol. 89, pp. 594-600. DOI: 10.1016/j.bbi.2020.07.037.

3. Yakshimbetova, A. I., Naguib A. M. M., Besedina O. A., Nasirdinova N. A., Akhmadeeva L. R. Anxiety and depression in patients surveying the new sars-cov-2 coronavirus infection. Re-health journal. 2022, Vol. 2, no. 14, pp. 95-98.

4. Kochetova Yu.A., Klimakova M.V. Studies of the mental state of people in the context of the COVID-19 pandemic. Sovremennaja zarubezhnaja psihologija[Modern foreign psychology], 2021, Vol. 10, no. 1, pp. 48-56. (in Russian)DOI: 10.17759/ jmfp.2021100105.

5. Rogers J.P., Chesney E., Oliver D., Pollak T.A., McGuire P., Fusar-Poli P. et al. Psychiatric and neuropsychiatric presentations associated with severe coronavirus infections: a systematic review and meta-analysis with comparison to the COVID-19 pandemic. Lancet Psychiatry. 2020, Vol. 7, no. 7, pp. 611–627. DOI: 10.1016/S2215-0366(20)30203-0.

6. Kazarina A. P., Selikhanova V. M. Post-covid depression. literature review. Nauka i zdravoohranenie[Science and health care], 2021, no. 3, pp. 16-23. (in Russian)DOI: 10.34689/SH.2021.23.3.002

7. Alihsan B., Kashfi S., Roarke D. T. First Manic Episode Following SARS-CoV-2 Infection. Cureus. 2023, Vol. 15, no 1, pp. e33986. DOI: 10.7759/ cureus.33986

8. Meeder R. et al. New-Onset Mania and Psychosis in Adolescents in the Context of COVID-19 Infection. Cureus. 2022, Vol. 14, no. 4, pp. e24322 DOI: 10.7759/cureus.24322

9. Taquet M., Luciano S., Geddes J. R., & Harrison P. J. Bidirectional associations between COVID-19 and psychiatric disorder: retrospective cohort studies of 62 354 COVID-19 cases in the USA. The Lancet Psychiatry, 2021, Vol. 5, i 2, pp. 130-140. DOI: 10.1016/S2215-0366(20)30462-4.

10. Robinson E. et al. A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic in 2020. Journal of affective disorders. 2022. Vol. 296, pp. 567-576. DOI: 10.1016/j.jad.2021.09.098.

11. Saddik B. et al. The psychological impact of the COVID-19 pandemic on adults and children in the United Arab Emirates: a nationwide cross-sectional study. BMC psychiatry. 2021. T. 21, Vol. 1, pp. 1-18. DOI: 10.1186/s12888-021-03213-2.

12. Dettmann L.M., Adams S., Taylor G. Investigating the prevalence of anxiety and depression during the first COVID-19 lockdown in the United Kingdom: Systematic review and meta-analyses. Br J Clin Psychol, 2022, Vol. 61, pp. 757-780. DOI: 10.1111/bjc.12360.

13. Dorozhenok I.Yu. Depression during the COVID-19 pandemic (analysis of clinical cases). Nevrologija, nejropsihiatrija, psihosomatika [Neurology, neuropsychiatry, psychosomatics], 2021, Vol. 13, no. 1, pp. 81–86. DOI: 10.14412/2074-2711-2021-1-81-86.

14. MKB-11. Glava 06. Psihicheskie i povedencheskie rasstrojstva i narushenija nejropsihicheskogo razvitija. Statisticheskaja klassifikacija. [ICD-11. Chapter 06. Mental and behavioral disorders and disorders of neuropsychic development. Statistical classification]. M .: "KDU", "University book" 2021, pp. 432. (in Russian) DOI:10.31453/kdu.ru.91304.0143. ISBN 978-5-91304-954-4.

15. Glushchenko Ya. Yu., Berezova A. S., Slavgorodskaya M. S., Matveev A. O., Dmitriev M. N. The first manic episode in a patient who had a moderate severity course of coronavirus infection: a clinical case. Somatonevrologija: materialy mezhdunarodnyh nauchno-prakticheskih konferencij studentov i molodyh uchenyh 2021-2022 gg [Somatoneurology: materials of international scientific and practical conferences of students and young scientists 2021-2022], Rostov-on-Don, Rostov State Medical University, 2022., pp. 51-59. (in Russian).

16. Uvais N. A. Mania precipitated by COVID-19 pandemic-related stress. The Primary Care Companion for CNS Disorders. 2020, Vol. 22, no. 3, pp. 27458. DOI: 10.4088/PCC.20l02641.

17. Sprenger S. et al. Acute mania following COVID-19 in a woman with no past psychiatric history case report. BMC psychiatry. 2022, Vol. 22, no. 1, pp. 486. DOI: 10.1186/s12888-022-04110-y.

18. Iqbal Y. et al. Mania and hypomania associated with COVID-19: a series of 15 cases seen by the consultation-liaison psychiatry service in Qatar. Qatar Medical Journal. 2021, Vol. 2021, no. 3, pp. 65. DOI: 10.5339/qmj.2021.65.

19. Russo M. et al. COVID-19 and first manic episodes: a systematic review. Psychiatry Research. 2022, Vol. 314, pp. 114677. DOI: 10.1016/j.psychres.2022.114677.

20. Varsak N., Topaloğlu M., Özdemir E. First Manic Attack During COVID-19 Treatment: A Case Report. Clinical Psychopharmacology and Neuroscience. 2021, Vol. 19, no 4, pp. 786. DOI: 10.9758/cpn.2021.19.4.786

21. Chen G. et al. Clinical and immunological features of severe and moderate coronavirus disease 2019. The Journal of clinical investigation. 2020, Vol. 130, no. 5, pp. 2620-2629. DOI: 10.1172/JCI137244.

22. Han H., et al. Profiling serum cytokines in COVID-19 patients reveals IL-6 and IL-10 are disease severity predictors. Emerging microbes & infections. 2020, Vol. 9, no. 1, pp. 1123-1130. DOI: 10.1080/22221751.2020.1770129.

23. Himmerich H., et al. Cytokine research in depression: principles, challenges, and open questions. Frontiers in psychiatry. 2019, Vol. 10, pp. 30 DOI: 10.3389/ fpsyt.2019.00030.

24. Varatharaj A., Thomas N, Ellul M. A., Davies N. W. S,. Pollak TA, Tenorio EL, et al. Neurological and neuropsychiatric complications of COVID-19 in 153 patients: a UK-wide surveillance study. Lancet Psychiatry. 2020. Vol.7, no. 10, pp. 875–882. DOI: 10.1016/S2215-0366(20)30287-X.

25. Mendelevich V.D, Mullina N.B. Case of acute hypomania in COVID-19: is the coronavirus guilty? Psychiatry and psychopharmacotherapy. P.B. Gannushkina [Psihiatrija i psihofarmakoterapija im. P.B. Gannushkina], 2020, no. 5, pp. 51–54.(in Russian)

26. Dmitriev M. N. Problems of establishing the boundaries of affective disorders at a non-psychotic level of disorders. 15–18 maja 2021 goda XVII S#EZD PSIHIATROV ROSSII sovmestno s mezhdunarodnym Kongressom Vsemirnoj psihiatricheskoj associacii «Interdisciplinarnyj podhod k komorbidnosti psihicheskih rasstrojstv na puti k integrativnomu lecheniju» [May 15-18, 2021 XVII CONGRESS OF RUSSIAN PSYCHIATRISTS together with the International Congress of the World Psychiatric Association "Interdisciplinary approach to the comorbidity of mental disorders on the way to integrative treatment"], St. Petersburg, NMITs PN im. V.M. Bechterev, 2021, pp. 1236-1237. (in Russia)

27. Uvais N. A., Moideen S. COVID-19 presenting with delirious mania: a case report. Bipolar Disord. 2022, Vol. 24, pp. 332-333. DOI: 10.1111/bdi.13180

28. E Haddad P. M., et al. Delirious mania in a patient with COVID-19 pneumonia. BMJ Case Reports CP. 2021, Vol. 14, no. 11, pp. e243816. DOI: 10.1136/bcr-2021-243816.

29. Jacobowski N. L., Heckers S., Bobo W. V. Delirious mania: detection, diagnosis, and clinical management in the acute setting. Journal of Psychiatric Practice®. 2013, Vol. 19, no. 1, pp. 15-28. DOI: 10.1097/01. pra.0000426324.67322.06.

DOI 10.34660/INF.2023.40.87.075

PROFESSIONAL LIABILITY INSURANCE AS A TOOL FOR LEGAL AND SOCIAL PROTECTION OF MEDICAL PROFESSIONALS WORKERS

Paikov Andrei Yurievich
Candidate of Medical Sciences, Associate Professor
Rostov State Medical University

Samoilova Yulia Borisovna
Candidate of Juridical Sciences, director of the Rostov branch
The St. Petersburg Academy of the Investigative Committee of the Russian Federation»

Paikova Viktoria Andreevna
Student
Russian Academy of National Economy and Public Administration under the President of the Russian Federation

Abstract. *The authors addressed the problem of voluntary insurance of professional liability of medical workers - doctors at the present stage. An analysis of various points of view made it possible to conclude that it is expedient to introduce compulsory insurance of medical activities. This is due to the fact that the current system of voluntary insurance of professional liability risks is not capable of becoming an effective tool that ensures both the protection of the patient's rights to guaranteed material compensation for the harm caused, and the interests of medical workers.*

Keywords: *professional liability insurance, doctor, medical worker, medical organization, patient's rights.*

There are various proposals regarding the release of medical workers from liability, in particular criminal liability, for medical errors. But they come down, as a rule, to the fact that the doctor should not go unpunished, but he should not be subjected to criminal prosecution either.

Thus, the head of the Ministry of Health, Mikhail Murashko, believes that excessive responsibility for doctors leads to the appointment of additional examinations and consultations, because of this, patients begin to be treated later. The Federal Service for Surveillance in Healthcare of the Russian Federation

proposed the use of alternative types of punishment in the event of a conscientious error of a doctor in the absence of the necessary experience or knowledge. If serious harm to the patient's health was caused due to negligence in the provision of medical care, the employees who allowed this could be temporarily suspended from work until they complete the advanced training cycle and pass the exam, said Anton Kolokolov, head of the department for organizing control of medical examinations of Roszdravnadzor. There is also an opinion that the responsibility of a doctor should be administrative [1].

Also, a proposal for medical liability insurance has been discussed for quite a long time. While generally supporting the expediency of this innovation, we believe that professional liability insurance cannot and should not replace the bringing of perpetrators to criminal, administrative, tort liability. This type of insurance is the most affordable remedy for professional liability risks.

The current practice of professional liability insurance indicates that in the event of a dispute, the courts in their decisions refer to the professional liability insurance of doctors at the time of treatment [2]. However, the law [3] enshrined the right, and not the obligation of a medical worker to insure the risk of his professional liability. There is no such obligation for the medical organization.

The insurance contracts currently offered by insurance companies indicate such a condition as the absence of signs of gross negligence in the actions of the insured. In turn, gross negligence implies both a violation of regulations that determine the procedure and conditions for medical activity, and job descriptions. Such a risk of liability of subjects of medical activity occurs on the condition that the medical personnel had to foresee the possibility of events that could cause damage to third parties as a result of non-compliance with the above requirements [4].

If we talk about health insurance in the Russian Federation in general, then this is the main form of social protection of the population in the field of health care. Z.P. Nomokonova defines its main goal as a guarantee of obtaining the necessary medical care in the event of an insured event, as well as financing of preventive measures [5].

At the moment, compulsory health insurance is aimed at the interests of the patient, while insurance for the health workers themselves and their professional risks is poorly developed. This is due to the fact that medical organizations, of course, even now have the right to insure professional activities, but clinics do not conclude such contracts if there are high risks. Medical workers can insure themselves, but only at their own expense.

According to the researchers, such contracts are concluded by private practitioners or private medical organizations. Public organizations simply do not have the funds to ensure their insurance protection [6], since budget financing does not provide for spending funds on such programs [7].

Professional liability insurance has some distribution abroad. There is compulsory liability insurance for medical workers in the Scandinavian countries (Finland, Sweden, Denmark and Norway). In the US, healthcare professionals can purchase insurance from private insurance companies that will cover the cost of legal defense and compensation for claims, with a limited amount of coverage. Even in states where physician insurance is not a requirement, most physicians purchase it because it is usually required by the hospital as evidence that the physician will be able to take financial responsibility for their own mistakes [8].

Such a model does not seem quite acceptable, since insurance is provided at the expense of medical workers, and not every doctor, especially the state and municipal health systems, can afford it. Thus, according to various companies, the premium for professional liability insurance of medical activities varies between 0.15% -5% of the sum insured. For example, in one of the large insurance companies, insurance amounts for legal entities start from 500 thousand rubles, for private practitioners - from 300 thousand rubles [9].

As a consequence, the introduction of compulsory medical liability insurance at the expense of the insurance premiums of the medical workers themselves may lead to an outflow of doctors. In this regard, it would not be superfluous to recall the words of the Minister of Health of the Rostov Region Yu.V. Kobzeva: "despite the increase in the number of doctors and the provision of nursing staff over the past five years, the shortage of health workers remains in primary care and in emergency medical units" [10].

Back in 1996, in the Russian Federation, a bill was developed that provided for the obligation of health care institutions to insure their liability in a special insurance fund. At the same time, the presence of an insurance policy became a prerequisite for obtaining a license to carry out medical activities. However, in 1999, the draft law mentioned was withdrawn from consideration [11].

We believe that compulsory insurance of medical activities can become one of the types of medical insurance aimed at providing social protection not only for patients, but also for medical workers.

A.A. Mokhov, exploring the problems of professional liability insurance in the period of biomedicine, states that it is no longer possible to postpone the decision on insurance in this area. At the same time, the author notes that it is also necessary to resolve the issue of the type of insurance: the professional liability of a doctor or a medical organization, or a combined model [12].

In the event of an insured event, insurance organizations, with the help of the professional community, will have to figure out what the medical error was, whether such a mistake was accidental and whether it was made at all.

It seems that in the event of an insured event, it is necessary to conduct an examination of the quality of medical care. Examination of the quality of medical

care at each stage of its provision should confirm the amount of insurance compensation.

The foregoing allows us to conclude that insurance of medical activities becomes necessary in terms of legal and social protection of medical workers. Insurance of occupational risks of medical workers should become mandatory for all medical organizations, regardless of their form of ownership.

References

1. Murashko: doctors cannot be judged for mistakes. [Electronic resource] - URL: https://www.miloserdie.ru/news/murashko-vrachej-nelzya-podvergat-sudebnomu-presledovaniyu/?ysclid=lbh0l8v414564775341 (date of access 01/25/2023).

2. Starchikov M.Yu. On the question of the rights and obligations of a medical worker: legislation and judicial practice. [Electronic resource] – Access from the reference legal system «ConsultantPlus».

3. Federal Law No. 323-FZ dated November 21, 2011 (as amended on December 28, 2022) "On the Fundamentals of Protecting the Health of Citizens in the Russian Federation". [Electronic resource] - Access from the reference legal system «ConsultantPlus».

4. On the issue of insurance of civil liability of subjects of medical activity. [Electronic resource]. URL: https://onegingroup.ru/press-tsentr/analitika/k-voprosu-o-strakhovanii-grazhdanskoy-otvetstvennosti-subektov-meditsinskoy-deyatelnosti/ (date of access 01/25/2023).

5. Nomokonova Z.P. Features of contractual relations in the field of medical insurance // State power and local self-government. 2009. No. 10. P. 25 - 26.

6. Zgonnikov A.P., Pushkareva A.N. Professional liability insurance of medical workers and the problems of maintaining medical confidentiality in the Russian Federation: a theoretical aspect // Legislation and Economics. 2015. No. 9. P. 48 - 51.

7. Pishchita A.N. Compulsory insurance of professional liability of medical workers as an economic factor in improving the quality of medical care // Legislation and Economics. 2007. No. 3.

8. Experience of the United States on the legal regulation of the responsibility of a doctor for causing harm to a patient's health due to negligence. [Electronic resource]. URL: https://health administration.rf/publ/zarubezhnyj_opyt/opyt_ssha_po_pravovomu_regulirovaniju_otvetstvennosti_vracha_za_nanesenie_vreda_zdorovju_pacienta_vsledstvie_khalatnosti/25-1-0-218?ysclid=lbj3axzijw450866433. (accessed 25.01.2023).

9. Who will pay for the mistakes of doctors. [Electronic resource]. URL: https://www.banki.ru/news/daytheme/?id=10892317&ysclid=lbgz7q3yjf437196642. (date of access 01/25/2023)

10. The shortage of doctors on the Don is going to be eliminated by transferring medical facilities to the state property of the region. [Electronic resource]. URL: https://don24.ru/rubric/zdorove/nehvatku-vrachey-na-donu-namereny-ustranyat-edinym-principom-upravleniya-meduchrezhdeniy.html?ysclid=lbjjn82dbu803398475. (date of access 01/25/2023)

11. Draft Federal Law No. 96700403-2 "On the Rights and Safety of Patients in the Sphere of Health Care" (withdrawn from consideration on June 15, 1999 by the Council of the State Duma of the Federal Assembly of the Russian Federation, Minutes No. 212, paragraph 23). [Electronic resource] - Access from the reference legal system «ConsultantPlus».

12. Mokhov A.A. Insurance of civil (professional) liability during the formation of biomedicine // Medical Law. 2020. No. 1. P. 12 - 18.

DOI 10.34660/INF.2023.89.68.076

STUDY OF THE EFFECT OF SODIUM LAURYL SULFATE ON THE CONDITION OF THE ORAL MUCOSA

Goreva Anna Oskarovna
Student
Privolzhsky Research Medical University

Spiridonova Saniya Akhmedovna
Candidate of Medical Sciences, Associate Professor
Privolzhsky Research Medical University

Uspenskaya Olga Alexandrovna
Doctor of Medical Sciences, Associate Professor,
Head of the Department
Privolzhsky Research Medical University

Annotation. *Oral health is one of the most important factors in the high quality of life of patients. Today, there are a huge number of items and means of oral hygiene on the market. A huge role in the prevention of pathology of hard tissues of the teeth is given to the use of toothpastes. Most of the pastes known to us contain foaming agents, such as sodium lauryl sulfate (SLS).* **Purpose of the study.** *To study the effect of sodium lauryl sulfate in toothpastes on the condition of the oral mucosa.* **Research task.** *Detect the presence of sodium lauryl sulfate in the oral fluid, buccal and gingival epithelium.* **Materials and methods.** *The study involved 30 people. Groups were distinguished: group 1 - patients who used R.O.C.S "active calcium" pastes with SLS (15 people); Group 2 - patients who used R.O.C.S "sensation whitening active granules" pastes without SLS (15 people).* **Results.** *When studying the oral fluid for the concentration of SLS in the 1st group 0.0000245±0.0000013 g/ml ($p<0.05$, between groups), in the 2nd group 0.0000005±0.0000012g/ml ($p<0$,05, between groups). When studying the buccal epithelium in the 1st group 0.0000036±0.0000009 g/ml ($p<0.05$, between groups), in the 2nd group 0.0000015±0.0000006 g/ml ($p<0.05$, between groups). Microscopic examination of the gingival epithelium showed its almost complete staining in blue and fragmentary in light green, which indicates the presence of SLS in the studied materials in both the 1st and 2nd groups. The presence of SLS in the 2nd group can be explained by the use by patients before the start of the study of pastes with SLS in their composition.*

Keywords: *oral fluid, buccal epithelium, gingival epithelium, sodium lauryl sulfate (SLS), oral mucosa.*

Introduction. Oral health is one of the most important factors in the high quality of life of patients. Today, there are a huge number of items and means of oral hygiene on the market. A huge role in the prevention of pathology of hard tissues of the teeth is given to the use of toothpastes. Most of the pastes known to us contain foaming agents, such as sodium lauryl sulfate (SLS). Sodium lauryl sulfate, when interacting with water, forms a foam that reduces surface tension at the plaque-water solution interface, followed by the formation of an emulsion. SLS is also known as a food additive E 487, the content of which should not exceed more than 1%, in fact, the amount of SLS in pastes reaches an average of 5%, which has a negative effect on the condition of the oral mucosa, causing superficial inflammation, and reduces the resistance of enamel to acids.

Purpose of the study. To study the effect of sodium lauryl sulfate in toothpastes on the condition of the oral mucosa.

Research task. Detect the presence of sodium lauryl sulfate in the oral fluid, buccal and gingival epithelium using pastes of the R.O.C.S line.

Materials and methods. A study was conducted on the basis of the Department of Therapeutic Dentistry of the Federal State Budgetary Educational Institution of Higher Education PIMU of the Ministry of Health of the Russian Federation, in which 30 people, aged 20 to 26, took part. We have identified groups: group 1 - patients who used R.O.C.S “active calcium” pastes with SLS (15 people); Group 2 - patients who used R.O.C.S “sensation whitening active granules” pastes without SLS (15 people). Inclusion criteria - practically healthy patients. For each subject, a dental card 043 / y was filled out, informed voluntary consent. All respondents underwent an examination of the oral cavity, the KPU index, the RMA index were determined.

The study of the oral fluid, buccal and gingival epithelium, was carried out on the basis of the Department of Biochemistry. G.Ya. Gorodisskaya FGBOU VO PIMU Ministry of Health of the Russian Federation, using the method of Arand M. at al. (1992). To study the oral fluid and buccal epithelium, biomaterial was taken in the morning on an empty stomach. The oral fluid was collected in sterile tubes, and the buccal epithelium from the buccal mucosa was collected using a sterile metal spoon into sterile tubes, then the methylene blue reagent (methylene blue, Na2So4, H2SO4, H2O) was added to the oral fluid and buccal epithelium at the laboratory base, then added chloroform and everything was shaken for 1 minute (to extract sodium lauryl sulfate and chloroform).

The tubes were centrifuged. After that, the lower phase (containing sodium lauryl sulfate and chloroform) was transferred with a pasteur pipette into an eppendorf containing Na2SO4 to remove residual water, the eppendorf was turned

over several times and the optical density of the supernatant was determined (1 ml cuvette, against chloroform, wavelength 651 nm.). Next, the optical density of the solution containing methylene blue and SLS was determined on a spectrophotometer. For microscopic examination of the gingival epithelium, it was centrifuged and stained with methylene blue. The gingival epithelium was homogenized, transferred to a sterile tube, and methylene blue reagent (methylene blue, Na2So4, H2SO4, H2O) was added, then chloroform was added and everything was shaken for 1 minute (to extract sodium lauryl sulfate and chloroform).

The tubes were centrifuged. The lower phase (containing sodium lauryl sulfate and chloroform) was then transferred with a pasteur pipette to an eppendorf containing Na2SO4 to remove residual water. Adsorption of methylene blue and SLS occurred. Next, the lower phases were transferred to glass slides.

Statistical data processing was performed using the Biostat program and the Microsoft Excel software product.

Results. 30 patients were examined, among them: males - 13 people (40%) and females - 17 people (60%) aged 20 to 26 years. At the time of the examination, the KPU and RMA indices were determined. K constant 7.8±0.02 ($p<0.05$, between groups), P constant 5.4±0.043 ($p<0.05$, between groups), U constant 2.8± 0.018 ($p<0.05$, between groups); in the 2nd group - constant "K" 4.14±0.02 ($p<0.05$, between groups), constant "P" 7.7±0.05 ($p<0.05$, between groups), constant "U" 1.9±0.02 ($p<0.05$, between groups). In the 1st group: PMA index - 1.32±0.03% ($p<0.05$, between groups); in the 2nd group: PMA index - 1.32±0.03% ($p<0.05$, between groups). When examining the oral cavity after 2 weeks of using the pastes: in the 1st group - 80% of the examined complained of dryness in the oral cavity, 20% complained of burning and discomfort, in the 2nd group there were no complaints.

When studying the oral fluid for the concentration of SLS in the 1st group 0.0000245±0.0000013 g/ml ($p<0.05$, between groups), in the 2nd group 0.0000005±0.0000012 g/ml ($p< 0.05$, between groups). When studying the buccal epithelium in the 1st group 0.0000036±0.0000009 g/ml ($p<0.05$, between groups), in the 2nd group 0.0000015±0.0000006 g/ml ($p<0.05$, between groups). Microscopic examination of the gingival epithelium showed its almost complete staining in blue and fragmentary in light green, which indicates the presence of SLS in the studied materials in both the 1st and 2nd groups. The presence of SLS in the 2nd group can be explained by the use by patients before the start of the study of pastes with SLS in their composition.

Conclusion. Therefore, our study revealed the presence of sodium lauryl sulfate in the oral fluid, buccal and gingival epithelium of patients using pastes containing it for oral hygiene, which is the rationale for the unsatisfactory condition of the oral cavity of patients when using these pastes and gives us the opportunity to confirm the negative the effect of SLS on the condition of the oral mucosa.

DOI 10.34660/INF.2023.79.67.077

ANALYSIS *IN SILICO* OF THE ACTIVITY OF NEW HYDRAZONES BASED ON 6-METHYLURACIL DERIVATIVES, CONTAINING A THIETANE AND DIOXOTHIETANE RING, USING BIGDATA DIGITAL TECHNOLOGY

Meshcheryakova Svetlana Alekseevna
Doctor of Pharmacy, Head of the Department
Bashkir State Medical University

Melnikov Alexander Sergeevich
Instructor of the Department of General Chemistry
Bashkir State Medical University

Nikishina Maria Sergeevna
Student
Bashkir State Medical University

Abstract. *Based on the BigData digital technology implemented by the Way2Drag Online service, the probable biological effects of new N^1-hydrazone derivatives of N^3-(thietanyl)- and N^3-(1,1-dioxothietanyl)-6-methyluracil have been studied. Promising directions for further research into the study of biological activity in vitro and in vivo have been determined. Some regularities "structure-activity" in silico are modeled.*

Keywords**:** *6-methyluracil, thietane, hydrazones, amino acids, biological activity.*

Relevance: Compounds obtained on the basis of 6-methyluracil containing a thietane fragment exhibit various types of biological activity. The activity of such substances largely correlates with the spatial structure of the substituents introduced into the parent compound [**1;2;3**]. In turn, in connection with the digital transformation in science, the search for new derivatives and the simplification of screening methods, using new innovative approaches, is an urgent task of pharmaceutical, medical, and bioorganic chemistry [**4,6**]. The *in silico* activity analysis makes it possible to reduce the time for revealing possible biological effects of newly synthesized modifications of various kinds of organic compounds [**1,2,5**].

Purpose: The purpose of this study was to synthesize new hydrazone derivatives based on N^3-(thietanyl)- and N^3-(1,1-dioxothietanyl)-6-methyluracil,

and further computer simulation of biological activity using *BigData* digital technology.

Materials and methods: *Synthesis of starting compounds*

6-methyl-1-(2-oxopropyl)-3-(thietan-3-yl)-uracil (**4**) and **6-methyl-1-(2-oxopropyl)-3-(1,1-dioxothietan-3- yl)-uracil** (**5**) were obtained on the basis of the interaction of the corresponding thietane-containing derivatives of 6-methyluracil (**1-2**), at t=80-85°C, for 6 hours, in an acetone medium, with an excess of chloroacetone (**3**) (molar ratio 1: 1.5) in the presence of calcined potassium carbonate (***Scheme 1***).

Amino acid hydrazides (**6-7**) were obtained by boiling the corresponding hydrochlorides of amino acid ethyl esters with an excess of hydrazine hydrate (ratio 1:1.2) in ethanol, with the addition of triethylamine. Recrystallization from methanol (***Scheme 2***).

All starting compounds were thoroughly purified and dried after preparation.

Synthesis of derivatives

Hydrazones (***10-13***), based on the initial derivatives of 6-methyluracil (***4-5***), were obtained by boiling, with the addition of ONION, for 3-4 hours in an environment of ethanol (***10-11***) and acetonitrile (***12-13***) with aminoacylhydrazides (***8-9***) in a molar ratio of 1:1.1 (***Scheme 3***).

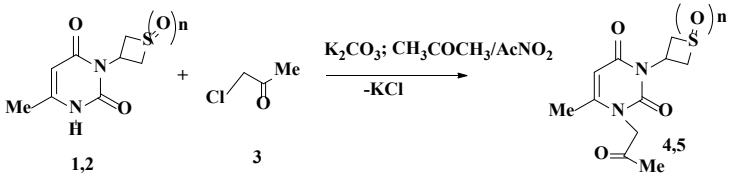
Modeling of probable types of biological activity, toxicity, and teratogenicity for new hydrazones ***10-13*** was carried out using *BigData* digital technology implemented on the Way2Drag platform, using the online resources *PASS* and *GUSAR*.

The individuality of the synthesized compounds was confirmed by thin layer chromatography (TLC) and melting point determination. The melting temperature was measured in a capillary on a PTP-M instrument (Russia), TLC on Sorbfil plates (ZAO Sorbpolimer, Krasnodar) using ethyl acetate as a mobile phase, visualization with iodine vapor, and under UV light on UFS-254. The structure of the compounds was established by ^{1}H NMR spectroscopy.

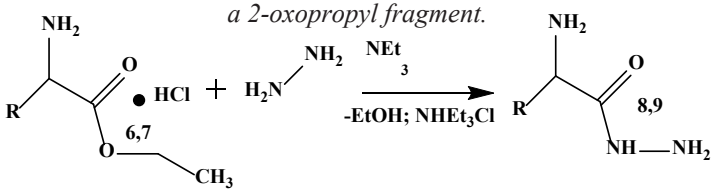
The results were statistically processed using correlation analysis and the *Statistica 10.0* software package (StatSoft Inc, USA).

Результаты и обсуждение:

We've synthesized

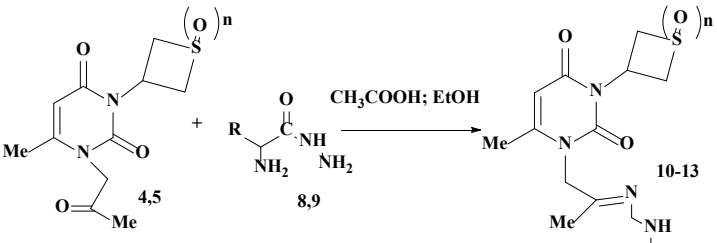


Scheme 1. *Synthesis of 6-methyluracil derivatives containing a 2-oxopropyl fragment.*



R= -CH(CH$_3$)$_2$(6,8); -CH$_2$--CH(CH$_3$)$_2$(7,9).

Scheme 2. *Synthesis of amino acid hydrazides*



n=0 (4, 10-11); 2 (5, 12-13).

R= -CH(CH$_3$)$_2$(7,9); -CH$_2$-CH(CH$_3$)$_2$(8,10).

Scheme 3. *Synthesis of hydrazone derivatives of 6-methyluracil*

New compounds were obtained in the form of solid crystals from white to light yellow.

The product yield was more than 60%.

Modeling of probable types of biological activity using *BigData* digital technology is presented in ***Table 1***.

Table 1

Modeling of probable types of biological activity, using BigData digital technology, of new hydrazone derivatives of 6-methyluracil

Type of activity	P_a	P_i
Antiviral	0,425±0,03	0,067±0,001
Fibroblast growth factor agonist	0,420±0,01	0,06±0,002
Growth hormone agonist	0,406±0,03	0,011±0,001
Neuropeptide Y4 antagonist	0,400±0,02	0,09±0,001

Pa is the probability of being active (chosen based on the condition Pa≥0.4), Pi is the probability of being inactive (chosen based on the condition Pi≤0.1).

According to the data obtained, based on the forecast of the *GUSAR* program, the synthesized compounds are low-toxic, non-teratogenic substances.

Conclusion: A comprehensive analysis of synthesis data and computer simulations can be reduced to the following foundations:

1. The method for the synthesis of hydrazides of α-amino acids was modified, using the example of leucine and valine, and the optimal conditions for the synthesis of new 2-oxopropyl- and hydrazone derivatives of 6-methyluracil were selected.

2. New hydrazones based on N^3-(thietanyl)- and N^3-(1,1-dioxothietanyl)-6-methyluracil have been isolated as substances with pronounced physicochemical characteristics, which can be further used for their identification.

3. The most probable for further study of the synthesized hydrazones are the following types of biological activity: antiviral, fibroblast growth factor agonist, growth hormone agonist and neuropeptide Y4 antagonist, which opens up prospects for the study of this group of substances as compounds with antiviral, regenerative activity, and antiepileptic properties.

Note that the first and second types of activity are equally characteristic of all synthesized hydrazone derivatives, the second and third types - with an increase in the hydrocarbon radical of the amino acid residue even by one $–CH_2-$ group, it sharply reduces the likelihood of manifestation, with a decrease in the radical, this activity is absolutely not predicted. Based on this, the most likely vector of research is recommended to be directed to the study of antiviral and regenerating activity.

References

1. The study of potential activity in a series of N3-(oxothietanyl)-6-methyluracil derivatives in silico/ Melnikov A.S., Meshcheryakova S.A. // Proceedings of the international scientific and methodological conference "Science and Education: Topical Issues of Theory and Practice", Samara - Orenburg - Nizhny Novgorod, 2021, p. 258-261.

2. Computer modeling of the "structure-activity" dependence in the series of derivatives of thietanylmethyluracil hydrozones/ Melnikov A.S., Shumadalova A.V., Zaikina A.V.// Proceedings of the All-Russian scientific and practical conference "Scientific research in the modern world. Theory and practice", St. Petersburg, 2020, p. 77-79.

3. Synthesis of 3-(1,1-dioxidothietan-3-yl)-6-methyluracil and its hydrazone derivatives/ Melnikov A.S., Meshcheryakova S.A. // Medico-pharmaceutical journal "Pulse". -2021. - T. 23. - No.5. - With. 181-189, http://dx.doi.org/10.26787/nydha-2686-6838-2021-23-5-181-189.

4. The use of Big Data in the pharmaceutical industry GxP news: [Electronic resource]. M., 2017. URL: https://gxpnews.net (Date of access: 03/20/2022).

5. Search for substances with biological activity synthesized on the basis of dioxothietanyl uracil/ Timokhina E.S., Bykova V.A., Melnikov A.S. // Vestnik of BSMU, No. 2, Ufa, 2020, p.123-128.

6. Macrocyclic derivatives of 6-methyluracil as ligands of the peripheral anionic site of acetylcholine esterase // MedChemComm. 2014. Vol. 5. no. 11. S. 1729-1735.

DOI 10.34660/INF.2023.50.66.078
UDC 664.681

OPTIMIZATION OF WHEAT FLOUR PROPERTIES FOR THE PRODUCTION OF HIGH-QUALITY FLOUR CONFECTIONERY PRODUCTS

Tumanova Alla Evgenievna
Doctor of Technical Sciences, Full Professor
Russian Biotechnological University

Antipova Olga Evgenievna
Postgraduate
Russian Biotechnological University

Rudneva Evgeniya Alekseevna
Master's degree Student
Russian Biotechnological University

Abstract. *The purpose of the study is to propose the most rational particle size of wheat baking flour for the production of high–quality flour confectionery products without resorting to the use of chemical improvers in their production. The properties of various samples of wheat baking flour were studied, the granulometric composition of the samples was evaluated and its effect on the quality of cupcakes was studied. For the production of cupcakes, a separated flour fraction with a particle size of 106-160 microns was used. In the manufacture of cupcakes, chemical improvers were not added. As a control, products made from wheat flour baking in / with a traditional recipe were used. The organoleptic and physico-chemical properties of the finished cupcakes were determined: appearance, taste, color, smell, shape, surface, appearance in the fracture, mass fraction of dry substances, alkalinity, density, water activity. Studies have shown that all the cupcakes produced had a flat surface, with small gaps on the upper crust, a regular shape, and developed uniform porosity of the crumb. Cupcakes made from the selected flour fraction differed from the control by a more pronounced taste and aroma, the tenderness of the crumb, while increasing the specific volume of products. The indicator – the activity of water in the products, was almost at the same level.*

Keywords: *flour confectionery, cupcakes, product quality, wheat flour in / with, granulometric composition.*

Producers of sweet flour products use wheat flour as the main raw material, mainly of the highest grade (GOST 26574-2017 Baking wheat flour) produced taking into account the requirements of the baking industry, not fully adapted to the production of a wide range of original technologies for flour confectionery goods (FCG) , which leads to a decrease in quality stability, loss of the marketable product, an increase in rejects and necessitates the use of various additives, including chemical additives - antioxidants, emulsifiers, water-retaining components, which make it possible to regulate the structural and mechanical properties of the semi-finished product [4].

The water absorption capacity (WAC) and the stability of the dough during kneading and molding are largely influenced by the state of proteins and their physical connection with starch. If, when grinding wheat grain, the amount of integral starch granules in the protein network surrounding them is 90%, and the amount of destroyed starch is 10%, then the flour will have optimal water absorption capacity and high stability of dough formation [1].

Therefore, an important indicator that is directly related to WAC and stability is the degree of starch degradation. The stability and predictability of the dough rheology depends on the degree of destruction of starch granules; porosity and volume of the product [3].

In turn, the degree of destruction of starch directly depends on the granulometric composition of the flour.

The purpose of the study is to offer the most rational particle size of baking wheat flour for the production of high quality flour confectionery products without resorting to the use of chemical improvers in their production.

In accordance with the goal, the following tasks were solved:

- analysis of particle size distribution and physical and chemical properties of wheat flour produced at domestic enterprises;
- study of the influence of the granulometric composition of wheat flour on the quality of cakes;
- substantiation of the optimal granulometric composition of wheat flour for the production of cakes, in order to obtain high quality products without the use of chemical improvers;

The objects of the study were samples of baking wheat flour obtained from 3 flour mills in Russia, as well as ready-made cakes made in accordance with the ''Stolichny'' cake recipe [2].

The dough for cupcakes in accordance with the basic recipe was prepared as follows: plasticized butter was churned with sugar in a kneader for 7-10 minutes, then melange was gradually added, and continued to churn for another 5-7 minutes. Separately, wheat flour of the highest grade with baking powder was sifted and added to the butter-egg mixture, thoroughly mixed for 5-8 minutes until

a homogeneous mass was formed. The moisture content of the finished dough was 18 + 2%. The dough weighing 50 g was laid out in silicone baking molds. Cupcakes were baked in a baking chamber for 20 minutes at a temperature of 180 ºC [5].

In wheat flour, the ash content was determined in accordance with GOST 27494-2016 (Flour and bran. Methods for determining ash content): moisture in accordance with GOST 9404-88 (Flour and bran. Method for determining moisture content); the quantity and quality of gluten GOST 27839-2013 (Wheat flour. Methods for determining the quantity and quality of gluten), particle size distribution according to GOST 27560-87 (Flour and bran. Method for determining fineness), WAC (viscosity) on the Farinograph device.

The criterion for evaluating the quality of products was organoleptic indicators: taste, color, smell, shape, surface, fractured appearance of products in accordance with (GOST 15052-2019 Cupcakes. General specifications and GOST 5897-90 Confectionery products. Methods for determining organoleptic quality indicators, sizes , net weight and components), mass fraction of solids in products - according to GOST 5900-2014 (Confectionery products. Methods for determining moisture and solids); alkalinity - according to GOST 5898-87 (Confectionery products. Methods for determining acidity and alkalinity), density according to GOST 15810-2014 (Confectionery products. Methods of determination), volume of products according to GOST 27669-88.

The water activity in cakes was determined by the method in accordance with GOST ISO 21807 - 2015 “Microbiology of food products and feed. Determination of water activity”, based on the determination of the “dew point” on the device AquaLab (USA) model 3TE, (the range of water activity measurement is from 0.200 to 1.000, the limits of the permissible absolute error of water activity measurements are ± 0.006.

We studied the physicochemical and rheological properties of 3 samples of wheat baking flour of the highest grade obtained from flour mills in Russia, produced in accordance with GOST 26574-17, the results are shown in table 1.

Table 1

Physical and chemical properties of premium wheat flour

Quality indicators	Sample №1	Sample №2	Sample №3
Ash content, %	0,54	0,53	0,50
Humidity, %	14,5	14,4	14,5
Amount of gluten, %	29,0	29,1	28,6
Gluten quality (IDK) units. etc.	58	68	70
WAC (viscosity),%	58,8	59,6	58,9

Analyzing the results of Table 1, it was found that in terms of ash content, humidity, amount of gluten, water absorption capacity, the samples differ slightly. In samples No. 2,3, the amount of gluten is close and higher than in sample No. 1.

Further, in Table. 2, data are given on the percentage distribution of particles of wheat flour of the highest grade, on sieves with different mesh sizes.

Table 2

Particle size distribution of premium wheat flour particles

Particles (sample 500 g)	Sample №1	Sample №2	Sample №3
Residue on a sieve 160 microns, %	0	1	1
Residue on a sieve 140 microns, %	1	1	2
Residue on a sieve 132 microns, %	20	10	25
Residue on a sieve 106 microns, %	26	25	22
Residue on a sieve 100 microns, %	29	25	28
Residue on a sieve 80 microns, %	14	24	10
Pallet, %	10	14	12
Total, %	100	100	100

In all samples of wheat flour, a high content of particles less than 106 microns was found, from 50 to 63% of the total mass. The proportion of particles larger than 140 μm in the samples is insignificant. The proportion of particles in the range of 140 - 132 μm varied from 10 to 25% of the total mass of particles.

For research, cupcakes were made using premium wheat flour with a maximum particle fraction of less than 106 microns, (Sample No. 2), as well as with an isolated flour fraction with a particle size of 106 to 160 microns. Table 3 shows the quality indicators of the prepared cakes.

Table 3

Quality indicators of cupcakes

Indicators	Norm	Cupcakes with grain size of wheat flour	
		less than 106 microns - 63%, (sample No. 2)	106-160 micron -100%
Moisture content, %	12,0-24,0	18,2	18,1
Alkalinity, hail	no more 2 deg	1,5	1,5
Density, %	no more than 0.55	0,52	0,43
Specific volume, cm 3/g	-	2,2	2,7

Analyzing the data table. No. 3 and the tasting conducted, it was noted that

with almost equal indicators of moisture and alkalinity of products, a flat surface with small gaps in the upper crust, regular shape, uniform porosity, a cake made on the basis of flour particles 106-160 microns in size had a more pronounced taste and aroma, lower density, more developed porosity and an increase in the specific volume of products, compared with a cake made from wheat baking flour.

Water activity is an indicator by which the susceptibility of products to microbiological spoilage is judged (for cakes this indicator varies within 0.6 - 0.9 units of the device), in cakes made from baking wheat flour and in cakes produced on the selected flour fraction was one level and amounted to 0.84 device units.

As a result of the studies carried out in samples of premium wheat flour obtained from various flour mills in Russia, a high content of particles less than 106 microns, from 50 to 63% of the total mass, was established.

The possibility of using the middle fraction of wheat flour with a particle size of 106-160 microns in the production of cakes was studied.

The organoleptic and physico-chemical indicators of the quality of cakes made on the basis of the use of a separate flour fraction with a particle size of 106-160 microns were studied in comparison with baking wheat flour.

An increase in the organoleptic and physico-chemical properties of products made from the middle fraction of flour, compared with traditional ones, has been established.

The results obtained will allow us to adapt the requirements for the granulometric composition of wheat flour for the production of high-quality eco-friendly cakes.

References

1. Berestnev E.V., Petrichenko V.E., Petrichenko V.V. Recommendations for the organization and conduct of the technological process at flour mills//M.: TD DeLi, 2020. – 367 p.

2. Lapshina, V. T., Fonareva, G. S., & Ahiba, S. L. (2000). A collection of recipes for cakes, pastries, muffins, rolls, cookies, gingerbread, gingerbread and fancy bakery products (part 3). Moscow: Khlebproinform. 2004 -548 p.

3. Petrichenko V.V. Why do bakeries bear all the losses and where is the way out of this situation? / V.V. Petrichenko, V. Strubbe, A. Yu. Shazzo, A. E. Tumanova, O. E. Antipova. In the collection: Bakery, confectionery and pasta products of the XXI century. Krasnodar. Proceedings of the VII International Scientific and Practical Conference, 2021, 48-57 p.

4. Sarafanova L.A. The use of food additives in the confectionery industry./ L.A. Sarafanova. - St. Petersburg: «Profession». 2005. – 304 p.

5. Technological instructions for the development of flour confectionery products. / RDIFS food industry. // 1992. – 240 p.

DOI 10.34660/INF.2023.88.28.079

ANALYSIS OF THE REPEATED USE POSSIBILITY OF ACTIVATED CARBON IN THE PURIFICATION OF WASTEWATER FROM ORGANIC COMPONENTS

Belyaeva Oxana Vladimirovna
Candidate of Chemical Sciences, Associate Professor
Kemerovo State University

Golubeva Nadezhda Sergeevna
Candidate of Technical Sciences, Associate Professor
Kemerovo State University

Gora Natalia Viacheslavovna
Candidate of Technical Sciences, Associate Professor
Kemerovo State University

Abstract. *The possibility of using low-temperature thermal regeneration to restore the adsorption capacity of active carbon after purification of wastewater from coke production from phenol and pyridine has been studied. It was determined that the maximum degree of recovery of adsorption capacity is observed during the second cycle of adsorption/regeneration, and is not more than 75% in relation to phenol, and 87% to pyridine.*

Keywords: *thermal regeneration, activated carbon, wastewater.*

Increasing volumes of coke production lead to the formation of a large amount of wastewater containing a wide range of dissolved pollutants, including phenol (PhH) and pyridine (Py). The discharge of waters containing phenol and pyridine into water bodies sharply worsens their general sanitary condition, affecting living organisms both by its toxicity and by a significant change in the regime of biogenic elements.

When ingested, pyridine and phenol cause damage to the central nervous system, digestive tract, liver and kidneys. MAC of pyridine for reservoirs of household and drinking and cultural and household water use - 0.2 mg/dm^3 according to the sanitary and toxicological indicator. MAC for phenol discharge into a fishery reservoir is 0.001 mg/dm^3.

One of the important environmental tasks is to prevent the ingress of toxic substances into natural water bodies, treatment and purification of wastewater. To

remove polluting organic components with a concentration of up to 100 mg/l from wastewater, it is advisable to use the adsorption method [1].

Activated carbons, which have a porous structure and a large surface area, have found the widest application in industry for the extraction of organic pollutants from aqueous media. Activated carbons have a number of advantages, such as high adsorption efficiency, ease of use and disposal after exhaustion of the resource, relatively low cost, and the ability to extract pollutants in small concentrations.

Since the efficiency of sorption technologies depends, among other things, on the possibility of repeated use of activated carbon, an important stage of research is the assessment of the degree of regeneration of carbon sorbents. To remove volatile organic compounds from the carbon surface, treatment with live steam, air or an inert gas at a temperature above the boiling (sublimation) temperature of the adsorbate, as well as chemical reagents, can be used.

Previous studies have shown a rather high efficiency of using active carbon of the SKD-515 brand as an adsorbent for purifying wastewater from phenol and pyridine without preliminary extraction of mineral components [2]. For this spent adsorbent, we chose low-temperature thermal regeneration in an inert atmosphere. It was assumed that during its implementation the oxidation of the carbon surface and desorption products would not occur. The use of chemical regeneration in connection with the generation of secondary waste was considered inappropriate.

To select the optimal regeneration temperature, a thermogravimetric analysis of activated carbon was carried out after the adsorption of a mixture of pyridine - phenol - mineral components at ratios corresponding to the composition of wastewater from coke-chemical enterprises. Differential mass loss curves (DTG) were recorded in the temperature range of 20–400°C in a helium atmosphere at a temperature rise rate of 2.5°C min-1 on a NETZSCH STA 409 PG/PS instrument. It has been established that the removal of adsorbed components ends at a temperature of about 305 ± 5 °C (Figure 1).

The assessment of the degree of recovery of the adsorption capacity of the spent sorbent was carried out for three adsorption-regeneration cycles. Activated carbon was regenerated with nitrogen for 4 hours at a temperature of 3500C and a gas flow rate of 100 cm3/min.

The results of the study showed (Figure 2) that the degree of recovery of the capacity of active carbon grade SKD-515 during the first cycle does not exceed 52% for phenol, and 75% for pyridine. However, already at the next adsorption/ regeneration, the capacity of the adsorbent increases by 23% and 14% for phenol and pyridine, respectively.

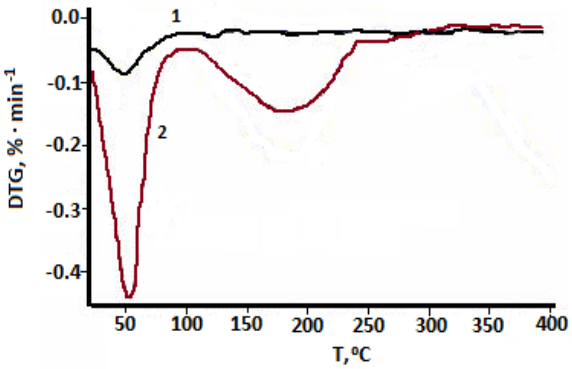


Figure 1. *Differential mass loss curves of activated carbon grade SKD-515 in an inert atmosphere: 1 - industrial; 2- after adsorption of pyridine and phenol.*

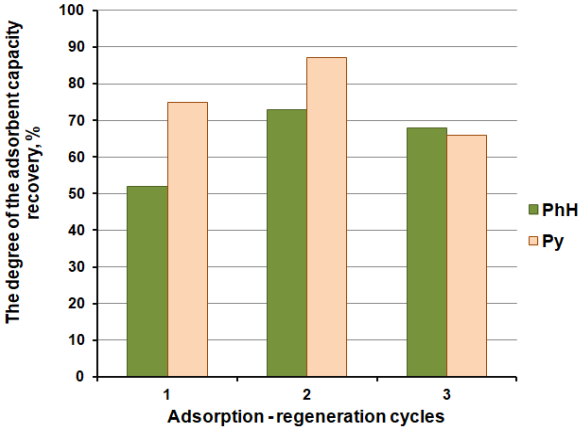


Figure 2. *The degree of recovery of the adsorption capacity during regeneration with an inert gas (the adsorption capacity of an industrial sample is taken as 100%).*

Both phenol and pyridine during adsorption are characterized not only by the sorbent–sorbate dispersion interaction, but also by the formation of hydrogen bonds with surface oxygen compounds [3, 4]. It can be assumed that, in this case, partial blocking of the pore surface can occur.

An increase in the efficiency of extraction of organic components by the second cycle of adsorption/regeneration is possibly due to the modification of the

sorbent by the organic substances themselves, which proceeds in parallel with the desorption of adsorbates. In a number of works, the ability of pyridine molecules to be firmly fixed on the surface of active carbon at elevated temperatures and even to be embedded in the structure of the carbon surface was mentioned [3–5]. The formation of secondary adsorption centers, which occurs in this case, may be the reason for the change in the adsorption capacity of active carbon.

Thus, the results of the study allow us to recommend for practical use the low-temperature thermal regeneration of active carbon grade SKD-515 with nitrogen for 4 hours at a temperature of 3500C. The advantage of this type of regeneration is the possibility, after capturing the desorption products, to return them to the technological cycle to the stage of primary cooling during the chemical processing of coking products.

References

1. Nikolaeva L.A. Aikenova. E.N. Adsorption treatment of phenol-containing wastewater from oil refineries. Theoretical and applied ecology. – 2020, No. 4. – P. 136-142.

2. Krasnova T.A., Golubeva N.S. Wastewater treatment from organic components of coke production. Ecology and industry of Russia. – 2008, No. 7 – P. 44 - 45.

3. Tamarkina Yu.V., Anishchenko V.N., Redko A.N., Kucherenko V.A. Adsorption of phenol by activated carbons based on fossil coals of various degrees of metamorphism. Chemistry of solid fuel. – 2021, No. 3. – P. 3–11.

4. Krasnova T.A., Belyaeva O.V. The interaction of pyridine with the surface of active carbons. Russian Journal of Physical Chemistry A. – 2011, No. 3. – Pp. 466-471.5. Zhu S., Bell P.R.F., Greenfild P.F. Adsorption of pyridine onto spend rundle oil shale in dilute aqueous solution. Water Research. – 1988, № 10. – Pp. 1331-1337.

DOI 10.34660/INF.2023.13.36.080

ON-LINE EXPRESS-ANALYSIS OF OIL-WATER EMULSIONS PROPERTIES BY PROTON MAGNETIC RESONANCE RELAXATION METHOD

Kashaev Rustem Sultanhamitovich
Doctor of Technical Sciences, Full Professor
Kazan State Power Engineering University

Ovsenko Galina Anatolyevna
Postgraduate
Kazan State Power Engineering University

Kozelkova Valeriya Olegovna
Postgraduate
Kazan State Power Engineering University

Abstract. *The paper is devoted to express-control of oil-water emulsions and crude oil properties in the flowing liquid using nuclear (proton) magnetic resonance (PMR) relaxometry method. Were elaborated methods of determination such oil properties as: water, oil, gas and alphaltene-resins concentrations, density, viscosity in oil and water droplets size distribution in the oil-water emulsions. Was shown, that PMR-method on the basis of PMR-relaxometry is rapid, high informative and can be used in technology processes of crude oil mining and preparation directly at oil-mining deposits.*

Keywords: *on-line, express-control, proton, magnetic, resonance, relaxometry.*

Method of pulse nuclear magnetic resonance has great, yet not disclosed opportunities for the express analysis of emulsions characteristics, water concentration and state of molecules in dispersion phase and media. Characterization of oil systems using NMR techniques is a vast scientific activity Lo [1]. To solve key problems of petroleum engineering the NMR is the most perspective technology, [2]. The unique feature of the NMR approach is the diversity of chemical and physical properties at different structural levels that can be accessed using a single noncontact, nondestructive and multifunctional NMR instrument. On its basis can be studied dynamics of molecules, phase composition, exchange and diffusion processes in media and oil and oil-water aggregates [3]. Wide opportunities of Nuclear (Proton) Magnetic Resonance Relaxometry (PMRR) for determination of

oils parameters were demonstrated in the papers [4-6] and it was established, that NMRR is unique for express-control of emulsions.

Was established that the dependences of SE amplitudes A(a.u.) from the flow velocity u(m/s) for water, 90% and 25% water emulsion. They are presented at fig.1.

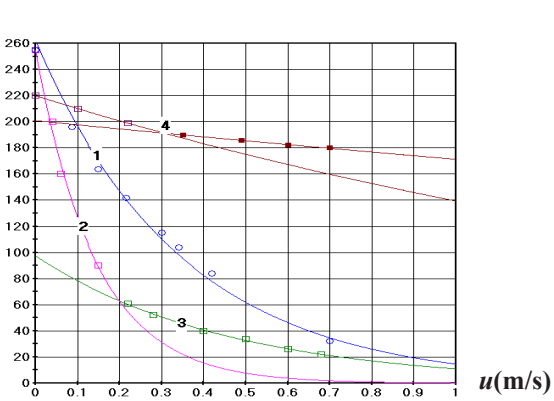


Figure 1. *PMR-signal SE amplitudes A(a.u.) from flow rateu(m/s). Curves: 1 – 100% water, 2 – 90% water in emulsion (u< 0.2 m/s), 3 - 90% water in emulsion (u> 0.2 m/s), 4 - 25% water in emulsion (u< 0.3 m/s), 5- oil (u> 0.3 m/s).*

So, flow rate can be determined from spin-echo amplitudes with error δ<±2.3 %.

Were elaborated methodics [1,7] for the express-control of properties oil-water emulsions and crude oil [8] by the following algorithm:

- measurement of the spin-spin relaxation times and SE amplitudes A_i in immobile water T_{2W} and oil/oil product T_{2O} in the time range $t = 2N\tau$, where N - number of RF-pulses in the CPMG-sequence [7] 90^o-τ_o-$[180^o$-$2\tau_o]_N$ - T,;

- measurement of the effective spin-spin relaxation times T_2*in flow emulsion on-line;

1. Determination of water concentration in emulsion by:

$$W_{\text{ПМР}} = T_{2W}(T_2 *- T_{2O})100\% /T_2 *(T_{2W} - T_{2O}) \quad (1)$$

The accuracy of single measurement in the range 0,5÷ 100% isδ≈±1 % in immobile sample and δ≈±3 % inflowing liquid, that is better than for nearest analogue MERA-MIG with δ≈±10% in the range 70-95%. Time of measurement is shorter in three times;

2. Determination of gas saturation of oil-well liquid G_{PMR} in the range G_{PMR} = 0-250% with error δ≈±3.8% byequation:

$$G_{PMR} = K_G(A_o - A_G) / A_o \quad (2)$$

where A_0 and A_G – initial SE amplitudes in the filled by liquid probe head and filled oil-well liquid, containing gas, K_G – correction coefficient. G_{PMR} gives opportunity to control specific energy consumption (SEC) at pipeline transportation, because the following equation is valid:

$$SEC = 155{,}3 - 0{,}796G_{PMR} \quad (3)$$

3.Measurement of oil density ρ_o in the expanded range700-1200 kg/m^{3}with the main reduced error (MRE) $\Delta\rho/\rho_{max} \sim \pm 1\%$:

$$\rho_O = \kappa_1 - \kappa_2 (T_{2A}) - \kappa_3 (T_{2A})^2 \quad \text{for } \rho_O = 700\text{-}900 \text{ kg/m3} \quad (4)$$

$$\rho_O = \kappa_4 \exp[-\kappa_5 (T_{2A})] \text{ for} \rho_O = 900\text{-}1100 \text{ kg/m}^3, \quad (5)$$

That is more precise, then in flow densitomer PLOT-3B-1P with MRE= 1.3 %. Time of measurement is shorter in 6 time.

4. Measurement of viscosity with MRE =±1.5%, by equation:

$$\nu = \eta/\rho = (1.12/\rho)\times(T/298\times T_{2A})^{1.25} \quad (6)$$

That is more precise, then by flow analyzer *Viscosite* with δ= ± 2%;

5. Measurement of integral characteristics of disperse size distribution (*DSD*) of water droplets in emulsions by spin-lattice relaxation times T_{1W} using equations in paper [8]:

$$D_{CA}(\mu m) = 0.164\exp(2.84\times T_{1A}) \quad (7)$$

$$D_{max} = 0{,}32\cdot\exp(1{,}37\cdot T_{1A}) \quad (8)$$

$$r_{3/2} = D_{3/2}/2 = 2{,}40\times(T_{1A})^{4{,}27} \quad (9)$$

6. Measurement of oil molecular mass with error δ≈ 2.1 % in the expanded range *MM* = 50-1000 a.u.м. by equation:

$$MM(a.u.m.) = 3011 + 3871.3\exp(-5.585T_{2O}) \quad (10)$$

7. Measurement of diesel temperatures of freezing with the error δ≈ 2.8 °C in the range of temperatures T_{FR} = - 70÷ - 40°C and in high paraphinic oils in the range T_{3ACT} = - 16÷ +56°C :

$$T_{3AC}(^oC) = 275 - 0.62T_{2A} + 2.8\times10^{-4}(T_{2A})^2 \quad (11)$$

8. Measurement of salts concentrations C in water [8]:

$$C(M) = 24.35T_{1W}^{-1} - 5.8 \quad (12)$$

9.Measurement of asphaltene-resins (A*R*) concentrations in the whole range with error δ≈±1 % :

$$AR(\%) = -3.76\ln(T_{1A}) + 25.8 \quad (13)$$

$$AR(\%) = -2.76\ln(T_{2A}) + 14.6 \quad (14)$$

Instrumental methods and instrumentation for *AR* determination was not found.

Increase of truth worthy proper appreciation of measurements by PMR-relaxometry using APC can be done by the methods of artificial neuron net (ANN), the main advantage of which is the possibility of training (teaching) with excluding of «mistakes» and «noise», define links and make conclusions about the truth worthy.

Was introduced the notion "apocrypha" of measurement of oil disperse systems characteristics – oil-well liquid, oils and waters through PMR-parameters: relaxation times T_{2Ai}, T_{2Bi}, T_{2Ci}, proton populations P_{2Ai}, P_{2Bi}, P_{2Ci}, and SE amplitudes A_{Ai}, A_{Bi}, A_{Ci}, determined as the extension of the summary error δs out of permissible limits. As the δs was taken one or several oils system properties–water and salts concentration, density, viscosity, *DSD, MM* .

The trustworthy determination of measurements by relaxometer PMR in APC [9] is carried out using method of system function control on the technology "client-server"[10], in which clients place is located at APC. Server part – in personal computer (notebook) of operator.

Algorithm of system function for determination of PMR-parameters, using ANN is the following:

1. To the information ANN is sent command to memorize the vectors of current experimental data of PMR-parameters:

$$N_{ij} = [T_{2Ai}, T_{2Bi}, T_{2Ci}, P_{2Ai}, P_{2Bi}, P_{2Ci}, A_{Ai}, A_{Bi}, A_{Ci}] \quad (14),$$

Where j= A, B, C–molecular phases of oil system corresponding to PMR-parameters.

2. This multi parametric vectors of measurements Nij are processed using the equations for decomposition of the spin-echo (SE) amplitudes envelope on three components:

$$A_i = \sum A_{0j} \exp(- t/T_{2j}), \text{ где } j = A, B, C \quad (15)$$

$$\ln(A_i/A_0) = -t/T_{2i} + \ln_{Ai}. \quad (16)$$

Differences between experimental PMR-data N_{ij} determined from experimental SE using eq.(15,16) and model (ideal) theoretical values N_{ijT}, described by distribution of relaxation times $P(T_{2AT}, T_{2BT}, T_{2CT})$, obtained by solution of Fredholm equation of the first order (see, for instance [11]), form current vector N_{it}:

$$N_{it} = [|A_{2AЭ}-A_{2AT}|,|A_{2AЭ}-A_{2AT}|,|A_{2AЭ}-A_{2AT}||T_{2AЭ}-T_{2AT}|,|T_{2BЭ}- T_{2BT}|,|T_{2CЭ}-T_{2CT}|,|P_{2AЭ}-P_{2AT}|,|P_{2AЭ}-P_{2AT}|,|P_{2AЭ}-P_{2AT}|] \quad (17)$$

3. Vector N_{it} is treated by ANN for defining its conformity to regime of relaxometer PMR function and to make conclusion by vector N_{out}=["NORM", "INCORRECT","INDEFINITE"].

4. Results of decision are transferred on operator monitor and are saved in data base for taking concluding decisions. Deviation of the parameters is presented in the form:

$$a_N = (N_{ij} - N_{ijT}) \times 100\% \quad (18)$$

Obviously correct relaxometer functioning correspond to αN near to zero and when $|\alpha N| \leq 3\sigma$, where σ is dispersion.For the use of obtained relation for the trust worthy determination of measurements by relaxometer PMR must be determined the most appropriate function of their control. Mathematic model for normal σN was decided to search in the form of universal power function,

described in paper [12]. So far it was received it in the form:

$$\sigma N = 0{,}65N^{-0{,}12} \quad (19)$$

For solutions of problems of verification current multi parametric control was used mathematical program packet Statistica 10, giving opportunity to form ANN of different configurations.

Conclusions

1.Proposed the use of the on-line nuclear magnetic resonance analyzer for the express-control of water concentration and droplets size distribution (*DSD*) in the oil-water emulsions - alternative new fuels for power plants.

2. By the nuclear magnetic resonance relaxometry (NMRR) method were elaborated methods of physical-chemical parameters of crude oils, oil/water emulsions and dispersions determination by automated instrumental-mechatronic complexes.

3.Presented the relations for the express-control of water concentration and *DSD* by portable proton magnetic resonance (PMR) relaxometer.

4.Was shown, that PMR-method on the base of relaxometry is fast, high informative and can be used in technology processes of crude oil preparation.

References

1. O.V.Kozelkov, A.G.Michailov, V.O.Kozelkova, G.A.Ovseenko, Tran Van Tung, Nguyen Chi Kien, R.S. Kashaev, "Technologies of express-control appatus-programmable complex on the base of PMR", Russ. Chemical Technology, V.23, №3, p.131-137, 2022.

2. N.G.Min, M.Ku, J.Yang, S.H. Kim, "Microfluidic production of uniform microcarriers through phase separation in emulsion droplets", Chem. Mater. vol. 28, pp.1430-1438, 2016.

3. W.N.Sharatt, V.E. Lee, R.D. Priestley, J.T. Cabral, "Precision polymer particles by flash nanomicrofluidic droplet extraction", ACS Appl. Polym. Mater. V.3, pp.4746-4768, 2021.

4. S.-W.Lo, G.J.Hirasaki, R.Kabayashi, Soc. Petrol. Eng. Journ. 7, 24-34,2002.

5. I.Shikhof , C.H. Arns, Appl. Magn. Reson 47: 1391, 2016. Doi: 10.1007/ s00723-016-0830-4.

6. S.SZalesskiy, E.Danieli, B.Blumich, V.P. Ananikov, Chem. Reviews, 114, 5641-5694, 2014.

7. O.V.Kozelkov, R.S.Kashaev Instrumental and mechatronic complexes in oil industry and energetic. Machachkala: «Aprobatsiya». - 112 p. 2019.

8. V.O.Kozelkova, R.S.Kashaev, G.A.Ovseenko, V.I.Karachin, Nguyen Chi

Kien Application of the on-line nuclear magnetic resonance analyzer for the express-control of water concentration and droplets size distribution //4-th Intern. Youth Conf.on Radio Electronics, Electrical and Power Engineering, IEEE, March 17-19, 2022 MPEI

9. G.A.Ovseenko, O.V.Kozelkov, R.S..Kashaev, Trang Van Tung. "Apparatus for on-line structure-dynamical analysis of oils by nuclear magnetic resonance relaxometry method". Internat. Conf. «Scientific research of the SCO countries: synergy and integration». Abstracts. Sept.15, Beijing, PRC, pp. 190-194, 2021. DOI: 10.26526/978-0-6452954-1-2

10. Yu.K.Evdokimov, A.A. Soldatov Neironet method of control of information-measurement complexes work regimes. Industrial ACS and controllers. V.11, 35-49, 2017.

11. E.I.Uskova, M.M.Doroginitski, V.D.Skirda, I.H. Fatkhutdinov. New Approach to Analyze 2D Map T_{1-T2}// Appl. Magn. Res. v.51, pp.183-193, 2020

12. N.Sh.KremerTheoryofprobabilityandmathematicalstatistics. – M.: UNITY-DANA, 2004. – 573 P.

DOI 10.34660/INF.2023.28.21.081

APPARATUS-PROGRAM COMPLEX FOR ON-LINE EXPRESS-CONTROL OF CRUDE OILS PROPERTIES BY PROTON MAGNETIC RESONANCE METHOD

Kashaev Rustem Sultanhamitovich
Doctor of Technical Sciences, Full Professor
Kazan State Power Engineering University

Nguyen Duc Ahn
Postgraduate
Kazan State Power Engineering University

Kozelkov Oleg Vladimirovich
Doctor of Technical Sciences, Associate Professor
Kazan State Power Engineering University

Abstract. *In the paper presented the application of the on-line bypass express-control mechatronic complex for crude oil properties in the flowing liquid determination using nuclear (proton) magnetic resonance (PMR) relaxometry method. Using PMR-parameters were elaborated methods of determination such crude oil properties as: flow rates of multiphase flow components, water, oil, gas and alphaltene-resinsconcentrations, density, viscosity in oil and droplets size distribution in the oil-water emulsions. Was shown, that PMR-method on the basis of PMR-relaxometry israpid, high informative and described mechatronic complex can be used in technology processes of crude oil mining and preparation directly at oil-mining deposits.*

Keywords: *on-line, express-control, proton, magnetic, resonance, relaxometry.*

Requirements of oil-industry is the formation of digital intellectual oil deposits with the express-control of oil disperse systems (ODS) - emulsions, oils and oil products properties such as: rates of multiphase flow components, water, oil, gas and alphaltene-resins concentrations, density, viscosity of oil and water droplets size distribution (*DSD*) in the alternative water-oil fuels for power plants at technology processes of oil-mining and crude oil preparation. It stimulated efforts of scientists on the elaboration of new instruments for exact determination of oil properties in the whole range.

Method of pulse nuclear magnetic resonance has great, yet not disclosed opportunities for the express analysis of emulsions characteristics, water concentration and state of molecules in dispersion phase and media. Characterization of oil systems using NMR techniques is a vast scientific activity Lo [1]. To solve key problems of petroleum engineering the NMR is the most perspective technology, [2]. The unique feature of the NMR approach is the diversity of chemical and physical properties at different structural levels that can be accessed using a single noncontact, nondestructive and multifunctional NMR instrument. On its basis can be studied dynamics of molecules, phase composition, exchange and diffusion processes in media and oil and oil-water aggregates [3]. Wide opportunities of Nuclear (Proton) Magnetic Resonance Relaxometry (PMRR) for determination of oils parameters were demonstrated in the papers [4-6] and it was established, that NMRR is unique for express-control of emulsions.

Last few decades proton magnetic resonance relaxometry (PMRR) technology has enabled a lot of industrial applications – in medical imaging, oil-well bore hole logging [7], rock structure determination of the kerns from test wells. But instruments, that are used for laboratory PMRR measurements, cann't be used for on-line flowing liquid control. In 1990 Caprihan and Fukushima [8] provided analysis of fluid flowing influence on NMR-signals. For flow velocity distribution measurements and velocity profile imaging Callaghan [9] elaborated method and instrument in 1991.

PMRR method gives information about relaxation parameters of the proton's three *i=A, B, C* phases in crude oils and water-oil emulsions: spin-lattice T_{1i} and spin-spin T_{2i} relaxation times, characterizing groups of protons with different molecular mobility in oil and water; populations (or concentrations) of this proton phases P_{1i} and $P_{2i;}$ inter proton distances R_{ij} and others. This set of PMRR structure-dynamical parameters (SDP) gives almost full picture about molecular dynamics and properties of the studied oils and water-oil emulsions.

Laboratory NMR-relaxometers [7,8] can't be used for the manual control on technology process line. So we elaborated mechatronic apparatus-program complex (APC-III) [10] for on-line bypass express-control of crude oil, in which relaxometer NMR NPp [11-12] (it have not prototypes) is the module for oil emulsions properties determination. It power supplied from 12 V accumulator or grid ≈ 220 V, measurement time < 2 min, sensibility is $K = \nu^2 D^3 = 2700\text{-}4150$ $MHz^2 см^3$ that is near to relaxometer "Minispecpc mq" (Bruker).

Sampling module is portable and easy transportable, its structure scheme is presented at fig.1.

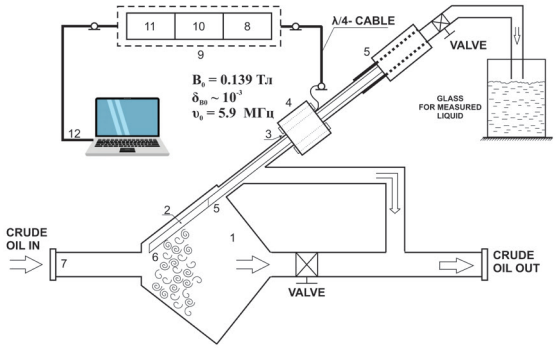


Figure 1. *Structure scheme of sampling module of the portable complex of crude oil express-control.*

At fig.2 presented the outward appearance of the portative apparatus-program complex for manual express-control with the notebook, at which can be seen the spin-echo signals envelope decomposition on three components, corresponding to the three proton phases PMR-parameters.

Figure 2. *Photo of the outward appearance of the portable apparatus-program complex with the notebook.*

Working mode of APC is automatic with the use of microcontroller *ATMEGA* 8515*L* with adjusting complex *STK*500 for *AVR* flesh-controllers of *Atmel* firm on the panel *SCKT*3000*D*3. Sampling of crude oil is performed in the way of on-line extraction of small portions from a pipeline in a flow proportional mode – ISO 3171 Code of Practice. Under the pressure over fall (P_P - P_B) between pipeline 7 P_P and position 6 P_B three components (oil, water, gas) are intensively mixed and homogenized inside the block (confusor) 1 of the sampling module and through

nipple 2 delivered into the RF-coil 3 inside the Halbach magnet 4 from the rare earth alloys *NdFeB-37*, having magnetic induction B_o =0.139 Tl with permanent field inhomogeneity $\sigma B_o = 10^{-3}$ in 1 cm^3, resonance frequency $\nu_o = 5.2\times10^6$ Hz. Heterogeneity of radiofrequency field B_1 is < 2% in 75% of volume. For flow rate measurements, nipple is disposed in the position 5. For crude oil properties measurement, nipple must be settled at the position 6, in which $(P_P - P_B) = 0$ and so the sampled liquid portion is immobile in the coil 3and the measurements are processed in immobile liquid. Under the effect of electromagnetic coil 5 the nipple can be displaced in three positions in the block 1 differing on 50 mm and so the probe sampling can be done in three different parts of confusor 1.Then under the pressure difference $(P_P - P_B)$ liquid is transferred in the RF-coil of the magnet 4, where through radiofrequency cable between magnet and transmitter 8 of the PMR-relaxometer 9 liquid portion is irradiated by the series of Carr-Purcell-Meiboom-Gill (CPMG) [9] sequence 90^o-τ_o-$(180^o$-$2\tau_o$-$)_N - T$, where time interval between 90^o and 180^o pulses τ_o = 200 ms, N – number of 180^0-pulses, T = 9 sec- delay time, number of accumulations n = 10. Between 1800-pulses are formed A_i spin-echo (SE) signals, which by the same cable are transferred to the receiver amplifier 10. For T1A,B,C and P1A,B,C determination the spin-echo recovery pulse sequence 90^o-t-90^o-τ_0-180^o was used with the measurement parameters: step of sequence τ - 3 ms, number of 1800 pulses N = 100, number of accumulations n = 3.

After measurements this liquid portion is displaced out by the next sample portion into the glass for measured liquid for verification of PMR-measurements by alternative methods. Not sampled liquid is directed out in the pipeline. Process organized in such a way for the explosive and fire safety. Length of the cable is $\lambda_o/4$ or $3\lambda_o/4$, where $\lambda_o = c/\nu_o$ is resonance wavelength, c – light velocity. Then analog signal data is transferred to analog-digital-converter (ADC) 11 and notebook 12, where using program for SE exponential envelope decomposition by equation $A = \sum A_i \exp(-t/T_{2i})$, and equations, correlating PMR-parameters with the oil characteristics, the oil properties are determined. Relaxation times T_{2i} and proton phases concentrations are attributed to i=A,B,C phases of water, light and heavy oil fractions.

For magnetic fields measurements by the Hall effect was used elaborated probe head on micro scheme AD22151YZX. At supply voltage 5V and output signal coefficient 0,4 mV/G the maximal range of measurements is B_o=1.25 Tl. Special program of Arduino Uno/Nano microcontroller counts field values using 10-bit ADC with frequency 10 kb/s. Data are calculated and represented on the notebook monitor through USB port of Arduino.

In the Table 1 presented the characteristics of APC-III compare to other NMR complexes. It should be mentioned, that among them Multiphase Flow Measurement Analyzer (MFMA) [13] is the most advanced flow analyzer.

Table1

Parameters of APC on the NMR-relaxometers base

Complex (company)	Ranges of measurements (%)	Mass (кg)	Measurement error (%)
NEDRA (KNIRTI), Kazan, 1998 y.	Flow rate (FR) 1-200 m^3/h; Concentration of water, oil in liquid 0-100%, gas 0-250 %	350	±4.0 FR; ±4.0 (water); ±4.0 (oil); ±6.0 (gas)
MFMA (Krohne) 2013 y.	0,64-46,3m^3/h (FR), 0-100 (water) 0-250 (gas)	5500	0.5-1.0; 0.5-1.0; 0.5-1.0
APC-III, Kazan State Power Engineering University, 2021 y.	0.66-475 m^3/h (FR); 0-100 (water, oil); 0-250 (gas); 700-1100 kg/m^3(density) 1.5-350mPa×s (viscosity); 0 – 15 mm (*DSD*); 0-15 % (alphaltene-resins)	200	±2.8 (water, oil); ±3.85(gas); ±1 (density); ±1(viscosity) ±1 (A*R*); ±1 (*DSD*)

Flow analyzer APC-III has the following advantages:

1. Universality and easy insertion in technology lines, control of non opaque and aggressive liquids in real time;

2. Wide nomenclature of measured parameters in the wide range: chemical composition; multicomponent analysis by a single instrument; sampling from the pipe of any diameter;

3. Absence of contact with studied mixtures and so, the absence of destructive affect of aggressive liquids on the equipment. Measurement process need not reagents.

Opportunity for on-line flow rate (FR) determination using PMR-relaxation measurements is grounded by the following considerations. If liquid flowing into probehead radio frequency coil have protons magnetization $M_{IN,}$ and flowed out with magnetization M_{OUT}, then magnetization Mliquid passing with mean productivity Q through probehead of volume V will change with the rate:

$$dM/dt = (M_{IN}\text{-}M_{OUT})Q/V \quad (1)$$

Rate of Mchange due to relaxation processes is described by equation:

$$dM/dt = (M_0\text{-}M)/T_2 \quad (2)$$

If the conditions $M_{IN} = M_0$ and $M_{OUT} = M$ are correct, then the change of M rate will be:

$$dM/dt = (M0\text{-}M)(1/T2+1/T2/) = (M0\text{-}M)/T2^* \quad (3)$$

where $T2/$ - is the time of liquid position in the RF-coil, at which 1/e part of depolarized protons are substituted by the polarized ones. If in the probehead liquid is mixed, then $T2/ = V/Q$. But it is true only for one phase liquids. For two phase oil-water mixtures (emulsions) the correctness of eq.(3) was confirmed experimentally. For100% ofwater, 90%, 75% and 25% emulsions were received

dependences of effective spin-spin relaxation rates $(T_{2eff})^{-1}$ from the flow velocity υ in the range υ = 0,0.7 m/sec, which are presented at fig. 3.

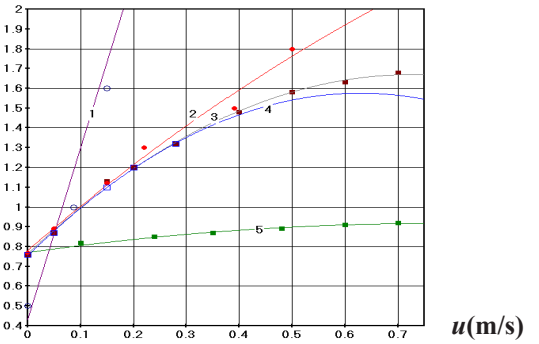


Fig. 3. Relaxation rate $(T_{2eff})^{-1}(s^{-1})$ from oil-well liquid flow velocity υ(m/s) for: 1 –water, 2 – 90% water emulsion, 3 – 85% water, 4 – 25% water, 5 – 20% water emulsion flow.

For used emulsions the dependences are two-component and with correlation coefficients R^2 = 0.93-0.99 and mean quadratic error (MQE) S = 0.01-0.08 at υ>0.2 m/sare described by equation:

$$\upsilon\ (\text{м/с}) = k1\exp(-\ k2\times T2), \qquad (4)$$

where$k1$(m/s) = 6.2; 6.1 and 24; $k2(s^{-1})$ = 3.2; 3.7 and 13.8 for 90%, 75%-йand 25% emulsions;

at υ<0.2 m/s for the same emulsions the equation is:

$$u\ (\text{м/с}) = k_3/T_2\ -\ k_4 \qquad (5)$$

Where $k3$(m) = 0.45; 0.76 and 1.77; $k4$ (m/s) = 0; 0; 1.355.

Coefficients k_1, k_2 and k_3 with R^2 = 0.97 and S = 1 depend from water concentration W in emulsions:

$$k_1 = 40.2\exp(-0.022W); k_2 = 24.1\exp(-0.023W); k_3 = 3\exp(-0.02W) \qquad (6)$$

This eq.(6-8) are necessary for the choose by computer program of the grade curves for flow rates function $\upsilon_{PMR}(T_{2eff}^{-1})$ determination. As the spin-echo amplitude envelope can be decomposed on the several (usually three) components with proper relaxation times and proton phases concentrations, here appeared the opportunity for the determination of flow rates and emulsions consumption of components Q_i and rates υ_i by the equation:

$$Q_i = \upsilon_i \times S = Q \times A_{oi}/\sum A_{oi} \qquad (7),$$

Where S – pipeline cross section, $A_{oi}/\sum A_{oi}$ – protons concentration of the i-th component of emulsion (water, oil fractions), determined from SE amplitudes envelope.

For the truthworthy proper appreciation of eq.(3) and precision of the curves in fig.3 we compared relaxation times T_{2oW} and T_{2oO} in the immobile water and oil, estimated from the curves with the one, calculated from eq.(3). From the curve 1 in fig.3 for immobile water was received relaxation rate $(T_{2oW})^{-1} = 0.43$ sec-1, which corresponds to $T_{2oW} = 2.32$ sec and differs from $T_{2W} = 2.26$ sec from direct measurement in immobile water on+ 0.06 сек. From curve 3 for the most complicated emulsion (here the phase inversion at ~ 75% of water concentration usually take place) was received $(T_{2o75})^{-1} = 0.654$ sec^{-1}.Taking into account different contribution of components in this 75% emulsion, value of $(T_{2o75})^{-1}$ is calculated considering percentage of 75% and 25% of the phases:

$$(T_{2o75)}{}^{-1} = 0.654 = 0.75(T_{2oW})^{-1} + 0.25(T_{2oO})^{-1} = 1.375, \quad (8)$$

where $((T_{2oH})^{-1} = 1.37)$. Result of eq.(10) calculation gives $T_{2oO} = 0.727$sec, which differs from $T_{2O} = 0.7$sec of direct measurement in the immobile oil on + 0.027 sec. This truth worthy proper appreciations confirm the accuracy of the measurements in the errors limits.

References

1. O.V.Kozelkov, A.G.Michailov, V.O.Kozelkova, G.A.Ovseenko, Tran Van Tung, Nguyen Chi Kien, R.S. Kashaev, "Technologies of express-control appatus-programmable complex on the base of PMR", Russ. Chemical Technology, V.23, №3, p.131-137, 2022.

2. N.G.Min, M.Ku, J.Yang, S.H. Kim, "Microfluidic production of uniform microcarriers through phase separation in emulsion droplets", Chem. Mater. vol. 28, pp.1430-1438, 2016.

3. W.N.Sharatt, V.E. Lee, R.D. Priestley, J.T. Cabral, "Precision polymer particles by flash nanomicrofluidic droplet extraction", ACS Appl. Polym. Mater. V.3, pp.4746-4768, 2021.

4. S.-W.Lo, G.J.Hirasaki, R.Kabayashi, Soc. Petrol. Eng. Journ. 7, 24-34,2002.

5. I.Shikhof , C.H. Arns, Appl. Magn. Reson 47: 1391, 2016. Doi: 10.1007/ s00723-016-0830-4.

6. S.SZalesskiy, E.Danieli, B.Blumich, V.P. Ananikov, Chem. Reviews, 114, 5641-5694, 2014.

7. Kashaev R.S. Apparature and NMR-method of oil disperse systems analysis.Lambert Academic publishing (LAP). GmbH&Co.KG, Saarbruken, Germany, 2012. 92 p.;

8. Kashaev R.S. Oil Disperse Systems Study Using Nuclear Magnetic Resonance Relaxometry (NMRR). Advan. in Energy Research. Nova Science publishers, Inc. ID 12590, N-Y USA,V.16. 2013.

9. R.S.Kashaev, N.R.Faskchiev Applied Magnetic Resonance V.41, i.1 pp. 31-43, 2011.

10. G.A.Ovseenko, O.V.Kozelkov, R.S.Kashaev, Trang Van Tung. "Apparatus for on-line structure-dynamical analysis of oils by nuclear magnetic resonance relaxometry method". Internat. Conf. «Scientific research of the SCO countries: synergy and integration». Abstracts. Sept.15, Beijing, PRC, pp. 190-194,2021. DOI: 10.26526/978-0-6452954-1-2

11. R.S.Kashaev., Z.Sh.Idiatullin., A.N.Temnikov Portable relaxometer NMR. Patent RF, №67719. Bull. №30. 2007.

12. R.S.Kashaev, O.V.Kozelkov, A.N. Temnikov, Tran V.T., Nguen C.K.. Realaxometers of proton magnetic resonance// Instruments and experimental technique. №2. C. 145-148, 2019.

13. J.Hogendoorn, A.Boer, M.Appel, H.deJong, R. de Lecuw. Magnetic resonance technology. A new concept for multiphase flow measurement // 31-st International North Sea Flow Measurement Workshop, 22-25 October 2013, Tensberg, Norway.

DOI 10.34660/INF.2023.85.40.082

TECHNOLOGICAL CHARACTERISTICS OF CRUSHING GRIDING SLUDGE FERROMAGNETIC PARTICLES IN ROTATING ELECTROMAGNETIC FIELD

Lebedev Valery Alexandrovich
Candidate of Technical Sciences, Full Professor
Don State Technical University, Rostov-on-Don, Russia

Vernigorov Yury Mikhailovich
Doctor of Technical Sciences, Full Professor
Don State Technical University, Rostov-on-Don, Russia

Shirin Andrey Alexandrovich
Postgraduate
Don State Technical University, Rostov-on-Don, Russia

Abstract. *Sludge wastes generated at mechanical engineering enterprises constitute a huge technical, economic and environmental problem, effective solution of which is largely determined by their processing with the aim to obtain high-quality secondary raw material for further usage. It is emphasized that in order to obtain secondary raw material of required quality out of sludge, a whole range of technological operations must be implemented. One of the key operations while processing sludge which provides the required granulometric characteristics of metal particles, is the operation of their grinding. For its realization, it has been proposed to use devices with the rotating electromagnetic field that allows to solve this problem effectively, in a contact-free way. The article presents the results of theoretical and experimental studies revealing the energetic features of grinding method. A dependence has been proposed that allows to estimate the energy condition of particles in the magneto-vibrational layer formed in the devices under the influence of a rotating electromagnetic field. An energy regulation determining a threshold value of a field induction gradient is established, which provides a stable mode of the magneto-vibrational layer and, as a result, grinding the particles up to a given size. An energy model for controlling the process of crushing griding sludge ferromagnetic particles in a rotating electromagnetic field has been developed and theoretical and probabilistic formulae for estimating the duration of the grinding process have been proposed. Experimental studies have confirmed the adequacy of model representations of the process of grinding particles in devices with a rotating electromagnetic field.*

Keywords: *metal production wastes, ferromagnetic particles, rotating electromagnetic field, magneto-vibrational layer, induction, energy, destruction, grinding.*

Introduction

At machine-building enterprises that treat metals, thousands of tons of metal-containing wastes are generated monthly, which constitute huge technical, economic and ecological problem. The processing of metal wastes allows to raise the coefficient of metal usage up to 90-95%, to reduce the losses of alloying elements, and obtain a significant economic effect.

The existing shortage of steel powders and the need to save material resources has led to reconsidering the problem of mechanical wastes usage, especially chip and sludge wastes. To obtain secondary raw material of required quality out of sludge, it is necessary to implement a whole range of technological operations, shown in Fig. 1.

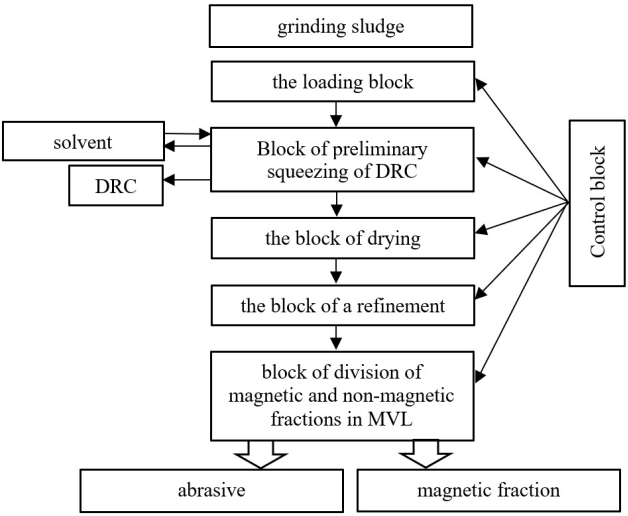


Figure 1. *Sludge processing*

The subject of given studies was the stage of processing of sludge wastes formed due to large forces of interparticle interaction, conglomerates of sludge wastes. It was this stage of processing that made it possible to provide high-quality granulometric characteristics of the ferromagnetic component of conglomerates, which is in demand during the manufacture of products in powder metallurgy.

If we take into consideration modern devices for grinding metal wastes, various kinds of crushers and hammer mills have received the greatest usage. However, the complexity of their design and the high degree of wearout leads to the search for more effective contact-free grinding methods. In this regard, devices with a rotating electromagnetic field are of scientific and practical interest (Fig. 2), in which, oscillating under the influence of the electromagnetic field, a plurality of particles form a magneto-vibrational layer (MVL), which provides the solution of a large complex of various technological problems.

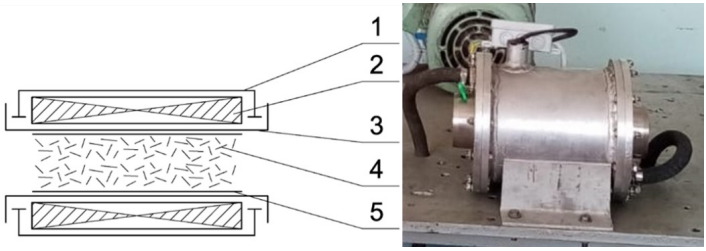


Figure 2. *Device with a rotating electro-magnetic field. (1-body, 2-inductor, 3- pipe, 4- sludge, 5- replacement insert)*

In contrast to a homogeneous field magneto-vibration in a rotating field, as shown in works [3,7] possesses a higher translational intensity and, as a result, great energy capabilities for implementing processes of destruction of sludge wastes conglomerates and grinding their metal particles. These particles can be characterized as solid bodies having ferromagnetic properties, which main characteristics are magnetic permittivity and magnetic moment.

Energy evaluation of state of particles in the magneto-vibrational layer. Energy evaluation reported by the rotating electromagnetic field to the particles can be calculated by a number of the following assumptions:

- under the steady state of magneto-vibrational layer, energy communicated to particles from external field is compensated by dissipation of energy spent on their destruction during contact interaction [1, 13];
- changes in the orientation of the magnetic moments of the particles during the time between successive collisions are relatively small, which makes it possible to linearize the equation of ferromagnetic particles motion in the external field;
- energy from the field is communicated to the particles through both translational and rotational degrees of freedom;
- interactions between particles result in an effective equilibrium between translational and rotational degrees of particle freedom;
- particles possess blocked magnetic moments.

In works [2, 3, 11, 12, 17] devoted to the study of ferromagnetic particles motion in a magnetic field, it has been found that the average amount of energy transmitted by the external field to the rotational degrees of freedom to one particle during $\frac{T}{2} = \frac{\pi}{\omega}$ is equal to $\frac{1}{2}I(\dot{\varphi} - \dot{\varphi_0})^2$ at $t = t_0 + \frac{T}{2}$ according to the initial values of φ_0 and t_0, where $\frac{T}{2}$ – is the time between collisions of particles, which is realized at extreme points of trajectory of reciprocating motion. Let us write an expression to determine the energy $E_в$, transmitted by the external field to particles per time unit at rotational-oscillatory motion in the following form:

$$E_в = \frac{1}{2}I(\dot{\varphi} - \dot{\varphi_0})^2 \cong \frac{1}{2}\frac{(p_m B_v)^2}{\pi \cdot I \cdot \omega^2}, \quad \text{J.} \tag{1}$$

To determine the energy transmitted to the particle-conglomerate from a rotating electromagnetic field with a gradient $\frac{\partial B_v}{\partial y}$, in one-dimensional case, without taking into account the resistance of the medium, let's write the equation of progressively-oscillatory motion in the following form:

$$m\ddot{y} = p_m \frac{\partial B_v}{\partial y} sin\varphi \; cos(\omega t), \tag{2}$$

where m – is the mass of the particle-conglomerate, $\ddot{y}$ – is acceleration of the translational movement of the particle, $\varphi = \phi_0 + \phi_1$ – is the angle between the vectors $\vec{B}$ and $\overrightarrow{p_m}$, immediately after the collision of the particles, ϕ_0 – is the angle between these vectors at the initial moment of time.

By integrating equation (2), and also assuming that the average amount of energy transmitted by the field during reciprocation of one particle per time T/2 is equal to $\frac{1}{2}m(\dot{y} - \dot{y_0})^2$ at $t = t_0 + T/2$ according to the initial values of y_o and t_0, we obtain an expression for the energy given by the field to particles per time unit during translational-oscillatory motion:

$$E_п = \frac{1}{2}m(\dot{y} - \dot{y_0})^2 \simeq \frac{1}{2}\frac{\rho_m^2}{\pi m \omega^2}\left[\frac{\partial B_v}{\partial y}\right]^2, \text{ J}, \tag{3}$$

where $\frac{\partial B_v}{\partial y}$ – is the induction gradient of electromagnetic rotating field, T/m.

Based on expressions (1) and (3), a relationship is proposed that allows to determine the total energy transmitted to the particle-conglomerate in a rotating electromagnetic field per time unit, as well as estimating their energy state in the magneto-vibrational layer:

$$E = E_в + E_п = \frac{1}{2\pi}\frac{\rho_m^2}{\omega^2}\left[\frac{B_v^2}{I} + \frac{1}{m}\left(\frac{\partial B_v}{\partial y}\right)^2\right], \text{ J}. \tag{4}$$

Energy condition of grinding of ferromagnetic particles. After the destruction of conglomerates and further separation of non-magnetic components, ferromagnetic particles of sludge with size of $D_н$ are formed, which under conditions

of high-gradient electromagnetic field can be subjected to further destruction – grinding by their splitting to the specified size of $D_К$.

Suppose that when colliding, ferromagnetic particles with different mass in magneto-vibrational layer:

- one of particles is destructed;
- particle interaction process is considered to occur within half the period, i.e. $T/_2 = \pi/_\omega$;
- particle has margin of kinetic energy defined by expression (4).

At the repeated shock pulse contact interaction, the amount of energy $Ея_р$ necessary for destruction of a ferromagnetic particle of sludge and its crushing with the degree $Z_u = D_Н/D_К$ according to [4] is equal to

$$E_р = \frac{\pi\sigma^2 D_К^3}{12E}(Z_u^3 - 1), \text{ J}, \quad (5)$$

where σ – is the breaking strength at ferromagnetic particle destruction. Pa; $D_н$ and $D_к$ – are initial and final equivalent particle diameters, *m*; $Z_u = \frac{D_Н}{D_К}$ – is the degree of particle grinding; E – is the module of particle elasticity, Па.

Let's write down the condition of particle destruction:

$$E_m\frac{T}{2} + E_M\frac{T}{2} = E_p$$

where the first summand is the energy, transmitted by magnetic field during half period to the first particle, the second summand is the energy, transmitted to the second particle.

Taking into account above mentioned assumption, the particle griding up to a given size – $D_К$, happens if the following condition is met:

$$\frac{1}{2\pi}\frac{\rho_m^2}{\omega^2}\left[\frac{B_v^2}{I} + \frac{1}{m}\left(\frac{\partial B_v}{\partial y}\right)^2\right] + \frac{1}{2\pi}\frac{\rho_M^2}{\omega^2}\left[\frac{B_v^2}{I} + \frac{1}{M}\left(\frac{\partial B_v}{\partial y}\right)^2\right] = \frac{\pi\sigma^2 D_К^3}{12E}(Z_u^3 - 1) \quad (6)$$

$$B_v^2\left(\frac{\rho_m^2}{I_m} + \frac{\rho_M^2}{I_M}\right) + \left(\frac{\partial B_v}{\partial y}\right)^2\left(\frac{\rho_m^2}{m} + \frac{\rho_M^2}{M}\right) = KD_к^3(Z_u^3 - 1), \quad (7)$$

where $= \frac{\pi^2\sigma^2\omega^2}{6E}$, Па/с^2 – is a a constant that depends on the mechanical properties of the material and the frequency of the variable field.

Condition (7) makes it possible to determine the threshold value of field induction gradient providing stable mode of magneto-vibrational layer which provides grinding of particles to specified size $D_К$

$$\frac{\partial B_v}{\partial y} = \sqrt{\frac{KD_К^3(Z_u^3 - 1) - B_v^2\left(\frac{\rho_m^2}{I_m} + \frac{\rho_M^2}{I_M}\right)}{\left(\frac{\rho_m^2}{m} + \frac{\rho_M^2}{M}\right)}}, \text{ T/m}. \quad (8)$$

Energy model of grinding process of ferromagnetic particles of sludge wastes in rotating electromagnetic field. Let ‘s take under consideration the process of chaotic influence in the magneto-vibrational layer of ferromagnetic particles described with the diameter *d(m)* and having the mass $m = \frac{\rho\pi d^3}{6}$ (kg) , magnetic moment $P_m = \frac{\Psi\pi d^3}{6}$(Am^2) , moment of inertia $I_m = \frac{\rho\pi d^5}{60}$(kg·m^2), where ρ(kg/m^3) – is the material density, Ψ (A/m) – intensity of material magnetization on randomly chosen particle with the initial diameter $D_н$, mass $M = \frac{\rho\pi D_н^3}{6}$, magnetic moment $P_M = \frac{\Psi\pi D_н^3}{6}$, moment of inertia $I_M = \frac{\rho\pi D_н^5}{60}$, and leading to its grinding up to the size of $D_к$.

Taking into account adopted values involved into particle interaction, the expression (8) will be put as follows:

$$\left(\frac{\partial B_v}{\partial y}\right)^2 = 9\frac{\rho K D_к^3\left(Z_u^3 - 1\right) - B_v^2\pi\Psi^2(d+l}{\pi\Psi^2(d^3 + D_н^3)} \quad (9)$$

By converting (9), we find a relation between the final and initial dimensions of the grinded particle and the field induction gradient in the following form:

$$D_к = \sqrt[3]{D_н^3 - K \cdot \left[0{,}1(d^3 + D_н^3)\left(\frac{\partial B_v}{\partial y}\right)^2 + B_v^2(d + D_н)\right]}, \text{ m}, \quad (10)$$

where $K^* = \frac{6\Psi^2 E}{\rho\cdot\sigma^2\cdot\omega^2}$ (м^2/T^2) – is a constant, which depends on mechanical and magnetic properties of the material and frequency of the alternating field. The ratio (10) allows to determine the field induction gradient at which a particle with the diameter $D_н$ destructs to a particle with the diameter $D_к$, provided that there is a collision between the particles with diameters $D_н$ and d. By setting the final particle size, which determines the size of the ground particle, from the ratio (8, 10) we determine at which fields the grinding is carried out with a given grain size distribution.

In order to estimate the duration of the grinding process of ferromagnetic particles of sludge wastes in the magneto-vibrational layer, we will use theoretical and probabilistic model proposed in works [2, 5, 6, 10] for practical calculations of the duration of vibrational shock hardening treatment in the form of:

$$t = \frac{k}{pf}, \quad (11)$$

where k – is the number of events providing technological effect; P – is the probability of event providing technological effect in one cycle of oscillations; f – is oscillation frequency, Hz.

The technological effect of grinding sludge wastes in the magneto-vibrational layer is provided as a result of chaotic and multiple impact of particles, which leads to a change in their composition and geometric dimensions. Therefore, as the quantitative value of the event providing the technological effect during the destruction of conglomerates, the average degree of their grinding $Z_{ш}$, which is the ratio of the masses of the starting particles released during the destruction of ferromagnetic particles to the particles required after the grinding, can be quite objectively taken.

Expressing the oscillation frequency through the angular velocity of the rotational motion of the magneto-vibrational layer in the electromagnetic rotating field $\omega = 2\pi f$, we obtain a formula for determining the duration of grinding ferromagnetic particles of sludge wastes:

$$t_{ш} = \frac{2\pi Z_i}{P\omega}, \text{ c}; \quad (12)$$

where: Z_i – is the average degree of grinding, P – is the probability of an event providing a technological effect in one cycle of oscillations, ω – is the angular velocity of the rotational motion of magneto-vibrational layer.

As for probability *P*, then its value is determined by the kinetics of the particles' movement in the magneto-vibrational layer, depends on its energy state, determined by the gradient of induction of the electromagnetic rotating field and is established experimentally.

The main parameter characterizing the efficiency of the grinding process of ferromagnetic particles is the degree of grinding. If we represent the particles of ferromagnetic material as spheres whose masses are equal to the mass of the particles, then the degree of grinding is set as the ratio of the diameters of the initial particle and the particle after impact. As the results of experiments [8, 9, 15] show, the degree of grinding differs from one in the third, fourth decimal place. Therefore, it can be assumed that a small portion is separated from the particle by a single act of impact.

In order to assess the impact destruction effect of particles of the dispersed ferromagnetic in the magneto-vibrational layer, S_mC_{o5} powder was used after grinding in a ball mill, the particle size distribution of which is shown in Fig. 3.

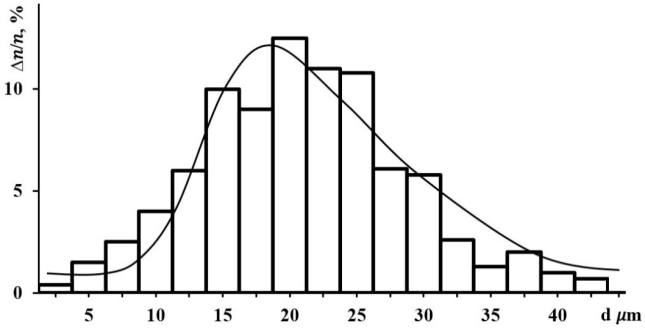


Figure 3. *Particle size distribution in the initial powder* $SmCo_5$

The powder was loaded into a screw drum placed in a device with rotating electromagnetic field. Under the influence of ponderomotive forces, the powder formed a magneto-vibrational layer in which impact grinding of particles was realized.

Suppose that in the magneto-vibrational layer, particle impact occurs every half of the period, setting the degree of grinding of the single act of impact to 1,0001 for a particle of 25 μm, thus, a diameter changes of 0,0025 μm are obtained. In this case, within one second at an industrial current frequency of 50 Hz, the particle participates in 100 collisions and its diameter decreases by 0,25 μm, respectively. By simple reasoning, it can be obtained that within one minute the particles undergo $6 \cdot 10^3$ collisions. In this case, the initial particle diameter of 25 μm decreases to a size of 10 μm, 20 μm – to 8 μm, 10 μm – to 4 μm, etc., which corresponds to a grinding degree of 2,5. Fig. 4 shows the histogram of the powder after 40 minutes of exposure to it by MVL.

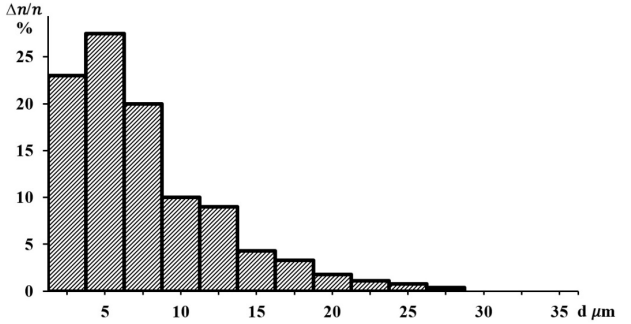


Figure 4. *The histogram of the particle distribution by sizes after 40 minutes exposure to MVL.*

Analysis of the obtained dependencies shows that the degree of grinding after 40 minutes of exposure to MVL is 3,27. Interestingly, after 60 minutes of exposure to MVL, along with the destruction process, a particle aggregation process was observed, which explains the lower degree of grinding after 60 minutes of exposure to MVL.

It should be noted that the above-mentioned results were obtained at a low concentration of particles in the magneto-vibrational layer. Thus, the weight of the powder suspension – 30 grams with an average particle diameter of 25 μm contains $43{,}7 \cdot 10^6$ particles. The volume of the experimental screw drum was equal to 290 sm^3.

Particles in magneto-vibrational layer in grinding mode are distributed over whole volume of a screw drum. The volume unit of the magneto-vibrational layer contains $150 \cdot 10^3$ sm^{-3} particles, the volume of which is $12{,}3 \cdot 10^{-10}$ sm^3. It can be assumed that at such a low particle impact concentration every half of the period is not realized, which corresponds to calculated values of the degree of grinding.

After 20 minutes of grinding in mode 1, the average size of the powder particles decreases from 81,3 μm to 19,2 μm. When creating in a grinding area stable magneto-vibrational layer in mode 2, the average particle size decreases to 9 μm; in mode 3 – up to 2,8 μm [14, 16] (Fig. 5). From the obtained results, it follows that the average particle size values are due not only to mechanical grinding conditions, but also to electromagnetic exposure modes.

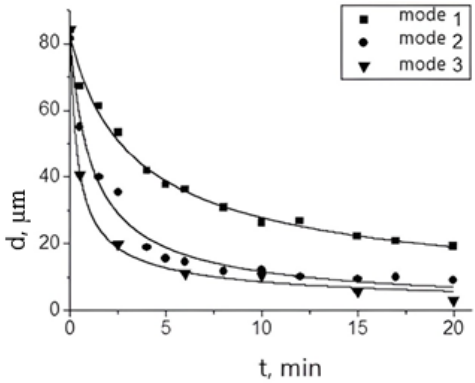


Figure 5. *Dependence of average particle size from grinding time*

As the grinding time increases from 10 minutes to 20 minutes in mode 1, the grinding degree increases from 3,2 to 4,4; in mode 2 – from 7,0 to 9,3; and in mode 3 – from 8,7 to 29,4. The grinding degree at milling during 25 minutes in mode 3 is increased to 43,9 and in mode 1 even after 120 minutes is increased only to 14,9.

With the increase of the induction gradient, the intensity of particle movement in the rotating electromagnetic field increases, which leads to an increase in the role of the self-grinding process [18].

Conclusion

As a result of theoretical and experimental studies, it has been shown that the use of devices with a rotating electromagnetic field allows contact-free method to effectively realize one of the important stages of processing sludge wastes of metal production associated with grinding its ferromagnetic particles, which provides the production of ferromagnetic raw materials with high granulometric characteristics.

On the basis of the balance of destruction energy and energy obtained by the particle from the electromagnetic field taking into account the mechanical and magnetic characteristics of the material, the energy model of grinding particles in the rotating electromagnetic field enables to realize the process of controlling the particle size of the ferromagnetic particles of sludge wastes.

Energy model of grinding particles in the rotating electro-magnetic field that has been proposed above allows to perform the managerial process over granulometric size of ferromagnetic particles of sludge wastes.

Financing was provided by RFFI within the frames of scientific project №20-38-90006.

References

1. B.E. Levin, Physicochemical bases of production, properties and use of ferrites, M.: Metallurgia, 1979, 427 p.

2. J. Thomson, Instability and disasters in science and technology, M.: Mir, 1985, 254 p.

3. Y.M. Vernigorov, Simulation of destruction of ferromagnetic materials particles in magneto-vibrational layer // World Science Proceedings of articles the international scientific conference. 2017, pp. 59-70. ISBN 978-5-00090-122-9.

4. Y.M. Vernigorov, Magneto-vibrational technology of powder magnets production // Dissertation for the degree of EngD, Rostov-on-Don, 1995, 369 p.

5. A.P. Babichev, Fine powder grinding device operating modes $SmCo_5$ // Fundamental and applied problems of engineering and technology, 2012. № 6 (296), pp. 64-70.

6. V.N. Bagaev, To the theory of magnetostatic interaction and structure formation in dispersed media // Magnetic hydrodynamics, 1986, №2, pp. 35-40. DOI: 10.22364/mhd

7. M.K. Bologa, Some peculiarities of magnetic fluidization of disperse systems // Magnetic hydrodynamics, 1981, №4, pp. 3-4. DOI: 10.22364/mhd

8. Y.M. Vernigorov, Science-intensive technology for producing composite powders in magneto-vibrational layer // Science-intensive technologies in mechanical engineering, 2019, № 5(95), pp. 3-8. DOI 10.30987/ article_5ca303087cba57.59333232

9. Y.M. Vernigorov, Simulation of destruction of aggregates of highly erstwhile dispersed ferromagnets in magnetic fields of different topology // Sciences of Europe, 2017. № 21-1(21), pp. 43-46.

10. Y.M. Vernigorov, Impact of particles of compact ferromagnetic material in magneto-vibrational layer // Vestnik of Don State Technical University, 2012, Vol. 12, № 1-1(62), pp. 95-98.

11. A.A. Kochubey, Technological support for strengthening processing of parts in a rotating electromagnetic field: specialty 05.02.08 "Engineering Technology": dissertation for the degree of candidate of technical sciences, Rostov-on-Don, 2017, 156 p.

12. V.A. Lebedev, Peculiarities of the technological process of devices for grinding ferromagnetic materials based on a magneto-vibrational layer // Science-intensive and vibration-wave technologies for processing parts of high-tech products, Rostov-on-Don, 2016, p. 26. ISBN: 978-5-7890-1570-4.

13. O.A. Myazdrikov, Electrodynamic fluidization // Interuniversity collection of LTU named after Lensoviet, 1976, №1, pp.3-13. ISBN 5-10-003174-3.

14. D.M. Plotnikov, Improving the quality of powder product materials due to the use of magneto-vibrational technology for separation of grinding sludges of bearing production: specialty 05.16.06 "Powder metallurgy and composite materials": dissertation for the degree of candidate of technical sciences, Rostov-on-Don, 2008, 129 p.

15. A.A. Shirin, Energy conditions ensuring the formation and stable mode of the magneto-vibrational layer in a rotating electromagnetic field // Fundamentals of physics, chemistry and mechanics of science-intensive technological systems for forming and assembling products, Rostov-on-Don, 22–26 September, 2020, pp. 338-342.

16. S.I. Egorova, Scientific foundations and practical aspects of the development of powder metallurgy technologies based on the use of a magneto-vibrational layer: specialty 05.16.06 "Powder metallurgy and composite materials": diss. for the degree of Doctor of Technology, Southern-Russian State Technical University (Novocherkassk Polytechnical Institute), Rostov-on-Don, 2009, 394p.

17. I.N. Egorov, Development of magneto-vibrational technology for grinding powders of magnetic materials, which provides the specified particle size distribution: specialty 05.16.06 "Powder metallurgy and composite materials": diss. for the degree of candidate of technical sciences, Rostov-on-Don, 2006, 159 p.

18. Y.M. Vernigorov, I.N. Egorov, S.I. Egorova, Efficiency of electromagnetic field application in mechanical grinding of ferromagnetic material powders // Vestnik of Don State Technical University, 2010, Vol. 10, № 3(46).

DOI 10.34660/INF.2023.61.37.083

EMULSION EXPLOSIVES FOR ARCTIC CONDITIONS

Gorinov Viktor Sergeevich
Consultant
Research and production enterprise «AgroSintez»
Gorinov Sergey Alexandrovich
Doctor of Technical Sciences, Leading Research Scientist
Institute for the Problems of Integrated Subsoil Development of the RAS
Kuprin Rodion Vitalievich
Founder
Research and production enterprise «AgroSintez»

Abstract. *The development of rich deposits of solid minerals in remote and sparsely populated areas of the Polar Urals, Eastern Siberia and the Far East requires effective explosive technologies that take into account harsh climatic conditions and inaccessibility of deposits.*

An analysis of blasting technologies shows that an urgent task is the development of a frost-resistant emulsion explosive (EE) for the creation of cartridges, including small diameter ones.

The paper shows that the necessary requirements are met by EE, the distinctive feature of which is the dependence of the water content in the oxidizing phase of the matrix emulsion on the content of calcium nitrate and chloride, at which water at negative temperatures will be in a crystalline hydrate state. To create a matrix emulsion, the DEP-1 polymer emulsifier was used.

The resulting EE in a practically significant temperature range (–60 - +40 ˚C) is an elastic-plastic body that allows you to form strong cartridges that retain their geometric dimensions. The socket for placing the detonator cap is easily made anywhere in the cartridge using an aluminum awl or a "spiral for wood" drill.

The EE reliably detonates from the detonator cap of the non-electric initiation system. The detonation velocity in plastic pipes with a diameter of 40 mm reaches 5000 m/s.

Keywords*: northern and arctic regions, emulsion explosive (EM), frost resistance, cartridged EE.*

Relevance

The development of the mineral resource base of Russia is carried out by large-scale development of rich deposits of solid minerals in hard-to-reach and sparsely populated areas of the Polar Urals, Eastern Siberia and the Far East. Up to 40% of gold reserves and almost 100% of primary diamond deposits are concentrated only in the Arctic zone of Russia [1]. The extraction of raw materials and the inevitable construction of buildings, structures, roads, airfields, ports, etc. requires increased consumption of industrial explosives (EE). Therefore, the development of technologies that allow efficient blasting in harsh climatic and complex mining and geological conditions is of utmost importance.

The basis of any explosive technology is the explosive used.

At present, in the mining industry of Russia, emulsion explosives (EE) are the most widely used [2]. However, the harsh climatic conditions and the remoteness of the deposits allowed a number of researchers to believe that when developing the northern and Arctic regions of Russia, it is advisable to focus not on emulsion, but on the simplest explosives and on the development of technologies for their application [1, 3-6]. This thesis is substantiated by the following statements [1]:

1. The production of emulsion explosives in the conditions of the North of Russia is unprofitable due to the high cost of energy required for their production;

2. The use of regular explosives is impractical due to expensive logistics and the lack of high-capacity explosives warehouses in remote regions.

However, the mass transition to the simplest explosives in the northern and Arctic regions of Russia is hampered by such factors as

- solubility of ammonium nitrate - the main mass component of the simplest explosives, which greatly complicates the conduct of blasting in unfrozen and flooded soils (rocks);

- the need for cartridged water and frost-resistant explosives, due to the wide spread of small-hole breaking in the extraction of ores of valuable non-ferrous metals, as well as in the performance of underwater and coastal blasting and the destruction of ice jams.

It should be noted that the development of technology for the production and use of emulsion explosives has shown the possibility of effective use of explosives in the extraction of ores in remote deposits located in harsh climatic conditions. It turned out that it is possible to produce a matrix emulsion at a considerable distance from the places of use of EVV, and deliver it there in corrugated cardboard containers [7]. Along with the developed methods of cold emulsion sensitization [7, 8], this makes it possible to use EE at a number of remote fields located in the northeastern region of the country.

However, these achievements do not allow abandoning regular patronized explosives. Therefore, the development of a frost-resistant EE for the creation of

cartridges, including those of small diameter, is an urgent task for the development of the northern and arctic regions.

Results of research

EE for arctic conditions should be resistant to temperature cycles. An analysis of studies of the stability of an inverse emulsion to "freeze-thaw" processes shows that an emulsion is stable, the fuel phase of which does not freeze until water freezes in droplets of the oxidizing phase [9-14].

Figure 1 shows the processes that occur when the emulsion freezes. If the fuel phase freezes first, it will be damaged by the volumetric expansion of the subsequently freezing oxidizing phase. As a result, a certain amount of the liquid oxidizing phase is drawn into the small slots of the frozen fuel phase. During thawing, these processes lead to the destruction of the emulsion, which inevitably leads to the loss of the detonation ability of the EE.

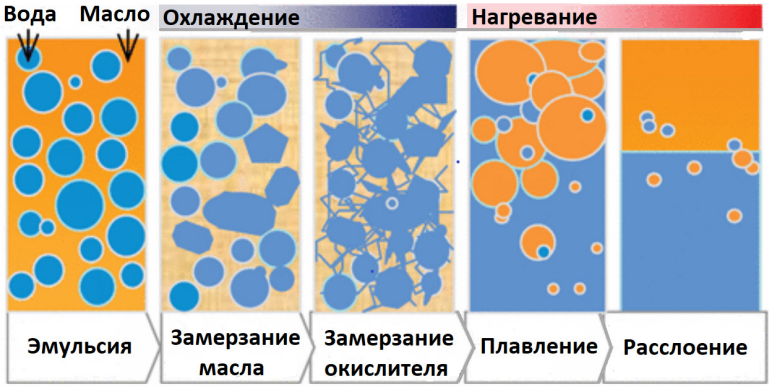


Figure 1. *Destruction of the inverse emulsion during the "freeze-thaw" processes [9].*

To solve this problem, it is proposed to use an EE with an oxidizing phase based on a binary solution of ammonium and calcium nitrate.

It is known that calcium nitrate forms several stable and unstable crystalline hydrates. Stable calcium nitrate crystal hydrates exist in the following temperature ranges [16]:

at 51,1 ˚C <t stable hydrates are not formed;
when 42,7 ˚C ≤t≤51,1 ˚C calcium nitrate trihydrate is formed;
when t<42,7 ˚C calcium nitrate tetrahydrate is formed,
where t - the temperature of the emulsion, ˚C.

Thus, at an emulsion temperature below 51.1˚C, the water present in the EE is bound into calcium nitrate trihydrate, and below 42.7˚C, into calcium nitrate tetrahydrate, which leads to a decrease in free water in the EE. Reducing the free water content reduces the likelihood of damage to the oil film, enveloping the particles of the oxidizing phase of the emulsion, when it is cooled below the freezing point of the oxidizing phase due to the increase in the volume of these particles.

The use of calcium chloride is associated with its ability to also form crystalline hydrates [17]:

- at temperatures below 50 ˚C, calcium chloride dihydrate, which exists at temperatures above 50 ˚C, turns into a tetrahydrate;
- when the temperature drops below 29.2 ˚C into hexahydrate.

This allows certain amounts of water entering the reactor to be bound into hydrates in excess of the calculated amount. In addition, the use of calcium chloride makes it possible to expand the range of permissible values for the content of calcium nitrate, at which it is possible to obtain effective EEs that do not have free water in the emulsion at temperatures below 50 °C.

For use in arctic conditions, an emulsion explosive is proposed, the matrix emulsion of which has a composition, the distinguishing feature of which is the dependence of the water content in the emulsion on the content of calcium nitrate and calcium chloride:

$$M_{H_2O} = \mu_{H_2O} \cdot \left(\frac{N_{Ca(NO_3)_2} \cdot M_{Ca(NO_3)_2}}{\mu_{Ca(NO_3)_2}} + \frac{N_{CaCl_2} \cdot M_{CaCl_2}}{\mu_{CaCl_2}} \right), \quad (1)$$

where μ_{H_2O}= 18, $\mu_{Ca(NO_3)_2}$=164, μ_{CaCl_2} =111 − molecular weight of water, calcium nitrate, calcium chloride, respectively, g/mol; $N_{Ca(NO_3)_2}$, N_{CaCl_2} − the number of water molecules in the hydrate associated with the molecule of the hydrate-forming substance; M_{H_2O} = 18 , $M_{Ca(NO_3)_2}$=164, M_{CaCl_2} − the proportion of water, calcium nitrate and calcium chloride in the emulsion, respectively, wt. %.

If condition (1) is met, when the emulsion is cooled, the water will be only in the crystalline state, which will provide the emulsion with reliable resistance to the "freezing-thawing" processes. It can be shown that the maximum possible amount of water in the emulsion, which can be in the crystalline state at temperatures below +40˚C, is achieved at $N_{Ca(NO_3)_2}$=4, N_{CaCl_2}=4. However, to ensure the reliability of the formation of crystalline hydrates, it is advisable to reduce the amount of water in the oxidative phase of the emulsion, therefore, to calculate the amount of water in the emulsion, $N_{Ca(NO_3)_2}$=3, N_{CaCl_2}=4 .

Then, substituting numerical values into equation (1), we obtain:

$$[H_2O] = 0{,}3293 \times [Ca(NO_3)_2] + 0{,}6486 \times [CaCl_2], \quad (2)$$

where $[H_2O]$, $[Ca(NO_3)_2]$, $[CaCl_2]$ – the content in the emulsion matrix of water, calcium nitrate and calcium chloride, respectively, wt. %.

This composition of explosives contains only 8.0-10.0% of the mass. water, which can cause rapid crystallization of the supersaturated solution of salts in the emulsion. Experiments have shown that resistance to crystallization is reliably ensured if a 20% solution of the polymer dispersant-emulsifier «DEP-1» in petroleum products is used as the fuel phase.

«DEP-1» (TU 20.41.20-002-73592474-2022 [18]) is a polymeric surfactant based on amino derivatives of polyisobutylene succinic anhydride (PIBSA).

To test the theoretical conclusions, EE of the required chemical composition were prepared and their detonation abilities were tested by the completeness of detonation of an open charge with a diameter of 36 mm when it was initiated by a detonator cap. Additionally, the detonation velocity was measured in polyethylene pipes with an inner diameter of 40 mm. Sensitization was carried out with glass microspheres with a diameter of 60-80 μm. The particle size of the emulsion is 2-3 microns.

Data on the compositions of EE and test results at EE temperature -25 ˚C are given in Table. 1. Experiments have shown that the proposed compositions of explosives can be obtained using various liquid hydrocarbons (diesel fuel, industrial mineral oils I-10, I-20, I-40 - and mixtures thereof).

Table.1

Compositions of emulsion explosive for use in the northern and arctic regions and their detonation properties at a temperature of -25 ˚C.

Components	**Composition numbers, wt %.**				
	1	**2**	**3**	**4**	**5**
Ammonium nitrate	53,2	60,1	64,39	62,5	58,85
Calcium nitrate	28,4	20,0	16,41	17,6	25,0
Calcium chloride	1,0	3,7	4,0	4,0	0,25
Fuel mixture: DEP-1 emulsifier + industrial oil	7,4	7,2	7,2	7,5	7,5
Water	10	9,0	8,0	8,4	8,4
EE density, g/cm3	1,177	1,166	1,161	1,161	1,171
EE detonation	full	full	full	full	full
Detonation speed, m/s	4670-4900	4670-4920	4740-5040	4750-5030	4780-5070

Figure 2. *Appearance of the developed EE*

The resulting EE in the temperature range of practical interest (-60 – +40˚C) is an elastic-plastic body, which makes it possible to form strong cartridges (Fig. 2). The socket for placing the detonator cap is easily made anywhere in the cartridge using an aluminum awl or a "spiral for wood" drill.

A further increase in the content of calcium nitrate and a decrease in the amount of water leads to a decrease in the stability of the emulsion, which is technologically and economically impractical.

Findings

An analysis of blasting technologies shows that an urgent task is the development of a frost-resistant emulsion explosive (EE) for the creation of cartridges, including small diameter ones.

The paper shows that the necessary requirements are met by EE, the distinctive feature of which is the dependence of the water content in the oxidizing phase of the matrix emulsion on the content of calcium nitrate and chloride, at which water at negative temperatures will be in a crystalline hydrate state. To create a matrix emulsion, the DEP-1 polymer emulsifier was used.

The resulting EE in a practically significant temperature range (-60 – +40 ˚C) is an elastic-plastic body, which makes it possible to form strong cartridges that retain their geometric dimensions. The socket for placing the detonator cap is easily made anywhere in the cartridge using an aluminum awl or a "spiral" type drill.

The EE reliably detonates from the detonator cap of the non-electric initiation system. The detonation velocity in plastic pipes with a diameter of 40 mm upon sensitization with glass microspheres reaches 5000 m/s.

References

1. Tikhonov V.A. Peculiarities of blasting during the development of mineral resources in the northern and arctic regions of Russia / Tikhonov V.A., Dudnik G.A., Panfilov S.Yu., Zhulikov V.V.// Mining industry. 2021 – No. 2. – p.102-106.

2. Sosnin V.A. Status and prospects for the development of industrial explosives in Russia and abroad / V.A. Sosnin, S.E. Mezheritsky // Bulletin of the Kazan Technological University. – 2016. – V. 19. – No. 19. – P. 84-89.

3. Viktorov S.D. Selection of efficiency criteria and methods for assessing the simplest explosives for the northern and arctic regions of Russia / S.V. Viktorov, A.E. Frantov // Proceedings of the 4th International Scientific School Academician of the Russian Academy of Sciences K.N. Trubetskoy «Problems and prospects for the integrated development and conservation of the earth's interior», Moscow, November 16-20, 2020 - P. 67-71.

4. Viktorov S.D. Directions for improving the simplest explosives for the northern and arctic regions of Russia / S.D. Viktorov, A.E. Frantov, I.N. Lapikov // Mine surveying and subsoil use. – 2020. - No. 6 (110). – P. 41-44.

5. Viktorov S.D. Development of innovative technologies for blasting using the simplest explosive granulites in the development of mineral resources in the northern and arctic regions of Russia / S.D. Viktorov, A.E. Frantov, I.N. Lapikov, R.A. Rakhmanov, Yu.I. Suvorov, V.Kh. Kantor, V.Yu. Fadeev, V.N. Tikhonov, V.V. Radkov, V.V. Zhulikov // Explosive activity. – 2020. – No. 129/86. – P. 116-146.

6. Viktorov S.D. Innovative directions for improving the simplest explosives with additives returned to production by recycling materials / S.D. Viktorov, A.E. Frantov, P.I. Opanasenko and others // Coal. – 2020. - No. 11 (1136). – P. 17-21.

7. B.N. Kutuzov: Production of emulsion explosive emulan PVV-A-70 for Olekminsky Rudnik LLC based on a low-temperature emulsion / B.N. Kutuzov, I.Yu. Maslov, P.A. Bragin and others // Mining Journal: 2011. – pp. 91-93.

8. Natarov O.V. Improving the technology of blasting with the use of emulsion explosives in the quarries of the Khibiny deposits: Thes. Cand. of Tech. Sciences: 25.00.20/ Natarov Oleg Valerievich. – Institute of Mining Col. of scientific center of the RAS. – Apatites. – 2006. – 113 p.

9. Chang L. Effect of oil phase transition on freeze/thaw-induced demulsification of water-in-oil emulsions/ L. Chang Lin , H. Gajhong, D. Hongjing etc.//Langmuir. – 2008. - May 20. - 24(10):5291-8. DOI: 10.1021/la704079s.

10. Ghosh S. Freeze-thaw stability of water-in-oil emulsions/ S. Ghosh, D. Rousseau// Journal of Colloid and Interface Science. - 2009, November 1, 339(1). – P. 91-102. - DOI:10.1016/j.jcis.2009.07.047.

11. Induction of instability in water-in-oil-in-water double emulsions by freeze-thaw cycling/ Rojas E.C, Papadopoulos K.D.// Langmuir. – 2007. - Jun 19. - 23(13):6911-7. DOI: 10.1021/la063533f.

12. Degradation of kinetically-stable o/w emulsions/ Capek I.// Adv Colloid Interface Sci. – 2004. - Mar 19. - 107(2-3):125-55. - DOI: 10.1016/S0001-8686(03)00115-5.

13. Stability of the emulsion (W/O): application to the extraction of a Dawson type heteropolyanion complex in aqueous solution /Bechiri O, Ismail F, Abbessi M, El Hadi Samar M.J.// Hazard Mater. – 2008. – Apr. 15. - 152(3):895-902. - DOI: 10.1016/j.jhazmat.2007.11.067.

14. Polymeric surfactants in disperse systems/ Tadros T.// Adv Colloid Interface Sci. – 2009. - Mar-Jun. - 147-148:281-99. - DOI: 10.1016/j.cis.2008.10.005.

15. Patent RU 2755069C1. Emulsion explosive for sulfide-containing rocks/ Gorinov S.A., Kuprin R.V. – 01/22/2021.

16. Pozin M.E. Technology of mineral salts (fertilizers, pesticides, industrial salts, oxides and acids. - L .: Publishing House «Chemistry». – Part II. – 4th ed., corrected, with the participation of L.Z. Arsent'eva, Yu .Ya. Kaganovich et al., 1974. – 792-1556 p.

17. Pozin M.E. Technology of mineral salts (fertilizers, pesticides, industrial salts, oxides and acids. – L .: Publishing house «Chemistry». – Part I. – 4th ed., corrected with the participation of L.Z. Arsent'eva, Yu. Ya. Kaganovich et al., 1974. – 791 p.

18. Patent RU 2652714C1 Universal inverse emulsifier / Kuprin V.P., Savchenko N.V., Kovalenko I.L. and others – 07/17/2017.

DOI 10.34660/INF.2023.31.79.084

EXPERIENCE OF USING LOW-CODE PLATFORMS IN THE DEVELOPMENT OF ENTERPRISE SOLUTIONS (USING THE EXAMPLE OF THE STUDENT TECHNOLOGY CIRCLE)

Eremina Irina Ilinichna
Candidate of Pedagogical Sciences, Associate Professor
Naberezhnye Chelny Institute of the Kazan Federal University,
Naberezhnye Chelny

Abstract. *The article is devoted to the applied experience of using low-code tools in the development of IT solutions for business by students, within the framework of the student scientific circle. The experience of the university in creating an individual trajectory of development in the field of IT for students, their training in popular technologies and solutions on interesting projects is considered.*

Keywords: *information technologies, information systems, low-code tools, student scientific and technological circle.*

The use of low-code tools in applied computer science is already the norm today. However, when training IT specialists for various sectors of the economy who are able to automate various reporting, build and work with data warehouses, study small-code development tools and edit data, and apply narrowly focused applications, not enough attention is paid. Scientific and technological circles at the university help to solve this problem. Student circles are a part of the university culture, without which it is difficult to imagine the educational and scientific work of any university in Russia.

Building analytical platforms is a complex and time-consuming task. However, any task can be simplified if you get this additional knowledge in a circle. This task determined the main goal of the student scientific circle (SNC): application development with minimal use of manual programming, integration of visual modeling tools and simple modules for solving typical tasks [1].

The main issues considered in the framework of the circle's activities:

1. Building IT platforms for data accumulation and analysis of any company;
2. Development and training of companies to apply "low-code concepts";
3. Implementation of CRM/ERP systems in the production process of enterprises;

4. Building business process models to optimize the activities of enterprises and create technically complex products;

5. Application of knowledge gained in the study of disciplines: Corporate information systems, Application development in 1C.

The results of the study. For self-assessment and determination of the level of complexity of the activities of the scientific and technological circle, the diagram of the scientific and technical initiative (STI) is used:

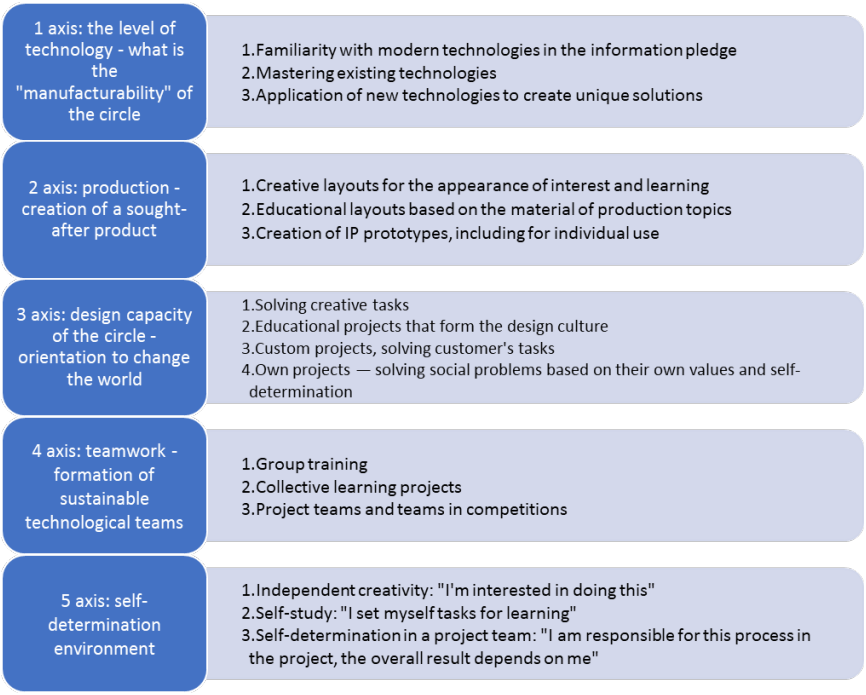


Figure 1. *Diagram of determining the level of complexity of the activities of the SNK*

Several methods are used during the meetings of the SNC:

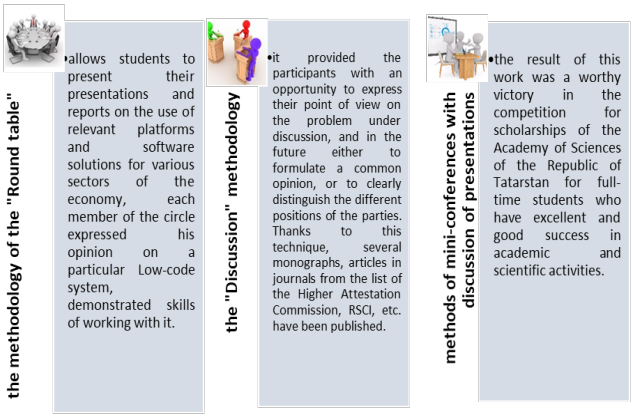


Figure 2. *Methods of conducting SNK classes*

During the work of the circle, various topics and directions of the circle work were selected. Together with students-members of the student scientific circle, low-code systems were developed, documents for registration of intellectual property objects according to these developments were collected and submitted [2].

The main stages of the life cycle of the circle during the academic year are shown in Fig. 3.

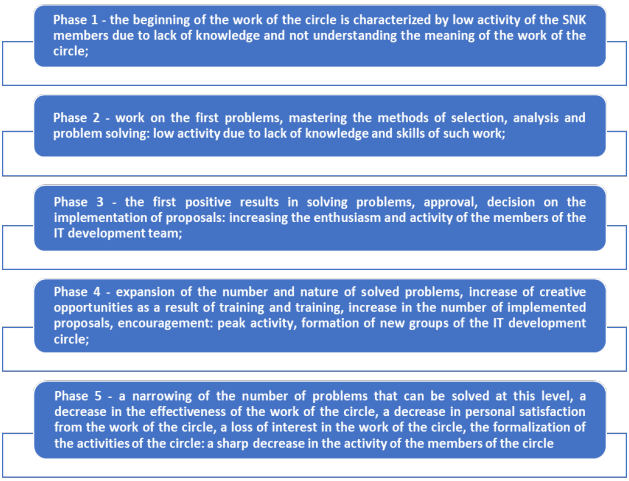


Figure 2. *The life cycle of the team of participants of the circle during the academic year*

In the process of working in the SNK , participants form the following key competencies:

Competencies in technology ownership:

• analysis of the subject area of development – flexible user skills soft skills are being developed;

• the ability to design architecture in a different way - a mathematical mindset, logical thinking is formed; the basics of designing business processes are studied;

• the ability to develop software – various software tools are analyzed with which you can create the right application;

• knowledge of the basics of programming, integration languages - basic knowledge and understanding of the general principles of creating algorithms, loops, pseudocodes, functions, data structures, etc. are applied, programming is actively practiced.

Organizational and communication competencies:

• ability to process heterogeneous data - search, critical analysis and synthesis of information are carried out, the ability to use a systematic approach to solve tasks is developed;

• ability to carry out social interaction – a role in the team is selected and implemented, communication with other students-colleagues on the project is organized;

• ability to carry out business communication in oral and written forms in the state language of the Russian Federation and foreign languages.

The partner of the circle is 1C company, 1C-Volga Region Company is a representative of 1C company on the territory of Mari El, Mordovia, Nizhny Novgorod region, Tatarstan, Udmurtia, Bashkortostan and Chuvashia, Perm Krai. The department has a cooperation agreement and a partner code, on the basis of which, on preferential terms, it is possible to purchase methodological and software for SNK.

Based on the above, the following conclusions can be drawn: the participation of students in the development of IT products based on low-code technology reveals their scientific abilities, intelligence and observation. Performing scientific research provides a large amount of additional knowledge.

By arousing students' interest in the subject, the circles contribute to the development of horizons, creative abilities, the development of independent work skills and thereby improve the quality of preparation for academic classes.

References

1. Eremina I.I., Lysanov D.M., Ishmuradova I.I., Puzyreva D.M. Methodological principles of distribution of tasks and labor resources at the enterprise / Science of Krasnoyarsk region. 2022. Vol. 11. No. 1-3. pp. 168-173.

2. Eremina I.I. Analysis of statistical data and forecasting of the quality of bachelor's training (on the example of the training direction 09.03.03, profile Applied Informatics in economics of the NCI KFU) / I.I. Eremina // International Journal of Advanced Studies. 2018. Vol. 8. No. 4. pp. 66-73.

DOI 10.34660/INF.2023.95.47.085

FOREST FIRE DAMAGE ASSESSMENT IN THE LOWER ANGARA REGION

Sokolov Vladimir Alexeevich
Candidate of Agricultural Sciences, Full Professor, Head of Laboratory
Sukachev Institute of Forest Siberian Branch of the Russian Academy of Sciences

Vtyurina Olga Petrovna
Research Officer
Sukachev Institute of Forest Siberian Branch of the Russian Academy of Sciences

Sokolova Nastassia Vladimirovna
Candidate of Agricultural Sciences, Senior Research Officer
Sukachev Institute of Forest Siberian Branch of the Russian Academy of Sciences

Abstract. *Fires cause the major damage to forests in the Lower Angara region. There is no a common methodology for calculation of the forest fire damage in Russia. Only fire losses of wood in quantitative and monetary terms are included into the cost of the forest fire damage in the case law. Thereat the costs of extinguishing the fire and fire suppression are not included in the damage calculation. Damage of forest ecosystems and environment damage is not estimated at all and is not included in official damage assessments. Data of 15 forest fires developed in the lower Angara region in 2019 have been analyzed. The total damage estimated in accordance with the current methodology has come to 757.9 million rubles. The damage calculated in accordance with Regulations of the Federal Forestry Agency 1998 has been estimated in the amount of 3,009.8 million rubles. Moreover, the losses of carbon sequestration by forest ecosystems have been evaluated expertly and have amounted to 3,407.9 million rubles. The total forest fire damage evaluated exceeds the officially registered fire damage by 8.5 times.*

Keywords: *the lower Angara region, forest fires, loss of wood, attritition, fire extinguishing costs, damage assessment.*

The main damage to forests in the Lower Angara region is caused by fires. This is due to the predominance of pine-larch forests in the ecoregion (about 50%

of forested land), which are characterized by a high natural fire hazard [1–3]. Accounting for damage from fires, including possible consequences in the form of degradation of forest ecosystems and forest conditions, is the most important element in the assessment of forestry activities in forestries in the field of forest protection from ecological, forestry and economic positions [4].

Taking into account the consequences of the impact of a fire, arising both during the combustion process and after a fire after a certain period of time, is also necessary to determine the overall assessment of damage from forest fires [2, 5, 6]. These consequences usually include loss of flora and fauna, soil transformation, reduction or loss of water protection, soil protection, recreational and other functions of the forest, loss of wood, including the subsequent loss of weakened trees affected by forest pests. Decay lasts, as a rule, from 2 to 7 years [4, 6].

In judicial practice, only the loss of wood during a fire, calculated in quantitative and monetary terms, is included in the amount of damage from natural forest fires. At the same time, the cost of extinguishing a fire and its liquidation is not included in the amount of damage.

The analytical-statistical method of research was used in the work. The analysis included regulatory legal acts in the field of forest fire protection and fire safety, as well as materials on 15 forest fires that broke out in the Lower Angara region in 2019 (Table 1).

The total area of 15 forest fires upon elimination was 70485 ha, and the average area of 1 fire was 4723 ha, the average area upon detection of a fire was 40 ha.

The analyzed fires were eliminated within 5 to 20 days, 12 days on average. No dependence on the timing of extinguishing fires on the area was revealed.

All fires listed in Table 1 were located in the aviation zone of forest protection and are classified as large (more than 200 hectares). In the ground protection zone, fires with an area of more than 25 hectares are considered large.

For each forest fire, the forestry conducts an internal investigation. Numerous documents are attached to the act of an internal investigation: an act on a forest fire, an order to create a commission, a decision of the forestry headquarters to extinguish a fire, a fire plan, a memorandum of the head on the progress of extinguishing a fire, a taxation description, a statement on the calculation of damage, a statement on the costs of extinguishing a forest fire, photographs, video recordings, etc. Based on the results of the liquidation, a log is issued to record the costs of extinguishing (liquidating) a forest fire. Materials on forest fires within 10 days after the fire is extinguished are sent to the Department of Forest Protection and Protection of the Ministry of Forestry of the Krasnoyarsk Krai.

Currently, there is no separate methodological document approved in accordance with the established procedure that determines the procedure for calculating the amount of damage caused to forests as a result of forest fires. Taking

this into account, Rosleskhoz, by letter No. MK-09-27/20734 dated October 24, 2019, when calculating the real damage due to forest fires, proposes using the Decree of the Government of the Russian Federation dated September 22, 2007 No. 310 "On the rates of payment per unit volume of forest resources and payment rates per unit area of a forest plot owned by the federal government" and Article 15 of the Civil Code of the Russian Federation. In case of confirmation by the authorized bodies of inquiry and investigation of the facts of violation of the forest legislation, the damage should be recalculated in accordance with the Decree of the Government of the Russian Federation dated December 29, 2018 No. 1730 "On approval of the features of compensation for damage caused to forests and natural objects located in them due to violation of forest legislation (hereinafter referred to as Decree 1730).

If forest fires arose from natural phenomena not related to the violation of forest legislation, then the rates (multiplicity) of Decree 1730 do not apply (letter of Rosleskhoz dated October 29, 2018 No. NK-09-54 / 18008).

An explanation should be made regarding the absence of a separate methodological document approved in the established manner that determines the procedure for calculating the amount of damage caused to forests due to forest fires. Actually, there is such a document, and Rosleskhoz knows about it.

Table1

Some data on forest fires in the Lower Angara region in 2019

Fire number	Forestry	District forestry	Discovery date	Start of extinguishing	End of quenching	Area upon detection, ha	Area during liquidation, ha
32	Kodinskoye	Nedokurskoye	27.06	27.06	15.07	2	7100
12	Gremuchinskoe	Bedobinskoye	03.07	03.07	12.07	15	14300
82	Aban	Pochetskoye	30.07	30.07	13.08	5	6100
43	Kodinskoe	Kovinskoye	04.07	04.07	14.07	2	500
94	Tungusskoko-Chunskoye	Chemdalskoye	19.07	19.07	05.08	4	1300
13	Gremuchinskoe	Bedobinskoye	03.07	03.07	08.07	10	1500
24	Gremuchinskoe	Bedobinskoye	29.07	29.07	13.08	0.5	4000
41	Kodinskoye	Nedokurskoye	03.07	03.07	12.07	1	1500
92	Tungusskoko-Chunskoye	Chemdalskoye	19.07	19.07	05.08	5	1300
24A	Kodinskoye	Kezhemskoye	22.06	22.06	03.07	2	1050

83	Tunguss-ko-Chunskoye	Chemdal-skoye	17.07	17.07	26.07	2	2000
51	Tunguss-ko-Chunskoye	Chemdal-skoye	12.07	12.07	02.08	5	8000
14	Gremuchin-skoe	Bedobinskoye	05.07	05.07	17.07	500	8000
7	Teryanskoe	Verkhne-Tery-anskoye	02.07	02.07	16.07	2	13200
12A	Khrebtovskoe	Pashutinskoye	06.07	06.07	16.07	45	995

At one time, in order to ensure a unified approach of the executive authorities of the constituent entities of the Russian Federation to documenting the consequences of forest fires, accounting for damage and loss of standing wood as a result of forest fires, as well as establishing the type of fire and its intensity, Rosleskhoz issued a letter of May 18, 2012 No. ET-09-54/5504 sent «Recommendations on accounting for damage and loss of wood as a result of a forest fire.» In turn, these recommendations were prepared on the basis of the order of the Federal Forestry Service of Russia dated 03.04.1998 No. 53 «On approval of instructions for determining the damage caused by forest fires.»

If we compare the above recommendations and instructions, we can conclude that the recommendations are a weak resemblance to the previous instructions.

According to the instructions, the total damage from a forest fire includes:

- the cost of loss of standing wood in middle-aged, maturing, mature and overmature plantations;
- damage from damage to young animals of natural and artificial origin;
- damage from damage to secondary forest management resources;
- expenses for extinguishing forest fires;
- the cost of burned objects and finished products in the forest (reduction in the cost of objects and finished products damaged by fire);
– expenses for clearing burnt areas and additional sanitary felling in stands damaged by forest fires;
- damage from the decrease in soil-protective, sanitary-hygienic, water-protective and other environmental functions of the forest;
- damage from air pollution by combustion products;
- damage from the death of animals and plants, including those listed in the Red Book of the Russian Federation;
- other losses.

Other losses may include costs and losses caused to other industries as a result of forest fires (temporary cessation of navigation, air flights, road and rail traffic, activities of survey parties, holiday homes and camps, tourist camps. These costs and losses may be included in total damage from forest fires when providing the

forestry or the Ministry of Forestry with certificates of losses incurred, drawn up in accordance with the established procedure.These losses are not included in the forest fire protocol, but are taken into account by the executive authorities of the constituent entities of the Russian Federation when determining the total damage from forest fires.

From the Instructions of 1998, in the Recommendations of 2012, the total damage from a forest fire included only the cost of standing wood in medium-aged, maturing, mature and overmature stands and damage from damage to young stands of natural and artificial origin. Other types of damage were ignored. In all likelihood, the compilers of the Recommendations were not satisfied with the methodological aspects of determining the damage from these species, as well as the significant complication of accounting for losses and losses from forest fires.

Therefore, when calculating losses from the analyzed forest fires, forestries were based on the recommendations of 2012 (Table 2).

Table 2

Damage from forest fires, rub.

Fire number	Extinguishing costs	Cost of standing wood loss	Damage from damage to young	Total damage	Damage per 1 hectare
32	5630145	115430128	22208449	143268722	20179
12	1558208	56697638		58255846	4074
82	2820600	13810738	207041354	223672692	36668
43	2720000	8562505		11282505	22566
94	2086902	19533891		21620793	16631
13	80956	15177767	2544444	17803167	11869
24	3801040	7470981		11272021	2818
41	799272	39308969	13783803	53892044	35928
92	3427164	11871525		15298689	11768
24A	4230653	824771		5055424	4815
83	1101462	16630380		17731842	8866
51	2548202	43584600		46132802	5767
14	2720597	85745982		88466579	11058
7	5105437	22891046		27996483	2121
12A	2006077	534640	12583147	15123854	15200

Based on the results of processing 15 registers of costs for extinguishing forest fires, the total damage amounted to 756.9 million rubles, including the cost of extinguishing - 40.6 million rubles. (5.4%), the cost of standing wood losses is 458.1 million rubles. (60.5%), damage from damage to young animals - 258.2 million rubles. (36.1%). The average damage per 1 ha from forest fires is 14,022

rubles. Previously, we determined the annual damage from forest fires in the Lower Angara region at 5.8 thousand rubles. per 1 ha, and the total annual damage is 1 billion rubles.

For comparison with the above figures, let us calculate the damage from 15 analyzed forest fires in accordance with the Instructions of 1998, taking into account all types of losses and losses.

Damage from forest fire damage to secondary use resources. The damage is calculated for each damaged resource, taking into account the operational area on which the corresponding resource is damaged, the value of the operational yield per 1 hectare and the rates of payment charged per unit of forest resource. In practice, the operational yield is usually assumed to be 50% of the biological yield.

The biological yield was determined according to the scales of the yield of berries and mushrooms of the forest inventory guide for the southern taiga forests of Central Siberia [8]. The average biological yield of lingonberries is 100 kg/ha, blueberries - 80 kg/ha, mushrooms - 10 kg/ha. The average operational yield is 50, 40 and 5 kg/ha, respectively.

The rates of payment per unit volume of food forest resources were taken in accordance with the Decree of the Government of the Russian Federation dated May 22, 2007 No. 310 1 kg of berries - 1.44 rubles, 1 kg of mushrooms - 3.6 rubles. The operational area with a damaged resource is assumed to be 50% of the total area of fires or 35,422 hectares. Forest conditions for the growth of berries and mushrooms are restored on average in 5–10 years [2, 6]. Therefore, the minimum period of damage to wild berries and mushrooms is assumed to be 5 years.

Thus, the minimum damage from forest fire damage to side-use resources over a 5-year period is 35422 hectares × 1.44 rubles. × 45 kg/ha × 5 years + 35422 × 3.6 × 5 × 5 = RUB 14,664,708

In accordance with the Instructions of 1998 (p. 19), in the absence of data on operational yields, payment rates and standards for damage to resources by forest fires, the amount of damage is taken at the level of 5% of the total cost of wood loss and damage from damage to young stands of artificial and natural origin. If this paragraph is applied, then the amount of damage will be equal to 35,811,838 rubles. or 2.4 times more.

Damage caused by damage or destruction of property in the forest by a forest fire

Such damage was not determined by the forest fire protocols.

Costs for clearing burnt areas and carrying out additional sanitary cuttings in plantations damaged by forest fire

Based on the materials on forest fires, such work, including subsequent artificial reforestation, will be required on an area of 15,120 hectares. The level of costs that has developed in recent years is 113,000 rubles/ha. The total amount of expenses will be 1,708,560,000 rubles.

Damage from the reduction of soil-protective, sanitary-hygienic, water-protective and other environment-forming functions of the forest

This damage is determined by multiplying the amount of damage from the loss of standing wood and from damage to young stands by the coefficient of ecological significance of forests in accordance with Appendix 5 of the Instruction. The coefficients of ecological significance for water protection forests are: forbidden strips of forests along the banks of rivers, lakes, reservoirs and other water bodies - 2.5; for operational scaffolding - 0.5.

The amount of damage from loss of wood and damage to young stands in water protection forests amounted to 21,487,103 rubles, in operational forests - 694,749,655 rubles. Consequently, the total amount of damage from the decrease in soil-protective, sanitary-hygienic, water-protective and other environmental functions of the forest will be 21,487,103 × 2.5 + 694,749,655 × 0.5 = 401,092,586 rubles.

Damage from air pollution by combustion products

This damage is determined by 4 types of pollutants released into the air during the combustion of biomass of forest plantations: carbon monoxide, hydrocarbons, nitrogen oxide and suspended particles. The average specific emission of these substances from 1 ton of burned biomass is: carbon monoxide - 125 kg, hydrocarbons - 12 kg, nitrogen oxide - 2 kg, suspended particles - 22 kg. The damage from each pollutant is determined as the product of three factors: the rate of payment for the emission of 1 ton of the substance, the volume of the release of the substance during a fire, and the coefficients of the environmental situation for the area where the forest fire occurred.

The basic standards for payment for the emission of 1 ton of pollutants into the atmosphere and the coefficients of the environmental situation were approved by the Ministry of Natural Resources of the Russian Federation on November 27, 1992. The standard for payment in rubles for 10 tons was: carbon monoxide - 0.05, hydrocarbons - 0.11, nitrogen oxide - 2.75 and suspended particles - 1.10. The coefficient of the environmental situation was determined for the East Siberian economic region in the amount of 1.4. Fee rates should be indexed to inflation rates. Paragraph 32 of the Instruction determines that before the development of standards for the volume of combustion of organic substances during forest fires, the total damage from atmospheric pollution is taken in the amount of 10% of the total damage in the form of the cost of loss of standing wood and damage from damage to young stands. Based on the provisions of paragraph 32, the total damage from air pollution with pollutant emissions amounted to 71,623,676 rubles.

Damage from the death of animals and plants, including those listed in the Red Book of the Russian Federation

Damage from the death of animals and plants is determined by rates for calculating the amount of penalties for damage caused by legal entities, illegal

extraction or destruction of animals and plants. In accordance with paragraph 35 of the Instruction, until the development of standards for the number of animals and plants dying from forest fires, the total damage from their death is taken in the amount of 5% of the damage caused in the form of the cost of loss of standing wood and damage from damage to young stands of artificial and natural origin. Based on this paragraph, the damage from the death of animals and plants amounted to 35,811,838 rubles.

Other losses

No information is available for other losses.

Thus, the total damage from the analyzed forest fires, taking into account the cost of extinguishing, the cost of loss of standing wood, damage from damage to young stands and other damage listed above, amounted to 40.6 + 458.1 + 258.2 + 35.8 + 1708.6 + 401.1 + 71.6 + 35.8 = 3,009.8 million rubles ., which exceeds the officially registered damage from fires by 2,293.6 million rubles. or 4.2 times. The average damage per 1 ha from forest fires amounted to 42,484.3 rubles. Recall that the average damage per 1 hectare, according to official data, was 14,022 rubles.

The results of the conducted research allow us to draw the following conclusions.

1. The current procedure for calculating the amount of damage caused to forests due to forest fires (letter of Rosleskhoz dated October 24, 2019 No. MK-09-27/20734) greatly underestimates the environmental and economic damage.

2. Therefore, when determining the damage, it is necessary to return to the Instruction for determining the damage caused by forest fires, approved by order of the Federal Forestry Service of Russia dated April 3, 1998 No. 53.

3. For a more objective determination of damage according to the Instructions of 1998, it is necessary to determine and clarify forest rates and taxes, productivity standards for by-products, pollutants, the number of animals and plants dying from fires, accounting for costs and losses incurred by other sectors of the national economy in the result of forest fires.

4. The current procedure for calculating the amount of damage caused to forests due to forest fires does not take into account the loss of absorption of carbon by forest ecosystems and the release of oxygen. These losses can be significant. The assessment of the cost of carbon absorption on the international market ranges from 8 to 20 euros per 1 ton. The cost of releasing 1 ton of oxygen can be from 8 to 9 thousand rubles, based on the price of its industrial production. According to S.V. Belov [9], the absorption of CO_2 in a 100-year-old stand during the growing season can be from 11 to 13 t/ha, the release of O_2 is 9–10 t/ha. Assuming the loss of biomass in the analyzed area of forest fires in the amount of 50%, the losses due to carbon absorption can be 425,070 tons, due to oxygen release - 336,514 tons, or 547.5 and 2,860.4 million rubles, respectively.

5. Based on the foregoing, we conclude that it is necessary to seriously adjust the current procedure for calculating damage from forest fires. Drastic underestimation of damage does a disservice to forestry, since it does not focus on environmental losses from natural forest fires.

The work was carried out within the framework of the Russian Science Foundation grant No. 21-46-07002 «Strategy for adaptive management of Siberian boreal forests in the context of global changes.»

References

1. Korovin G. N. Analysis of the Distribution of Forest Fires in Russia // Fire in Ecosystems of Boreal Eurasia. Dordrecht; Boston; London; Kluwer Academic Publisher, 1996. P. 112–128.

2. Ivanova G. A., Konard S. G., Makrae D. D., Beskorovainaya I. N., Bogorodskaya A. V., Zhila S. V., Ivanov V. A., Ivanov A. V., Kovaleva N. V., Krasnoshchekov E. N., Kukavskaya E. A., Oreshkov D. N., Perevoznikova V. D., Samsonov Yu. N., Sorokin N. D., Tarasov P. A., Tsvetkov P A., Shishikin A.S. The impact of fires on the components of the ecosystem of the middle taiga pine forests of Siberia. Novosibirsk: Nauka, 2014. 232 p.

3. Sokolov V. A., Varaksin G. S., Vtyurina O. P., Goryaeva E. V., Kuzmik N. S., Sokolova N. V., Farber S. K. Regeneration of forests in the Angara region. Saarbrucken, Germany: LAP Lambert Academic Publishing, 2018. 262 p.

4. Sofronov M. A., Goldammer I. G., Volokitina A. V., Sofronova T. M. Fire danger in natural conditions. Krasnoyarsk: Sukachev Institute of Forest SB RAS, 2005. 330 p.

5. Reinhardt E. D., Keane R. E., Brown J. K. Modeling fire effects // Wildland Fire. 2001. V. 10, N. 3-4. P. 373–380.

6. Ivanova G. A., Ivanov A. V. Fires in the pine forests of Central Siberia. Novosibirsk: Nauka, 2015. 240 p.

7. Shevelev S. L., Kuzmichev V. V., Pavlov N. V., Smolyanov A. S. Forest inventory guide for the southern taiga forests of Central Siberia. M.: RNRISFM, 2002. 166 p.

8. Belov S.V. Evaluation of the hygienic role of the forest // Forestry. 1964. No. 1. P. 8–13.

DOI 10.34660/INF.2023.58.82.086

ON THE ISSUE OF THE NEGATIVE IMPACT OF URBAN ENVIRONMENTAL FACTORS ON THE PLANT COMPONENTS OF THE ECOSYSTEM OF BOTANICAL GARDENS (ON THE EXAMPLE OF THE BOTANICAL GARDEN NAMED AFTER B.M. KOZO-POLYANSKY, VORONEZH STATE UNIVERSITY, VORONEZH C.)

Popova Sofia Sergeevna
Student
Voronezh State University of Forestry and Technologies Named after G.F. Morozov
Prokhorova Nadezhda Leonidovna
Senior Lecturer
Voronezh State University of Forestry and Technologies Named after G.F. Morozov

Currently, active human economic activity on a global scale violates the stability of the biosphere, the danger of the current situation is the destruction of homeostasis mechanisms. The rapid growth of urbanized territories disrupts the normal functioning of natural systems and, as a result, unable to withstand anthropogenic pressure, they disintegrate. Subsequently, new systems that are less resistant to stressful situations appear in their place [8]. In this regard, the topic of preserving the biodiversity of the planet has acquired particular relevance.

The role of botanical gardens in the preservation of floristic diversity in regions with intensive industrial development is constantly increasing. It consists in the development of fundamentally new technologies for the restoration of floristic diversity, the transfer of populations of rare and endangered plants, as well as the creation of reserve populations on the territory of botanical gardens [9].

The role of botanical gardens in studying the biodiversity of various regions with intensive industrial development is invaluable. Educational, scientific and educational activities are based on the study of a large number of collection specimens of plants of the natural flora of the planet. For the purpose of cultural and educational work of people with disabilities (blind, visually impaired, autistic people), specialized aromatic («fragrant») gardens have been created [13,14].

The preservation of the biological diversity of regional floras and plants of the world as a whole, the popularization of botanical knowledge through educational

programs, and the expansion of the range of new species introduced into urban landscaping are also the merit of botanical gardens. Their value increases with the increase in collections of plants of natural flora. Botanical gardens that collect, create, preserve and maintain collections of living plants, develop the theory of introduction, study the characteristics of the biology of growth and development of introducers, preserve the biodiversity of plants, are, of course, the main base for solving various problems: the reintroduction of rare and endangered species into natural communities, development of an actual range of species for modern urban floristry [15].

But, nevertheless, botanical gardens are a systematic collection of various plant species: rare, endangered and confined to certain natural habitats. The content of such plant components, which have their own specific characteristics, require constant monitoring and care.

The purpose of our study was to determine how the introduced plants can survive in their new natural environment. To achieve this goal, long-term observations were carried out over the natural complex of the Geographical Park of the Botanical Garden of the Voronezh State University of Forestry and Technologies Named after G.F. Morozov.

As a result of the work carried out within the framework of the research, the criteria for assessing the state of the specimens of introduced plants selected for study were determined, and a conclusion was made about the adaptation and ability to survive of these species of woody plants in the natural conditions of the park.

The Botanical Garden is a scientific, environmental and educational center located in the northwestern part of Voronezh. The object of our research is the central area of the Botanical Garden of the VVoronezh State University of Forestry and Technologies Named after G.F. Morozov - Geographical Park, a valuable and unique natural object of the city of Voronezh.

The objectives of the study included the following types of work: we studied in detail the biological changes in the territory of the garden. In the course of observations, it was found that the recreational load changes the quantitative and qualitative components of natural ecosystems. Individual system components react differently to loads. Tree species and soil cover were singled out as the main objects of research to assess changes in the state.

The geographical park is located on the territory of the right bank of the city of Voronezh, where urban moderately humid weather prevails, under which a characteristic agro-ecological background of the botanical garden is formed. Climate: temperate - continental, average annual temperature + 5.6 °C; average January temperature - 10.5 °C; the average July temperature is + 20.0°C. Recently, there has been some shift in seasons: the summer season lasts until mid-September, and the duration of winter has decreased [1]. The weather is characterized by

instability, winter thaws, especially in the south of the region, can lead to snow cover melting and an increase in river water content in a short time, and the cold returning after the thaw can lead to freezing of the soil cover. In winter, western, southwestern, and southeastern winds predominate in the region, and arctic and tropical air masses are occasionally observed (in summer) [6].

The main soil-forming rocks in this area are mainly cover clays and loams, underlain by a thick layer of fluvioglacial sandy deposits. The main background of the soil cover is soils of the chernozem type, specifically, leached and podzolized chernozems, as well as gray forest ones [7].

As noted earlier, the territory of the botanical garden has a number of unique natural landscapes that represent endemic biodiversity and perform important phytocenotic functions in the face of increasing technogenic pressure on urban tree plantations. Of particular importance are the indigenous ravine oak grove located in the "reserved ravine", with a tree stand over 200 years old, aspen forests of primary and secondary origin 100 years old, blackthorns, steppe slopes and other plant communities [16].

Among the factors that negatively affect the «settlers», changing their quantitative and qualitative characteristics, not only the natural and climatic conditions characteristic of the Central Chernobyl region, but also the recreational load that increases every year, stand out. This is due to the intensive growth of residential areas around, as well as a change in the structure of the landscape for the construction of a road junction. The entire territory of the park is accessible to all residents of Voronezh and is intensively used.

The influence of various factors, anthropogenic (recreation) and natural (changes in temperature) changes the quantitative and qualitative indicators of the components of natural ecosystems. The assessment of these changes makes it possible to predict the sustainability of recreational forests. Plant communities react differently to loads; tree species of the park were taken as the main objects for assessing changes in the state. In the course of the work, a field-route and descriptive method was used, in which observations were made, with the measurement and description of the objects under study, and the state of the plantations was assessed. Analytical, mathematical and statistical methods were used to process the obtained data.

Field studies were carried out from August 2016 to the present. Trial plots were established in five plots based on differences in taxation characteristics [11].

During the research period, work was carried out on the inventory and forest pathological examination of the forest stand of the geographical park to accurately determine the species composition and main taxation indicators. We have assessed the vital status of each of the selected breeds, taking into account their pathological specificity. All trees in the geographical park with a trunk diameter

at chest height of more than 12 cm were numbered and described in detail. The description indicated the following data: breed, diameter in thickness steps, height, height, external pathological signs, including anomalous trunk shapes. The results obtained were summarized in the summary standard tables of the forest pathological examination and statistically processed using the Excel program [16].

Based on the results of the studies carried out as part of the next stage of the implementation of the scientific topic on the study of the ecological and sanitary state of tree plantations and the development of sanitary measures to increase the biological stability of the biocenoses of the botanical garden, data were obtained on the current state of the forest stand.

Based on the results of the study of tree and shrub species, carried out earlier by Tsaralunga V.V., Prokhorova N.L., in already defined areas (trial areas), the state of the forest stand was re-evaluated and described, with a trunk diameter at chest height of more than 12 cm. The studies were carried out in order to establish the dynamics of changes in the composition of the forest stand. As already noted, monitoring studies are necessary to control the sanitary condition of plant components, as well as to determine their vitality.

Based on the methodology proposed by E.G. Mozolevskaya, during the study, the following were evaluated: diameter, breed, height and a set of indicators characterizing external signs (shape and configuration of the crown, signs of pathology, not excluding anomalous forms of the trunk). Tree species are divided into 3 quality categories: good, satisfactory and unsatisfactory condition. It should be noted that, first of all, trees with bare roots were taken into account.

Illumination is one of the most sensitive indicators. In the course of the work, we used specialized equipment, namely, a portable photoelectric light meter Yu-117 (light meter accuracy class - 10 according to GOST 8.401-80), designed to measure illumination. An increase in the level of illumination (a decrease in crown density from 75-90% to 25-30%) is the main reason for the displacement of forest grasses by meadowy.

The herbaceous cover (divided into ecological-coenotic groups) is sensitive to changes in the environment. It has a great negative impact on the violation of the water-air regime of the soil as a result of trampling. Ground cover plant species were divided into four groups according to the method of A.A. Nitsenko: 1) forest 2) forest-meadow, 3) meadowy, 4) weed-ruderal.

At a distance of 0.2 m, 0.5, and 1 m from the path, we took samples of the litter, taking into account the stages of digression and the degree of change in the properties of the analyzed soil components over a period of time.

The paths were analyzed according to the classification of M.S. Shapochkina (2003): in terms of width, depth of compaction and grass cover. The severity of paths was subdivided into 3 levels: weak, medium and well expressed, in order to

trace the degree of degradation during the formation of the road and path network.

According to the results of the study, it became clear that in the process of increasing transport accessibility, mass development of urban areas, the recreational load increased, as a result of which the hydrological regime changed and the level of complex pollution increased.

An analysis of the data obtained during the studies of the tree layer led to the conclusion that the mechanical impacts caused by humans disrupted the viability of trees, provided the possibility of pests and the development of diseases such as canker, parasitic fungus and other infections.

As a result of trampling, with an increase in the compaction of the upper soil layer, the humidity changed, chemical and biological processes were disturbed. Trampling was one of the factors for reducing the state of the forest stand (exposure of the root system, limiting the development of plant roots), loss of undergrowth (Fig. 1). A shrub layer is formed, presented in the form of single individuals.

Figure 1. *Exposure of the root system*

Since the founding of the Geographical Park, the composition of plantings has undergone changes. Introduced species are gradually being replaced by endemics. An analysis of the results of the research work carried out showed that the weighted average category of the state of the entire forest stand is 2.58, which corresponds to a strong degree of weakening. The worst condition is noted in such tree species - apple, oak, pear, chestnut. Their condition category (CC) ranges from 3.51 to 3.05. The best indicators of the CP are observed in linden, ash and maple, from 1.96 to 1.20.

In the course of the study, it was possible to find out that the laying of transport routes contributes to the degradation of all components of the botanical garden. During the period of construction work, 1.6 thousand trees were cut down along the border of the botanical garden (Figure 2).

Figure 2. *Cutting down trees along the boundaries of the botanical garden.*

A complete analysis of the data obtained allows us to conclude that, along with climatic factors, anthropogenic is quite influential. In this regard, it is proposed to consider the following measures to minimize damage to the natural components of the garden:

– it is necessary to constantly conduct monitoring studies that will allow to control negative changes in the components of plant communities and take timely measures or develop measures to reduce their destructive effect;

– finalize the system of protection and rational use of the park's resources to create favorable conditions for recreation, ensure the safety and use of the natural complex within its ecological capacity.

In conclusion, it can be canceled that the level of recreational influence has a detrimental effect on all components of the ecosystem of the Botanical Garden. It is necessary to continue research in this direction in order to maintain the sustainable state of the entire ecosystem of the park as a whole in an urban environment.

References

1. Akimov, L. M. Spatial and temporal patterns of distribution of climatic characteristics on the territory of the Voronezh region / L. M. Akimov // Bulletin of the Voronezh State University. Series: Geography. Geoecology. – 2013. – No. 1. – P. 192-198.

2. Botanical Garden. prof. B.M. Kozo-Polyansky Voronezh State University / D.I. Shcheglov, L.M. Kartasheva, Z.P. Mukovnina and others – Voronezh: Voronezh Publishing House. state un-ty, – 2003. – 23 p.

3. Voronezh Encyclopedia: In 2 volumes / Ch. ed. M. D. Karpachev. - Voronezh: Center for the Spiritual Revival of the Chernozem Territory, 2008. - V.1: A - M. - 524 p.

4. Ermakov P. V., Iteshina N. M. Scientific innovations in the development of agro-industrial complex: collection. – Izhevsk FSBEI HE Izhevsk State Agricultural Academy, 2020. – 119 p.

5. Zakharova O.A. Botanical gardens and dendrological parks of higher educational institutions: a collection. – Gorki, 2017. – 45 p.

6. Voronezh Land / ed. V. I. Fedotov. - Voronezh: Voronezh state. University, 2006. - 531 p.

7. Cadastral report on PAs natural monument of regional significance «Botanical Garden named after B.M. Kozo-Polyansky Voronezh State University (21.12.2022)

8. Kapitonov D.Yu. On the issue of environmental education / D. Yu. Kapitonov, N.L. Prokhorova // Proceedings of the international scientific-practical conference «Ecological safety of the region», Bryansk, 2012. – P.128-129.

9. Kupriyanov A.N. The role of botanical gardens in the conservation of floristic diversity in industrialized regions: a scientific publication. - Tomsk, September 28–30, 2020. – 121 p.

10. Mironova L.N., Reut A.A. Collections of flower and ornamental plants of the botanical garden as a form of ecological education of the population // Samarskaya Luka: problems of regional and global ecology. 2017. No. 4.

11. Musievsky A.L. Taxation of forest assortments: a reference book / A.L. Musievsky - Ministry of Education and Science of the Russian Federation, FSBEI HPE «VGLTA». – Voronezh, 2011. – 228 p.

12. Pyrkova A. G. The system of Russian legislation on specially protected natural areas and natural objects // Russian Journal of Economics and Law. 2010. No. 2 (14).

13. The strategy of botanical gardens for the protection of plants. - M.: Publishing House of MBG RAS, 1994. – 62 p.

14. Botanical Gardens and Biodiversity. Federal Ageney
for Nature Conservation, 2000. – Bona-Bad Godesberg, 2000. - XVI.

15. Tkachenko K.G. Collections of botanical gardens and green building: a collection. – St. Petersburg, 2017. – 298 p.

16. Tsaralunga, V. V. Forest pathological state of the forest stand of the geographical park of the Botanical Garden. Prof. B.M. Kozo-Polyansky Voronezh State University / V. V. Tsaralunga, N. L. Prokhorova, A. A. Voronin // Forestry journal. – 2017. – V. 7. - No. 1 (25). – P. 33-41.

NOTES

NOTES

Proceedings of International University Scientific Forum

Practice Oriented Science:
UAE – RUSSIA – INDIA

UAE

January 27, 2023

Signed in print 27.01.2023 г. 60x84/16.
Ed. No. 1. Circulation of 500 copies.
UAE, 2023.
Infinity publishing, 2023