SCIENTIFIC RESEARCH OF THE SCO COUNTRIES: SYNERGY AND INTEGRATION

上合组织国家的科学研究：协同和一体化

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NEURAL NETWORKS: INCREASING THE TRUST OF RETAIL CUSTOMERS IN THE ACTIVITIES OF COMMERCIAL BANKS

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摘要。本文讨论了商业银行神经网络活动的关键领域，其活动的目的之一是提高客户对金融服务的信心。作者为俄罗斯银行提出了一项计划，让零售客户能够快速浏览他们的银行产品，并因此信任俄罗斯经济的银行业。该计划适用于那些没有时间监控银行账户的客户；这个角色被委托给神经网络。

关键词：神经网络、24/7　模式、商业银行、移动应用程序、客户、银行产品、财务状况、零售客户、信任、额外收入。

Abstract. *The article discusses the key areas of activity of neural networks in commercial banks, whose activities are aimed, among other things, at increasing customer confidence in financial services. The author proposes a scheme for Russian banks that will allow retail customers to quickly navigate their banking products and, thanks to this, trust the banking sector of the Russian economy. The scheme is intended for those customers who do not have time to monitor their bank accounts; this role is delegated to the neural network.*

Keywords: *neural network, 24/7 mode, commercial bank, mobile application, client, banking products, financial status, retail client, trust, additional income.*

Introduction

According to experts, the use of neural networks by banks allows them to significantly improve their interaction with retail customers and thereby increase their confidence in the bank. Let’s consider several key areas, which are presented in Table 1.

Table 1.

Key areas of activity of neural networks in commercial banks that increase customer confidence in banks.

No.	Name of the area	Neural network activity	Reasons for increasing customer confidence in the bank
1.	Personalized offers	Neural networks can analyze customer behavior, transactions, interests, and needs to create personalized offers for bank products and services. For example, a customer who frequently makes purchases in certain product categories may receive an offer for a favorable loan for these products.	Customers value a personalized approach and believe that the bank cares about their needs.
2.	Prediction of financial needs	By analyzing data on past expenses and income, it is possible to predict the future financial needs of a customer. This allows you to offer services before the customer needs to search for them on their own.	Banks demonstrate an understanding of their customers' life situations and a willingness to offer assistance in advance.
3.	Service automation	Using chatbots and voice assistants based on neural networks helps customers quickly get answers to questions and solve problems without having to talk to an operator.	Fast and high-quality support creates a sense of reliability and professionalism in the bank. [3]
4.	Credit scoring optimization	Neural networks allow you to more accurately assess the creditworthiness of customers using many factors, including behavioral data, social networks, and other sources of information. This reduces the risk of refusals and improves the quality of credit portfolios.[2]	Fairer lending decisions increase customer loyalty.
5.	Fraud control	Machine learning models can identify suspicious transactions and prevent fraudulent activities in real time. For example, if the system notices unusual activity on a customer's account, it can block the transaction and notify the account owner.	Fraud protection is a top priority for customers, and confidence in the safety of their funds strengthens trust in the bank.

6.	Improving the quality of customer service	Neural networks help optimize the work of call centers and other support channels, offering operators the most appropriate scenarios for interacting with the client based on the history of requests and behavior.	Fast and high-quality service leaves a positive impression and increases customer satisfaction.
7.	Training and consulting	Banking neural networks can provide clients with educational materials and advice on financial management based on their individual needs and level of financial literacy.	Educational initiatives show that the bank is interested not only in making a profit, but also in the well-being of its customers.
8.	Forecasting market trends	For investors and those who use banking products to accumulate capital, it is important to have access to analytical tools. Neural networks can predict changes in the securities market, exchange rates and other assets, helping clients make informed investment decisions.	Trust in the bank grows when customers see that it provides them with useful tools for managing their investments.
9.	Transparent data management	One of the important aspects of trust is the transparency of personal data processing. Neural networks can help banks comply with data protection laws, ensuring the security and confidentiality of client information. [1]	Transparent data processing processes strengthen customer confidence that their information is reliably protected.

Main part

So, there is a category of clients of the retail segment of the banking business that does not monitor their accounts and other issued products of the banking ecosystem. For example, the client's insurance against fraudsters has expired, the bank deposit has expired, bonus categories have not been selected for various reasons. At the same time, clients would like their banking products and ecosystem products to be reissued on time and clients to receive additional income without visiting a bank branch with minimal effort. This function could be performed by a neural network that would provide complete information to the client about what is available now and how to earn in the future. Currently, neural networks provide information to the client in the form of SMS and push notifications, but this is not enough, since the client does not have a full understanding of what is happening with his accounts until he contacts the customer support service by phone or visits a bank branch. In our opinion, there is a need to create a banking neural network that would provide a full report to the client 24/7 on what banking products he has open (name), what profit is expected from them (amount) and the expiration

date of the product (date). This information would be provided to the client in the form of a report. Each client would have the opportunity to order such a report online either independently using a PC, mobile phone or tablet, or through a bank employee, as he can order his credit history. The neural network would also offer new banking products to the client, promotional codes that could be applied and receive a monetary benefit.

Figure 1 shows the scheme for providing the client with a report on his financial status with the help of a bank employee, which ensures transparency and increases the client's trust in the bank.

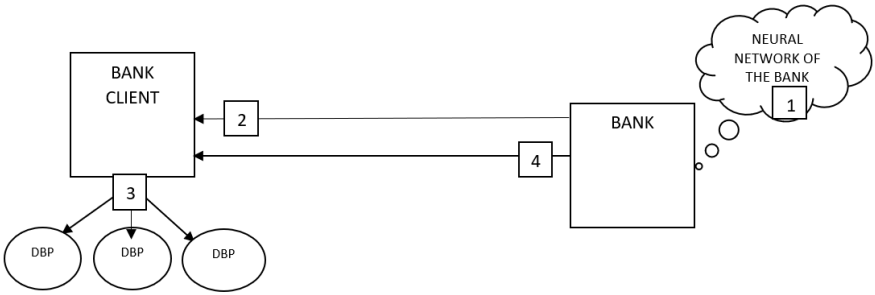

Figure 1. *Schemes for obtaining a report on the client's financial status with the help of a bank employee (at a bank branch)*

Source: Compiled by the author

Let's look at Figure 1 in more detail. For example, a retail client came to the bank to renew his deposit:

1. The bank employee, after or before opening a new deposit for the client, requests, with his consent, a report on the client's financial status from the neural banking network. (The report includes information on all of the client's banking products that are currently available and that can be issued for the purpose of receiving additional income in the future, including the bank's ecosystem).

2. Based on the data from the client's financial status report, which were generated using the neural network, the bank employee shows the client which products can still increase income in the short term and in the long term.

3. If desired, the client issues additional banking products with the help of a bank employee, which were recommended to him, including by the neural network.

4. Next, using a push notification in the mobile application, the client receives general recommendations after visiting the bank office on his mobile phone.

The authors believe that the client's financial status report should include the following key parameters:

1. Credit rating
2. Wallet (how many and what bank cards, their validity periods)
3. Deposits and accounts (quantity, name, amounts, terms, interest)
4. Investments and pensions (types, terms, amounts, profit)
5. Insurance (types, terms, amounts, benefits)
6. Subscriptions (types, terms, amounts, benefits)
7. Credit (balance amount, term)
8. Credit potential, which would include neural network recommendations (what new banking products or services can be issued to increase income in the future).

Thus, Figure 1 shows a diagram of how a client receives a report on his financial status with the help of a bank employee, which ensures transparency and increases the client's trust in the bank through the use of a neural network.

Figure 2 shows a diagram in which a client can independently receive a report on his financial status through a remote banking service channel using a neural network.

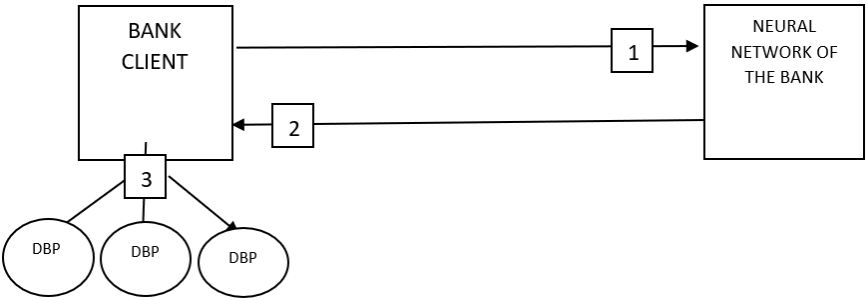

Figure 2. *Schemes for the independent receipt by the client of a report on his financial status, for example, in the bank's mobile application*

Source: Compiled by the author

Let's look at Figure 2 in more detail:

1. In his mobile application of the bank or in the personal account of the WEB version (on the website) of the bank, the client made a request for a report on all his banking products.

2. Based on the report on the client's financial status, the neural network provides the client with information about the banking products that he has and suggests to the client which products can still increase his income both in the short term and in the long term.

3. If desired, the client issues additional banking products that the neural network recommended to him with benefit and receives additional income in the future.

Client benefits: convenience, saving time and money (it is cheaper to renew an existing product than to issue a new one), transparency.

Bank benefits: increasing customer confidence in banks; obtaining additional income from the registration of new banking products, automatic renewal of existing banking products based on neural network recommendations.

Conclusion

1. The use of banking neural networks allows banks to get closer to their customers by providing personalized service, fraud protection and improved credit terms.
2. As a result, customers feel more secure and confident in their choice of financial partner, which leads to increased loyalty and trust.
3. The author has developed a scheme that will allow retail customers of the bank to better navigate their banking products and increase their trust in the retail segment of the banking business through the use of a neural network.

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俄罗斯疗养休闲发展趋势
TRENDS IN THE DEVELOPMENT OF HEALTH RESORT RECREATION IN RUSSIA1[1]

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注释。本文分析了俄罗斯联邦的温泉疗养，确定了主要趋势以及该行业目前面临的问题。本文研究了温泉组织的关键绩效指标——客房入住率、平均度假时间、所提供服务的成本等。它研究了各种类型的健康旅游，确定了俄罗斯人对这种度假方式的偏好和要求。已经确定并研究了健康旅游的新领域。

关键词：旅游、疗养胜地休闲、健康旅游、疗养院。

Annotation. *The article analyzes spa treatment in the Russian Federation, identifies key trends, as well as problems currently facing the industry. The article examines key performance indicators of spa organizations – room occupancy rates, average vacation duration, cost of services provided, and others. It examines various types of health tourism, identifies preferences and requirements of Russians for this type of vacation. New areas of health tourism have been identified and studied.*

Keywords: *tourism, health resort recreation, health tourism, sanatoriums.*

Health tourism facilities in Russia are divided into several categories - from sanatoriums to spa hotels. Most of them provide medical services according to the standards of spa treatment and receive a license from the Ministry of Health of the Russian Federation, but each has its own characteristics [1].

Vacations in sanatoriums and hotels offering health programs are becoming increasingly popular in Russia. This is explained by the fashion for a healthy lifestyle, as well as qualitative changes in the programs themselves.

[1] The article was prepared within the framework of the state assignment of the Institute of Social Sciences of the State Scientific Research Institute of the Academy of Sciences of the Republic of Belarus

It is no secret that the tourism market is undergoing global transformations, especially in the health resort sector. This area shapes the health of the nation, the entire population of Russia. This postulate runs like a red thread through the Strategy for the Development of the Health Resort Complex of the Russian Federation, which assumes important measures for the development of the health resort complex of the country. In addition, new rules have been approved for maintaining the state register of the resort fund of Russia, which, among other things, imposes the obligation to expand information on the therapeutic factors of the facilities. More and more measures are being taken to strengthen the health of the population and develop the health resort complex. This also applies to Crimea, which once bore the loud name of "all-Union health resort" [2].

The All-Russian Classifier of Economic Activities (ACEA) identifies three key positions related to the area under consideration: 86.90.4 "Activities of health resort institutions", 79 "Activities of travel agencies in the tourism sector", 55.10 "Activities of hotels and other places for temporary accommodation". All of them imply booking of health and wellness programs by tourists.

Today, the health resort business occupies a borderline position between healthcare and tourism: it involves both medical spa specialists who comply with all the rules for providing medical services, and tourism specialists whose activities are regulated by standards developed for the tourism sector [1]. Both industries - medicine and tourism - are undergoing digitalization: new software products, information systems, work formats, etc. are emerging. However, it is important for representatives of both areas to know the differences between health resort activities and health tourism. This is necessary to understand the quality standard of services, generate correct information for their customers, set up legislative industry aspects, etc. In their work, hoteliers should take into account that the tourism market is constantly changing: new players, new connections, new formats of cooperation appear in the industry.

Nowadays, tourists go on holiday not only to lie on the beach. Now they have higher demands on their leisure time. Moreover, many travelers are interested in health improvement. Russia Discovery notes that 73% of tourists consider physical and mental well-being not a luxury, but a necessity, so they actively "invest" in their health, taking advantage of the opportunities offered by the health resort industry. At the same time, 53% of travelers prefer accommodation facilities that implement sustainable innovations. Fewer and fewer people are willing to compromise on aesthetics and amenities. Thus, tourists aged 25-35 are ready to spend an additional 15 thousand rubles per day on the latter, over 35 years old - up to 10 thousand. Most often, they choose health resorts with a category of at least 4 *.

Many hotels are expanding their range of "near-medical" services in search of their clients. "Mental wellness", art therapy, retreats, etc. are popular now. More

and more health resorts practice healthy lifestyle training. The service options of hotels are also gradually expanding: bicycle rental for active leisure, outdoor entertainment complexes for children, nutritionist consultations, etc. There is a clear reorientation towards wellness. According to the National Tour Operator ALEAN, the demand for sanatoriums exceeds supply by 40-50%. Responding to this trend, the company announced the opening of its first own sanatorium, built from scratch, in 2026-28.

According to the Association of Health Tourism and Corporate Health, the physical volume of the health resort industry (number of overnight stays) increased by 4% - from 75 million in 2022 to 78.1 million in 2023 [3].

The composition of players in the health resort services market has changed.

This includes both classic sanatoriums aimed at specialized treatment and/or rehabilitation, and hotels with a medical license and a minimum range of services. In the Strategy for the Development of the Sanatorium and Resort Complex of the Russian Federation, the concept of "sanatorium and resort complex" includes both organizations providing services for sanatorium and resort treatment and related accommodation facilities. The market is moving away from the understanding of the old format of a sanatorium - without repair, with queues, poor service and a standard menu. Demand has initiated the emergence of a new segment of players, conditionally occupying an intermediate position between a hotel and a classic sanatorium. Such facilities offer an expanded range of services. Indicative in this sense are the words of Oganes Khanamiryan, Director of Sales and Marketing for the Amaks chain: "We simply added European service to the unique system of Soviet sanatorium" [3].

According to the Association of Health Tourism and Corporate Health, a 15% increase in the income of the health resort industry of the Russian Federation in 2023, compared to 2022, allowed the industry to earn 34.6 billion rubles in profit. Its growth of 66% compared to 2022 is a record period since 2015. At the same time, an increase in the costs of the health resort industry of the Russian Federation in 2023, compared to the previous one, by +9% is noted, which can be explained, according to surveys of industry participants, by the direction of operating cash flow to the reconstruction / modernization / repair of infrastructure (room stock, healing springs, terrain cures, etc.), as well as the purchase of more expensive medical equipment. In 2023, the number of guests of health resort organizations exceeded 7 million people, and the operating profitability of the industry reached 15%.

All this speaks of the high investment potential of the tourism industry. The industry's economy has demonstrated higher growth rates than the country's economy as a whole, as well as an increase in income for three years in a row. For the sake of health resort services, tourists come to rest for a longer period, and their

trips are becoming more expensive. All this affects the profitability of the business as opposed to beach holidays, business tourism, and leisure trips.

This area is money-intensive: occupying 1% of the global turnover of man-days, it provides 5% of income. According to the Unified Interdepartmental Information and Statistical System, for the first quarter of 2023, the income of health resort organizations amounted to almost 50% of the revenue of collective accommodation facilities. Experts from the portal sanatorii-rossii.rf add that for the third quarter of 2023, sanatoriums in the Southern Federal District earned 15% more than hotels.

Let us present the results of the analysis of the development of the health resort services market.

More than 1,000 people aged 25 to 65 took part in the all-Russian survey, of which 54% were women and 46% were men.

According to the report, the Russian market of health resort services has almost recovered from the impact of the pandemic, but does not yet demonstrate high development dynamics. The supply of quality services is still quite limited.

According to Rosstat, in 2022, the number of people accommodated in health resort organizations increased by 12% compared to 2021. If we talk about the volume of offers (room stock) of health resort organizations, then in recent years it has remained practically unchanged.

There has also been no significant investment in the development of the health resort industry in recent years; only a few projects in the area of new construction or reconstruction of facilities have been implemented.

The growth in revenue and profit of health resort organizations is mainly due to an increase in the average bill; the occupancy rate of health resorts has not yet recovered to the 2019 level (on average in 2019 it was about 50%).

The average daily bill for a vacationer at a sanatorium has increased by 34% since 2019 (up to 2.6 thousand rubles in 2022). In 2022, the average occupancy rate of health resort organizations in the Russian Federation is 8–9% lower than in 2015–2019. At the same time, some popular facilities are occupied almost all year round, their occupancy rate reaches 75–80% on average per year.

Despite the actual recovery in 2022 of the tourist flow to health resort organizations to the level of 2019, the number of overnight stays is still lower than in the pre-pandemic period, which is due to a stable trend in recent years - a reduction in the average length of stay on vacation. Despite this, taking into account the projected growth rate of domestic tourism, already in 2023 the average occupancy rate of Russian health resort facilities may reach ~50%.

At the same time, the best properties are already occupied significantly above average, their average annual occupancy exceeds 70-75%, and in the summer season it reaches 95-100%. Therefore, as the quality of supply improves (new modern

properties appear), we can expect further growth in the average occupancy on the Russian market.

The key centers of health resort services in the Russian Federation are traditionally Krasnodar Krai (25% of income from health resort organizations), Stavropol Krai (15%) and the Republic of Crimea (13%).

At the present moment, several factors can be identified – both favorable and restraining – in the development of the health and wellness tourism market.

Among the favorable factors: recovery of demand after the pandemic, stable growth of the average bill, relatively weak seasonality of demand, high occupancy of individual popular health resort facilities (70–80% on average per year), rich resource base (thermal springs, mud, etc.), limited opportunities for travel to foreign resorts (geopolitics, exchange rate, etc.) and active state support for investment in the development of tourism infrastructure.

Among the restraining factors, the authors of the report note the following: the formed perception among people aged 25–45 of the sanatorium as a "Soviet legacy" with an appropriate level of infrastructure and service, a high share of non-commercial demand (trade union vouchers), creating the risk of a drop in occupancy in the event of a reduction in these expenses, and, in general, high wear and tear of the infrastructure of sanatorium and resort organizations, negatively affecting the experience of tourists.

The services of health resort organizations may be of interest not only to people over 55 years of age. A sociological survey conducted with the participation of residents of Russian regions showed that the opportunity to relax with medical and (or) health programs is ready to be considered by the dominant number of respondents of different ages [3].

From the point of view of medical and health procedures, the young audience (25-35 years old) is primarily interested in: anti-stress programs, cosmetology, weight loss/detox programs and treatment of gastrointestinal diseases.

An older audience (35 and older) is interested in anti-stress programs, weight loss, prevention and treatment of diseases of the musculoskeletal system and cardiovascular system.

The availability of additional entertainment is one of the top 5 most significant factors when choosing a resort for recreation for all age groups, which requires facilities to have a well-thought-out infrastructure concept and event program.

According to Yandex Travel estimates, demand for sanatorium tours from October to December 2024 increased by 20% compared to last year. In total, 7 million people vacationed in sanatoriums in 2023, and another 600 thousand tourists in hotels with spa treatment services.

That is, 7.6 million people per year - this is the official statistics. If in overnight stays, then this is almost 70 million overnight stays - 11% of the total number of nights in all collective accommodation facilities in Russia. Our statistics only take

into account those who spend the night, and there are also those who do not stay overnight.

At the same time, the average length of stay in sanatoriums, according to 2023 data, is 11 days. This is significantly more than in general for collective accommodation facilities in Russia.

According to forecasts, growth will continue, while health resort organizations will have to adapt to new audience demands, including renovating the hotel rooms and developing new comprehensive recreation and treatment programs.

Health tourism facilities in Russia are divided into several categories - from sanatoriums to spa hotels. Most of them provide medical services according to the standards of spa treatment and receive a license from the Ministry of Health of the Russian Federation, but each has its own characteristics [4].

The sanatorium provides guests with accommodation (hotel rooms), full board meals and treatment. During the course, natural healing factors (mineral waters, mud) and other methods of physiotherapy are used.

A health resort (sanatorium-health resort) is very similar to a sanatorium in terms of the scope of services, but may not use natural healing factors, limiting itself to other methods of physiotherapy.

Boarding houses with treatment (hotel-sanatorium) also offer treatment, but not to all guests - here only some of the vouchers are sold with mandatory treatment and health programs.

The preventive medicine clinic (medical spa) offers preventive medicine programs and a high level of service along with accommodation.

Currently, there are only about two dozen medical spas in Russia, and all of them operate in the luxury segment. The wellness programs focus on preventive medicine, nutritional support, and special diets. Due to this approach, prices are higher than the market average."

Spa hotels also provide wellness services, but the procedures are not included in the cost of accommodation, but are offered to be purchased separately. There are many such hotels on the market now.

Wellness hotels are a relatively new phenomenon on the market. Guests are offered anti-stress or relaxation programs along with their stay, aimed not so much at treating any illnesses as at maintaining mental health. That is, there may not be physiotherapy, but there will be meditation, yoga, and a course of psychological relief.

Sports hotels are a rare category of facilities aimed at professional athletes. In addition to health, often rehabilitation programs, they have their own large sports and physical education complex.

There are currently 278 resorts and health resorts in Russia, where 1,742 health resort organizations operate. According to statistics, half of them are fully booked for several months ahead.

Tour operators' data for the last two years show a stable deficit of places in sanatoriums in leading resort destinations - it reaches 50%. That is, half of those wishing to cannot buy a ticket to the country's sanatoriums. The depth of booking in the southern regions reaches 9 months.

We are talking about a shortage of places in quality accommodation facilities, because the overall occupancy rate in the industry, if you look at Rosstat, is 47%. The numbers do not add up. This means that facilities with new equipment, good repairs in the rooms and a high level of service are in demand, and in old sanatoriums, not everything is so rosy.

It is important to take into account that we have many departmental, trade union and social sanatoriums, which you cannot just get into. There are also about 500 children's sanatoriums, which are practically not present on the market, and places in them are allocated at the expense of the budget.

More than 98% of the existing sanatoriums were built before the 1990s, and in the following two decades, practically no new health resorts were built in Russia. Only in the last 10 years, at best, one new facility was opened per year. Now the situation is changing, and in the near future about two dozen new sanatoriums may enter the market, most of which are concentrated in Crimea, Krasnodar Krai and Kavminvody.

According to the expert, market growth is limited by high costs of opening new facilities and current economic difficulties. At the same time, government support has become an incentive for the development of the industry - for example, preferential lending under national projects.

In 2024, several new sanatoriums opened for the first time in Russia, including the Don sanatorium (Voronezh), Istochnik (Kislovodsk), and Erino (New Moscow). At the same time, about 20 investment projects have begun to be implemented in different regions of the country: construction has begun in some places, while projects are still being developed in others. Examples include the reconstruction of the Volna sanatorium (Khosta), the construction of Altai Restart (Altai Krai), and the Ptitsa health and recreation complex (Saki).

Most often, the renovation of sanatoriums becomes possible at the expense of the owner or reinvestment of income. Investors enter the sanatorium and resort industry less willingly than the hotel industry, because this business format is much more complex and requires a wider range of competencies (medicine, long-term accommodation service, organization of leisure, maintenance of large areas), including more personnel with special education and high qualifications.

The situation is further complicated by the personnel shortage that the entire tourism industry is facing. At the same time, sanatoriums are short of not only service personnel, maids and cooks, but also medical specialists.

The average length of vacation for Russians is one to two weeks, so sanatoriums are beginning to look for ways to provide effective treatment in a shorter time.

We are talking about high-quality re-equipment, because most Russians simply cannot afford to vacation for 3-4 weeks, and for these average 11 days of vacation in a sanatorium, people want to get the most. That is why health tourism organizations will improve the quality of the room stock, service, purchase new equipment, and also look for new medical technologies, more comprehensive and effective treatment protocols for short periods.

Along with the reduction of the duration of health programs, new products have begun to appear on the market that provide not only treatment and recovery from serious illnesses, but also quality rest without a doctor's referral.

The core of the industry remains the sanatorium and resort treatment of various types of diseases, but new products and solutions for vacationers are beginning to form on its platform. We expect that the story of mental health support and anti-stress programs will actively develop.

In addition, there is a trend towards personalized and preventive medicine, including due to the national project for the development of modern health-preserving technologies, which is currently being developed.

This approach includes more in-depth types of diagnostics, both hardware and laboratory, nutritional and drug correction of metabolic disorders, an individual approach to each patient, and healing at the cellular level. These technologies will develop, gradually enter the mass market and, accordingly, take their share of the health tourism market.

Since the start of the pandemic, when Russian tourists began to show more interest in domestic destinations, water or mud vacations have become fashionable. Such vacations are more often chosen by young people who pay attention to a healthy lifestyle.

There are more young people, families and at the same time elderly people. We see these trends in different directions and objects. And, of course, the growth in the number of young vacationers is very noticeable. If it was previously believed that a health resort vacation was for pensioners and about the treatment of serious or chronic diseases, now this stereotype is crumbling. Now we have young and middle-aged people on vacation who led a healthy lifestyle and understand that this helps them work and achieve their own goals more effectively.

It is family programs, including entertainment and health components for children, and relaxation products, that will be in the greatest demand because they are suitable for the widest possible audience.

The average cost of a trip to a 3* sanatorium for 11 days starts from 70 thousand rubles per person without a flight or from 96 thousand with a flight. This is comparable to the price of a tour to some foreign resorts.

The price, of course, depends on the level of service and the number of rooms. Now you can find an offer for any taste and budget, but the cheaper, the more likely you are to stay in an old hotel. At the same time, I cannot say that staying in a good hotel will be cheaper. And this is a paradox.

The fact is that a full-fledged health resort vacation includes treatment and three or four meals a day, so according to the cost structure it should be a priori more expensive.

Due to the high cost of services in health tourism, one should not expect a reduction in prices: the higher the level of service, the more expensive the trip will be. At the same time, health tourism is a tool for increasing life expectancy, and perhaps in the future it will become somewhat more accessible due to subsidies or government support.

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犯罪的产前因素
PRENATAL FACTORS OF DELINQUENCY

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摘要。作者分析了母亲的产前危险因素与其后代犯罪行为表现之间的关系。特别是，研究了怀孕期间对胎儿的毒性作用的犯罪后果。吸烟、母亲吸毒和酗酒以及职业危害可能是未成年人犯罪的其他产前危险因素。对胎儿的毒性作用被认为是青少年犯罪的预测因素。所获得的结果将使我们能够制定新的犯罪预防方向，定位于医疗保健领域，旨在改善母亲怀孕期间的健康状况。

关键词：犯罪、产前中毒、未成年人、预测因素、犯罪行为、怀孕。

Abstract. *The authors analyze the relationships between prenatal risk factors in the mother and subsequent manifestations of delinquent behavior in her offspring. In particular, the criminogenic consequences of toxic effects on the fetus during pregnancy are studied. Smoking, maternal drug and alcohol use, and occupational hazards may represent additional prenatal risk factors in terms of subsequent crimes committed by minors. Toxic effects on the fetus are considered as a predictor of crime among adolescents. The obtained results will allow us to formulate a new direction in crime prevention, localized in the field of health care and aimed at improving the health of mothers during pregnancy.*

Keywords: *crime, prenatal intoxication, minor, predictor, delinquent behavior, pregnancy.*

Criminology has not yet provided a comprehensive answer to the question of the causes of crime, so scientists continue to study the sociological and biological factors of delinquent behavior. In particular, the focus is on the study of criminogenic biological features of human development at early stages, the impact of harmful factors and the degree of their influence on behavior are analyzed. It is assumed that the results obtained will allow us to form a new direction in crime prevention in the field of public health and aimed at improving the health of mothers during pregnancy. These activities will make it possible to develop a more effective policy for the prevention of crime in society.

As part of this study, data were analyzed on complications of pregnancy and childbirth, the use of psychoactive substances and the impact of industrial hazards during pregnancy. A relationship was found between the amount of maternal toxic effects on the fetus and the frequency of bringing minors to justice for committing non-violent and violent crimes. Regular and massive use of psychoactive substances by mothers is consistently correlated with persistent criminal behavior of their minor children. The results of the conducted studies demonstrate the existence of a connection between prenatal intoxication of the mother and antisocial behavior of her children in adolescence [1, pp. 613-618]. Thus, a greater number of pregnancy complications were found among children with delinquent behavior than among control subjects. At the same time, the researchers noted a positive correlation between prenatal intoxication of the mother and the number of repeated offenses among juvenile offenders. The pronounced role of prenatal factors in the development of aggression in minors is also confirmed by the presence of minor physical anomalies that indicate the presence of prenatal intoxication. Physical anomalies correlate with aggression, hyperactivity, impulsivity and criminal violence [2, pp. 419-423; 3, pp. 563-565]. Toxic risk factors of the prenatal period associated with manifestations of delinquent behavior in minors are numerous and varied. One such risk factor is maternal smoking during pregnancy. Maternal smoking during the prenatal period causes the following behavioral characteristics in the child: impulsivity, absenteeism, attention deficit disorder, and difficulty concentrating. Links with criminal behavior have also been noted [4, pp. 215-219].

The association between maternal smoking during the prenatal period and delinquent behavior in her offspring is observed taking into account potential covariates. Maternal nicotine intoxication was found to predict behavior problems, independent of the child's race, age, and gender. Other studies have found that maternal smoking also predicted behavior problems in children after controlling for parental psychopathological factors, nontoxic pregnancy risks, and parenting practices. Studies have found that toxic effects on the mother's body during pregnancy cause a number of adverse medical outcomes. Researchers have found chronic ischemia, fetal hypoxia, hypertonicity, increased tremor, and hyperreaction of fear

in infants. This suggests a link between toxic effects on the mother's body and the development of central nervous system deficits in the child [5, pp. 318-326]. These CNS deficiencies may be the basis for the formation of a pathopsychological complex and a mediating factor in delinquent behavior in the offspring.

Maternal intoxication during pregnancy poses a biological risk for the development of increased aggressiveness, which is a predictor of certain patterns of crime. If we agree with the theory of antisocial behavior of T.E. Moffitt, repeated offenses throughout life, in contrast to isolated offenses, have a biological basis [6, pp. 69-96].

The research results provide strong grounds for asserting that prenatal toxic factors are associated with aggressive and criminal manifestations in adolescence. In addition, it was found that the influence of prenatal chronic stress on criminal outcomes was more clearly traced in children exposed to a conflictual family environment. Analysis of the data obtained by A. Raine, P. Brennan, & S.A. Mednick showed similar biosocial interactions that allow us to predict the manifestations of aggressive and habitual criminal behavior [7, pp. 984-988]. This study expanded the criminological horizon by examining the relationship between maternal toxic exposure and abnormalities in children and adults up to the age of 34 years. Consequently, it became possible to differentiate the outcomes in the context of juvenile delinquency and habitual criminal offenses throughout life. The relevant prenatal risk factors were recorded in sufficient detail by medical personnel - obstetricians-gynecologists and pediatric neurologists in the medical records of newborns. An impressive data set made it possible to exclude background interference and to evaluate the potential interaction of maternal intoxication and other risk factors in predicting the commission of crimes. As background interference, genetic influences and neurobiological bases of criminogenicity were excluded first of all [8, pp. 24-40]. Physicians recorded complications of pregnancy and childbirth, which included such pathologies as bleeding, preeclampsia, breech presentation, transverse position, forceps extraction of the fetus, prolapse of the umbilical cord [9, p. 3-16]

The results of a number of studies confirm the hypothesis that maternal intoxication during pregnancy determines an increase in the level of crime in adolescents. This conclusion correlates with information on the links between behavioral problems, especially its delinquent characteristics, as well as adolescent crime, and prenatal maternal nicotine intoxication [10, pp. 342-349]. Further studies have expanded on these findings, demonstrating that not only maternal smoking is associated with habitual juvenile delinquency.

Information on complications during childbirth and maternal intoxication can be used to predict juvenile criminal violence, as reflected in the studies of A. Raine, P. Brennan, & S.A. Mednick (1994), as well as E. Kandel & S.A. Med-

nick (1991), who note the indirect effect of complications during childbirth on the frequency of violent crime [7, pp. 984-988; 11, pp. 519-529]. The authors state that the combination of several risk factors makes the indicated correlation more pronounced, and the vulnerability of the fetus inevitable.

Potential social risk factors, such as low social status and parental psychopathological factors, do not interact with maternal prenatal intoxication and have virtually no effect on the prognosis of criminal consequences. However, biosocial interactions can be very specific. Such a combination is very difficult to predict criminal consequences today. It should also be taken into account that perinatal intoxication processes are a purely individual phenomenon that is caused by the physiological characteristics of the mother's body during pregnancy, the amount and type of substance, the intervention of which affects the fetus, forming the prerequisites for delinquency.

Prenatal intoxication of the mother in the third trimester provided grounds for predicting an increase in the commission of both violent and non-violent crimes by minors. Complications of pregnancy and childbirth, the mother's use of prescription drugs during pregnancy, the age of the mother and other "background" effects were taken into account.

However, not all effects could be assessed or detected. Thus, the mother's psychological history outside the hospital, reliable use of alcohol or drugs, and the presence of occupational hazards during the early stages of pregnancy could not be verified. However, perinatal intoxication of the mother clearly correlated with the child's problematic behavior [12, pp. 670-676].

A reliable link between prenatal intoxication of mothers and the commission of violent crimes by their children in adolescence was confirmed by subsequent criminological studies. Toxic damage to the central nervous system of the fetus demonstrates a link between the resulting pathology and the fact of committing a crime in juvenile age. Unfortunately, the research data did not include information on specific doses of intoxication in a particular trimester of pregnancy or intoxication of the mother after the birth of the child. It is advisable to focus attention, first of all, on determining and studying the specific effects of intoxication on the brain of the fetus and identifying the degree of their criminogenicity. Thus, prenatal toxic effects on the mother's body are reliable predictors of stable and consistent criminal behavior in the offspring. Individual features of the prenatal intoxication process can be superimposed and combined with manifestations of the physiological prenatal process and form the basis for deviations of varying levels of manifestation. Criminogenic consequences are more clearly manifested in males. The mechanism of action, the features of its intermediate stages, changes in the central nervous system of the fetus, arising as a result of toxic effects on the

mother's body during pregnancy, and criminal offenses of the offspring require further detailed study.

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从组织本科生、研究生、青年科研人员科研实践会议的经验看“青年与科学：走向知识的巅峰”

FROM THE EXPERIENCE OF ORGANIZING RESEARCH-TO-PRACTICE CONFERENCE FOR UNDERGRADUATE & GRADUATE STUDENTS, YOUNG RESEARCHERS “YOUTH AND SCIENCE: TO THE HEIGHTS OF KNOWLEDGE”

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注释。本研究的相关性归因于评估教育质量的现代问题。本文致力于在维特斯白令堪察加国立大学组织和举办第一届学生、研究生和青年科学家地区科学实践会议“青年与科学：走向知识的顶峰”的特点。本次活动的目标和目的是：普及学生的智力和创造性活动；吸引公众关注保护和发展社会智力潜力的问题；吸引有才华的年轻人参与研究活动，并通过创建一个多学科平台来支持年轻科学家的研究计划，以便舒适地交流、交流经验、展示自己的研究成果并接受合格专家的专家评估。

会议以多种形式的互动而著称（圆桌会议、分会、问题讨论、大师班、创意实验室、竞赛、演讲、教育课程），允许组织学生、研究生和青年科学家之间的交流，交换信息，并促进增加富有成效的联合活动。

关键词：科普、青年科学家、教育质量、国家教育政策、科学实践会议。

Annotation. *The relevance of the study is due to modern problems of assessing the quality of education. The article is devoted to the features of organizing and holding the 1st regional scientific and practical conference of students, postgraduates and young scientists “Youth and Science: to the Heights of Knowledge” at the Vitus Bering Kamchatka State University. The goals and objectives of this event are: popularization of intellectual and creative activities of students; attracting public attention to the problems of preserving and developing the intellectual potential of society; attracting talented youth to research activities and supporting research initiatives of young scientists by creating a multidisciplinary platform for comfortable communication, exchange of experience, presentation of the results of their own research and receiving expert assessment from qualified specialists.*

The conference was distinguished by a variety of forms of interaction (round tables, sections, problematic discussions, master classes, creative laboratories, competitions, presentations, educational courses), allowing for the organization of communication between students, postgraduates and young scientists, the exchange of information, and contributing to the increase of productive joint activities.

Keywords: *popularization of science, young scientists, quality of education; state educational policy; scientific and practical conference.*

Modern strategies for the socio-economic development of the Russian Federation are based on the activation of those areas of state policy that contribute to the maximum involvement of young people in science.

The need to improve the university education system and attract young people to research activities already at the early stages of obtaining higher education is dictated by the development of the information society. Today, initiative, competitiveness, scientific literacy, creativity, critical thinking and a high level of professionalism in all areas of activity are in demand. The active growth of socio-economic transformations and scientific and technological progress determine the need to change the value guidelines in the higher education system, which today should be aimed at the comprehensive development of a student who not only knows a certain block of information and is able to apply it in appropriate situations, but is also able to competently assess the rapidly changing conditions of the surrounding reality and make adequate decisions in these conditions.

Popularization of science is the process of disseminating scientific knowledge and ideas to a wider audience. It helps society better understand the world around us, stimulates the development of science and technology, and increases the prestige of scientific activity. Popularization of science among students is aimed at increasing the interest of young people in research activities and involving them in scientific projects. This is achieved through the organization of special events, such as science festivals and virtual exhibitions, which contribute to the formation of research competencies and skills.

The most important part of training students and postgraduates is the process of developing research skills, which include a whole range of skills - the ability to “see” a problem; search for literary data, setting goals and objectives aimed at its implementation; analysis of the results obtained; formulation of conclusions. The result of the work, as a rule, is a speech to an audience or a scientific article.

In 2023, the first scientific and educational school for young scientists was held at the Vitus Bering Kamchatka State University (hereinafter referred to as Vitus Bering Kamchatka State University, the University), the purpose of which was to form and develop students’ skills in organizing and conducting collective and

individual multidisciplinary scientific research and applied developments, as well as commercializing the results of intellectual activity.

The student scientific community and the Council of young scientists of Vitus Bering KamSU could not ignore this event. The context of such a dialogue, as well as the need for scientific communication, the ability to actively use modern educational technologies, determined the decision to hold the 1st regional scientific and practical conference "Youth and Science: to the Heights of Knowledge", which took place on April 15-19, 2024 at Vitus Bering KamSU as part of the annual Student Science Week. The co-organizer of the conference was the center for intercultural communications and ethnolinguistic studies of the university.

For the progress of the country, for the development of science and production, it is necessary to develop students' ability to think creatively, to develop scientific thinking. The research nature of reports allows for the development of students' scientific thinking and their worldview. Students' participation in conferences also develops a habit of work and the obligation to carry out what is planned.

The aim of the conference was to popularize the intellectual and creative activities of students and to attract public attention to the problems of preserving and developing the intellectual potential of society.

Students usually willingly speak at conferences, as they have the opportunity to meet like-minded people on certain issues, friends with similar interests. As a rule, these are highly motivated people. Participation in scientific conferences does not pass without leaving a trace for any speaker. These events bring the following benefits: they broaden the participant's horizons by familiarizing themselves with current problems, instill independence: students must carry out an experiment themselves, if the topic of the work requires it, record the results obtained, find sources of literature.

The conference was attended by students, postgraduates and young scientists educational institutions of the Kamchatka Territory. The participants' reports and speeches covered the most pressing issues of popularizing scientific research activities. Great interest was shown in the system of measures to support young scientists in the Russian Federation.

The conference was distinguished by a variety of forms of interaction (round tables, sections, problematic discussions, master classes, creative laboratories, competitions, presentations, educational courses), allowing for the organization of communication between students, postgraduates and young scientists, the exchange of information, and contributing to the increase of productive joint activities.

Over the course of the week, the program of events included meetings of 12 sections, during which students from all faculties of the university discussed almost 100 classroom and poster presentations (Appendix 1).

At sectional meetings, students, postgraduates and young researchers discussed the most pressing problems and prospects for the development of science in Kamchatka Krai. As part of the sectional meetings, a competition was held for the best reports presented by conference participants.

During the conference, an educational course on "Fundamentals of Project Activities" was organized for all interested parties (Appendix 2).

The round table "On Science Without Boredom" that opened the conference was devoted to the problem of attracting young people to scientific research activities and popularizing science in the Kamchatka Territory.

As a result of the active discussion of the presented materials by the round table participants, the following factors were identified that hinder the involvement of young people in science: insufficient attention to the issues of informing young people about opportunities in the scientific field; low level of real awareness of young people about activities in the scientific field; insufficient activity of the business community in the implementation of scientific achievements in practice; insufficient consideration of the position of researchers by government bodies.

The section "Current Issues of Modern Pedagogy: Results of Experimental and Theoretical Research" was devoted to studying the complex problems that teachers and educational institutions face in the modern world. The reports presented at the section discussed issues of digitalization of education, technological support, differentiation of education, social and emotional aspects of education, as well as the role of school in the formation of personality.

The papers presented at the section "Ig Nobel Prize: Funny Scientific Works That Will Make Us Laugh and Think" were devoted to the achievements recognized by the Ig Nobel Prize (a humorous award given by the scientific and humorous magazine AIR, with the aim of making people think about serious science) and considered examples of funny and absurd scientific discoveries.

The section "Young Researcher: Challenges and Prospects" was organized with the aim of exchanging the results of students' research activities in studying current pedagogical problems, such as: digitalization of education, the use of modern technologies to improve learning; adaptation of learning to the individual needs of each student; the introduction of an individual approach in teaching children; attention to the psychological and emotional state of students; the role of the school in the formation of values, skills and worldview of students; involvement of parents and the public in the educational process.

The section "Scientific Prophets: How Scientists Predict Future Events" is devoted to the discussion of methods and approaches used by scientists to predict future events. The participants of the section considered examples of successful and unsuccessful predictions made by various scientific figures, and also discussed the role of science in shaping public opinion and decision-making.

As part of the organization of the work of the sections, a competition for the presentation of scientific research results in the form of scientific reports was held. The main goal of the competition was to stimulate scientific progress, exchange of experience and ideas between young scientists, and to identify the most promising areas of research. Original scientific research papers completed individually or in collaboration with other students were evaluated.

Throughout the conference, an educational course "Fundamentals of Project Activity" was held, aimed at studying the fundamentals of project activity and forming a system of knowledge in this area. The goal of the course is to teach how to develop projects, create project teams and successfully manage projects. The training covered the competencies of a project manager, the importance of taking into account the human factor, sociological methods, conflict management, company registration and protection of intellectual property.

As part of the course, a master class "10 techniques for creating cool presentations" was held, the purpose of which was to help in creating effective and attractive presentations.

In addition to the above events, a presentation of collective creative activities (hereinafter referred to as CCA) was held as part of the implementation of practical training in secondary comprehensive schools. First-year students of the Faculty of Psychology and Pedagogy developed collective creative activities of various types in groups, in the following areas of activity: cognitive, labor, artistic, sports, environmental, and leisure activities.

Collective creative activities are an integral part of the training of future teachers, allowing students to realize and develop their abilities, expand their knowledge of the world around them, acquire design skills, demonstrate organizational skills, consolidate communication skills, and develop abilities for reflection (analysis). The practical lesson ended with a presentation of the developed creative activities by each group.

The intellectual quiz "Man of Science" is a team intellectual tournament on school subjects. It involves teams of 3-6 schoolchildren or students of secondary specialized educational institutions aged 12 to 17 years. The tournament consists of five rounds and is held with the aim of popularizing intellectual games and forming a positive perception of scientific fields.

According to the participants, the conference was interesting, informative, and held at a high organizational level.

The practical significance of the conference for students, postgraduates and young scientists was as follows:

1. Developing a research career through participation in scientific events.

2. Gaining experience, becoming familiar with current topics and trends in scientific fields, learning how to present research at a professional level.

3. Exchange ideas and receive feedback from other students, postgraduates and scientists.

4. Improving presentation skills, the ability to speak in front of an audience and to argue your research.

5. The opportunity to publish research results and increase your visibility in the scientific community.

6. Networking with professionals in your field, which opens doors to mentoring, internships, and future career opportunities.

In accordance with the decision of the organizing committee and the wishes of the conference participants, it was decided to hold the conference annually in a mixed format with mandatory publication of a collection of participants' works, which will include publications by students, postgraduates and young scientists. For this purpose, a seminar "Structure of a scientific article" was held for all interested parties, dedicated to the classical structure of a scientific article for presenting empirical research.

The main achievement of the conference was the emergence of fruitful contacts between students from different faculties and cooperation in joint research projects.

Along with stimulating interest in scientific activity, the conference helps to develop skills for extracting significant information. At all stages of preparation for the conference, a whole palette of skills and competencies is developed: public speaking skills, communication culture at scientific forums, self-expression and self-affirmation. Elements of oratory skills and various aspects of professional communication are honed. In addition, skills inherent in social interaction are acquired: the ability to work in a team, initiative, responsibility for the assigned task, respect, avoidance of conflict situations. Participation in a scientific conference is a springboard for future serious speeches and publications, an opportunity to declare oneself, demonstrate a penchant for scientific analysis, an incentive for professional growth. The skills acquired during participation in a student scientific conference can be further transferred to the real professional training of a young specialist or used in further scientific activity.

Appendix 1

Conference Event Plan

Time	*Venue*	*Events*
April 15		
10.00	Building 1, room 7	Round table «On science without boredom: ways to attract young people to scientific research activities»
14.00	Building 1, room 24	Seminar "Structure of a scientific article"

15.30	Building 1, room 24	Section «Current issues of modern pedagogy: results of experimental and theoretical research»
17.00	Building 1, room 7	Master class «10 techniques for creating cool presentations»
April 17		
13.20	Building 1, room 7	Intellectual quiz «Man of Science»
April 18		
11.50	Building 1, room 34	Section «Ig Nobel Prize: Funny scientific works that will make us laugh and think»
15.00	Building 1, room 24	Section «Young Researcher: Challenges and Prospects»
April 19		
10.00	Building 1, room 24	Section «Scientific Prophets: How Scientists Predict Future Events»
13.00	Building 1, room 7	Presentation of collective creative works «Pedagogical piggy bank»

Appendix 2

Educational course "Fundamentals of project activities"

Course program

Author of the course	Gnezdilova Elena Valerievna, Senior Lecturer, Department of Pedagogy, FGBOU VO «KamSU named after Vitus Bering»
Target	Formation and development of students' project activity skills, which is one of the fundamental characteristics of a modern person
Results	– development of communication skills, educational and research activities, critical thinking; ability for innovative, analytical, creative, intellectual activities; – development of project activity skills, as well as independent application of acquired knowledge and methods of action in solving various problems, using knowledge of one or several academic subjects or subject areas; – the ability to set a goal and formulate a research hypothesis, plan work, select and interpret the necessary information, structure the argumentation of research results based on the collected data, and present the results
Categories of students	Bachelor students of 1-2 years of all faculties
Quality assessment	Interim assessment in the form of tests, reports in the form of presentations, tests and an innovative project; final testing

Form of study	Full-time with the use of distance learning technologies
Expected results	The program includes 4 training modules, including lectures, practical classes and trainings, master classes, which will be held in person with the possibility of online connection: Module 1 “Preparatory stage of the project” (introduction to the basics of project activities; the concept of “risk”; hypothesis; hypothesis testing). Module 2 “Project Implementation” (structure of the individual project; title page; section “Introduction”; section “Main Part”; section “Contents”). Module 3 “Project Defense” (presentation for the speech; speech). Module 4 “Public Speaking Training”. During the training, students will be able to: – consult with leading scientists and teachers of the school in various sciences, who are ready to share their knowledge and experience; – develop in a supportive community of young scientists; – receive a diploma of professional retraining upon successful completion of all modules; – have post-access to all module materials.
Issued document	Upon completion of the course, the student will receive a certificate of participation.

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英语文化在全球化中的作用
THE ROLE OF ENGLISH-SPEAKING CULTURE IN THE GLOBAL WORLD

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摘要。本文致力于在公共生活日益全球化的背景下对英语文化及其组成部分的思考，以及它对国际文化一体化进程的影响。指出，任何语言的发展程度都受到与不同文化的社会和地域关系的影响。

关键词：英语民族文化、文化形式、文化功能、英语文化组成部分、全球化。

Abstract. *The article is devoted to the consideration of English-speaking culture and its components in the context of the increasing globalization of public life and its impact on the process of international cultural integration. It is noted that the degree of development of any language is influenced by social and territorial relationships with different cultures.*

Keywords: *culture of English-speaking peoples, forms of culture, functions of culture, components of English-speaking culture, globalization.*

At all times, knowledge of other peoples' languages has been considered an indicator of a high level of human development as a personality. Over time, knowledge of foreign languages has become a vital necessity:

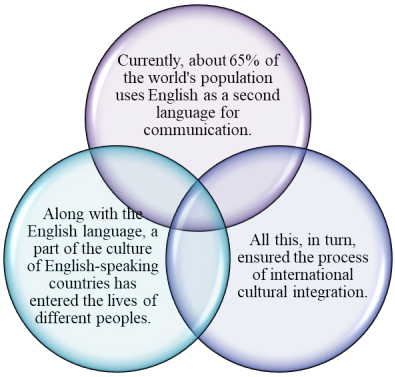

Figure 1. *Reasons for the process of international cultural integration.*

The phenomenon of culture, as a social phenomenon, is extremely important in conjunction with other social values. Since the concept of culture is inextricably linked with the development and improvement of society, and is also quite tightly integrated into the increasingly complex system of public relations, it is obvious that a certain pluralism of opinions and approaches to the interpretation of such an institution of society as culture [5].

In the scientific community, it is customary to identify several approaches to understanding culture as a social phenomenon [1]:

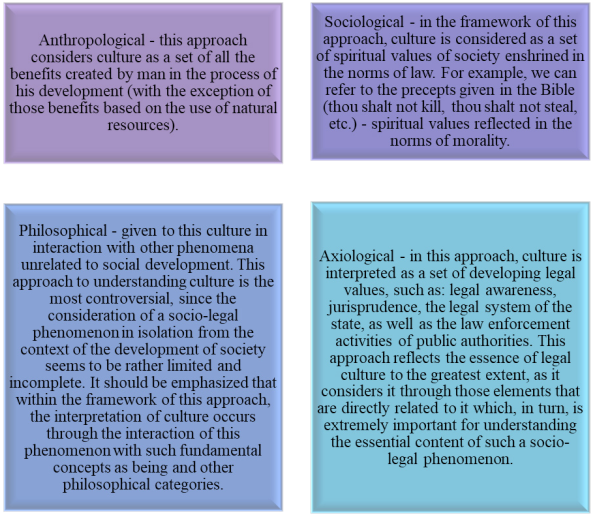

Figure 2. *Theoretical approaches to understanding culture.*

The existing variety of theoretical approaches to understanding culture is primarily due to the fact that this socio-legal phenomenon plays a huge role in the entire system of public relations. In addition, analyzing the variety of approaches to the interpretation of culture, it should be noted that not all of them reflect the essential content of that phenomenon, considering to a greater extent the features of its interaction with other social institutions of public life.

In a broad sense, culture is a historically determined, constantly updating dynamic complex of phenomena, forms, principles, methods and results of active creative activity of people in all spheres of public life. In a narrow sense, culture is a process of active creative functioning, during which spiritual values are consistently created, distributed and consumed.

Let's take a closer look at some forms of culture:

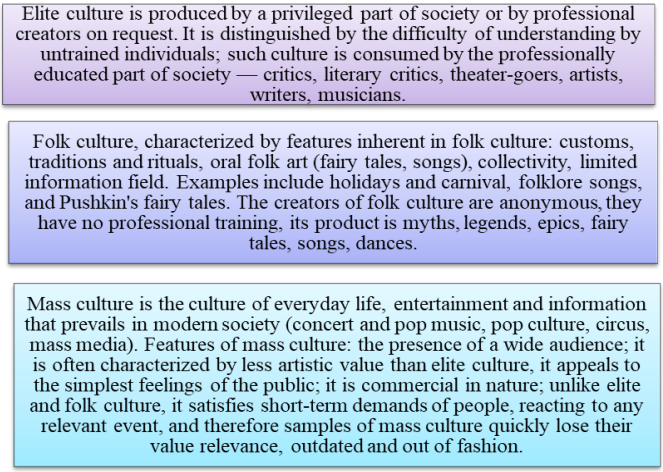

Figure 3. *Forms of culture.*

The most important aspect of understanding culture as a socio-legal phenomenon is the issue of cultural functions. The phenomenon under consideration has a number of specific functions [3]. Let's consider these functions.

Cognitive function – considering the fact that culture acts as a kind of indicator of the development of personality, society and the state. It can be assumed that it stimulates the desire of citizens to learn about various phenomena in the life of society. The desire to study these aspects of life appears due to the fact that in order to improve one's own cultural level, it is necessary to constantly expand the amount of available knowledge, and for this additional sources of information are needed, etc.

Transformative function - the transformative role of this function is explained by the fact that culture can have a significant impact on the mechanisms of statehood development (for example, in the field of lawmaking), as well as contribute to the formation of civil society institutions which, accordingly, contributes to the emergence of positive evolutionary processes.

Value-normative function - this function plays a special role in the life of citizens, its various facts that have a certain value, because it is reflected in the consciousness and actions of people as members of a particular society. That is, the essence of this function is manifested in the fact that it demonstrates in the minds of individuals examples of positive legitimate and negative inappropriate behaviour of subjects in various spheres of social interaction.

Communicative function – taking into account the fact that an increase in the level of culture implies an expansion of the individual's sphere of knowledge, it becomes obvious that against the background of an expansion of knowledge, a person's communicative ability in all areas of social life also increases. In view of this, the communicative function of culture allows different subjects to carry out mutual communication within the framework of their topics of interest.

The mentioned above list of cultural functions is by no means exhaustive, but in some ways the most important from the point of view of analyzing the practical role of culture in the daily lives of citizens and society. These functions play a significant role both in shaping the culture of an individual, society, and the state as a whole.

It is also worth emphasizing that by fulfilling the functions assigned to it, culture as a social phenomenon serves as a productive tool that promotes the proper and harmonious development of the individual.

Further, within the framework of the problem under consideration, we consider it necessary to pay attention to some aspects of English-speaking culture that have had the greatest impact on world culture.

It is obvious that music is a special area of English-speaking culture. It is music, as the most emotional manifestation of culture that accompanies humanity from the very dawn of its origin. The English Music School, represented by hundreds of performers and dozens of genres, is today one of the most diverse and well-known in the world. For example, the Russian school of rock developed under the influence of mainly English-speaking foreign performers. English-speaking performers had a great influence on Russian rock culture through the introduction of new styles of performance, a combination of sounds, and cultural images. For example, the American rock band The Kiss was the first in the world to use eccentric stage makeup and unusual provocative costumes in their performances. This trend was partly adopted by members of the Russian group "The King and the Fool", using stage images of fairy tales in their performances.

The spread of English-language music has not only given rise to the development of similar genres in our country. Also, the spread of such music unites fans of various artists around the world which can be observed at concerts held during the tours of famous bands. Thus, English-language music has become not only a catalyst for the development of similar trends in other countries, but, most importantly, it has also become a way to unite people based on common cultural preferences.

Music has a strong impact on young people who are often in search of their own identity. Genres and musical texts can influence fashion, behaviour, language, and values professed by young people.

Language and slang also contribute to the influence of musical compositions on the younger generation which can be seen in the active use of certain words and phrases among young people. The lyrics contribute to the dissemination and introduction of new expressions into everyday speech and their corresponding impact on the vocabulary of young listeners.

In addition, music can touch on topics related to social issues, politics, ecology, etc. Thus, song lyrics can become a source of information and have an ambiguous impact on the formation of the worldview and values of young people.

Do not forget that not only music plays a special role in global and popular culture. There is also cinema and English-language films. This aspect of culture is able to shape and change the values, trends and perceptions of people around the world, on the one hand, contributing to the promotion of cultural diversity and the discussion of social issues. On the other hand, it promotes sometimes harmful and unnecessary ideas. It should be noted that, ultimately, the cinema of English-speaking countries is a powerful means of communication and entertainment, influencing the cultural landscape of various countries, including the Russian Federation. Thus, it is important to maintain critical thinking and realize that there is an active process of creating and manipulating images and ideas behind the screen.

Discussions about the globalization of the English language and its status as a language of international communication are far from empty words. Many questions on this topic remain open. Let us note that the process of development of any language is influenced by social and territorial interaction with other languages. One should also not forget about aspects of an extra-verbal nature when integrating English discourse into other languages [2].

It is worth noting that the definitions of “global language” and “international language” are similar in meaning, except that an artificial language cannot be a global language. The need to unify the language of international communication has always been on the agenda. Examples of this are the myth of the Tower of Babel and active attempts to create a common Esperanto language. Unfortunately, such attempts were unsuccessful: people could not find a common language of communication, since any language is closely related primarily to national culture.

There is a common opinion in the scientific world that English can be a benchmark for a global language, since it is widely spoken. Therefore, it can be one of the official languages of many countries and is quite concise in its structure. Interaction in different languages in solving the most important issues of the world order is certainly an integral task. Therefore, the ideas of unification of languages remain relevant. For example, in the field of solving problems related to combating natural disasters and reducing social inequality [4]. However, globalization in a broad sense also has its negative sides. Due to the increasing pace of globalization trends, information and linguistic inequality is forming, therefore, the cultures of many peoples may lose their identity. Thus, it can be concluded that widespread globalization may lead to a loss of the sovereignty of the uniqueness of the nation and affect the reduction of the development process of the state language.

The results of the study allow us to conclude that by now the culture of English-speaking countries is becoming global. Most of the inhabitants of the planet are in constant contact with this culture in one way or another. English today is universal and aspires to the status of an international language, and the culture created in English-speaking countries unites more than one generation. One question remains relevant - to what extent these trends contribute to solving the main task of the subjects of the world order: the maintenance of universal peaceful coexistence of countries and peoples.

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美国文学中的战争观
PERCEPTION OF WAR IN THE AMERICAN LITERATURE

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摘要：本文对 S. Crane、J. Heller、J. Jones、K. Powers 的小说进行了比较分析，得出以下结论：在美国文学中，战争主要被视为一种永恒现象，而不是历史事件。

关键词：战争小说，荒诞风格，存在主义，“白板”，永恒现象，历史事件。

Abstract. *The paper contains the comparative analysis of S. Crane's, J. Heller's, J. Jones', K. Powers' novels and comprises following conclusion: war has been primarily treated as a timeless phenomenon rather than a historical event in the American literature.*

Keywords: *war novel, the manner of the Absurd, existentialism, "tabula rasa", a timeless phenomenon, a historical event.*

Attempts of perception of war were made from the moment of state origin in the USA. It was typical for the American culture because of the military necessity to assert the New World's independence and to occupy Indian's territories. Then there were two world wars and active USA's struggle for supremacy in the world. So, many works about war appeared in the American art.

Like in the 20th century, nowadays the USA makes wars on the other country's territories. These wars are often grasped as absurd actions by the Americans. There was an opposite situation in the 19th century, in the American Civil War's time (1861-1865). One of the first significant war novel in the American literature devotes to the war between the North and the South not accidentally. It is Stephen Crane's (1871-1900) masterpiece *The Red Badge of Courage* (1895). The author describes "An Episode of the American Civil War", but he omits the historical details. Crane represents war as the inhuman power, which can change Henry Fleming's youthful consciousness.

The author describes the war as a fantastic battle, where the youth's regiment turns out to "one of those moving monsters wending with many feet" [1, p. 23], the

enemy's troops – to "the composite monster" [1, p. 41] and "redoubtable dragons" [1, p. 51], the war – to "the red animal" [1, p. 85] and "the blood-swollen god" [1, p. 85], the national banner – to "a creation of beauty and invulnerability" [1, p. 129], "a goddess, radiant" [1, p. 129], "a woman, red and white, hating and loving" [1, p. 129]. This allegoric picture helps to show that a man becomes a grain in the battle. The author also exposes the traditional ideas about patriotism and heroism. For example, one of the Crane's characters – "the man of the cheery voice" – can't remember his native city and can't explain the war's causes: "I couldn't tell <…> which side I was on. Sometimes I thought I was sure 'nough from Ohier, an 'other times I could 'a swore I was from th' bitter end of Florida" [1, p. 90]. Thus the writer takes away the opposition between the North's and the South's armies.

It is also very important that Crane expose "external character of heroism and shows the true heroism" [6, p. 139] in his novel, which is the feeling of fault to another man. In Crane's conception, true heroism is not ability to get wound – "the red badge of courage", but it is a result of awareness of feelings of guilt towards your neighbor. Wars force people to suppress their humanism. That's why wars "as crimson blotches on the pages of the past" [1, p. 11] are sharply condemned by the author.

Crane's style of war description was developed by the 20th century American writers. For example, Ernest Hemingway (1899-1961) in his novel *A Farewell to Arms* (1929) and Joseph Heller (1923-1999) in his novel *Catch-22* (1961) emphasize an absence of war's moral justification. Hemingway's main character Frederic Henry and Heller's main character Yossarian realize the battle-front's nonsense and then become deserters.

Heller especially emphasizes the absurdity of war. In his interpretation, the events of World War II represent a series of senseless actions leading to death. Heller writes that soldier's actions are controlled by special article of the charter – Catch-22: "Anyone who wants to get out of combat duty isn't really crazy" [4, p. 62]. Heller's desire to focus attention precisely on the absurd side of the war is quite natural from a historical point of view. It is known, that the Americans fighting far from their homeland during the First and Second World Wars did not have a clear understanding of the purpose of the struggle, which radically distinguished them from the soldiers of the armies of the North and South, who were deciding the fate of their own country. However, in *The Red Badge of Courage*, which reflects the events of the American Civil War, we can also find an indication of the absurd nature of the events described. For example, we can remember the episode of Fleming's flight from the battlefield and receiving a wound in a fight with another deserter. This "red badge of courage" paradoxically makes Henry a hero in the eyes of others. The novels of Crane and Heller are also brought together by the perception of war as a timeless evil, the historical versions of which, from the

point of view of both writers, are not so significantly different from each other. Heller describes World War II as like as Crane has described the American Civil War.

Another view on war we can see in James Jones's (1921-1977) works. The writer tries to reveal the timeless causes of the concrete historical event – World War II. In his nonfictional book *WWII. A Chronicle of Soldering* (1975) Jones writes: "In modern history, human evolution was in danger of a very real <…> retrogression into organized barbarism; and the door had been opened on all the dark side of human nature" [3, p. 210].

According to Jones' position the 20th century wars distinguish from the preceding wars and need historical and timeless analysis. Thus, the author suggests two World War II conceptions in his novel *The Thin Red Line* (1962). The first conception – war as "a regular business" [2, p. 37] – refers to the 20th century war's particularity. Jones' characters find themselves as "a tool with its serial number" [2, p. 368] and feel "complete helplessness" [2, p. 198] because of the WWII's commercial aspect. So, they have the existentialist perception of the world: "Life was pointless" [2, p. 121].

The second conception – war as "a sort of sexual perversion" [2, p. 286] – explains the timeless side of a war, its biological base. Jones emphasizes soldiers' unhealthy sexual feelings when they see a death, a suffering, a pain: "Sexual excitement, sexual morbidity <…> as if they were voyeurs behind a mirror watching a man in the act of coitus" [2, p. 66].

The author also analyses the human's actions on a battlefield in *The Thin Red Line*. Like Crane, Jones comes to a conclusion that courage is closely connected with cowardice. Crane and Jones oppose true courage and false bravery. In *The Red Badge of Courage* the false bravery is the result of "the impetus of enthusiasm" [1, p. 135], "nervous fear" [1, p. 136] and "an anxiety" [1, p. 136]; in *The Thin Red Line* – "nervous fear and anxiety" [2, p. 185] and "gross false enthusiasm" [2, p. 185]. As for true courage, Crane defines it as the fearless ability to stand before the court of one's own conscience (which can be observed in the finale of the novel using the example of the fate of Henry Fleming); and Jones – as the ability to consciously sacrifice life for the sake of another person (indicative of this meaning the episode of the death of Sergeant Keck, who covered a grenade with himself and thereby saved the soldiers of his platoon). However, on a battlefield people often turn out to be "automatons without courage or cowardice" [2, p. 306], everyone is "not a man but a member" [1, p. 44].

All in all it is very important for the 20th century American novelists to reflect private's view. This inductive manner we can see in the modern USA's literature too. The 21st century American writers focused on the modern USA's wars in the East. For example, Kevin Powers' (b. 1980) debut novel *The Yellow Birds* (2012)

bounds up with the recent Iraq war (2003-2011). The plot of this work is built around the figure of the narrator - twenty-one-year-old private John Bartle, who fought in the Iraqi city of Al-Tafar and returned to his hometown near Richmond. Powers reveals the details of his army service gradually: compositionally, the novel is an alternation of fragments of the character's pre-war, war and post-war life. Nevertheless, the author represents neither military politics nor historical fighting. Like Crane, Powers describes war influence on young private John Bartle's "tabula rasa" consciousness. However, if Henry Fleming goes from disharmony to harmony, then the main character of the novel *The Yellow Birds* moves in the opposite direction: from a naive positive view of the world to the most severe form of alienation and dissociation. The author picks out the stages of Bartle's psychological growing up: the youth period till his arrival to Iraq, the maturity period in Al-Tafar and period of psychological old age after homecoming. So, in *The Yellow Birds* modern American soldier is represented as human being in general.

Powers shows the war as a timeless phenomenon too. The war is a cruel being in *The Yellow Birds*: "The war tried to kill us <…> While we slept, the war rubbed its thousand ribs against the ground <…> When we pressed onward through exhaustion, its eyes were white and open in the dark. While we ate, the war fasted" [5, p. 3]. The image created by Powers is devoid of historical and political overtones. War is portrayed as a timeless destructive force, a monster always looking for new victims.

Powers emphasizes that the war experience can lead people to solipsism. Powers points out his character's indifference to the deaths of those around him, noting that Bartle is overcome by a blind desire to survive: "War is the great maker of solipsists: how are you going to save my life today? Dying would be one way. If you die, it becomes more likely that I will not. You're nothing, that's the secret: a uniform in a sea of numbers, a number in a sea of dust" [5, p. 12]. The same recruit's thoughts has been also described by James Jones in *The Thin Red Line*: "Safety, safety. He did not care if anyone else was left alive or not" [2, p. 459]. However, only Bartle can frankly admit that in the battlefield he "was no hero" [5, p. 180].

Thus, Powers touches upon traditional American questions about war (the essence of war, the influence of war experience on human being, the problem of courage and cowardice) and omits the documentary details in his novel. The recent appearance of *The Yellow Birds* confirms the following conclusion: war has been primarily treated as a timeless phenomenon rather than a historical event in the American culture.

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计算莫斯科南部地区大田作物碳足迹和灰色森林土壤二氧化碳通量的新模型
A NEW MODEL FOR CALCULATING THE CARBON FOOTPRINT OF FIELD CROPS AND CO_2 FLUXES ON GRAY FOREST SOILS OF THE SOUTHERN MOSCOW REGION

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注释。提出了一种计算农业生态系统产品碳足迹的新型多层次模型。引入了“最终碳足迹”的概念，既包括拖拉机、联合收割机、土壤腐殖质氧化、氮肥在土壤中转化过程中的CO2-eq. 的直接CO2 排放，也包括间接CO2 排放——在生产和使用矿物肥料、农药、拖拉机、联合收割机、耕作设备等过程中向大气中释放的二氧化碳。

基于莫斯科南部灰色森林土壤田间试验结果，结果表明，当对大田作物施用平均剂量的矿物肥料时，间接CO2 排放量与机械在田间作业时有机燃料氧化产生的CO2 输入量相当。在较高剂量的肥料下，间接排放量明显高于机械运行产生的CO2排放量。三叶草是一种碳负作物（-1.82 吨/公顷二氧化碳），即土壤中封存的二氧化碳超过了干草作物生产产生的所有二氧化碳排放量。

关键词：巴黎气候协定、计算大田作物碳足迹的新模型、农业生态系统中的直接和间接二氧化碳排放、最终碳足迹、谷物作物、三叶草、玉米、矿物肥料、土壤腐殖质平衡。

Annotation. *A new multi-level model for calculating the carbon footprint of agroecosystem products is proposed. The concept of “final carbon footprint” is introduced, which includes both direct CO_2 emissions from the operation of tractors, combines, oxidation of soil humus, CO_2-eq. during the transformation of nitrogen fertilizers in the soil, and indirect CO_2 emissions - the release of carbon dioxide into the atmosphere during the production and use of mineral fertilizers, pesticides, tractors, combines, tillage equipment, etc.*

Based on the results of field experiments on gray forest soils in the southern Moscow region, it is shown that when applying average doses of mineral fertilizers to field crops, indirect CO_2 emissions are comparable to the CO_2 input from the oxidation of organic fuel when machinery is operating in the field. At higher doses of fertilizers, indirect emissions are significantly greater than the CO_2 emissions

from machinery operation. Clover is a carbon-negative crop (-1.82 t/ha CO_2), i.e., CO_2 sequestration in the soil exceeds all CO_2 emissions from hay crop production.

Keywords: *Paris Climate Agreement, new model for calculating the carbon footprint of field crops, direct and indirect CO_2 emissions in agroecosystems, final carbon footprint, grain crops, clover, corn, mineral fertilizers, humus balance in soils.*

Currently, the Earth is experiencing a significant increase in the average annual temperature of the atmosphere, which may lead to major negative environmental and economic consequences. The main reason for this phenomenon is officially considered to be the increase in the concentration of so-called greenhouse gases in the atmosphere, mainly carbon dioxide, methane and nitrogen oxide (13). However, scientists have other opinions about the causes of warming (9, 10).

Fedorov V.V. and co-authors (9) believe that the long-term variability of the carbon dioxide content in the atmosphere is mainly the result of long-term variability of the temperature of the ocean surface waters and a decrease in the solubility of CO_2 in water. The increase in water temperature, in turn, is a consequence of an increase in insolation contrast caused by a decrease in the angle of inclination of the Earth's rotation axis.

A detailed analysis of the problem of global warming and attempts to solve it, including with the help of low-carbon energy, has been published (7). It has been shown that thermal pollution makes the greatest contribution to warming among anthropogenic factors by humans as a result of obtaining and using all types of energy (heating the air in rooms, operation of refrigeration units and air conditioners, discharge of cooling heated water, heating of soils by pipelines, etc.).

Greenhouse gases generally trap the infrared spectrum of solar radiation reflected from the planet's surface, which contributes to its heating. It is assumed that the main way to reduce the content of greenhouse gases in the atmosphere will be to reduce the use of fossil fuels, including per unit of production (carbon, carbon footprint). Carbon footprint is the totality of emissions greenhouse, produced directly and indirectly by an individual, organization, event, or product. The carbon footprint is measured in metric kilograms of carbon dioxide (CO_2).

Currently, in the European Union, the optimization of the CO_2 balance in the atmosphere is planned to be carried out by introducing a border carbon correction mechanism within the framework of the European Green Deal (11) through fines on imported energy-intensive products (metals, cement, etc.) for excess emissions during their production compared to emissions in Western European countries.. The European Commission has published a draft Cross-Border Carbon Regulation (CBC), which would impose a tax on EU imported goods based on their carbon

footprint. In the absence of reporting by the exporter, emissions will be equal to the average CO_2 emissions of the worst 10% of European producers.

In the future, we may also be talking about agricultural products. Penalties may be applied not only in Europe, but also in countries where the Russian Federation (RF) exports agricultural products. In this regard, it is currently necessary to develop an objective and comprehensive methodology for calculating the carbon footprint when cultivating field crops so that it can be discussed at the international level in the future.

A number of studies have been conducted around the world to assess CO_2 emissions into the atmosphere in agricultural landscapes and calculate the carbon footprint of field crops.

The suitability of 19 domestically bred spring wheat varieties for carbon farming was assessed (5). To determine the amount of greenhouse gas emissions, data on the consumption of fuel, mineral fertilizers, and pesticides were used, and N_2O emissions associated with the mineralization of wheat plant residues were taken into account. Greenhouse gas emissions during fertilizer production were taken as follows: for nitrogen (N) – 2.9 kg CO_2-eq. per 1 kg, for phosphorus – 0.71 kg CO_2-eq. /kg, for potassium – 0.46 kg CO_2-eq. /kg. Carbon dioxide pollution of the atmosphere during the production of agricultural machinery was not taken into account. N_2O emissions into the atmosphere from nitrogen fertilizers applied to the soil were calculated using a coefficient of 2.55%. The work shows that, on average, the carbon footprint of spring wheat was about 49 kg CO_2-eq. per 1 centner of grain of 19 varieties. The average grain yield for all varieties was 37.6 c/ha.

Majeed Safa et al. (11) conducted a study on 35,300 ha of irrigated and dryland wheat fields in Canterbury, New Zealand. Total CO_2 emissions from wheat production were 1032 kg CO_2/ha. About 52% of the total CO_2 emissions were due to fertilizer use and about 20% were due to fuel used in wheat production. Nitrogen fertilizers accounted for 48% (499 kg CO_2/ha) of the CO_2 emissions. The relationship between nitrogen use, CO_2 emissions, and crop production showed that reducing CO_2 emissions would result in lower crop production and net financial gain.

In progress (2) the results of calculating the carbon footprint of an agricultural enterprise are presented based on an analysis of the capabilities of the carbon calculators Cool Farm Tool, AgRe-Calc, Farm Carbon and Ex-Act V9.4, as well as the Methodology of the Ministry of Natural Resources of the Russian Federation (6). The latter defines the carbon footprint as the total emissions of greenhouse gases from fuel combustion, soil respiration and mechanical losses of carbon, and defines the carbon input into the soil with plant residues and fertilizers as sources of replenishment of the soil carbon pool.

Differences in estimates based on different methods are recorded not only in the total volumes of carbon footprint obtained, but also in the structure of the carbon footprint for each crop. It is shown that some calculators attribute a large role in the carbon footprint to fertilizers, while others attribute it to the influence of plant residues. None of the calculators take into account the impact of CO_2 emissions during the production of equipment used in agriculture and the balance of humus in the soil on the value of the carbon footprint of field crops.

We believe that for a full assessment of the impact of agriculture on the atmosphere from an ecological-biosphere standpoint, it is necessary to analyze not only the combustion of fuel in tractor engines and motor vehicles, but also greenhouse gas emissions obtained during the production of mineral fertilizers, pesticides, various agricultural machinery and equipment, as well as the release of carbon dioxide during the oxidation of soil humus.

For a detailed analysis of CO_2 emissions or sequestration during the cultivation of field crops, we developed a multi-level model for the first time during the reporting period.

We divide CO_2 emissions into the atmosphere during the production of agricultural products into direct and indirect. Direct emissions occur directly in the agricultural landscape during the oxidation of organic fuel in internal combustion engines during the cultivation of agricultural crops, harvesting, transportation and processing of the harvest. We also include the oxidation of humic substances in soils during their mechanical processing and the application of nitrogen fertilizers as direct emissions.

Indirect carbon dioxide emissions can be calculated through the technical energy costs for the production of tractors, combines, agricultural machinery, motor vehicles and their depreciation. Depreciation of the embodied energy costs during the operation of each unit per shift is carried out (1) taking into account the average annual equipment load (in hours) and service life using the formula: $Ac = (Bp + \sum Kr) / (T * C)$, where Ac is the shift (7 h) depreciation rate (MJ), Bp is the initial energy costs for the production of equipment at factories (MJ), Kr is the sum of the energy costs for major and current repairs over the entire service life of the equipment (MJ), T is the depreciation service life (years), C is the approximate annual equipment load (7-hour shift). In the absence of actual data on the technical energy costs for the production of equipment, an energy equivalent of 86 MJ per 1 kg of machine weight can be used for calculations.

Based on the data on depreciation of production and repairs of equipment, indirect emissions of CO_2 into the atmosphere during operation are estimated using the formula: $CO_2 = Ac*3.0/29.3$, where CO_2 is the indirect emissions of carbon dioxide into the atmosphere for 7 hours of machine operation, kg, Ac is the shift depreciation rate of machines (MJ), 3.0 is the generalized equivalent (CO_2 emis-

sions per 1 kg of standard fuel), 29.3 is the conversion of energy (MJ) into kg of standard fuel.

CO_2 flows in ecosystems during oxidation of soil humus are determined by its balance taking into account the humification coefficient of crop, root residues and organic fertilizers. In this case, humus decomposition from the application of nitrogen mineral fertilizers is taken into account (3). Losses of N_2O from nitrogen fertilizers are calculated using the emission factor (EFN_2O) as a percentage of the fertilizers applied to the soil.

The concept of "final carbon footprint" has been introduced, which includes both direct CO_2 emissions from the operation of tractors, combines, and motor vehicles, as well as the release of CO_2 into the atmosphere during the oxidation of soil humus, and indirect CO_2 emissions from the production of mineral fertilizers, pesticides, tractors, and agricultural equipment.

Using a long-term field crop rotation (a prototype of an agricultural carbon testing ground) in the southern Moscow region as an example, direct and indirect technical energy costs for growing and harvesting the main crops were analyzed, the CO_2 balance in agroecosystems was calculated, and the carbon footprint of the products was determined. The geographical location of the experimental site is determined by the coordinates: 54º49' north latitude and 37º26' east longitude. The plot size is 4.5 hectares. The soils are gray forest medium loamy podzolized with a second humus horizon. The main elements of soil cultivation are: plowing with a plow with a skimmer to a depth of 20-22 cm, early spring harrowing, pre-sowing cultivation, rolling of crops, inter-row cultivation of corn crops. Harvesting of grain crops was carried out by a combine with collection and removal of straw from the field to the livestock farm. The energy costs for the production of nutrients in mineral fertilizers are taken as follows: nitrogen (N) – 100 MJ/kg (CO_2 emissions are 10.2 kg), per 1 kg of P_2O_5 – 21.3 MJ (CO_2 emissions are 2.2 kg), 1 kg of K_2O – 5.96 MJ (CO_2 emissions are 0.61 kg). Per unit of applied fertilizer nitrogen, 0.2 units of nitrogen are formed from humus on gray forest soils (3). If we assume that the C:N ratio in soil humus is 10, then 6.58 kg of CO_2 will be released into the atmosphere from decomposed humus from 1 kg of applied fertilizer nitrogen.

Studies have shown that the carbon footprint of field crops largely depends on the type of plant, its productivity, and the intensity of application of mineral fertilizers. Crops differ sharply in CO_2 emissions both per 1 ha and per 1 centner of yield (table). Fertilizers have significantly increased plant yields. However, even when applying average doses of fertilizers to grain crops, indirect CO_2 emissions are comparable to direct ones.

At higher fertilizer doses, indirect carbon dioxide emissions significantly exceed direct emissions. In order of increasing total carbon footprint per 1 ha, the

crops are arranged as follows: silage corn > winter wheat > barley > clover. When calculating only by direct CO_2 emissions, the carbon footprint at medium fertilizer doses was 37.9 kg/cwt of grain for winter wheat and 38.3 kg/cwt of grain for barley. The total carbon footprint (direct + indirect CO_2 emissions) for grain crops was: 79.3 kg CO_2/cwt of grain for winter wheat and 93.2 kg CO_2/cwt of grain for barley. At higher fertilizer doses, the carbon footprint increased sharply. The final carbon footprint for winter wheat in the N135 P150 K100 variant was 127.2 kg CO_2 per 1 centner of grain, and for barley in the N140 P140 K80 variant it was estimated at 134.7 kg per 1 centner of grain.

Taking into account N_2O losses of 1.0% from applied nitrogen fertilizers (4, 14) the total final carbon footprint at average doses of fertilizers in terms of CO_2-eq. was 82.3 kg CO_2-eq. per 1 centner of grain for winter wheat and 98.9 kg CO_2-eq. for barley. A significant increase in N_2O emissions and the total carbon footprint was observed in variants with increased doses of nitrogen fertilizers. In terms of CO_2-eq., the total carbon footprint for winter wheat reached 134.5 kg per 1 centner of grain and for barley – 146.5 kg per 1 centner of grain. Clover is a carbon-negative crop – -1.82 t/ha CO_2, i.e., CO_2 sequestration in the soil exceeds all CO_2 emissions during hay harvesting. This feature of clover is due to both the lower CO_2 input into the field from the use of diesel fuel during cultivation and harvesting, the absence of the use of energy-intensive nitrogen mineral fertilizers, and the minimization of the number of mechanical tillage operations, as well as a large amount of root and crop residues and a positive humus balance.

Table.

Yield and carbon footprint of field crops on gray forest soils of the southern Moscow region, average for 5 years

Options	Harvest, c/ha commercial* products	Post-harvest residues, c/ha, dry matter	Direct emissions (+) or sequestration (-) of CO_2, kg/ha				Indirect emissions, CO_2, kg/ha	Total carbon footprint, CO_2, kg	
			fuel oxidation	oxidation of soil humus	total direct emissions	carbon footprint, CO_2 per 1 centner of production	total	per 1 ha	per 1 centner of production
Winter wheat									
Control	33.2	39.6	933	673	1 606	48.4	923	2 529	74.2
N40P40K40	38.1	45.1	1,050	392	1 442	37.9	1,581	3 023	79.3
N135P150K110	41.0	45.4	1 142	1 014	2 156	57.0	3 060	5 216	127.2
Corn for silage (4-year average)									
Control	355,0	24.6	600	2 284	2 884	8.1	330	3 214	9.1
N90P60K40	501.4	28.7	752	2 599	3 351	6.7	1 519	4 870	9.7
N150P190K190	600.2	30.3	842	2 833	3 675	6.1	2 762	6 434	10.7
Barley									
Control	16.4	18.2	782	638	1 420	86.6	838	2 258	137.7
N60P40K40	31.4	16.5	973	229	1 202	38.3	1 725	2 927	93.2
N140P140K80	35.2	19.3	1 014	815	1 829	52.0	2 912	4 741	134.7
Clover 1 and 2 years of use for hay, 3 cuttings									
Control	135.0	70.1	786	-3 610	-2 824	-20.9	357	-2 467	-18.3
P80+40K80+40	152.0	69.2	878	-3 655	-2 777	-18.3	956	-1 821	-12.0
P160+80K200+100	151.9	67.8	893	-3 411	-2 518	-16.6	1,547	-971	-6.4

* Grain at 14% moisture, hay at 20% moisture

It should be noted that for all crops and all studied variants, the carbon content in plant biomass exceeded the total CO_2 emissions per 1 ha of crop. For example, for winter wheat, the carbon content in the synthesized biomass (grain, straw, crop residues) was 7.1 times higher than the carbon in the total CO_2 emissions, and for barley, it was 4.5 times higher.

Currently, the application of mineral fertilizers in the world is extremely uneven (4). For example, in Western Europe, the highest doses of nitrogen fertilizers per unit of crop area in 2016 were in the Netherlands - 244.9 kg/ha N, Belgium - 216.4, Germany - 138.7 kg/ha. In Russia, only 11.6 kg N per 1 ha was applied during this period. Studies of the use of mineral fertilizers for grain crops over a five-year period (2016-2020) in the main natural and climatic zones of the Russian Federation showed that the use of fertilizers was also limited. In the Non-Chernozem zone, the application of mineral fertilizers varied by region from 15 to 78 kg / ha of sown area. On chernozems of the European part, the application of fertilizers was 15-87 kg / ha, in the Asian part - 1-34 kg / ha (8).

An important factor influencing the carbon footprint is the loss of organic matter in soils. The experiment showed that CO_2 emissions from humus imbalance in soils under corn exceed CO_2 emissions from fuel combustion in tractor engines. In this regard, the international methodology for calculating the carbon footprint must include an analysis of the humus state in soils, mandatory accounting of runoff and CO_2 emissions in the soil-atmosphere subsystem.

Conclusion

A new multi-level model for calculating the carbon footprint of agroecosystem products is proposed. Using the example of field crop rotation on gray forest soils, it is shown that underestimation of CO_2 emissions from the production of mineral fertilizers, agricultural machinery and the release of CO_2 from the soils of agroecosystems in countries intensifying agricultural technologies obviously underestimates the calculated value of total CO_2 emissions into the atmosphere and the carbon footprint of agricultural crops. In order to unify the assessment of the impact of agriculture on the content of carbon dioxide in the atmosphere, it is necessary to develop and approve an international methodology for calculating the carbon footprint, which would take into account both CO_2 emissions during cultivation and harvesting, and during the oxidation of soil humus, the influx of CO_2 atmosphere in the production of agricultural machinery and mineral fertilizers.

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衰老的遗传和表观遗传机制
GENETIC AND EPIGENETIC MECHANISMS OF AGING

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摘要。衰老是一个系统过程，影响生物组织的不同层次。本文讨论了一些理论。有自体中毒、端粒、自由基、遗传和表观遗传理论。特别关注衰老和长寿的遗传机制。作者给出了不同的例子，说明了这个过程的遗传决定因素（鲑鱼、裸鼹鼠和人类加速衰老的疾病）。本文讨论了调节衰老的遗传和表观遗传机制。本文的最后一部分分析了衰老过程的现代研究方向。

关键词：衰老理论、衰老调节、长寿、早衰症、衰老候选基因、表观遗传机制。

Abstract. *Aging is a systematic process, which affects different levels of biological organization. Some theories are discussed in this article. There are autointoxicational, telomeric, free-radical, genetic and epigenetic theories. Special attention is paid to genetic mechanisms of aging and longevity. Authors give different examples, which illustrate genetic determination of this pro- cess (salmon fishes, naked mole-rat and human diseases of accelerated aging). Genetic and epi- genetic mechanisms of regulation of aging are discussed in this article. The final part of present article contains analysis of modern directions of research on the aging process.*

Keywords: *theories of aging, regulation of aging, longevity, progeria, genes-candidates of aging, epigenetic mechanisms.*

Introduction

Aging is a process of gradual inhibition of the basic functions of the body, including regenerative and reproductive, as a result of which the body becomes less adapted to environmental conditions (loses the ability to withstand stress, disease and injury), which makes its death inevitable (Moskalev, 2009).

Another term closely related to the concept of aging is longevity. Longevity refers to the survival of a person to a high age. The highest level of longevity is longevity (living to 90 years or more). It should be noted that aging also occurs in long-livers. However, for them this process is extended over time, and its pace is slow. Centenarians experience normal functioning of all organ systems for a long time.

Aging is a complex process that affects various levels of biological organization, from the molecular to the organismal. At the molecular level, damage accumulates in the macromolecules of the cell. At the cellular level, this manifests itself in the form of damage to the endoplasmic reticulum, accumulation of aberrant proteins and active synthesis of pro-inflammatory cytokines. Active inflammatory processes cause tissue damage. At the body level, aging leads to the emergence and development of age-associated diseases such as Alzheimer's disease, cataracts and Parkinson's disease. Other age-related changes in the body include: disruption of circadian rhythms and diseases of the cardiovascular system.

Theories of aging

For a long time, the problem of aging has worried the minds of researchers. Even Hippocrates (460–377 BC) tried to explain the reasons underlying aging. In his essay "On Diet," he explained aging and limited life by the gradual loss of "natural heat," which is given to each organism in a certain amount from birth and is gradually lost throughout life. Since the 19th century, many theories have been developed to explain the mechanisms by which aging occurs. In our time, Mechnikov's autointoxication hypothesis has received the most recognition.

According to this theory, aging is based on chronic poisoning of the body by waste products of putrefactive microorganisms living in the intestines. Toxins activate macrophages, which cause the pathological process of phagocytosis, degenerative changes in tissues, impaired organ functioning, and, as a result, aging. The quantitative composition of putrefactive microflora is determined by the diet and lifestyle that a person leads, i.e. environmental factors (Mechnikov, 1907). The autointoxication hypothesis suggests physiological and biochemical mechanisms as the main factors of aging.

The evolutionary hypothesis (Anisimov, 2008) considers aging as one of the mechanisms that removes from the population individuals who have lost the ability to reproduce. Another mechanism that removes post-reproductive age individuals from the population is carcinogenesis. Both mechanisms are closely related to each other, since 70% of all tumors occur in old age (Anisimov, Solovyov, 1999).

In an attempt to explain the causes of aging and develop effective means of prolonging life by the end of the 20th century. humanity has created more than three hundred theories, each of which assumes a violation of one or another biological process as the main cause of age-related degradation (Trubitsyn, 2012).

The free radical theory has become widespread. According to this theory, aging is caused by the accumulation of reactive oxygen species (ROS) in cells. A small level of ROS is necessary for cells. However, high concentrations of reactive oxygen species can be toxic. With an age-related decrease in the activity of systems involved in neutralizing ROS, the latter accumulate in the cell and cause damage to biopolymers: proteins, lipids and nucleic acids. A significant contribution to the development of free radical theory was made by V.P. Skulachev (2013).

An argument in favor of this theory is the accumulation of reactive oxygen species in cells with age. However, this theory in a number of cases conflicts with a number of facts. Thus, there are long-lived species with a high content of ROS (for example, Heterocephalus glaber). Their lifespan can be several times higher than that of closely related species with relatively low ROS content.

According to the telomere theory, lifespan is determined by the ability of cells to proliferate. The limits of cell proliferation are limited (Hayflick limit): for culture cells this is 50 divisions. The mechanism of this phenomenon is determined by the peculiarities of the organization and replication of the terminal regions of chromosomes - telomeres, which shorten over time, change their morphology and do not restore their structure. Thus, telomeres serve as a kind of molecular clock, recording the "proliferative biography" of each cell. However, telomere length can be maintained at the same level throughout many cell divisions.

Telomeres play an extremely important role in the cell: they stabilize the ends of chromosomes, preventing chromosomal aberrations. When they are critically shortened, the risk of chromosomal rearrangements increases, which can lead to tumor transformation of cells (Carneiro, 2016). To prevent this from happening, cell division is blocked, and the cell enters a state of irreversible arrest of the cell cycle (senescence state). Senescent cells remain viable, but lose their ability to divide. On the one hand, this can prevent the formation of malignant tumors, and on the other, the accumulation of senescent cells occurs, which negatively affects the possibility of tissue renewal (Malygina, 2012).

An argument in favor of this theory is the shortening of telomeres of most somatic cells with age as they undergo divisions due to the absence of active telomerase in them (Weng et al., 1997). At the same time, telomerase activity is present in 90–95% of tumor cells that are capable of unlimited proliferation. However, the telomere theory, despite its attractiveness, faces some contradictions. Thus, there are both aging somatic cells with active telomerase (cells of the cornea or oral mucosa) and potentially immortal tumor cells that do not possess telomerase (Trubitsyn, 2012). Thus, none of the hypotheses discussed above is without shortcomings, which does not allow us to accept it as the only correct one.

Currently, the most popular theory is that aging is caused by damage to the cell's genetic systems. Moreover, such damage includes not only shortening of telomeres as cell divisions occur (as postulated in the telomere hypothesis), but also mutations in genes encoding proteins that are involved in the regulation of many vital cellular processes, for example, repair.

Examples that support the genetic determination of the aging process

The significant contribution of genetic factors to the development of the aging process can be illustrated by many examples. For the first time, the assumption about the important role of genetic factors in aging was made on the basis of observations of animals that are not model objects of genetics (Skulachev, 2013).

A classic example is salmon fish. The genus of Pacific salmon includes migratory fish (chum salmon, coho salmon, pink salmon) that live in the salty waters of the Pacific and Atlantic oceans. To spawn, these fish leave the rich salty waters and, overcoming difficult obstacles and vast distances, return to fresh water bodies where they themselves were once born. After spawning, phenoptosis is activated in salmon fish - rapid programmed death of the organism, a kind of biochemical program aimed at destroying the individual. With phenoptosis, degenerative changes occur that affect the brain, digestive, excretory and cardiovascular systems, which leads to the death of the body.

There is an opinion that the death of Pacific salmon is associated with depletion, but this is supported by the fact that other species of anadromous salmonids (for example, salmon) also occur in distant countries, but do not undergo rapid aging. A hypothesis has been proposed linking the phenoptosis of Pacific salmon with the dramatic hormonal changes that these fish constantly experience. It is assumed that an important role in the activation of phenoptosis is played by a change in the ratio between sex hormones (testosterone in males or 17-β-estradiol in females) and gonadotropic hormones (in particular, follicle-stimulating hormone). After spawning, the concentration of gonadotropins increases sharply, and sex hormones decrease, which possibly leads to disruptions in cell signaling systems and, as a consequence, irreversible changes in the entire body (Atwood et al., 2017). The genetic determination of the aging process is evidenced by a comparison of life expectancy in organisms of similar species. These species include the house mouse (Mus musculus) and the naked mole rat (Heterocephalus glaber).

To prove the genetic nature of aging, other examples of long-lived species, both among animals and among plants, can be cited. The longest-lived non-colonial organism among all animals known to modern science is the bivalve Arctica islandica with a maximum lifespan of 405 years. You can give other, no less amazing, examples of long-lived animals: Aldabra giant tortoise (Aldabrachelys gigantea) - 250 years, bowhead whale (Balaena mysticetus) - 211 years, Aleutian sea bass (Sebastes aleutianus) - 205 years, sea urchin (Strongylocentrotus franciscanus) – 200 years. Long-lived plants include evergreen sequoia (Sequoia sempervirens) - 2500 years and amazing Welwitschia (Welwitschia mirabilis) - 2000 years.

A clear example illustrating the key role of genetic factors in the development of the aging process in humans is the existence of hereditary diseases of accelerated aging - progeria. Progeria is a systemic disease that manifests itself at all levels of biological organization.

Currently, two forms of progeria are the most studied: childhood (Hutchinson-Gilford syndrome, manifests itself in early childhood) and adult (Werner syndrome, manifestation occurs during puberty). Childhood and adult forms of prog-

eria are caused by mutations in genes encoding different proteins. It was found that Hutchinson-Gilford syndrome is associated with a mutation in the gene encoding the lamin A protein (Gonzalo, Kreienkamp, 2015), and Werner syndrome is associated with a mutation in the WRN gene, encoding DNA helicase (Oshima et al., 2017). Lamin proteins regulate the binding of the progerin protein to the nuclear membrane, and DNA helicase is important for the processes of repair and replication. It is noteworthy that in both cases there is a disruption of the cell's repair systems.

Longevity

One example of the genetic determination of the aging process is long-livers among people. As a rule, centenarians maintain good health until a very old age, regardless of lifestyle. They are free from cardiovascular diseases, Alzheimer's disease, diabetes and cancer. Population studies to search for polymorphic variants of genes associated with high life expectancy in humans have shown a pronounced heritability of longevity. Polymorphic variants of such genes (FOXO1a, SOD2, IGFr1) were also found among close relatives of centenarians. It has been shown that the likelihood of inheriting longevity in families of centenarian individuals increases by 4–17 times. Moreover, the incidence of age-related diseases in the descendants of centenarians is reduced by 50% (Baranov, 2010). This suggests that the prerequisites for exceptional longevity are more genetic than environmental in nature.

Currently, one of the highest priority areas in the genetics of aging is the search for candidate genes, i.e. genes whose polymorphisms are associated with longevity. The main tool used to carry out such studies is the GWAS method. The GWAS (or genomic association search) method is based on scanning hundreds of thousands of markers located on all human chromosomes. When analyzing the data obtained, the results of the HapMap program are used, which contains all the SNPs of the sequenced genomes.

The role of epigenetic mechanisms in the regulation of the aging process

Observations have shown that the aging process is regulated by not only genetic, but also epigenetic mechanisms that do not affect the nucleotide sequence of DNA. According to modern concepts, one of the most important epigenetic mechanisms involved in the regulation of the aging process is methylation. In connection with the discoveries made in the field of epigenetics over the past decade, considerable attention is now being paid not only to genetic, but also to epigenetic mechanisms of regulation of aging. The fact of the influence of environmental factors on genetic systems is increasingly being confirmed. Impacts such as alcohol, drugs, smoking, and constant stress have a negative impact on the functioning of these systems, which ultimately can lead to a decrease in life expectancy. Therefore, a healthy lifestyle is an integral part of active longevity.

In this regard, the development of healthy lifestyle programs (fighting stress, smoking, alcohol, drugs) is of great importance. This is one of the components of active longevity, which can slow down the rate of aging, as well as delay the onset of age-associated diseases. Unfortunately, there are many difficulties with conducting large-scale studies of the genome of each person and developing a genetic passport. The first steps towards the transition to predictive medicine can be taken now by developing programs for a healthy lifestyle and the prevention of premature aging. However, to achieve maximum effectiveness, preventive measures must be carried out at a young age.

Conclusion

Aging is a complex multi-stage process, which is based on the extinction of many vital functions of the body, which is recorded at different levels of biological organization: molecular, cellular, tissue and organismal. Due to the complex nature of the aging process, many theories have been proposed that reflect age-related disorders of various biological systems, but none of the hypotheses can provide a comprehensive explanation of the mechanism by which aging occurs. However, it is assumed that genetic mechanisms underlie this process. Numerous studies have identified genetic markers of aging, i.e. those genes whose expression changes with age in all cells without exception. The function of the proteins encoded by these genes is associated with ensuring vital cellular processes, such as regulation of the cell cycle and repair of damaged cellular structures. There are other genes whose expression changes with age.

Despite the genetic basis of aging, an important role in the regulation of this process belongs to epigenetic mechanisms that affect gene expression without changing the nucleotide sequence of DNA. It is assumed that methylation plays a major role in epigenetic regulation. Epigenetic mechanisms are influenced by environmental influences, so the rate of aging is determined by environmental factors that can either accelerate or retard aging.

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7岁以上儿童重型颅脑复合伤呼吸频率昼夜节律变化
CIRCADIAN RHYTHM OF RESPIRATORY RATE IN SEVERE COMBINED TRAUMATIC BRAIN INJURY IN CHILDREN OVER 7 YEARS OLD

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摘要。入院当天，第1组4例、第2组9例受伤患儿按指征转入呼吸机，两组均在CMV模式下呼吸机通气时间均为8天。随后几天，随着自主呼吸恢复，根据指征转入SIMV模式，在充分呼吸恢复控制下拔管。第2组患儿的每日呼吸波动比第1组高1-2次/分钟。对第2组患儿进行应激保护治疗具有更多积极作用，可使第2组病情较重的患儿更有效地恢复自主呼吸，而无需重复进行MRS。

关键词：昼夜节律、呼吸、重度复合性脑外伤、儿童。

Abstract. *On the day of admission to the clinic, 4 patients of group 1 and 9 injured children of group 2 were transferred to mechanical ventilation according to indications. The duration of mechanical ventilation in the CMV mode was 8 days in both groups. In the following days, as spontaneous breathing was restored, children were transferred to the SIMV mode according to indications, then extubated under the control of adequate breathing restoration. Daily fluctuations occurred at a higher level by 1-2 breaths per minute in group 2 than in group 1. Stress-protective therapy carried out in children of group 2 had more positive properties, allowing for more effective restoration of spontaneous breathing in more severe patients of group 2 without the need for repeated MRS.*

Keywords: *circadian rhythm, respiration, severe combined traumatic brain injury, children.*

Relevance. The degree of participation of the external respiratory system in compensatory mechanisms of hemodynamic restructuring, the homeostasis system as a whole in the process of adaptation in conditions of traumatic disease caused by acute traumatic brain injury against the background of a severe systemic inflammatory response of the body caused by a large array of damaged tissues, acute cerebral insufficiency is difficult to overestimate. Unfortunately, the most advanced respiratory support devices available in clinical practice are not able to fully provide complex functionally interconnected changes in the external parameters of the respiratory system, capable of immediately rebuilding in the constantly changing conditions of the internal environment of the body, which is in stress mobilization of defense systems under conditions of a general inflammatory reaction, aggravated by the lack of a controlling and corrective function of the brain damaged by traumatic brain injury. In this regard, given the leading compensatory significance of external respiration in ensuring adaptive changes in the homeostasis systems of the children's body, the study, development, and improvement of methods for correcting external respiration is one of the leading tasks of intensive care of critical conditions, including those caused by TBI [1-5]. In light of the above, we made an attempt to study and evaluate changes in the frequency of spontaneous breathing before transfer to mechanical ventilation, as well as after restoration of spontaneous adequate breathing after prolonged mechanical ventilation in school-age children with TBI.

Objective of the work. To study the features of the circadian rhythm of the respiratory rate in severe combined traumatic brain injury in children over 7 years old.

Material and methods of the study. The study included 20 children aged 7.1 to 18 years. Upon admission to the intensive care unit, the victims underwent a set of diagnostic procedures, biochemical blood composition and general analysis, blood clotting potential was studied, chest X-ray and existing bone fracture zones were performed as indicated, and all victims underwent computed tomography of the head. The InjurySeverityScore (ISS) scale was used to assess the severity of the injury. The resulting value (from 1 to 75 points) in digital form shows the severity of the injury. The ISS scale has become the most widely used abroad and is an anatomical standard for injury severity [Demetriades D. et al., 1995; Osier T. et al., 1997; Oestern H.-J., 1997; Tatic M. et al., 2000; Wagner A. K. et al., 2000]. Non-invasive continuous monitoring with hourly recording of parameters, carried out in the intensive care unit, consisted of measuring arterial pressure, AVT, blood oxygen saturation, heart rate (HR), respiratory rate (RR), and myocardial oxygen demand (MOD).

For the period 2018-2022, the components of intensive complex therapy were studied in 10 children (Group 1) aged 7.1-18 years. A comparative analysis was carried out with a group of 10 children identical in diagnosis, age, and severity of condition for 2023-24 (Group 2). No significant differences in age, gender, duration of hospital treatment, or duration of intensive care in the ICU were found. Comparative data on the volume of drug correction in the first 10 days of treatment revealed a significantly higher use of painkillers. Thus, if in Group 1 fentanyl was administered 13.9±5.8 mcg/kg per day, then in Group 2 it was almost 4 times more 52.6±20.9 ($p<0.05$). In group 1, Profol was administered at an average dose of 0.9±0.7 mg/kg/day, and in group 2, the daily dose of Profol administered was 26.7±8.4 mg/kg per day (188% more than in group 1). In group 1, Arduan was administered at 9.0±3.6 mg/kg per day, in group 2 - almost twice as much (16.8±5.6 mg/kg per day). It should be noted that in group 1, due to the short duration of action of the administered drug, GHB 100-150 mg/kg, midazolam, sibazon, and barbiturates were administered liberally. Thus, it was noteworthy that with comparatively large traumatic injury, volume of damage, severity of TBI in dynamics, stress-limiting therapy was significantly increased in group 2 by prolonged administration of the above drugs throughout the day. Due to the severity of TBI, the duration of mechanical respiratory support (MRS) in the CMV mode in 1 patient and the SIMV mode in 1 patient in Group 2 was more than 29 days (Fig. 1, 2).

Results and their discussion. No significant differences in the parameters of the phase structure of the circadian rhythm of the respiratory rate were found in the studied groups (Table 1).

Table 1.

Average parameters of the phase structure of the circadian rhythm, respiratory rate per minute

Groups	Mesor	In acrophase	In the bathyphase	Amplitude	Daily range
1	23±2	26±3	21±2	2±1	4±2
2	25±3	27±4	22±2	3±2	5±2

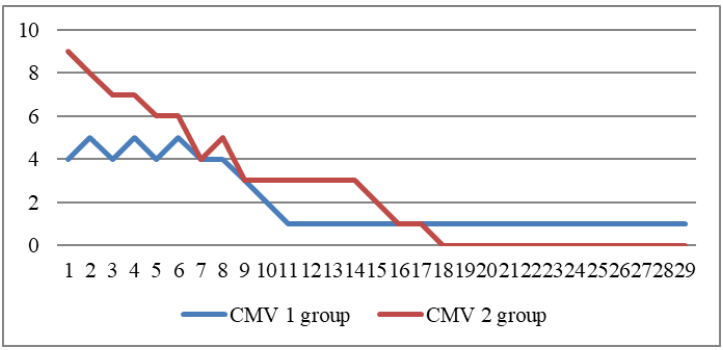

Figure 1. *Patients on artificial ventilation*

On the day of admission to the clinic, 4 patients of group 1 and 9 injured children of group 2 were transferred to artificial ventilation according to indications. The duration of artificial ventilation in the CMV mode was 8 days in both groups (Fig. 1). In the following days, as spontaneous breathing was restored, children were transferred to the SIMV mode according to indications, then extubated under the control of restoration of adequate breathing, reflexes, consciousness according to existing protocols for the management of patients with severe traumatic brain injury, traumatic disease on artificial ventilation (Fig. 3).

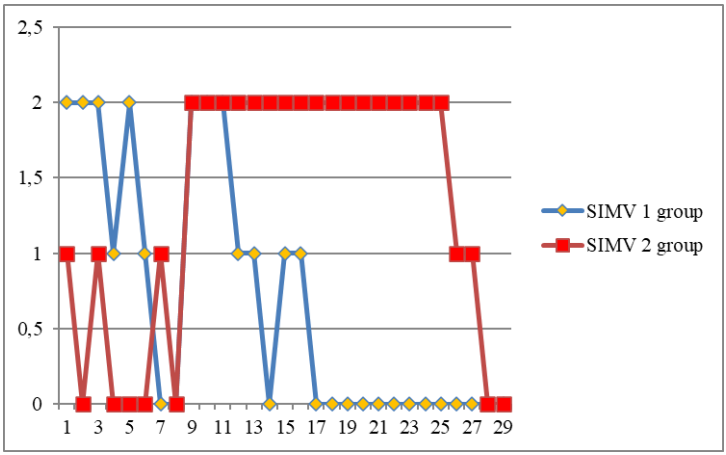

Figure 2. *Number of patients by days with MRS in SIMV*

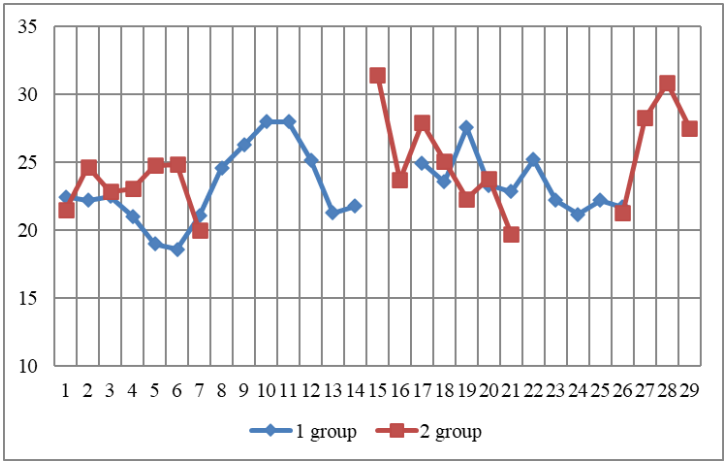

Figure 3. *Dynamics of the mesocircular rhythm of the respiratory rate*

As can be seen from the data presented in Fig. 3, on days 14-17 all injured patients of group 1 were on MRS. In group 2, all patients remaining in the ICU were given artificial ventilation/intact mechanical ventilation until day 15 (Fig. 3).

Table 2.

Dynamics of the mesomorphic circadian rhythm of the RR

Days	1 group	2 group
1	22±1	22±1
2	22±2	25±1
3	22±0,3	23±1
4	21±1	23±1
5	19±1	25±1
6	19±0,2	25
7	21±1	20
8	25±1	мрп
9	26	мрп
10	28±1	мрп
11	28±1	мрп
12	25±2	Мрп
13	21±1	мрп
14	22±1	мрп
15	mrs	31±1
16	mrs	24±1

17	25±1	28±1
18	24±1	25±1
19	28±1	22±1
20	23±1	24±1
21	23±1	20±1
22	25±2	Мрп
23	22±1	Мрп
24	21±1	Мрп
25	22	мрп
26	22±1	21±1
27	mrs	28±3
28	mrs	31±2
29	mrs	28±1

Table 3.

Average circadian rhythm of RR

Hours	**1 group**	**2 group**
8	24±2	25±2
9	24±2	25±3
10	24±2	25±3
11	24±2	25±2
12	23±2	25±3
13	23±2	25±3
14	23±2	24±3
15	23±2	25±2
16	23±2	25±3
17	23±2	25±2
18	23±2	25±2
19	23±2	25±3
20	23±2	25±3
21	23±2	25±3
22	23±2	25±3
23	23±2	25±4
24	23±2	25±3
1	23±2	25±3
2	23±2	25±2
3	23±2	25±3
4	23±2	26±3
5	23±2	25±2
6	23±2	26±3
7	23±3	26±3

As shown in Table 2, no significant differences were found depending on the severity of the condition or drug correction. Analysis of the dynamics of the indicator in terms of studying changes in the average values of the circadian rhythm of the respiratory rate allowed us to state that the projection of the acrophase of the circadian rhythm of the respiratory rate in Group 1 corresponded to the norm (9 a.m.), while in Group 2 a shift in the acrophase of the circadian rhythm of the respiratory rate by 4 a.m. (inversion) was detected. Daily fluctuations occurred at a higher level by 1-2 breaths per minute in Group 2 than in Group 1 (Fig. 4).

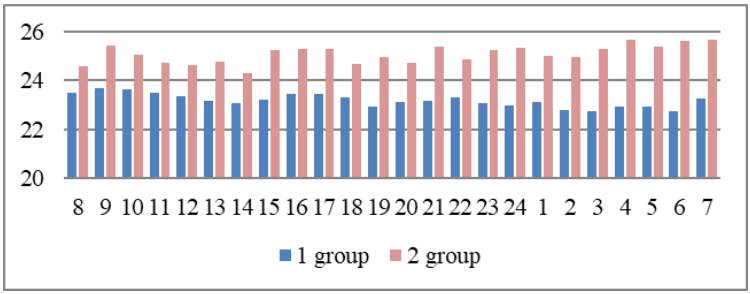

Figure 4. *Average circadian rhythm of RR*

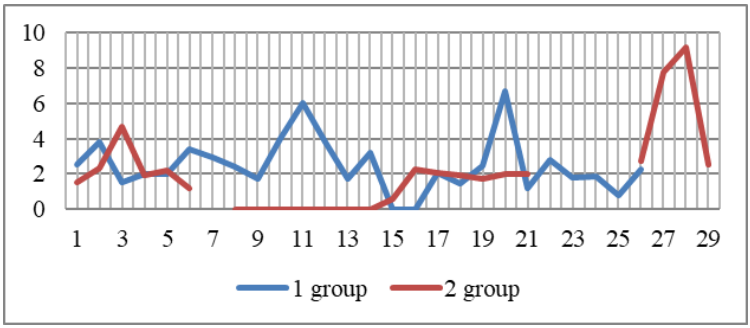

Figure 5. *Amplitude of the circadian rhythm of spontaneous breathing (RR per minute)*

The amplitude, daily fluctuations of RR in the circadian rhythm were characterized by instability, amounting to 6 per minute on the 11th day in group 1, 5 on the 3rd day in group 2 (Fig. 5). It seems that stress-protective therapy carried out in children of group 2 had more positive properties, allowing for a more effective, successful (without the need for repeated MRP) restoration of spontaneous breathing in more severe patients of group 2 (Fig. 6).

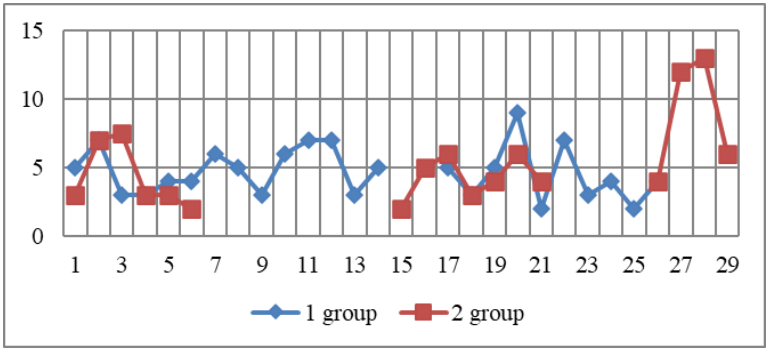

Figure 6. *Daily fluctuations in spontaneous RR per minute.*

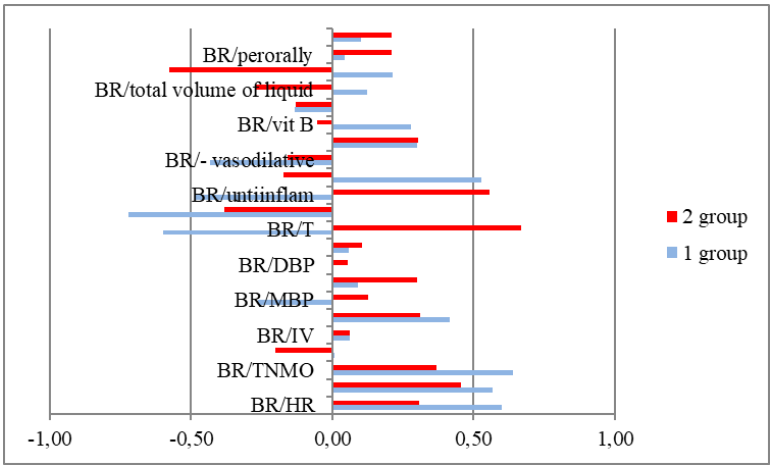

Figure 7. *Correlation relationships of RR.*

In group 1, there was a tendency to form a direct dependence of HR on RR (0.6), while this relationship was significantly weakened in group 2 (0.31). The tendency to restore vegetative regulation was also more pronounced in group 1 (0.57) than in group 2 (0.46). At the same time, in group 1, there was a tendency to compensatory increase in respiratory rate with an increase in MVP (0.64), and in group 2, a decrease in this relationship (0.37) was understood as a more effective protective sedative drug correction for myocardial trophism, i.e. prevention of myocardial hypoxia (Fig. 7). Suppression of the respiratory center function was expressed in a negative reliable relationship between RR and sedative therapy (-0.72) in group 1, which decreased in group 2 (-0.38). A positive effect of paren-

teral infusion therapy on respiratory rate was revealed in group 2 (-0.58), which was absent in group 1 (0.22). An increase in body temperature in group 1 showed a tendency to decrease respiratory rate (-0.6), while in group 2 the hyperthermic reaction was accompanied by a physiological increase in respiratory rate (0.67). That is, in the more severe group, the tendency to form a compensatory reaction to hyperthermia persisted. The duration of inversion was longer in children of group 2, amounting to 41% of the duration of intensive care in the ICU, while in group 1 it was 20%. The findings characterize the adaptive restructuring of the circadian rhythm of respiratory rate in a comparatively more severe condition of children in group 2 (Fig. 8).

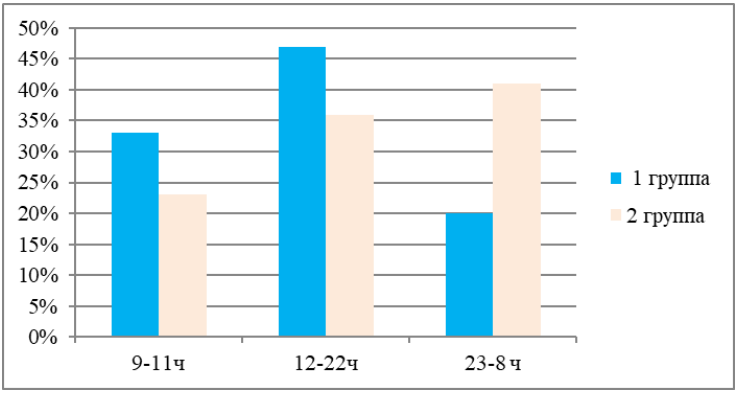

Figure 8. *Duration of circadian rhythm inversion of respiratory rate in %.*

Conclusion. On the day of admission to the clinic, 4 patients of group 1 and 9 injured children of group 2 were transferred to mechanical ventilation according to indications. The duration of mechanical ventilation in the CMV mode was 8 days in both groups. In the following days, as spontaneous breathing was restored, children were transferred to the SIMV mode according to indications, then extubated under the control of adequate breathing restoration. Daily fluctuations occurred at a higher level by 1-2 breaths per minute in group 2 than in group 1. Stress-protective therapy carried out in children of group 2 had more positive properties, allowing for more effective restoration of spontaneous breathing in more severe patients of group 2 without the need for repeated MRP.

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人工通气对幼儿急性脑衰竭血氧饱和度昼夜节律的影响
THE EFFECT OF ARTIFICIAL VENTILATION ON THE CIRCADIAN RHYTHM OF OXYGEN SATURATION IN ACUTE CEREBRAL FAILURE IN YOUNG CHILDREN

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摘要。对有自主呼吸的患者进行强制性氧疗，使用辅助或强制人工通气方法的机械呼吸支持，可使受检幼儿的氧饱和度达到生理年龄水平。第 2 组儿童表现出氧饱和度升高的趋势。长时间人工通气后，患者恢复自主呼吸的过程伴随着中位指数、振幅、氧饱和度昼夜节律的每日波动明显不稳定。第 2 组发现氧饱和度降低对 PMC 有负面影响。所有受试者的平均氧饱和度和体温昼夜节律均有增加，第 1 组为（-0.44），第 2 组为（-0.4），第 93 天为（-0.58）。

关键词：人工通气、昼夜节律、氧饱和度、急性脑衰竭。

Abstract. *Mandatory oxygen therapy of patients with spontaneous breathing, mechanical respiratory support with auxiliary or forced methods of artificial ventilation of the lungs provided the physiological age level of oxygen saturation of the examined young children. A tendency towards a higher level of oxygen saturation was revealed in group 2 children. The process of bringing the patient to spontaneous breathing after prolonged artificial ventilation was accompanied by a noticeable instability of the mesor index, amplitude, daily fluctuation of the circadian rhythm of oxygen saturation. A negative effect of a decrease in oxygen saturation on the PMC was found in group 2. All subjects were found to have a positive effect of an increase in the average circadian rhythm of oxygen saturation and body temperature, which in group 1 was (-0.44), in the first 20 days in group 2 (-0.4), 93 days (-0.58).*

Keywords: *artificial ventilation, circadian rhythm, oxygen saturation, acute cerebral failure.*

Relevance. Normally, saturation in children should be more than 95%, if pulse oximetry shows a value lower, then hypoxia is present. Factors that reduce oxygen saturation in full-term newborns without organic cardiovascular diseases have

been identified - complicated pregnancy and childbirth, polycythemia, decreased myocardial contractility. An increase in the gradient of indicators between the upper and lower extremities is observed with mild cerebral ischemia and in children with high birth weight and length. Each hemoglobin molecule binds to four oxygen molecules in the lungs. When hemoglobin molecules carry the maximum amount of oxygen, the saturation of arterial blood with it is 100%. The concentration of oxygen in the blood can decrease due to infection of the body with the COVID-19 virus, as well as with: chronic obstructive pulmonary disease; pneumonia; severe anemia; blood diseases; bronchial asthma; obstructed airway patency; pulmonary fibrosis, which can also be a complication of coronavirus infection. The risk of decreased saturation appears during pregnancy, when the load on the vessels and heart increases, and the volume of blood in the body increases. The oxygen content in the blood can fall during intense physical exertion, when tissues actively absorb it. In old age, there are often disturbances in the functioning of the respiratory and circulatory systems, which also lead to a decrease in saturation [1-5]. Due to the lack of information on the effect of complicated severe pneumonia on the oxygen saturation indicator, we set the goal of studying the features of the circadian rhythm of oxygen saturation in acute cerebral insufficiency in young children.

Objective of the work. To study the effect of artificial ventilation on the circadian rhythm of oxygen saturation in acute cerebral insufficiency in young children

Material and methods of research. The results of continuous prolonged monitoring with hourly recording of the parameters of oxygen saturation, hemodynamics, and respiration were studied in children admitted to the ICU of the RRCEM in a critical condition caused by infection complicated by acute cerebral and respiratory failure at the age of 5.5 months to 2.5 years. Intensive care was carried out according to the recommendations in the relevant clinical protocols. Group 1 included 8 children with impaired consciousness aged 12.6±5.5 months who had no indications for mechanical respiratory support upon admission to the clinic or during intensive care. Almost all patients of Group 2 (11 children) aged 17.4±6.1 months were transferred to mechanical ventilation according to indications from the moment of admission to the clinic. Impairment of cerebral function was assessed according to the Glasgow scale in group 1 9.1±0.4, in the second 6.5±1.0 points, which corresponded to a reliably significant suppression of brain function by 29%, which determined the duration of MCI, the duration of intensive care in the ICU and in the hospital as a whole. As the condition improved, the impaired organ functions were effectively corrected, reflexes and consciousness were restored, the patients were transferred to a specialized department. The research data were processed by the method of variation statistics using the Excel program by calculating the arithmetic mean values (M) and errors of the mean (m). To as-

sess the reliability of differences in two values, the parametric Student's criterion (t) was used. The relationship between the dynamics of the studied parameters was determined by the method of paired correlations. The critical level of significance was taken to be 0.05.

Results and their discussion.

Mandatory oxygen therapy of patients with spontaneous breathing, mechanical respiratory support with auxiliary or forced methods of artificial ventilation of the lungs provided the physiological age level of oxygen saturation of the examined young children. No significant differences in the mesor indices, the value in the acrophase, bathyphase, changes in the amplitude and daily fluctuations of the circadian rhythm of oxygen saturation in the studied groups were revealed (Table 1).

Table 1.

Average values of the phase structure of the circadian rhythm of the oxygen saturation index in %.

Groups	Mesor	In acrophase	In the bathyphase	Amplitude	Daily range
1	97,1±0,6	98,3±0,6	95,6±1,1	1,2±0,5	2,7±1,1
2	97,9±0,6	99,1±0,6	96,2±1,3	1,2±0,5	2,9±1,3

The circadian rhythm mesoscale indices in the first day and throughout the observation period in groups 1 and 2 did not differ from the normative data (Table 2). The tendency towards a higher oxygen saturation level in group 2 children was noteworthy, demonstrating better blood oxygen saturation even with more severe pneumonia (Fig. 1). The revealed feature of the influence of the MRS on blood oxygen saturation is also confirmed by a relatively higher level of fluctuations in the average circadian rhythm of the oxygen saturation index in patients of group 2 (Fig. 2). The projection of the peak of the oxygen saturation acrophase in group 1 was at 11:00, in group 2 a shift of this index to night time (22:00) was noted.

Table 2.

Measuring circadian rhythm of oxygen saturation in %.

Days	1 group	2 group
1	94,5±1,9	96,6±0,9
2	96,4±0,3	97,6±0,5
3	97,1±0,4	98,0±0,5
4	97,3±0,3	97,3±0,7
5	96,3±0,5	97,7±0,3
6	97,5±0,3	97,0±0,6
7	97,4±0,4	97,3±0,5
8	97,5±0,3	98,5±0,4

9	96,4±0,4	98,1±0,5
10	98,0±0,5	98,4±0,3
11	98,1±0,4	97,9±0,5
12	96,7±0,5	98,0±0,3
13	96,9±0,6	98,2±0,5
14	97,1±0,6	97,4±0,4
15	97,8±0,6	96,9±0,4
16	97,4±0,5	96,9±0,4
17	96,4±1,1	96,4±0,4
18	98,1±0,4	95,6±1,5
19	96,7±0,6	98,1±0,5
20	97,7±0,4	97,8±0,5

Table 3.

Average circadian rhythm of saturation oxygen in %.

Hours	**1 group**	**2 group**
8	97,1±0,7	97,8±1,0
9	97,3±0,7	97,1±1,8
10	97,3±0,7	97,7±0,9
11	97,5±0,5	97,9±1,0
12	97,2±1,0	97,9±1,0
13	97,0±0,8	97,9±1,0
14	97,2±0,7	97,9±0,9
15	97,4±0,8	97,9±0,9
16	97,1±1,1	97,8±1,0
17	97,0±0,9	97,9±0,9
18	96,8±1,0	97,7±0,9
19	97,0±0,9	97,6±1,0
20	96,6±0,7	97,6±1,2
21	97,0±0,7	98,1±0,8
22	96,9±1,0	98,1±0,8
23	97,0±0,8	98,0±0,9
24	97,3±0,7	98,0±0,8
1	97,1±0,7	98,1±0,8
2	97,0±0,8	98,1±0,8
3	97,0±0,5	98,1±0,8
4	96,9±0,8	98,1±0,8
5	97,1±0,7	97,9±0,9
6	97,0±0,6	97,9±0,9
7	97,2±0,6	98,1±0,8

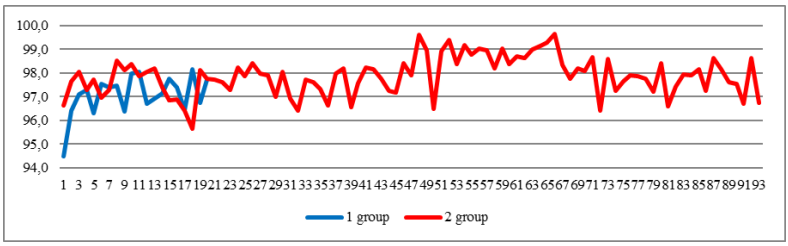

Figure 1. *Mesor of the circadian rhythm of oxygen saturation in %.*

The process of bringing the patient to independent breathing after prolonged mechanical ventilation was accompanied by a noticeable instability of the mesor indicator, amplitude, daily fluctuation of the circadian rhythm of oxygen saturation (Fig. 3, 4), which can have an additional adverse effect on oxygenation at the cellular level, contributing to the aggravation of mitochondrial insufficiency, an energy-deficient state with subsequent fatal multiple organ dysfunction up to irreversible changes in the organs, reducing the effectiveness of complex intensive care, worsening the outcome and prognosis of managing children in critical condition.

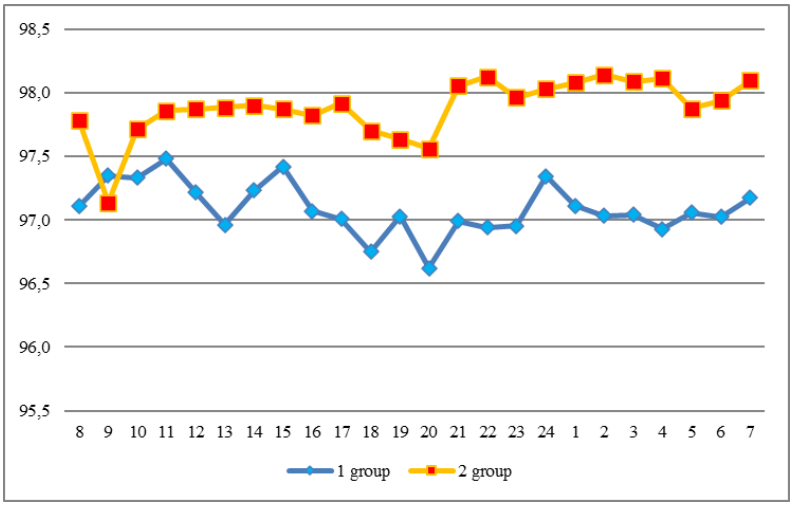

Figure 2. *Average circadian rhythm of oxygen saturation in %.*

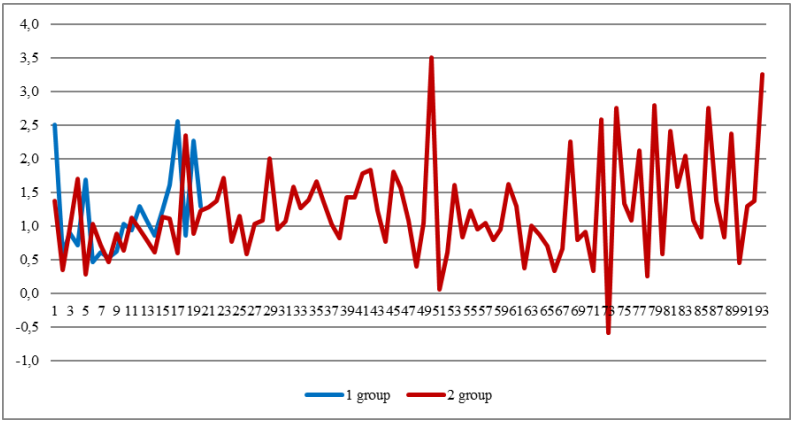

Figure 3. *Amplitude of the circadian rhythm of oxygen saturation in %.*

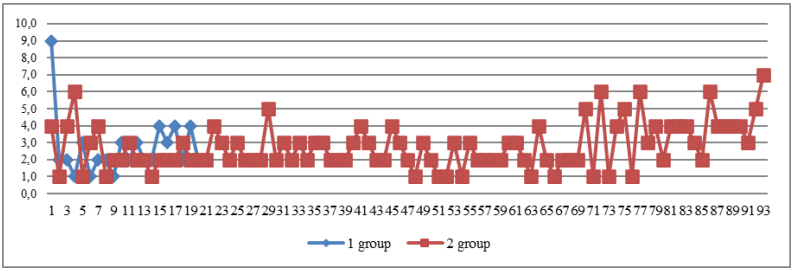

Figure 4. *Range of daily fluctuations in oxygen saturation in %.*

Table 4.

Duration of inversion of the circadian rhythm of the oxygen saturation index

Groups	Norm	Moderate shift	Inversion
	9-11 hours	12-22 hours	23-8 hours
1	50%	35%	15%
2	27%	40%	31%

As shown in Table 4, in Group 1, normal projection of the acrophase of the circadian rhythm of oxygen saturation was noted for 50% of the duration of treatment in the ICU. While in Group 2, the volume of treatment, including MRS, was insufficient to prevent inversion of the circadian rhythm of oxygen saturation for 33 days (31%). Perhaps, the routine preferential volume of infusion therapy (water load) in the first half of the day was of no small importance.

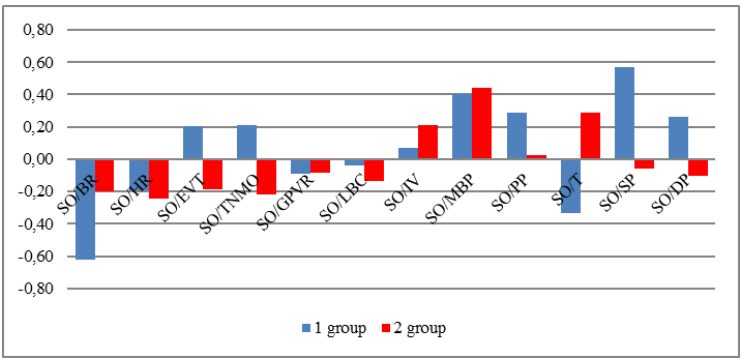

Figure 5. *Correlation links of the mesoscale circadian rhythm of oxygen saturation*

A tendency of direct correlation link of the oxygen saturation index from the level of SBP (0.57) and inverse correlation of oxygen saturation from RR (-0.62) in group 1 was found (Fig. 5). More severe cerebral, respiratory failure of children in group 2 completely disrupted possible compensatory hemodynamic reactions.

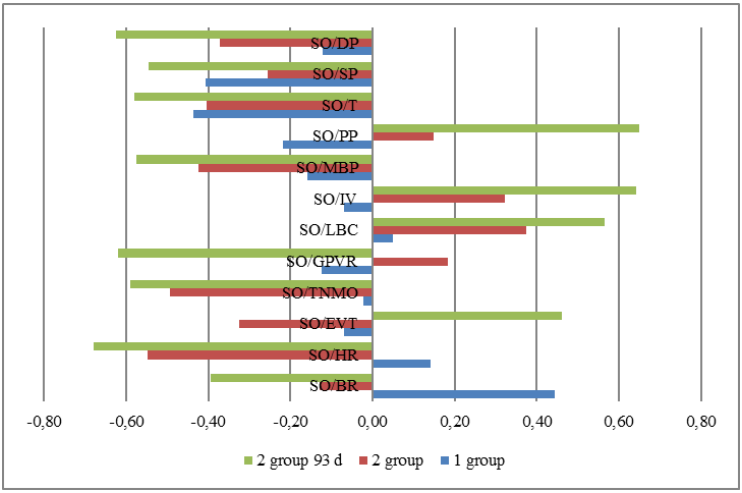

Figure 6. *Correlation relationships of the average circadian rhythm of oxygen saturation.*

The correlation relationships of the average circadian rhythms of oxygen saturation and hemodynamic parameters turned out to be interesting (Fig. 6). Thus, in

group 1, the observed direct tendency of the relationship between oxygen saturation and RR (0.44) in the first 20 days turned into a negative relationship (-0.39) over the course of 93 days. In group 2, a negative correlation of the oxygen saturation index and HR was revealed both in the first 20 days (-0.55) and 93 days (-0.68), which confirms the compensatory increase in heart rate in response to more pronounced hypoxemia in group 2. A negative effect of decreased oxygen saturation on MBF was found in group 2 (-0.59), confirming an additional mechanism for the development of an energy-deficient state of the myocardium with subsequent acute heart failure. The detected feature indicates the advisability of supportive cardiotropic metabolite therapy in severe infection complicated by ACI. An unfavorable factor for hemodynamics is the negative correlation between oxygen saturation and total peripheral vascular resistance (-0.62) in group 2. A positive effect of the increase in the average circadian rhythm of oxygen saturation on the MBV (0.57) and SV (0.64) indicators was revealed in group 2. All subjects showed a positive effect of the increase in the average circadian rhythm of oxygen saturation and body temperature, which in group 1 was (-0.44), in the first 20 days in group 2 (-0.4), 93 days (-0.58). Conclusion. Mandatory oxygen therapy of patients with spontaneous breathing, mechanical respiratory support with auxiliary or forced methods of artificial lung ventilation ensured the physiological age level of oxygen saturation in the examined young children. A tendency towards a higher level of oxygen saturation was revealed in group 2 children. The process of bringing the patient to independent breathing after prolonged artificial ventilation was accompanied by a noticeable instability of the mesor index, amplitude, and daily fluctuation of the circadian rhythm of oxygen saturation. A negative effect of decreased oxygen saturation on the PMC was found in group 2. All subjects showed a positive effect of the increase in the average circadian rhythm of oxygen saturation and body temperature, which in group 1 was (-0.44), in the first 20 days in group 2 (-0.4), 93 days (-0.58).

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慢性心力衰竭患者肾功能损害的评估
ASSESSMENT OF RENAL FUNCTION IMPAIRMENT IN INDIVIDUALS SUFFERING FROM CHRONIC HEART FAILURE

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摘要：慢性心力衰竭（CHF）伴有多种并发症，其中肾功能障碍占据重要地位。CHF患者的肾功能受损与预后不良、住院和死亡风险增加有关。心力衰竭和肾脏疾病具有共同的病理生理机制，可导致相互功能障碍，称为心肾综合征。肾功能障碍是导致疾病进展、心血管并发症发生率高和人群死亡率的常见且独立的因素。

关键词：慢性心力衰竭，肾功能障碍，心肾综合征。

Abstract. *Chronic heart failure (CHF) is accompanied by a high frequency of comorbidities, among which kidney dysfunction occupies a key place. Impaired kidney function in patients with CHF is associated with a worse prognosis, an increased risk of hospitalization and mortality. Heart failure and kidney disease have common pathophysiological mechanisms that can lead to mutual*

dysfunction, known as cardiokidney syndrome. Kidney dysfunction is a common and independent factor in disease progression, high incidence of cardiovascular complications and mortality among the population.

Keywords: *chronic heart failure, kidney dysfunction, cardio kidney syndrome.*

Introduction

Despite significant progress in modern cardiology, chronic heart failure (CHF) remains a disease with an unfavorable prognosis. The mortality rate among patients with CHF exceeds the average for the population by 4-8 times, and almost half of patients die within five years from the date of diagnosis. In cases of CHF functional class (FC) IV, mortality within the first six months reaches critical levels [10].

Heart failure and kidney disease have common pathophysiological mechanisms that can lead to mutual dysfunction, known as cardiokidney syndrome.

It has been revealed that kidney dysfunction in patients with CHF is a significant prognostic indicator of an unfavorable outcome. According to various studies, the frequency of kidney dysfunction in CHF varies from 25% to 60%. One of the early markers of kidney dysfunction is the glomerular filtration rate (GFR) [9]. The development of cardiokidney syndrome in patients with CHF is a natural manifestation of functionally interrelated processes at the organ level. Impaired kidney function is a widespread and independent factor contributing to the progression of the disease, an increase in the incidence of cardiovascular complications and mortality among patients with asymptomatic or clinically expressed CHF. This is due to the pathogenetic mechanisms of CHF development, especially in patients with its ischemic form [2].

Preservation of subclinical kidney dysfunction during treatment, even when control over RF (risk factors) is achieved and organ damage regresses, can negatively affect the patient's prognosis. Analysis of the functional state of the kidneys plays a key role in determining optimal preventive and therapeutic strategies. [12].

In patients with heart failure, kidney dysfunction is associated with hemodynamic and non-hemodynamic factors. Both a decrease in kidney blood flow and blood congestion in the kidneys due to heart failure can lead to impaired kidney function. Kidney disease and kidney function impairment are independently associated with poor prognosis in patients with both acute and chronic heart failure [4].

Systemic oxidative stress and increased levels of proinflammatory cytokines in the blood play a key role in the development of this condition, leading to the loss of negative charges of glomerular capillary endothelial cells and increased glomerular filter permeability. An additional factor in the development of kidney dysfunction is glomerular hypertension, which is observed already at the early stages of heart failure progression and is associated with kidney hemodynamic disturbances [8].

Thus, accurate diagnosis of kidney function is crucial in the treatment of patients with heart failure. In clinical practice, the main indicators of kidney function are serum creatinine levels and glomerular filtration rate (GFR). However, in order to overcome the limitations of these methods, new biomarkers reflecting the state of glomeruli and tubules have been proposed in recent years. In addition to these biomarkers, imaging techniques such as kidney blood flow Doppler provide important data for the analysis of pathophysiological processes and help identify patients with heart failure prone to developing kidney dysfunction and worsening prognosis [11].

Objective of the study

To study the relationship between kidney dysfunction and the clinical course of the disease, quality of life and indices of left ventricular systolic function in patients with CHF.

Materials and methods

The study involved 135 patients with CHF of functional classes I–III according to the New York Heart Association (NYHA) classification. Among them, 63 people (46.6%) were women and 72 (53.4%) were men. The average age of the participants was 64.53 ± 0.5 years. (Table 1).

Table 1

Clinical characteristics of patients

General CHF patients	100 (100%)
Men	72 (53.4%)
Women	63 (46.6%)
CHF I FC	31 (22.9%)
CHF II FC	50 (37.1%)
CHF III FC	54 (40%)
LVEF<40%	12 (8.9%)
LVEF = 40–49%	44 (32.6%)
LVEF >50%	79 (58.5%)
GFR >60 ml/min/1.73 m^2	74 (54.8%)
GFR ≤60 ml/min/1.73 m^2	61 (45.2%)

CHF: chronic heart failure, FC: functional class, LVEF: left ventricular ejection fraction, SCF: glomerular filtration rate.

Exercise tolerance was assessed (6-minute walk test), the clinical condition was assessed using the clinical assessment scale, and (QOL) the quality of life of patients with CHF was assessed using the Minnesota questionnaire. The functional state of the kidneys was assessed: the creatinine level was determined, the

SCF was calculated using the CKD-EPI formulas. Kidney blood flow was studied using a SONOACEX6 ultrasound device (South Korea) using the color Doppler mapping method.

Pulse-wave and power Doppler mapping with a 3.5 MHz sector sensor at a scanning angle of up to 60 ° were also used for the study. The following parameters were analyzed: systolic velocity (Vs), diastolic velocity (Vd), mean blood flow velocity (Vmean), resistive index (RI) and pulsatility index (PI), measured at the level of the right and left kidney arteries, as well as in segmental and lobar arteries.

Structural and functional changes in the myocardium and left ventricular (LV) remodeling were assessed using a MEDISON ACCUVIX V20 echocardiograph (South Korea) with a 3.25 MHz sensor. The study was performed using the transthoracic method in standard positions, in accordance with the recommendations of the American Association of Echocardiography.

Left ventricular systolic function was assessed by measuring its LV end-systolic and diastolic volumes (LVESV), LV end-diastolic volume (LVEDV) and LV ejection fraction (LVEF), which were calculated based on data obtained using the Simpson formula.

Patients with acute decompensated heart failure (HF), acute deterioration of kidney function or severe kidney failure (SCF<15 ml/min) were excluded from the study.

The data obtained during the study were processed using a Pentium-IV personal computer and Microsoft Office Excel-2020 software, which includes built-in functions for statistical analysis. Parametric and nonparametric statistics were used, with the calculation of mean values (M), standard deviation (SD), standard error of the mean (m) and relative values (in percentages and frequencies). Comparison of mean values was carried out using the Student's t-test with the determination of the probability of error (p). The normality of distribution was assessed by the excess criterion, and the equality of variances was assessed using Fisher's F-criterion. Dynamic changes were analyzed using the corresponding paired criteria. If the number of groups was more than two, the differences between the mean values were assessed using one-way ANOVA. Differences were considered significant at a significance level of $p<0.05$. For qualitative variables, the chi-square criterion and z-criterion were used. The relationship between the features was determined by calculating the Pearson correlation coefficient (r).

Results

To analyze the clinical and functional characteristics of patients with CHF FC I–III, taking into account the degree of kidney failure, all study participants were divided into two groups. The first group included 74 patients with CHF FC I–III and SCF>60 ml/min/1.73 m², and the second group included 61 patients with CHF FC I–III and SCF ≤60 ml/min/1.73 m².

The results of the study showed that in patients of the first group, the average distance covered in the 6-minute walk test was 293.2±12.5 m. In the second group, where SCF was ≤60 ml/min/1.73 m², physical tolerance was lower: the average distance was 231.6±14.4 m, which is 21% less than in the first group (p<0.001).

Analysis of clinical symptoms based on the clinical assessment scale data showed that the average score in patients of the first group was 5.4±0.17 points. At the same time, patients of the second group, with an SCF≤60 ml/min/1.73 m², showed a deterioration in the clinical condition. This was manifested by an increase in the total score of the clinical assessment scale by 14.81% compared to the first group (p<0.001), reaching a value of 6.2±0.2 points. (Table 2).

Table 2

Indicators of physical activity tolerance and quality of life in patients with chronic heart failure (CHF) I–III FC depending on the severity of the disease (M±SD)

Indicators	6-minute walk test, meter	Minnesota questionnaire, points	Clinical assessment scale, points
GFR >60 ml/min/1.73 m² (n=61)	293.2±12.5	38.6±0.7	5.4±0.2
GFR ≤60 ml/min/1.73 m² (n=74)	231.6±14.4***	41.4±0.6***	6.2±0.2***

***p<0.001 compared to the group of patients with CHF with SCF>60 ml/min/1.73 m². SCF- glomerular filtration rate, M- mean value, SD-standard deviation.

Analysis of the Minnesota questionnaire data demonstrated that the level of quality of life of patients with chronic heart failure (CHF) is associated with the severity of kidney dysfunction. As the severity of kidney failure progressed, the overall indicator of the patients' quality of life worsened, which was expressed in an increase in the total score on the Minnesota scale. In particular, the initial indicators of the patients' quality of life according to the Minnesota questionnaire showed that the overall indicator in patients of group I with SCF>60 ml/min/1.73 m² was 38.6 ± 0.7 points. As CKD progressed, the overall quality of life score increased by 7.25% compared to Group I and was 41.4 ± 0.6 points (p<0.001) in Group II patients with SCF ≤60 ml/min/1.73 m².

Analysis of kidney blood flow in patients with CHF with SCF >60 ml/min/1.73 m² revealed significant changes in hemodynamic parameters of the kidney arteries (right and left) compared to the group with SCF >60 ml/min/1.73 m².

The pulsatility index (PI) decreased by 17.2% in the left, indicating a decrease in blood flow pulsatility. The resistance index (RI) also decreased by 13.16%, indicating a decrease in vascular resistance in the right kidney artery. The average blood flow velocity (Vmean) in the right kidney artery increased by 7.34% compared to the left, where the increase was 4.19%. This may indicate an increase in the overall blood flow in the right artery. Diastolic blood flow velocity (Vd) decreased by 6.40%, indicating a slowdown in blood flow during the diastolic phase. Systolic blood flow velocity (Vs) in the right kidney artery increased by 15.57%, while in the left artery the increase was only 4.57%. Also, changes in the parameters of kidney hemodynamics at the level of the left segmental kidney arteries, the pulsatility index (PI) decreased by 17.24%, which also indicates a significant decrease in the pulsation of blood flow in the left segmental kidney artery. The resistance index (RI) decreased by 11.81%, indicating a decrease in vascular resistance. The mean blood flow velocity (Vmean) increased by 7.18%, although in comparison with the right kidney artery it was 4.25%. The diastolic blood flow velocity (Vd) decreased by 4.88%, which also indicates a decrease in diastolic velocity. The systolic blood flow velocity (Vs) significantly decreased by 4.57%, which indicates a significant deterioration in systolic blood flow in the right segmental kidney artery. In patients with SCF ≤60 ml/min/1.73 m², there is a significant decrease in pulsatility and resistance parameters in all arteries, indicating a decrease in vascular resistance. Velocity parameters, especially systolic (Vs) and mean (Vmean), are usually increased, which may indicate adaptive changes in hemodynamics. These effects are more pronounced in the right kidney artery. Kidney dysfunction associated with CHF has a significant impact on various parameters of blood flow in the kidney arteries, with changes in the left kidney artery being more pronounced than in the right. (Table 3).

Table 3

Changes in kidney hemodynamic parameters (kidney and segmental arteries) in patients with CHF depending on the degree of kidney dysfunction (M ± SD)

Indicators		**Vs см/сек**	**RI**	**Vd см/сек**	**Vmean cm/s**	**PI**
Right kidney artery	GFR >60 ml/min/1.73 m^2 (n=61)	68.1±2.8	15.2±2.4	12.5±0.7	21.8±0.5	9.8±1.3
	GFR ≤60 ml/min/1.73 m^2 (n=74)	78.7±5.3	12.5±2.4	11.5±0.7	23.4±0.6	7.5±1.2

Left kidney artery	GFR >60 ml/min/1.73 m² (n=61)	39.4±2.5	15.2±2.4	12.5±0.7	21.5±0.6	8.7±1.2
	GFR ≤60 ml/min/1.73 m² (n=74)	41.2±2.5	13.2±2.4	11.7±0.7	22.4±0.6	7.2±1.1
Right segmental kidney artery	GFR >60 ml/min/1.73 m² (n=61)	32.9±2.1	12.7±2.0	12.3±0.7	21.2±0.5	8.1±1.2
	GFR ≤60 ml/min/1.73 m² (n=74)	34.4±2.1	11.2±2.1	11.7±0.7	22.1±0.5	6.6±1.1
Left segmental kidney artery	GFR >60 ml/min/1.73 m² (n=61)	30.5±1.9	12.2±1.9	11.3±0.7	19.5±0.5	7.6±1.1
	GFR ≤60 ml/min/1.73 m² (n=74)	32.8±1.9	10.5±1.9	11.3±0.7	20.9±0.5	6.3±0.9

Where *significance $p<0.05$, **significance $p<0.01$ between groups.

Similar changes were recorded in the segmental kidney arteries on both the right and left sides in patients with chronic heart failure and glomerular filtration rate ≤60 ml/min/1.73 m². The increase in the resistance index (RI) was 15.9% ($p<0.05$) and 14.6% ($p<0.01$), and the pulsatility index (PI) was 31.1% ($p<0.001$) and 32.8% ($p<0.001$). A decrease in the mean blood flow velocity (Vmean) by 24.1% ($p<0.01$) and 22.5% ($p<0.001$) was also noted, and diastolic blood flow velocity (Vd) by 16.7% ($p<0.05$) and 15.3% ($p<0.05$), respectively, compared with the values in patients with CHF and a SCF level above 60 ml/min/1.73 m². In patients with CHF and kidney failure, changes were noted at the level of lobar and segmental kidney arteries, characterized by a significant increase in the pulsatility index (PI) and resistance index (RI), as well as a decrease in diastolic (Vd), systolic (Vs) and mean blood flow velocity (Vmean). Analysis of left ventricular (LV) systolic function depending on the presence of kidney failure showed that in the second group (SCF ≤60 ml/min/1.73 m²) there was an increase in LV end-diastolic volume (LVEDV) by 13.4% ($p<0.001$) and LV end-systolic volume (LVESV) by 28.4% ($p<0.001$) compared to the first group (SCF>60 ml/min/1.73 m²). Parameters of LV ejection fraction (LVEF) and LV fractional shortening (Fs%) in the group with SCF ≤60 ml/min/1.73 m² also had significant differences: a decrease in LVEF by 9.6% ($p<0.001$) and Fs% by 6.9% ($p<0.001$). (Table 4).

Table 4

Left ventricular systolic function in patients with chronic heart failure (CHF) depending on glomerular filtration rate (M ± SD)

Indicators	LVEF, %	LV EDV, ml	LV ESV, ml	HR, min	FS%
GFR >60 ml/ min/1.73 m^2 (n=61)	56.2±1.4	87.2±5.7	45.5±2.8	69.5±1.5	39.1±2.1
GFR ≤60 ml/ min/1.73 m^2 (n=74)	50.8±0.87***	98.9±6.2***	58.4±4.2***	69.7±1.6	36.4±2.3***

***p <0.001 — significance of differences between the parameters in patients with SCF ≤60 and SCF>60 ml/min/1.73 m2. SCF-glomerular filtration rate, M-mean value, SD-standard deviation, LVEF-left ventricular ejection fraction, LVEDV-left ventricular end-diastolic volume, LVES-left ventricular end-systolic volume.

It was observed that in the group with SCF>60 ml/min/1.73 m2, there is a moderate positive relationship between the glomerular filtration rate (SCF) and the left ventricular ejection fraction (LVEF) (r=0.54). In the group with SCF ≤60 ml/min/1.73 m², a strong negative correlation was found between these parameters (r = -0.83), indicating a significant decrease in LV function with a decrease in SCF.

Discussion

Impaired kidney function is one of the key prognostic factors for an adverse outcome in patients with chronic heart failure (CHF), exceeding in significance even the severity of CHF and the left ventricular ejection fraction (LVEF). With a decrease in the glomerular filtration rate SCF below 60 ml/min/1.73 m², the risk of death increases by 2.1 times. In patients with impaired systolic function of the left ventricle, the probability of death in CHF increases by 3.8 times, and with preserved systolic function - by 2.9 times. The main parameter determining the prognosis in CHF is LVEF, while creatinine level is an independent predictor of adverse outcome [3].

Kidney dialysis in patients with chronic heart failure (CHF) significantly affects the clinical course of the disease and reduces the quality of life. This is due to the deterioration of the cardiovascular system and kidneys, which worsens cardiokidney relationships. Such negative changes occur against the background of complex disorders of the autonomic and neurohumoral regulation of the body [14].

Pronounced changes in the structure of the heart in patients with chronic heart failure (CHF) and their further aggravation are associated with the activation of the neurohumoral system. This process stimulates the launch of a number of

pathogenetic mechanisms, such as the sympathetic-adkidney and renin-angiotensin-aldosterone systems. These mechanisms play a key role in cardiac remodeling and deterioration of cardiokidney interactions [5]. In patients with chronic heart failure (CHF), neurohumoral mechanisms are activated to compensate for decreased tissue perfusion. However, excessive sympathetic nervous system activity caused by impaired baroreceptor reflexes leads to increased renin secretion by juxtaglomerular cells of the kidneys. Increased renin concentration stimulates the synthesis of angiotensin II, which has a systemic maladaptive effect on the heart, vascular system, and kidneys. In the kidneys, angiotensin II promotes narrowing of the efferent arterioles and an increase in the proportion of plasma passing through glomerular filtration [13]. A decrease in kidney blood flow or perfusion pressure stimulates the release of renin by juxtaglomerular cells of the afferent arterioles. This is due to a decrease in blood flow in the ascending limb of the loop of Henle and activation of pressure-sensitive baroreceptors. This results in sodium retention, increased vascular congestion and deterioration of kidney function due to narrowing of kidney afferent arterioles [6]. Ciccone et al. confirmed that quantitative assessment of kidney arterial perfusion is a new parameter that independently predicts outcome in patients with CHF, supporting its possible role in current clinical practice to more accurately assess kidney function and predict prognosis in patients [1].

In the works of M. Iacoviello and his co-authors the association between impaired kidney blood supply and deterioration of their functional state in patients with CHF was investigated in univariate and direct stepwise multivariate logistic regression analysis showed that in the subgroup of patients with higher values of the resistive index there was a progressive increase, changes in the absolute level of creatinine ($p < 0.001$ by ANOVA analysis) and a relative decrease in SCF-EPI ($p < 0.05$ by the results of variance analysis), as well as an increased risk of deterioration of kidney function. In patients with deterioration of kidney function compared to patients without deterioration of kidney function, the probability of hospitalization for HF is increased. Moreover, after 1 year they had a more significant absolute decrease in LVEF and a more frequent deterioration in functional state, defined as an increase in the NYHA class. The optimal cutoff value for the RI index is 70 with a sensitivity of 91% and a specificity of 50%, and its potential role in modern clinical practice for more accurate determination of the risk of cardiokidney syndrome progression is increasing [7].

Conclusion

Thus, in patients with CHF, assessment of kidney blood flow provides information on cardiokidney pathophysiology, reflecting the effect of hemodynamics on kidney function, and can facilitate early diagnosis of kidney dysfunction. In patients with CHF and impaired kidney function, changes in kidney blood flow were

characterized by a significant increase in pulse and resistive indices, a decrease in kidney blood flow velocity at the level of lobar and segmental kidney arteries.

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Authors' contribution:

Zakirova G.A. - planning, analytics.

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Dusanova N.M., Sadieva Z.A. - examination of patients, standardization of research methods, work with databases.

Mirzaev R.Kh. - statistics.

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基于结缔组织细胞的细胞疗法治疗口腔黏膜缺损的前景
PROSPECTS OF USING CELL THERAPY BASED ON CONNECTIVE TISSUE CELLS TO TREAT ORAL MUCOSA DEFECTS

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摘要。本文介绍了基于成纤维细胞的细胞疗法在口腔黏膜缺损中的应用实验研究结果。整个研究期间白鼠血清的生化研究结果与对照值和参考值没有统计学上的显著偏差，表明应用细胞疗法和组织工程方法的有效性。形态学分析结果表明，使用基于成纤维细胞的细胞疗法和组织工程结构诱导上皮细胞和成纤维细胞的分化以及血管化，在观察的第 3 天和第 7 天统计学上更为显著。

应用基于结缔组织细胞的疗法来优化口腔黏膜缺损的愈合是辅助的，有助于实现最佳效果。

关键词：口腔黏膜缺损、成纤维细胞、实验研究、再生。

Abstract. *This article presents the results of an experimental study on the use of cell therapy based on fibroblasts in oral mucosal defects. The biochemical study results of the serum from white rats throughout the research period showed no statistically significant deviations from control and reference values, indicating the effectiveness of the applied cell therapy and tissue engineering methods. Morphological analysis results revealed that the use of cell therapy and tissue-engineered structures based on fibroblasts induced the differentiation of epithelial cells and fibroblasts, as well as vascularization, statistically more significant predominantly on the 3rd and 7th day of observation. The application of connective tissue cell-based therapy to optimize the healing of oral mucosal defects is auxiliary and helps achieve optimal results.*

Keywords: *oral mucosal defects, fibroblasts, experimental study, regeneration.*

Patients who have undergone extensive surgeries that result in defects in the oral cavity become socially disabled, so the question of immediate functional and cosmetic rehabilitation takes priority, which involves planning and performing reconstructive-restorative surgery alongside the main procedure. Constant contact of the transplanted graft with saliva and the flora of the oral cavity, which

has high virulence, must be considered. The graft used in the oral cavity should be reliable enough to withstand constant functional loads and possess good regenerative properties [4]. At the same time, grafts moved to the oral cavity must adapt well to local tissues and, therefore, be optimal in quality, elasticity, and thickness. Interest in transplanting cultured autologous fibroblasts from the patient arises from the possibility of creating a permanent graft with minimal trauma to the patient's own tissues. The use of dermal fibroblasts is a promising method for treating skin defects [2,3]. These cells can be easily cultured in laboratory conditions without losing their functions. Due to their key role in maintaining tissue homeostasis, fibroblasts, more than any other cells, are capable of effectively creating conditions for the proliferation and migration of other cell types[1,5,6]. The aim of this study was to clinically and experimentally justify the application of cell therapy based on autologous fibroblasts in oral defects.

Materials and Methods

The experiment involved healthy adult white rats of the Wistar strain, weighing 180–220 g. The animals were kept in compliance with sanitary rules for the equipment and housing of experimental animals. The rats were fed natural and pelletized food according to approved norms and underwent quarantine and acclimatization for 14 days in the vivarium. Each experimental group, including the control, consisted of 6 animals with similar body weight. After creating the experimental model of the defect, the animals were kept under identical conditions and on a regular diet.

The study of reparative regeneration of the tissue-engineered structure made from silk gauze and allofibroblasts, conditionally called "SG+AF," was carried out at the Tashkent Scientific Research Institute of Vaccines and Sera, in accordance with the normative and methodological documents of the Republic of Uzbekistan and the European Convention for the Protection of Vertebrate Animals used for Experimental Research (ETS No. 123, Strasbourg, 1986).

The distribution of the rats into groups based on the treatment used was as follows:

- I group: silk gauze + fibroblasts;
- II group: silk gauze + fibroblasts + additional fibroblast injections;
- III group: silk gauze only;
- IV group: fibroblast injection only;
- V group: defect without treatment.

The creation of a model for an experimental surface defect in the oral mucosa was accomplished by creating a circular mucosal defect measuring 0.5 x 0.5 centimeters in diameter using a scalpel in the buccal area, after pretreating the surgical field. A tissue engineering construct (TEC) containing allofibroblasts was then placed in the created defect and fixed with sutures.

Observation was conducted at 1, 3, 5, 7, and 14 days. The overall condition of the animals, clinical signs of possible intoxication, feed and water consumption, changes in body weight, behavior, and activity levels were evaluated. A biopsy and blood samples for biochemical analysis were taken on days 3 and 7.

Results

The proposed scheme for the use of autofibroblast injections in combination with silk boiled gauze with autofibroblasts to optimize the condition of the tissues of the surgical field will improve the functional results of treatment, while simultaneously addressing a number of serious issues: a significant reduction in the severity of operations and the resulting reduction in postoperative complications. The hematological and biochemical studies of the peripheral blood and serum of the rats did not show any statistically significant deviations from control values, confirming the safety and non-toxicity of the applied methods. The study of biochemical indicators of the serum showed that the levels of aminotransferase enzymes (ALT, AST), alkaline phosphatase, and other markers remained within the physiological norm. Furthermore, the morphological analysis demonstrated that the use of fibroblast-based tissue-engineered constructs induced differentiation of epithelial cells and fibroblasts, as well as vascularization, which was statistically significant mainly on the 3rd and 7th day.

Conclusion

The use of cell therapy to optimize the healing of oral mucosal defects is an auxiliary method that helps achieve optimal results. However, there are factors that should be considered when applying this method, as cell therapy is an expensive procedure. Despite this, the undeniable advantages of cell therapy justify its clinical application, making it a promising approach for treating patients with oral mucosal defects.

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北方地区居民 COVID-19 合并症患者血液学指标的预后价值
PROGNOSTIC VALUE OF HEMATOLOGICAL INDICES IN COVID-19 INFECTION IN COMORBID PATIENTS, RESIDENTS OF THE NORTHERN REGION

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摘要。冠状病毒感染中的血液学疾病非常重要。实验室参数的评估在为冠状病毒感染或疑似感染患者开药和调整治疗方面起着重要作用。对这些疾病中的血液学参数（内源性中毒和免疫反应指标）的研究将使我们能够更清楚地确定患者的管理和预后策略。该研究的目的是评估血液学指标在冠状病毒感染急性病程中合并症患者的诊断和预后意义，以评估其病程和结果的意义。研究结果。几乎所有的中毒指标，尤其是死亡患者的中毒指标都超过了参考值，死亡患者的白细胞中毒指数和Reis白细胞中毒指数明显较高。免疫反应指标：淋巴细胞-嗜酸性粒细胞比例指数和中性粒细胞反应指数显著升高，中性粒细胞-淋巴细胞比例指数显著低于参考值，单核细胞-淋巴细胞比例指数与常态无差异。同时，死于COVID-19感染的患者的白细胞中毒指数、Reis白细胞中毒指数、核指数、中性粒细胞-淋巴细胞比例指数、单核细胞-淋巴细胞比例指数和中性粒细胞反应指数的值与95%和99%概率的幸存者的值不同。结论。60岁以上患者的年龄、合并症高、中毒指标值高、免疫反应指标值低决定了COVID-19感染急性期的预后不良。

关键词：COVID-19感染、合并症、指标的预后价值。

Abstract. *Hematological disorders in coronavirus infection are of great importance. Evaluation of laboratory parameters plays an important role in prescribing drugs and adjusting treatment for patients with coronavirus infection or suspected of it. The study of hematological parameters - indices of endogenous intoxication and immunological reactivity in these diseases will allow us to more clearly determine the tactics of patient management and prognosis. The aim of the study is to evaluate the diagnostic and prognostic significance of hematological indices in the acute course of coronavirus infection in comorbid patients to assess the significance of its course and outcomes.* ***Study results.*** *Almost all intoxication*

indices, especially in deceased patients, exceeded the reference values, and the leukocyte intoxication index and the Reis leukocyte intoxication index were significantly higher in deceased patients. Indices of immunological reactivity: the lymphocyte-eosinophil ratio index and the neutrophil reactive response index were significantly higher, the neutrophil-lymphocyte ratio index was significantly lower than the reference values, and the monocyte-lymphocyte ratio index did not differ from the norm. At the same time, the values of the leukocyte intoxication index, the Reis leukocyte intoxication index, the nuclear index, the neutrophil-lymphocyte ratio index, the monocyte-lymphocyte ratio index, and the neutrophil reactive response index in patients who died from COVID-19 infection differed from the values in survivors with 95% and 99% probability. Conclusions. An unfavorable prognosis for the acute phase of COVID-19 infection is determined by the age of patients 60 years and older, high comorbidity, high values of intoxication indices, and low values of immunological reactivity indices.

Keywords: *COVID-19 infection, comorbidity, prognostic value of indices.*

Relevance. The challenges to modern man are chronic non-communicable diseases, the mortality from which, according to the World Health Organization, reaches 71% of all deaths in the world, and emerging infections spreading in epidemics [1, 2]. A large number of chronic non-communicable diseases in 1 person - comorbidity, determines polypharmacy. In the 21st century, the challenges to humanity among viral infections include Sars-Cov-2 infection, the spread of which required the declaration of a pandemic, which claimed 7,010,569 and 404,756, or 0.99% and 1.67% of all infected, respectively, from the beginning of 2020 to April 9, 2024, in the world and in Russia [3, 4]. This infection creates problems for a person with a comorbid background of chronic non-communicable diseases, both in its acute phase and in late periods, since it has been proven that age and comorbidity are predictors of a severe course of Sars-Cov-2 infection and its adverse outcomes, the development of de novo pathology [5-7]. It has reduced the life expectancy of Russians from 73.4 years to 70.1 years, continuing to have a negative impact [8-11]. The body's response determines the prognosis for the patient, and the severity of endogenous intoxication is regulated by the immune system [12-15]. Great importance is attached to hematological disorders in coronavirus infection [16-18]. Evaluation of laboratory parameters plays an important role in prescribing drugs and adjusting the treatment of patients with COVID-19 or suspected of having it. The study of hematological parameters - indices of endogenous intoxication and immunological reactivity in these diseases will allow us to more clearly determine the tactics of patient management and prognosis. The purpose of the study is to evaluate the diagnostic and prognostic significance of hematological indices in the acute course of COVID-19 infection in comorbid patients to assess the significance of its course and outcomes.

Materials and research methods. The work was carried out according to the research plan of the Department of Internal Medicine of the *Budgetary Institution* (BI) of Higher Education of *the Khanty-Mansi Autonomous Okrug* (KhMAO) - Yugra "Surgut State University" and the topic "Predictors of the Genesis of Development, Course and Outcomes of Chronic and Comorbid Diseases" (No. 123060100028 - 5) at the clinical bases of the BUKhMAO-Yugra "Surgut City Clinical Polyclinic No. 3", in the anti-*COVID* hospital deployed on the basis of the BUKhMAO-Yugra "Surgut District Clinical Hospital" for the period from 16.06.2020 to 23.11.2023. A two-stage study was conducted to assess the prevalence of *COVID-19* infection in the assigned population, its severity, gender and age parameters, comorbidity with calculation of the *Charlson comorbidity index* (CCI), course, complications, outcomes of 471 (6.33%) hospital cases out of all 7,449 (17.1%) cases from 43,653 attached contingent. Of the 471 hospitalized, 277 (58.8%) and 194 (41.2%) patients had moderate and severe/extremely severe course. The diagnosis of COVID-19 infection in all 7,449 (17.1%) cases was established in accordance with the codes of the International Classification of Diseases (ICD-X) as U07.1 (Coronavirus infection COVID-19, the virus has been identified) upon isolation of Sars-Cov-2 RNA by the *polymerase chain reaction* (PCR) method, and as U07.2 (Coronavirus infection COVID-19, the virus has not been identified) based on the clinical and epidemiological history. Diagnosis of COVID-19 infection and chronic non-communicable diseases was carried out on the basis of current temporary clinical recommendations using the entire range of laboratory and instrumental arsenal [19]. Comorbidity, ICH, hematological indices (intoxication and immunological resistance) were assessed in 167 (35.5%) of 471 hospitalized comorbid patients with COVID-19 infection, divided into 2 groups according to its outcomes - in 96 recovered and in 71 died from it.

4 intoxication indices were studied: 1. Leukocyte intoxication index Ya.Ya. Kalf-Kalifa (LII) – 4 myelocytes + 3 metamyelocytes + 2 band neutrophils + 1 segmented neutrophil x plasma cells + 1 / (monocytes + lymphocytes) × (eosinophils + 1) – with reference values from 0.62 ± 0.09 to 1.6 ± 0.5; 2. Leukocyte intoxication index of B.A. Reiss (LIIr) - myelocytes + metamyelocytes + band neutrophils + segmented neutrophils / monocytes + lymphocytes – eosinophils - with reference values 1-1.6; 3. Leukocyte to ESR ratio index (LESR) of S.I. Shevchenko et al. – leukocytes x ESR/100 – with reference values of 1.87 ± 0.76; 4. Nuclear index (NI) of G.D. Dashtanyants – monocytes + metamyelocytes + band neutrophils / segmented neutrophils – with reference values of 0.05-0.01; and 4 indices of immunological reactivity: 1. Neutrophil-to-lymphocyte ratio index (NLR) of S.I. Mustafina et al. – segmented neutrophils + band neutrophils / lymphocytes – with reference values of 2.47 ± 0.65; 2. Lymphocyte-eosinophil ratio (LER) – lymphocytes/eosinophils – with reference values of 8.73 ± 1.26; 3.

Monocyte-lymphocyte ratio (MLR) – monocytes/lymphocytes – with reference values of 5.34 ± 0.59; 4. Neutrophil reactive response index (NRI) – (myelocytes + metamyelocytes + 1) × band neutrophils × segmented neutrophils / (lymphocytes + basophils + monocytes) × eosinophils – with reference values of 10.6 ± 2.1. Study design: continuous sampling (stage I, clinical and epidemiological), random sampling and case-control methods, cohort randomized combined (cross-sectional, prospective) study. Inclusion rules - hospital cases of COVID-19 infection, exclusion rules - outpatient cases of COVID-19 infection in the assigned contingent. A sample of 471 hospital cases of COVID-19 infection, among which 71 (15.1%) cases had a fatal outcome of COVID-19 infection, with an assessment of the dynamics of hematological indices in 167 (35.5%) of all, sufficient for prompt processing with values of $p = 0.05$ and $p = 0.001$. Statistical data processing was carried out using Statistica 10.0, Excel programs using parametric and non-parametric research methods.

Results and discussion. At the first clinical and epidemiological stage for the period from June 16, 2020 to November 23, 2023, it was shown that among the attached population, every 5th to 6th adult (7,449, 17.1%) fell ill with COVID-19 infection, with asymptomatic and mild forms (n = 6,978, 93.7%) prevailing over moderate, severe and extremely severe courses (n = 471, 6.3%), the latter of which were hospitalized in an anti-COVID hospital. Among 7,449 patients, COVID infection corresponded to ICD-X codes U07.1 and U07.2 in 7,120 (95.6%) and 329 (4.4%), respectively. Of the 471 cases of acute COVID-19 infection, the reason for hospitalization were moderate (n = 427, 90.6%), severe (n = 32, 6.8%), and extremely severe (n = 12, 2.6%) forms. Our data do not contradict the literature [9]. Gender and age parameters among 471 hospitalized patients with COVID-19 infection indicate a predominance of women with a ratio to men of 1.6: 1 - 303 (64.3%) to 188 (35.7%), respectively, whose age ranged from 26 to 96 years. A total of 167 patients were selected: 44 with severe and extremely severe cases and 123 patients with moderate cases of COVID-19 infection, of which 52 (42.3%) cases of moderate cases progressed to severe/extremely severe forms. Of the 167 patients, 71 (42.5%) died, including 27 (52%) with an initial moderate course and all 44 patients with severe forms. Thus, among the attached population infected with Sars-Cov-2 (n = 7,449), the mortality rate reached (n = 71, 0.96%), which is consistent with national and global data. And the assessment of comorbidity and hematological indices from 167 cases was carried out on cohorts of recovered (n = 96, 57.5%) and deceased (n = 71, 42.5%), or taking into account the outcomes of “recovery” (group 1, n = 96) and “death” (group 2, n = 71). To determine the significance of comorbid pathology, the ICC was calculated, and gender and age parameters were studied. A 95% probability of female predominance was established – 107 against 60 men ($\chi 2$ 25.3; $p < 0.001$) – 1.7-fold predominance of

women in the cohort of recovered patients ($\chi 2$ 4.05; $p < 0.0443$) and 1.95-fold – in the cohort with a fatal outcome ($\chi 2$ 3.88; $p < 0.0488$) (Table 1).

To assess the prognostic significance in 2 groups of patients, 8 hematological indices were studied – 4 – endogenous intoxication (EI) and 4 – immunological reactivity (IIR). In the 1st and 2nd groups, among IEI, LII, LIr and IL ESR changed significantly; among IIR – ISNL, ISML, RON. The table shows the dynamics of the increase in values in two groups of patients. Comparison according to the Mann-Whitney criterion (Table 3).

Table 1

Values of endogenous intoxication indices and immunological reactivity in comorbid patients with COVID-19 infection, taking into account its outcome

Indicator	1st group (n = 96)	2nd group (n = 71)	U; p =
Intoxication indices			
LII	1,59 ± 0,11	2,72 ± 0,3*	3,78; 0,0001
LIIR	3,26 ± 0,23*	5,57 ± 0,76*	3,24; 0,004
IL ESR	2,32 ± 0,11*	2,05 ± 0,17*	2,37; 0,0174
YaI	0,18 ± 0,01*	0,24 ± 0,02*	>0,05
Indices of immunological reactivity			
ISNL	1,7 ± 0,2*	1,88 ± 0,57*	3,96; 0,0000
ISML	4,26 ± 0,3	5,91 ± 0,55	2,8; 0,0050
RON	14,1 ± 1,37*	34,5 ± 4,39*	5,4; 0,0000
ISLE	19,8 ± 0,95*	19,0 ± 1,18*	>0,05

Note: p – groups 1 with group 2; pN* – differences with reference values

As can be seen from the data in Table 1, almost all intoxication indices, especially in the deceased, exceeded the reference values, and LII and LIIr were significantly higher in deceased patients (Table 3). The indices of immunological reactivity ISLE and RON were significantly higher, ISRL were significantly lower than the reference values, and ISML did not differ from the norm (Table 3). At the same time, the values of LII, LIr, IR ISRL, ISRL, RON in patients who died from COVID-19 infection differed from the values in survivors with 95% and 99% probability.

Conclusion. Among the attached population of the region equivalent to the North, Sars-Cov-2 infection developed in 17.1% of cases, mainly in the form of asymptomatic and mild forms (93.7%), but with the prevalence of active viral excretion (95.6%), in every fifteenth to sixteenth (n = 471, 6.3%) case requiring hospitalization with moderate (n = 427, 90.6%), severe (n = 32, 6.8%), extremely severe (n = 12, 2.6%) forms. Of the 471 hospitalized patients, 71 cases (15%)

died. Of these, the moderate course progressed to severe/extremely severe course in 27 (5.7%) patients. An unfavorable prognosis for the acute phase of COVID-19 infection is determined by the age of patients 60 years and older, high comorbidity, high values of intoxication indices, low values of immunological reactivity indices.

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功能不对称和半球间相互作用是精神和躯体疾病的预测因素
FUNCTIONAL ASYMMETRY AND INTERHEMISPHERIC INTERACTIONS AS PREDICTORS OF MENTAL AND SOMATIC DISORDERS

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摘要。人们对探索健康个体和患者心理活动中的个体功能不对称的持续兴趣引发了许多科学研究。然而，这些发现的实际应用仍然相当有限。对来自各种来源的数据的荟萃分析显示，功能不对称特征与患某些疾病的几率之间存在显著联系，以及其进展的具体特征，特别是在精神病学和治疗环境中。

重要的是，关于这种联系的研究存在差距，特别是在心脏病患者中，包括原发性动脉高血压患者。在这一群体中，疾病的发展与自主神经系统功能障碍密切相关，通常表现为交感神经兴奋过度。

半球间不对称的个体特征决定了心理功能的性质，并可能作为原发性动脉高血压发病的预测因素。基于这些见解，将一种新的筛查方法———一种快速识别左撇子的测试——纳入诊断方案似乎很有希望。这种方法目前正在验证中，以其速度、效率和可访问性而脱颖而出。它不需要专门的工具，财务影响很小，研究人员和参与者几乎不需要付出任何努力，因此非常适合各种临床环境。

目标：研究功能不对称特征对心血管疾病发生、进展和治疗的影响。

关键词：功能不对称、左撇子、半球间相互作用。

Abstract. *The ongoing interest in exploring individual functional asymmetry in mental activity among both healthy individuals and patients has led to many scientific studies. However, the practical use of these findings is still quite limited.*

A meta-analysis of data from various sources shows a significant link between the functional asymmetry profile and the chances of developing certain diseases, along with the specific characteristics of their progression, particularly in psychiatric and therapeutic settings.

Importantly, there is a research gap regarding this link, especially among cardiology patients, including those with primary arterial hypertension. In this group, the disease's development is closely related to dysfunction in the autonomic nervous system, often shown as sympathicotonic hyperactivity.

The individual profile of interhemispheric asymmetry shapes the nature of mental functions and may act as a predictor for the onset of essential arterial hypertension. Based on these insights, incorporating a new screening method—a quick test for identifying left-handedness—into diagnostic protocols seems promising. This method, which is currently being validated, stands out for its speed, efficiency, and accessibility. It requires no specialized tools, has minimal financial implications, and necessitates little effort from both researchers and participants, making it well-suited for a variety of clinical environments.

***Goal:** To study the influence of functional asymmetry profiles on the occurrence, progression, and treatment of cardiovascular diseases.*

***Keywords:** functional asymmetry, left-handedness, interhemispheric interaction.*

Introduction

The subject of interhemispheric asymmetry and interaction is increasingly attracting the interest of researchers. Neuroscience, benefiting from interdisciplinary collaboration, now holds a central role in contemporary science, integrating areas such as neuropsychology, neurology, and neurophysiology. Since the mid-20th century, numerous studies have illustrated the structural and functional asymmetry present in the human central nervous system [1].

Interhemispheric interaction is evident through motor, sensory, and mental asymmetries, which can be objectively evaluated using modern research techniques. The concept of left-handedness has expanded to encompass the lateralization of all paired organs (hands, feet, eyes, ears) [2]. Each individual has a distinct profile of functional asymmetry that varies in degree and may act as an etiopathogenetic factor for various diseases [1].

Gaining insight into the mechanisms that govern interhemispheric interaction is essential for delivering comprehensive care across different medical specialties. This fundamental challenge forms the basis of this study.

The asymmetry profile is influenced by genetic and gender factors, environmental conditions, stress, and both congenital and acquired central nervous system disorders. Although the cerebral hemispheres are structurally similar, they exhibit

significant functional disparities. Their interaction depends on commissural fibers, mainly the corpus callosum, which connects homotopic regions of the neocortex. The corpus callosum acts as a marker for functional lateralization, even though its size does not consistently correlate with functional asymmetry [3].

Functional lateralization is primarily linked to conscious mental activity and is essential for maintaining balanced neuropsychological function. However, a reduction in functional asymmetry can adversely affect brain efficiency and intellectual capacity [4].

Materials and Methods

The impact of interhemispheric asymmetry on an organism's adaptability has been extensively researched. Arshavsky distinguished three phenotypes of interhemispheric response: right-hemispheric, left-hemispheric, and mixed, each linked to different levels of human adaptability [5]. Research indicates that individuals with a right-hemispheric dominance tend to handle social stressors more effectively, while those with left-hemispheric dominance are better at coping with natural stressors. Mixed profiles are particularly adept at navigating extreme and rapidly changing environments [7].

A significant relationship has been observed between functional asymmetry profiles and the occurrence and progression of various diseases [1]. For instance, left-handed individuals have a higher incidence of epilepsy than their right-handed counterparts, while ambidextrous individuals demonstrate an even greater prevalence of certain types of epilepsy [8].

Oyebode F. and Davison K. notably observed that in a case study of epilepsy coupled with psychosis, all examined males exhibited right-handedness. In the context of schizophrenia, it was found that 61.5% of patients identified as right-handed, while the remaining 38.5% were either ambidextrous or left-handed. Among females, right-handedness was observed in 70.6%, leaving 29.4% falling into the categories of left-handed or ambidextrous individuals [9].

The relationship between psychiatric disorders, including schizophrenia and psychosis, and asymmetrical brain profiles is evident. For example, left-handed individuals diagnosed with schizophrenia tend to experience more frequent episodes that necessitate hospitalization [10]. Furthermore, research indicates that left-handed children are at a greater risk of anxiety (70% more likely) and other mental health issues (31% more likely) compared to their right-handed counterparts [11]. Notably, depression is more commonly identified in individuals with a dominant right hemisphere [12].

Moreover, gender-specific variations in asymmetrical profiles impact the occurrence of both affective and organic psychiatric disorders. Research suggests that men are more susceptible to psychiatric conditions associated with damage to the dominant hemisphere, while women are more likely to manifest these dis-

orders when the non-dominant hemisphere is compromised [13]. Several studies have also explored the link between brain asymmetry and substance abuse. In individuals suffering from alcoholism, there is a significant increase in ambidextrous traits associated with their dominant eye compared to healthy controls. Conversely, those with chemical dependencies display a marked prevalence of left-sided brain dominance [14].

Additionally, profiles of asymmetry significantly impact susceptibility to addiction. Research indicates that patients with chemical dependencies exhibit a notable prevalence of left-hemispheric dominance, coupled with poorer treatment outcomes for left-handed individuals struggling with alcoholism [15].

Moreover, left-handed patients are twice as likely to develop ulcerative colitis compared to their right-handed counterparts [17]. The physiological implications of asymmetry also extend to immune function and cancer prognosis. For instance, research shows that left-handed individuals face a higher risk of both ulcerative colitis [17] and postmenopausal breast cancer [19]. Immune responses vary considerably among gastric cancer patients based on their asymmetry profiles, particularly in relation to sympathetic nervous system activity [18].

There exists a clear relationship between asymmetry profiles and immune activation as well as suppression processes in gastric cancer patients, especially those experiencing increased sympathetic activity. In left-hemispheric patients undergoing sympathicotonia, an enhanced mitogen-induced proliferation of T- and B-lymphocytes is observed, along with a relative rise in CD8+ lymphocyte counts in peripheral blood. Conversely, individuals with right hemisphere dominance present a different immune response—characterized by diminished spontaneous and mitogen-induced lymphocyte proliferation, as well as reductions in CD3+, CD4+, and CD20+ lymphocyte populations and phagocytic activity of monocytes [18].

Additionally, the incidence of breast cancer among postmenopausal women appears to be higher in left-handed individuals compared to their right-handed peers [19]. Notably, a study conducted by Kanareikin and Babenkova revealed that 65% of cerebral hemorrhages occur in the left hemisphere, while 35% are found in the right hemisphere [20].

A moderate degree of general asthenia, along with a prevalence of adaptive and relatively adaptive coping strategies, is typical for patients with lesions in the left cerebral hemisphere. These individuals often exhibit a low level of self-control within interpersonal relationships. Conversely, patients with damage to the right cerebral hemisphere display a moderate level of depression, a propensity towards maladaptive cognitive and behavioral coping strategies, and low self-regulation regarding their health [21].

Research by Abramova et al. revealed that patients with varying dominant brain hemispheres exhibit distinct clinical and immunological profiles in the man-

agement of rheumatoid arthritis. Right-handed individuals with this condition often experience an acute onset of exacerbations and demonstrate a more pronounced response to treatment; in contrast, ambidextrous patients display a less severe and more prolonged disease course [22]. Additionally, significant clinical and immunological differences are noted between genders during the acute phase of ischemic stroke, influenced by both disease severity and the location of cerebral damage [23].

There are also distinctions in peripheral blood parameters between right- and left-handed men; specifically, left-handed men possess higher levels of monocytes expressing HLA-DR molecules and circulating immune complexes compared to their right-handed counterparts. Moreover, ambidextrous men have shown greater proliferative activity of mononuclear cells than right-handed men [24].

In HIV-infected males with a dominant left hemisphere, immunological parameters tend to align more closely with normal values than those observed in men with a right-dominant hemisphere [25]. However, standardized methods to assess interhemispheric interaction have yet to be implemented in clinical practice. A group of researchers (Zaitsev O.S., Kamenetskaya M.I., Reverchuk I.V., Kasimova L.N., Sychugov E.M., Dorofeev E.V., Ivanova G.R., Vinogradova E.A., Petrova T.E.) has developed a rapid assessment tool (TEVPL) to identify signs of left-handedness, aimed at investigating various populations, both healthy individuals and those with diverse psychopathological conditions [26]. As part of ongoing research on interhemispheric asymmetry in cardiological patients, this test will be utilized in upcoming studies (see Application 1). In the proposed methodology:

1. Queries regarding the preferred hand utilized in daily activities were consolidated into a singular metric;
2. Indicators that displayed a nearly equal distribution (approximately 50:50) across various subject groups were eliminated, including assessments like interlacing fingers, crossing arms over the chest (‘Napoleon’s pose’), and sitting with one foot over the other;
3. Tests that necessitate specialized equipment (such as nut-pumping apparatus, dynamometers, halascopic picture presentation devices, Seguin boards, etc.) were also excluded.

The design of the test, the established protocol along with its adaptations, and the application of the test on healthy individuals received approval from the Ethical Committee of the Burdenko Centre for Neurosurgery.

Discussion

Upon examining the gathered data, we observed a notable scarcity of research on the relationship between functional asymmetry profiles and the incidence, progression, and treatment of cardiovascular diseases. Consequently, our future investigations will be dedicated to exploring this topic. According to Lang’s the-

ory, the primary factor in the pathogenesis of essential arterial hypertension is the dysfunction of the cerebral cortex and hypothalamus. Recent experimental findings indicate that stimulation of the dorsal nucleus of the hypothalamus leads to systolic hypertension, while activation of the central nucleus results in diastolic hypertension. Additionally, stimulation of the cortical elements within the limbic system has also elicited a hypertensive response. Lang posited that the root cause of hypertension resembles a type of vascular neurosis, stemming from disrupted receptor relationships between the cortex and subcortical areas, which inevitably triggers activation of the sympathetic nervous system over time. Cardiovascular diseases are closely linked to the impact of the autonomic nervous system and heightened sympathicotonic activity. Consequently, hemodynamic disturbances are influenced by the activation of the hypothalamic-pituitary-adrenal axis as well as the renin-angiotensin-aldosterone systems. Therefore, an individual's profile of interhemispheric asymmetry plays a crucial role in defining the nature of mental functions and serves as a predictor for essential arterial hypertension.

Conclusions

Analysis of the available literature leads us to the vital conclusion that new methodologies and innovations must be integrated into clinical practice to assess the impact of interhemispheric asymmetry on both mental and physical health, alongside responses to stress and pharmacological treatments. Future research focused on identifying individual asymmetry profiles will be utilized as a screening tool during the evaluation of cardiological patients, particularly those diagnosed with primary arterial hypertension.

Understanding the asymmetry phenomenon presents a valuable opportunity for practical healthcare applications, especially in the rehabilitation of individuals experiencing a variety of neuropsychiatric, cardiological, and other disorders. Recent studies highlighted the significance of brain hemisphere asymmetries in relation to the pharmacological treatment of patients. Experimental investigations into different medications have shown varying degrees of tolerability and potential side effects based on diverse asymmetry profiles.

Moreover, the consideration of asymmetry profiles is crucial in the selection and training of athletes. Factors such as dominant hand in fencing, leading eye in shooting, preferred stance in boxing and wrestling, as well as rotational preferences in gymnastics, acrobatics, and figure skating, are often guided by the intuitive judgments of coaches and the athletes themselves. Leveraging this information could enhance performance levels across various sports and facilitate better alignment with suitable athletic disciplines.

Additionally, acknowledging asymmetry profiles in professional settings can boost productivity, diminish employee turnover, and support the mental well-being of workers. A promising avenue for future exploration is the collaboration

with artificial intelligence systems, as there is speculation concerning the limitations of replicating “right-hemispheric” cognitive processes.

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***Application* 1**

Test for rapid identification of signs of left-handedness (TEVPL)

Name _____

1	Answer to the question, are there any left-handed people among your relatives? No (R), distant - grandmother, grandfather, aunt, uncle, nephews (O) Close - mother, father, sister, brother, children (L)	R	O	L	Un-known
2	Self-esteem (R - right-handed, O - no preference, L - left-handed)	R	O	L	Un-known
3	Was there any retraining from left-handedness to right-handedness? No (R), doubtful (O), yes (L)	R	O	L	Un-known
4	Preferred hand in everyday life (underline in which case not right) in any activity: a) writing, b) drawing, c) eating, d) carving with scissors, e) throwing a ball, f) other: only right (R), doubt (O), at least in one place left (L).	R	O	L	Un-known
5	Which hand is more active when you applaud?	R	O	L	Un-known
6	Which foot kicks the ball?	R	O	L	Un-known
7	Which leg does sitting down draw when asked to draw the number 5 on the floor?	R	O	L	Un-known
8	Sighting eye when shooting (or looking through a telescope)	R	O	L	Un-known
9	Which eye remains open when winking	R	O	L	Un-known
10	To which ear does he put the telephone receiver	R	O	L	Un-known
11	What witch ear does he listen to the ticking of the clock lying on the table in front of him?	R	O	L	Un-known
12	Do you have prophetic dreams? No (R), rarely (up to once a year) or doubtful (O), more than once a year (L)	R	O	L	Un-known
13	Is the perception of the future marked by ‘recollection of the future’? No (R), rarely (up to once a year) or doubtful (O), more than once a year (L)	R	O	L	Un-known
14	Is right and left confused? No (R), sometimes (O), often (L)	R	O	L	Un-known
15	Mirroring in quick personal signature or writing the numbers 245, 369 with two hands with eyes closed: NO (R), individual items (O), yes (L)	R	O	L	Un-known

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现代世界中的信息卫生问题：从一般卫生和劳动过程强度的角度看
THE PROBLEM OF INFORMATION HYGIENE IN THE MODERN WORLD: A LOOK THROUGH THE PRISM OF GENERAL HYGIENE AND THE INTENSITY OF THE LABOR PROCESS

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注释。本文从一般卫生学的角度探讨了现代世界中的信息卫生问题。特别关注信息过载对人类健康和绩效的影响，以及该问题与工作过程强度之间的联系。提出了改善信息卫生以减少对工作人群的负面影响的方法。

关键词：信息卫生、信息过载、一般卫生、工作过程压力、健康、绩效、情绪倦怠。

Annotation. *The article is devoted to the problem of information hygiene in the modern world, considered from the point of view of general hygiene as a science. Particular attention is paid to the impact of information overload on human health and performance, as well as the connection of this problem with the intensity of the work process. Methods for improving information hygiene to reduce the negative impact on the working population are proposed.*

Keywords: *information hygiene, information overload, general hygiene, work process stress, health, performance, emotional burnout.*

The modern world is characterized by the rapid development of information technologies, which have a significant impact on all areas of human life. However, along with positive aspects, such as acceleration of communications and access to knowledge, there is a problem of information overload, which negatively affects human health and performance. Information hygiene is becoming increasingly relevant and already involves considering it as a separate concept and section of general hygiene, in the context of growing digitalization and its noticeable influence as a factor in the intensity of the work process. This article examines the problem of information hygiene from the point of view of general hygiene as a science, as well as its connection with the work activity of a modern person.

Information hygiene: definition and main aspects.

Information hygiene is a field of hygienic knowledge that allows us to understand the impact of the information environment on human health and to develop prevention methods in the form of minimizing the negative consequences of information overload. The main aspects of information hygiene include:

1. **Control of information volume**- preventing excessive consumption of information, which can lead to cognitive overload.
2. **Quality of information**- ensuring access to reliable and useful data, eliminating misinformation and "garbage" information.
3. **Information consumption mode**- regulating the time spent interacting with information sources to prevent fatigue and stress.

The Impact of Information Overload on Health.

Information overload has a negative impact on a person's physical and mental health. The main consequences include:

- **Cognitive fatigue**- decreased ability to concentrate, deterioration of memory and thinking.
- **Emotional burnout**- increased irritability, anxiety, depression.
- **Sleep disorders**- excessive use of electronic devices before bedtime leads to insomnia and deterioration in the quality of rest.
- **Somatic diseases**— prolonged exposure to stress can provoke the development of cardiovascular diseases, gastrointestinal tract disorders and other pathologies.

Information hygiene and the intensity of the work process.

The modern work process is characterized by high intensity and the need for constant interaction with information technologies. This creates additional risks for the health of workers:

1. **Multitasking**— the need to perform several tasks simultaneously increases cognitive load.
2. **Constant availability**— the use of mobile devices and remote working platforms blurs the boundaries between work and leisure.
3. **Information noise**— an excess of data that is not directly related to work responsibilities is distracting and reduces productivity.

The tension of the work process associated with information overload leads to a decrease in labor productivity, an increase in the number of errors, an increase in stress load and, as a consequence, an increase in occupational diseases. For example, in the work [1] it is emphasized that the impact of information overload on a person is quite large-scale, since it covers his work activity, health and emotional-psychological state, in addition, it is large-scale in terms of geographic aspect (according to the Reuters news agency [3], while some countries have already found mechanisms to overcome the problem of information overload (USA, Ja-

pan, Western Europe), the countries of Southeast Asia suffer from its consequences (Hong Kong, Singapore), and for the countries of Eastern Europe the problems are still ahead (Russia, Poland, etc.)).

Methods for improving information hygiene.

To minimize the negative impact of information overload, it is necessary to implement the following measures:

1. **Regulation of working hours**— establishing clear time frames for working specifically with information systems.
2. **Training in information hygiene skills**— conducting trainings for employees on information flow management and personal time management.
3. **Use of technological solutions**— implementation of software that filters unnecessary information and reminds about the need for breaks.
4. **Creating a positive work environment**- organization of workplaces that help reduce stress and fatigue.

Conclusion.

The problem of information hygiene is becoming increasingly relevant in the conditions of the modern world, where information technologies play a key role in work activities, and artificial intelligence threatens to replace half of the professions, which creates an additional factor of fear in people. Considering this issue through the prism of general hygiene will allow us to develop effective measures to protect the health of the working population. Taking into account the intensity of the work process and the introduction of information hygiene methods tend to contribute to improving the quality of life and labor productivity.

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高空飞艇——移动互联网通讯设备载体
HIGH-ALTITUDE AIRSHIP – CARRIER OF MOBILE INTERNET COMMUNICATION EQUIPMENT

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摘要。光纤互联网正逐渐进入北海航线的港口，而西伯利亚大陆地区和俄罗斯北极地区则使用昂贵的太空互联网。整个地区的通信问题将通过基于平流层飞艇的高空网络解决。本文描述了网络和载体的设计，确定了移动的能量来源和通信系统的运行。声明了将网络开发为分布式系统的前景——空间激光通信和地面光纤互联网交互的接口。

关键词：高空载体；平流层飞艇；光纤互联网；激光空间通信；"Access"项目；自适应数字天线阵列。

Abstract. *Fiber-optic Internet is gradually coming to the ports of the Northern Sea Route, while the continental regions of Siberia and the Russian Arctic use expensive space Internet. The problem of communication throughout the region will be solved by a high-altitude network based on stratospheric airships. The article describes the network and the carrier design, identifies the source of energy for movement and the operation of the communication system. The prospects for*

developing the network as a distributed system - an interface for the interaction of space laser communications and terrestrial fiber-optic Internet are declared.

Keywords: *high-altitude carriers; stratospheric airships; fiber-optic Internet; laser space communications; the "Access" project; adaptive digital antenna arrays.*

The Institute of Engineering and Digital Technologies of the Belgorod State University, together with the SNOiIT enterprise, proposed the "Access" project - work on the creation of a mobile communications network and broadband Internet for sparsely populated areas of the Russian North, Siberia and the Far East with services costing at the level of the European part of Russia.

The "Access" project is a high-altitude communication system with the basing of radio relay equipment and base stations on high-altitude airships.

Atmospheric devices (drifting stratospheric balloons Loon, Google Corporation; UAV aircraft Aquila, Facebook - Meta Platforms) have already been used as Internet platforms, but the projects were closed.

Project Description

The errors of projects for the development of mobile communications networks on high-altitude carriers were analyzed by the SNOiIT enterprise, and in the new concept of construction, onboard base stations (BTS) retain their positions directly above local consumers: villages, factories, camps. The onboard BTS signal from an altitude of 18,000 – 24,000 m is sent to the ground BTS of the facility or directly to standard user gadgets.

For clarity, the "Access" project is tied to the Chukotka Autonomous Okrug (area 720 sq. km; population 50 thousand people; about 50 cities and towns with a population mainly up to 1,000 people).

Carriers with repeaters and onboard BTS (network platforms) "hover" over the ground BTS of facilities located at a distance of 100 – 300 km from each other.

25 – 30 platforms will provide mobile Internet to all settlements of Chukotka.

The platforms have their own propulsion. Controlled by an automated information system (AIS), they take off from airfields and go to "standing" points. When new objects appear, the network is developed by simply adding platforms that independently arrive at new points and are "registered" in the system.

The signal in the high-altitude network is distributed using radio relay communication. Internet sources are fiber-optic communication lines (FOCL) nodes in the ports of the Northern Sea Route, Figure 1.

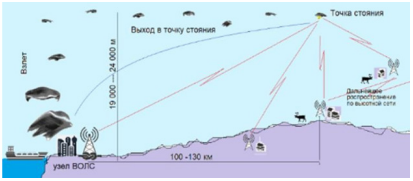

Figure 1. *Network binding to the fiber-optic communication line node*

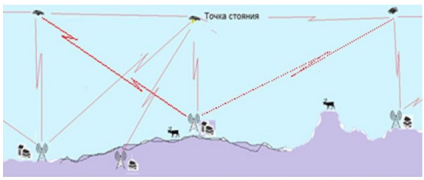

Figure 2. *Connection diagram of the «Access» project*

Communication system. Adaptive digital antenna arrays (ADAA)

The network is based on onboard adaptive digital antenna arrays —ADAA. The onboard system scans the space, determines the directions of communication opponents and generates up to five communication beams simultaneously in the directions of three or four neighboring platforms and one or two ground base stations, Figure 2.

ADAA does not require gyrostabilization. The beams are generated by antenna fragments in the directions of the opponent systems. The orientation of the beams in flight is carried out by phase shifters.

Automated information system

AIS provides flight control of platforms, scanning modes and orientation of the ADAA communication beams, routing of information flows.

The "Access" system is fully operational during scaling.

The AIS resource is spent mainly on routing information flows and only a small part on navigation and piloting of carriers, which exit to specified coordinates, maintain stable communication positions and return to the airfield mainly under the control of the on-board computer.

Airship design

The platform is capable of maneuvering in autonomous mode due to its own systems and has an operating altitude range of 18,000 - 24,000 m.

The carrier airship has no propellers. Controlled flight and maneuvers are ensured by the rate of climb and directional movement during descent.

The shape of the shell has a "wing" profile, Figure 3.

On-board equipment: electric motor, gas balance and air ballast pump with rotation supports, and all on-board devices of the carrier (batteries, on-board computer, electronic equipment unit) - everything, with the exception of solar batteries and antennas, is located in a single heat-protected case.

The antennas of the Wi-Fi router and the ATSAR system, solar panels, and control manipulators are connected to the interfaces inside the thermal block via contact groups of Ethernet cables, eliminating "cold bridges". The data from the sensors on the surface of the shell is taken using a Wi-Fi signal.

Full-functional module and coordinates in the project

Full-functional module of the "Access" system is a fragment of a high-altitude network, including a platform tied to a fiber-optic communication line node, a platform above the remote BTS of the village and a ground BTS, a platform for direct consumer service (without BTS).

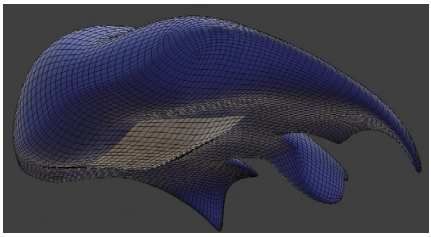

Figure 3. *"Wing" shell*

Figure 4. *Platform above BTS*

The center of coordinates (C.C.) of the system module is the ground BTS, with coordinates (0, 0, 0).

The lower working position of the platform is a point at an altitude of 18,000 m above ground level on the vertical axis above the ground BTS with coordinates (0, 0, 18,000). For example: the upper position of the southeastern boundary of the working area is (3,000, – 3,000, 24,000), Figure 4.

Axis 0X is east-west, 0Y is south-north, 0Z is the vertical axis.

The center of coordinates of the platform is the geometric center of the shell, its geometric center of gravity with coordinates (C.G.) = (0,0,0); axes — 0x, 0y, 0z.

Platform control force

In the working area, the platform always strives to gain maximum height, i.e., to increase its potential energy — the source of movement relative to the ground.

In directed movement (diving) to a given point, including for the purpose of maintaining a position in the communication zone, the platform is controlled by aerodynamic force.

On the "wing" shell, distributed aerodynamic loads (with signs "+" / "-") arise, reduced to a discrete force FАД. The resultant, directed along the axis 0z of the platform at an angle to the flight path: FΣ = FАД + mg + FArchimedes + FCoriolis + +Fcentrifugal. - controls the velocity vector, ensures the stability of the carrier in flight.

The on-board computer records and takes into account the orientation of the airship, the direction of the wind speed and the speed of the platform and calculates the trajectory of the platform to a given point (0, 0, 18 000). Every 1 - 5 seconds, the calculation is repeated with new data.

The on-board computer makes a correction - conducts piloting, changing the pitch and roll angles of the carrier. The platform moves along an optimal trajectory, close in shape to the brachistochrone curve, where the role of gravity is played by FVERT — the projection of the resultant FΣ onto the vertical, and the role of the support reaction is played by the difference in vectors FSUPPORT = FΣ — FVERT, that is, we have a "rolling" force causing a directed and controlled movement and a "support" reaction, due to which the "rolling" force is consistent.

Methods for implementing the proper motion of the platform

The proper motion system of the platforms has two modes of movement.

A. Translational movement of the exit to the point as movement in the flow.

The carrier lifts to the level of the air flow in the same direction.

The platform reaches the specified operating point of the system (0, 0, 18,000 – 24,000).

In the working area, the platform is "registered" in the AIS, gains altitude to the maximum possible (acquires maximum potential energy) and is included in the processes: communication with the ground BS or directly with subscribers; retransmission of the mobile communication signal and the Internet over the network; maintaining the position in the communication area.

The demolition (shift) of the platform from the axis of the standing area by a random flow is similar.

The initial position of the platform included in the working processes, having arrived in the working area, is ideally a point at an altitude of 24,000 m above the BTS. Due to atmospheric movement, the platform shifts from the initial point to the boundary of the communication area, limited by a cylinder with a height of 6,000 m (24,000 - 18,000) and a radius of 3,000 m from the vertical axis of the ground BTS.

Return to the point occurs according to the algorithm of movement in the oncoming flow. That is, ...

The airship "drops" the lift and returns to the vertical axis of the working area along a curved glide path at an altitude of at least 18,000 m.

During the descent, the flat brachistochrone curve can be "twisted" into a spiral.

B. Movement in the opposite flow.

This is a cruise flight of the airfield - the working area and returns to the central axis in the broadcast mode.

If during takeoff from the airfield and ascent to the 24,000 mark, no tail flow to the "registration" point is found, the directed movement of the platform will require "spending" the potential energy of the flight altitude.

The carrier with a negative pitch angle and bank drops the lift and begins to move downwards (dive) in the direction of the point (0, 0, 18,000). First, along a

descending spiral until reaching the direction to the BTS. Then the roll is removed, and the dive occurs in the vertical plane.

At a high speed of the oncoming flow, the pitch angle increases up to the maximum (–75°), which will eventually ensure the aircraft enters the working area.

The moment of arrival at the point 18,000 on the BTS axis is the start of a new cycle of "saving" coordinates: rise to 24,000 — drift — movement in a spiral — directional dive.

Platform Movement Abnormalities

Unpredictable disturbances occur in the atmosphere, which can cause uncontrolled displacement of carriers over significant distances. Platforms can end up in a position of an adjacent communication zone, or outside the coverage area.

Possible options: registration of the platform above a new BTS; return to its position in an oncoming flow; return to the airfield when replacing the AIS position with another platform.

Platform Design

The platform equipment and mechanisms are assembled in a single heat-protected case: flight control unit; communication control unit; battery, compressor, electric motor for the mechanization drive, compressors and convector; other devices.

The solar panels on the shell are installed symmetrically relative to the 0X and 0Y axes. External antennas, during installation, will also not disturb the balance along the 0X and 0Y axes; but can shift (c.g.) the platform along the 0Z axis. The installation of a single hull in the shell cavity returns the (c.g.) of the platform to the geometric center of the aircraft.

The casing of a single hull in the form of a polyhedron with planes of different colors and textures has three of its own degrees of freedom of rotation (+/– 90°). The rotation of the casing (orientation of the facets reflecting and absorbing energy on the sun) occurs independently of the orientation of the casing inside the casing, and does not cause a displacement (c.g.) of the platform.

The casing has its own, independent degree of freedom — rotation relative to the longitudinal axis 0X (+/– 90°). The rotation of the casing does not change the orientation of the casing. The rotation displaces the (c.g.) of the platform relative to the 0X axis and creates a roll angle of the platform (+/– 45°).

The casing casing with a degree of freedom of longitudinal displacement in the direction from (c.g.) to the nose of the platform (along the 0X axis) before descent (dive) sets the pitch angle (0° — – 75°) of the platform.

The specified pitch and roll in combination with the "drop" of the lift force cause a descent along the brachistochrone curve or along a spiral, which are the main methods of controlled platform motion.

Aerodynamic force

The carrier's rate-of-climb system provides the potential energy necessary to overcome the resistance of flows during translational motion.

During a dive, an aerodynamic force develops on the surface of the shell, which is estimated by "blowing" in a virtual wind tunnel, Figure 5.

An experiment in a real wind tunnel is expensive and difficult due to the volume of the airship, and can be carried out using a hybrid scheme of real and virtual blowing.

Qualitative values of a small number of discrete virtual forces on the surface of the mathematical model of the shell are calibrated by the corresponding force values according to the readings of several sensors on the real airship in the wind tunnel.

All uncovered values of virtual forces are corrected proportionally to the calibrated values according to the developed algorithm, Figure - 5.

Figure 5. *Values of forces and aerodynamic flows of virtual blowing*

The resultant force of the diving platform will coincide with the velocity vector, which, upon reaching the threshold value, will allow overcoming the resultant force of the oncoming air flow and wind, Figure 6.

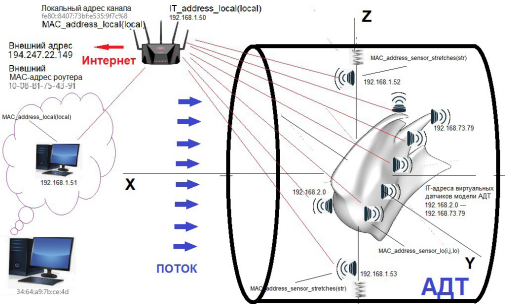

Figure 5. *Hybrid experiment in a real wind tunnel*

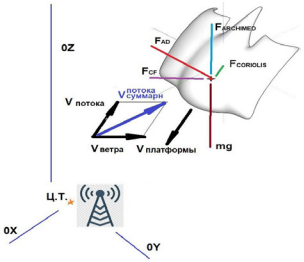

Figure 6. *Decomposition of forces, direction of velocity and flow*

Project Prospects. The Access Network is an "interface" for communication between Earth and space

The most efficient transmission channels of the World Wide Web are land and sea fiber-optic communication lines, powerful fiber-optic cables with an information flow transmission frequency of several terabits per second or more.

In turn, low-orbit satellite constellations form a laser communication network - the Internet with the efficiency of terrestrial fiber-optic communications.

Figure 7 — The Access Network — a “distributed interface” for communication between the terrestrial and space Internet

The optical flow is not applicable for communication between the laser orbital system and the terrestrial fiber-optic communication network: the laser beam attenuates in the atmosphere at an altitude of ~15,000 m above the ground.

But this will not prevent the optical beam from becoming a source of information flow for the high-altitude platforms of the Access project at an altitude of 18,000–24,000 m.

Thus, the laser signal of the space network will reach the stratosphere, and the Access platforms will convert the optical flow into electromagnetic waves and “distribute” mobile communication to terrestrial base stations and other users, Figure 7.

And most importantly...

The second stage of the Access project — the Access Interface — will be a qualitative breakthrough in the development of the Internet and radio communications in general.

In the future, a high-altitude airship network may become a “spatial interface” between a space laser system and a ground-based fiber-optic communication network. In this case, heavy radio relay communication equipment between platforms will become unnecessary, the platforms themselves will be lighter, and the network will be more efficient, both functionally and economically.

The “Access” project with innovations in the field of communication (ACA), progressive methods of movement and long-term autonomy of airships may become the first practical implementation of Internet platforms and a fundamentally new aeronautics.

Conclusion

The Institute of Engineering Technologies of the National Research University Belgorod State University and the SNOiIT enterprise continue to work on the project.

The ACA systems are modified for more stable information exchange and an increase in the range of radio relay communication.

The design of the “wing” shell and mechanical units and devices of the airship control systems is being improved.

The development of a technology for collecting energy from the airship surface is underway to increase the energy potential - the autonomous flight time of the platform and the operation of the Access network in polar night conditions.

ATsAR, carrier climb rate, new energy and the prospects of the Access-Interface project in development at BelSU - SNOiIT - a new concept for the development of mobile communications and aeronautics in general.

LONG LIVE THE NEW RUSSIAN AERONAUTION!

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电阻传感器的电阻变送器，用于通过双线通信信道远程测量过程参数
RESISTANCE TRANSDUCERS OF RESISTIVE SENSORS FOR REMOTE MEASUREMENT OF PROCESS PARAMETERS VIA TWO-WIRE COMMUNICATION CHANNEL

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摘要。本文考虑了有源电阻传感器远程测量传感器主要单元的操作算法和结构，不受通信线路参数和干扰影响。测量通道是一条双线通信线路。传感器适用于高温和长通信线路条件。

关键词：测量传感器、电阻传感器、高温井、电抗元件、通信通道、转换算法、电流源、仪器放大器、转换误差、数字计数器、采样存储装置、加法器。

Abstract. *The paper considers the algorithms of operation and structures of the main units of remote measuring transducers of active resistance of the sensor, invariant to the parameters of the communication line and the influence of interference. The measuring channel is a two-wire communication line. The transducers are oriented to work in conditions of high temperatures and a large length of the communication line.*

Keywords: *Measuring transducers, resistive sensors, high-temperature wells, electric reactive elements, communication channel, conversion algorithms, current source, instrumental amplifier, conversion error, digital counter, sampling-storage device, adder.*

1. Introduction

The structural diagram of the sensor resistance transducer with capacitor for the case of two-wire communication channel is shown in Figure 1.

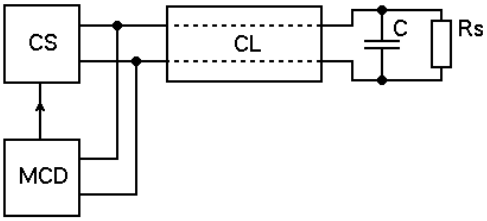

Figure 1. *Structure diagram of sensor resistance conversion with a capacitor over a two-wire communication channel*
CS - current source, MCD - measuring and computing device,
CL - communication line

Capacitor *C*, the capacitance of which is much larger than the total capacitance of the communication line, is charged with direct current from the CS current source. In the initial scheme, the voltage fixation in the process of charging is carried out at the following moments of time [1], [2], [3]:

1) at the beginning of the transient process, when it can be considered that the communication line capacitance is charged and capacitor *C* is not yet charged;

2) at the end of the transient process, when it can be considered that the communication line capacitance and capacitor *C* are charged.

The current source under the influence of the MCD measuring and computing device creates a current jump I, the duration of which must be sufficient to charge the capacitance of the communication line and capacitor *C*. The measuring and computing device MCD measures the voltage at the terminals of the current source at the initial moment of time, when the charge of capacitor *C* can be neglected, and at the final moment of time, when capacitor *C* is fully charged. The voltages at the output of the communication line at the beginning and at the end of the transient will be equal, respectively:

$$V_1 = IR_{lc} + E_d;\ V_2 = IR_{lc} + E_d + IR_s,$$

where R_{lc} - resistance of the communication line; R_s - resistance of the sensor; E_d - e.d.c. of the interference affecting the communication channel.

According to the voltages V_1, V_2 the measuring and computing device determines the sensor resistance R_s:

$$R_s = \frac{V_2 - V_1}{I}.$$

The advantage of the considered converter structure is the extreme simplicity of the conversion process. However, there are several significant disadvantages related to each other.

The first disadvantage is the presence of a conversion error due to the charging of capacitor C when measuring the voltage at the beginning of the transient. To

reduce this error, the capacitance of capacitor *C* has to be increased, which leads to the second disadvantage.

The second disadvantage is the low speed of the converter due to the need for measurements at the end of the transient in capacitor C.

The third disadvantage is the influence of the interference, E_d, which can be distributed randomly along the length of the communication line. The interference E_d will be different at different points in time, resulting in additional error.

2. Algorithms of operation of the sensor resistance transducer

Since a real communication line contains reactive and active components of its resistance, the first measurement should be made after the end of transients in the communication line. During this time capacitor *C* has time to charge up to the level determined by the values of capacitance of the capacitor, resistance of the transducer and time of establishment of transients in the communication line.

At first, let us consider in more detail the measurement algorithm according to Figure 1.

Let us assume that the current in the communication line at the initial stage of measurement is described by the expression:

$$i_{lc}(t) = I \cdot \left(1 - e^{-t/\tau_{lc}}\right),$$

where $i_{lc}(t)$ is the current in the communication line; τ_{lc} is the time constant of the communication line.

The voltage on capacitor C during the time of establishment of transients in the communication line $t = t_s$ will become equal:

$$\Delta V_C = \frac{1}{C}\int_0^{t_s} I \cdot \left(1 - e^{-t/\tau_{lc}}\right)dt = \frac{I \cdot t_s}{C} + \frac{I \cdot \tau_{lc}}{C} e^{-t_s/\tau_{lc}} - \frac{I \cdot \tau_{lc}}{C}.$$

Hence the voltage V_1 measured at the beginning of the transient:

$$V_1 = I \cdot R_{lc} + E_D + \Delta V_C = I \cdot R_{lc} + E_d + \frac{I \cdot t_s}{C} + \frac{I \cdot \tau_{lc}}{C} e^{-t_s/\tau_{lc}} - \frac{I \cdot \tau_{lc}}{C};$$

$$V_1 \approx I \cdot R_{lc} + E_d + \frac{I \cdot t_s}{C} - \frac{I \cdot \tau_{lc}}{C};$$

Voltage difference:

$$V_2 - V_1 = I \cdot R_{lc} + E_d + I \cdot R_s - (I \cdot R_{lc} + E_d) - \frac{I \cdot t_s}{C} + \frac{I \cdot \tau_{lc}}{C},$$

$$V_2 - V_1 = I \cdot R_s - \frac{I \cdot t_s}{C} + \frac{I \cdot \tau_{lc}}{C}.$$

The resistance of the sensor will be approximated by the formula:

$$R_s^* = \frac{V_2 - V_1}{I} - \frac{t_s - \tau_{lc}}{C}.$$

The error can be reduced by increasing the capacitance of the capacitor, C, which, however, leads to an increase in the conversion time.

An effective way to reduce the error without a significant reduction in performance is the use of the following conversion algorithms.

1. Measurement of the voltage at the output of the communication line at the beginning of the transient process is carried out twice: at the moments of time t_s and $2t_s$. The third measurement is carried out after the end of the transient process in the capacitor [2], [3]:

$$V_1 \approx I \cdot R_{lc} + E_d + \frac{I \cdot (t_s - \tau_{lc})}{C};$$

$$V_2 = I \cdot R_{lc} + E_d + \Delta V_C \approx I \cdot R_{lc} + E_d + \frac{I \cdot (2t_s - \tau_{lc})}{C};$$

$$V_3 = I \cdot R_{lc} + E_d + I \cdot R_s.$$

The procedure for processing the measurement results is as follows.

The differences are determined:

$$V_2 - V_1 = \frac{I \cdot t_s}{C};$$

$$V_1 - (V_2 - V_1) = I \cdot R_{lc} + E_d + \frac{I \cdot t_s}{C} - \frac{I \cdot \tau_{lc}}{C} - \frac{I \cdot t_s}{C};$$

$$V_1 - (V_2 - V_1) = I \cdot R_{lc} + E_d - \frac{I \cdot \tau_{lc}}{C};$$

$$V_3 - [V_1 - (V_2 - V_1)] = I \cdot R_{lc} + E_d + I \cdot R_s - \left(I \cdot R_{lc} + E_d - \frac{I \cdot \tau_{lc}}{C}\right)$$

$$V_3 - V_1 + V_2 - V_1 = I \cdot R_s + \frac{I \cdot \tau_{lc}}{C}.$$

The resistance of the sensor will approximate:

$$R_s^* = \frac{(V_3 - V_1)}{I} + \frac{(V_2 - V_1)}{I} - \frac{\tau_{lc}}{C}.$$

Absolute error for the first algorithm [4], [5]:

$$\Delta R_{s1} = |R_s^* - R_s| = \frac{t_s - \tau_{lc}}{C}.$$

Absolute error for the second algorithm:

$$\Delta R_{s2} = |R_s^* - R_s| = \frac{\tau_{lc}}{C}.$$

Suppose the total resistance of the communication line is 200 ohms, the total capacitance of the communication line is 2 μF, the resistance of the sensor is 500 ohms and the capacitance of the capacitor $C = 50\ \mu F$.

The charge time constant of capacitor C will be equal to:

$$\tau = 500 \cdot 50 \cdot 10^{-6} = 25 \cdot 10^{-3}\ s.$$

The time constant of charge of the communication line capacitances will be:

$$\tau_{lc} = 200 \cdot 2 \cdot 10^{-6} = 0.4 \cdot 10^{-3} s.$$

Time to fully charge capacitor C:

$$t_f \cong (5 \cdots 10) \cdot \tau = 0.125 \cdots 0.25\ s.$$

The charging time of the communication line is approximated to be:

$$t_s \cong (5 \cdots 10) \cdot \tau_{ls} = (5 \cdots 10) \cdot 0.4 \cdot 10^{-3} = (2 \cdots 4) \cdot 10^{-3} s.$$

Let, for example, $\tau_{ls} = 0.4\ ms, t_s = 3\ ms,\ C = 50\ \mu F$.

For these values, the absolute errors will be.

$\Delta R_{Д1} = 2.6 \cdot 10^{-3}/50 \cdot 10^{-6} = 52\ Ohm,\ \Delta R_{Д2} = 0.4 \cdot 10^{-3}/50 \cdot 10^{-6} = 8\ Ohm.$

The relative error will be [4], [5]:

$$\frac{\Delta R_{Д1}}{R_Д} \cdot 100\% = \frac{52}{500} \cdot 100\% = \mathbf{10.4}\%, \qquad \frac{\Delta R_{Д2}}{R_Д} \cdot 100\% = \frac{8}{500} \cdot 100\% = \mathbf{1.6}\%.$$

2. better result can be achieved by applying another algorithm for processing the results of V_1, V_2, V_3 voltage measurements.

Let's make a system of equations for V_1, V_2, V_3 as follows:

$$\begin{cases} V_1 = I \cdot R_{lc} + E_d + \dfrac{I \cdot t_s}{C} - \dfrac{I \cdot \tau_{lc}}{C}; \\ V_2 = I \cdot R_{lc} + E_d + \dfrac{I \cdot 2t_s}{C} - \dfrac{I \cdot \tau_{lc}}{C}; \\ V_3 = I \cdot R_{lc} + E_d + I \cdot R_s. \end{cases}$$

Transform the system:

$$\begin{cases} V_1 = I \cdot R_{lc} + E_d + \dfrac{I \cdot \tau_{lc}}{C}\left(\dfrac{t_s}{\tau_{lc}} - 1\right); \\ V_2 = I \cdot R_{lc} + E_d + \dfrac{I \cdot \tau_{lc}}{C}\left(\dfrac{2t_s}{\tau_{lc}} - 1\right); \\ V_3 = I \cdot R_{lc} + E_d + I \cdot R_s. \end{cases}$$

Let's introduce the notations: $v_1 = I \cdot R_{lc} + E_d$, $v_2 = (I \cdot \tau_{lc})/C$, $v_3 = I \cdot R_S$, $k = t_S/\tau_{lc}$:

$$\begin{cases} V_1 = v_1 + v_2(k-1); \\ V_2 = v_1 + v_2(2k-1); \\ V_3 = v_1 + v_3. \end{cases}$$

Let us solve the system in matrix form:

$$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 1 & k-1 & 0 \\ 1 & 2k-1 & 0 \\ 1 & 0 & 1 \end{bmatrix}^{-1} \times \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}.$$

Matrix multiplication gives:

$$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} \dfrac{2V_1k - V_1 - V_2k + V_2}{k} \\ \dfrac{-V_1 + V_2}{k} \\ \dfrac{-2V_1k + V_1 + V_2k - V_2 + V_3k}{k} \end{bmatrix}.$$

For the voltage drop across the sensor $I \cdot R_s$ we obtain:

$$v_3 = V_3 - V_1 + (V_2 - V_1)\left(1 - \frac{1}{k}\right).$$

or

$$R_s^* = \frac{V_3 - V_1}{I} + \frac{(V_2 - V_1)}{I} - \frac{(V_2 - V_1)}{I} \cdot \frac{1}{k}.$$

If the exact value of *k* is known, the error from recharging capacitor C will be equal to zero. But even with an approximate determination of k it is possible to achieve a smaller resulting error than in the previous algorithm.

3. Structural diagrams of the main assemblies of the resistance converter

The main units of the transducer resistance transducer are the device for forming the transducer control pulses and the measuring and computing device that performs the necessary operations to obtain the transducer output value proportional to the transducer resistance. The structural diagram of the control pulse shaper is shown in Figure 2.

The control pulse shaper includes:

- a grid synchronization device (NS), which generates input pulses for the digital counter (BC). These pulses follow a mains frequency of 50 Hz;

- a digital counter that sets the time intervals of the converter during the entire logging cable transient;

- measuring current source (CS), which produces a direct current of high stability;

- electronic keys S1...S3, controlling the operation of the sampling-storage devices;

- electronic key S4, providing discharge of logging cable capacitance;

- threshold and logic devices (TD1, TD2, LD), forming time intervals at the beginning and end of the transient process in the logging cable.

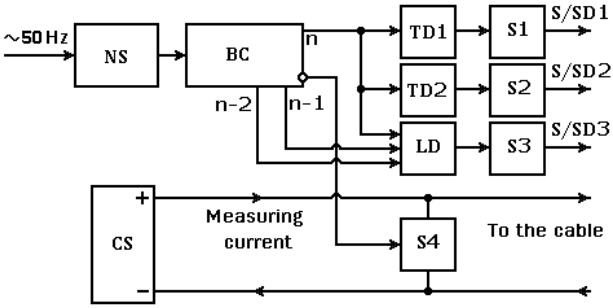

Figure 2. *Structural diagram of the control pulse shaper*
NS- network synchronization device, BC - binary counter, CS - current source, S/SD - sampling/storage device, TD - threshold device, LD - logic device

If there is a logical zero in the high digit of BC, the inverse output is a logical one, the key of S4 closes the cable. During this time, as long as there is a logical zero in the high digit of BC, the logging cable capacitance and capacitor C, which is connected in parallel to the sensor, are discharged.

When a logical one appears on the direct output of the counter, the sensor resistance conversion process begins, which occurs before the counter is set to zero. At first, the threshold device TD1 is triggered, it affects the key S1, which - on the sampling-storage device S/SD1, for a time t_s. Then during time $2t_s$ the threshold device TD2 is triggered, it affects the key S2, which affects the sampling-storage device S/SD2. At the end of the transient process, under the influence of signals from BC trigger logic device LD and key S3. The latter acts on the sampling-storage device S/SD3.

The structural diagram of the measuring and computing device is shown in Figure 3.

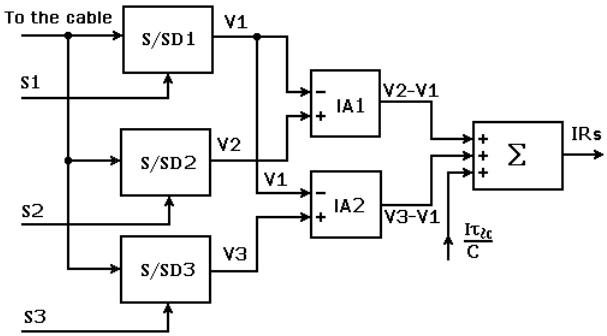

Figure 3. *Structural diagram of the measuring and computing device*
IA - instrumental amplifier

The operation of the measuring and computing device is as follows. S/SD1 memorizes the logging cable voltage at interval t_s of the beginning of the transient:

$$V_1 \approx I \cdot R_{lc} + E_d + \frac{I \cdot t_s}{C} - \frac{I \cdot \tau_{lc}}{C}.$$

S/SD2 memorizes the logging cable voltage at $2t_s$ of the transient onset interval:

$$V_2 \approx I \cdot R_{lc} + E_d + \frac{I \cdot 2 \cdot t_s}{C} - \frac{I \cdot \tau_{lc}}{C}.$$

The S/SD3 memorizes the logging cable voltage at the end of the transient:

$$V_3 = I \cdot R_{lc} + E_d + I \cdot R_s.$$

These voltages are fed to two instrumental amplifiers (IA1 and IA2), at the outputs of which the differences are formed: $(V_2 - V_1)$ and $(V_3 - V_1)$. These differences as well as the correction signal $(I \cdot \tau_{lc})/C$ are fed to the adder Σ. The output of the adder will set the signal $(I \cdot R_s)$, which, with a stable and constant current *I*, will depend only on the resistance of the sensor R_s.

4. Key findings

1. Algorithms for remote conversion of the active resistance of a sensor over a two-wire communication channel are considered, which allow to significantly reduce the conversion error caused by the influence of the communication channel on the conversion result.

2. These conversion algorithms assume the use of a minimum number of electronic elements in the area of the sensor location. There are only two such elements: the sensor itself and a capacitor of high capacitance $C \gg C_{lc}$. In addition, there are no high requirements for the capacitor capacitance stability. Its main requirement is to maintain its performance under the conditions of the environment

in which the sensor is located. This requirement is met by a number of electrolytic capacitor types produced by industry.

3. The construction of sensor resistance transducers is considered in detail at the level of structural schemes of two main nodes: the control pulse shaper and the measuring and computing device.

4. Measuring devices developed on the basis of the considered transducers can be recommended for measurement of technological parameters at considerable length of communication line, if the value of this parameter is related to the resistance of the transducer. Such a situation occurs, for example, in thermometry of oil and gas wells.

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异步电动机偏心的数学建模

MATHEMATICAL MODELING OF ECCENTRICITY OF ASYNCHRONOUS ELECTRIC MOTORS

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注释。本文指出，异步电动机如今已非常普遍，成为工业企业主要技术设备的电力驱动装置。为了及时发现异步电动机轴承单元故障或转子轴弯曲的发展，有必要开发诊断其实际状态的方法，这可以使用数学模型获得。在这方面，本文的目标是相关的，它包括开发异步电动机的数学模型，其中定子电流记录在自然三相坐标系中。

本文提出的异步电动机数学模型允许模拟由轴承单元故障或转子轴弯曲引起的偏心，记录在定子电流的三相坐标系中，这允许在发生机械损坏时对定子电流进行更定性的分析以识别它们。

关键词：数学模型、异步电动机、状态诊断、偏心、定子电流。

Annotation. *The paper notes that asynchronous electric motors have become quite widespread today as electric drives for the main technological equipment of industrial enterprises. In order to promptly detect the development of faults in the bearing unit or the bending of the rotor shaft of an asynchronous electric motor, it is necessary to develop methods for diagnosing its actual state, which can be obtained using a mathematical model. In this regard, the objective of the paper is relevant, which consists in developing a mathematical model of an asynchronous electric motor with stator currents recorded in a natural three-phase coordinate system.*

The mathematical model of an asynchronous electric motor presented in the work allows for the simulation of eccentricity caused by the failure of a bearing unit or bending of the rotor shaft, recorded in a three-phase coordinate system for stator currents, which allows for a more qualitative analysis of stator currents when mechanical damage occurs in order to identify them.

Keywords: *mathematical model, asynchronous electric motor, condition diagnostics, eccentricity, stator currents.*

Due to the simplicity of their design and maintenance, asynchronous electric motors have become quite widespread today as electric drives for the main process equipment of thermal and nuclear power plants, as well as metallurgical enterprises. However, the use of asynchronous motors places a number of demands on the technical diagnostics of their actual condition in order to prevent their premature failure. Some of the most common defects in the mechanical part of an asynchronous motor are: failure of its bearing assembly, which accounts for about 40% of the total number of mechanical damages that occur [1 - 2] and misalignment of the rotor axis relative to the inner surface of the stator. The occurrence of these defects has a significant impact on the occurrence of engine vibrations and their nature [3 - 5]. For the timely detection of the development of these malfunctions of an asynchronous electric motor, it is necessary to develop methods for diagnosing its actual condition, which can be obtained using a mathematical model, to which a number of works are devoted [6 - 8]. However, the presented mathematical models are implemented in a two-phase coordinate system, both for stator currents and for rotor currents, which complicates the analysis of transient processes in stator currents that occur during eccentricity, since a transition to a three-phase coordinate system is required at each calculation step.

Therefore, the objective of the presented work is relevant, which consists in developing a mathematical model of an asynchronous electric motor with stator currents recorded in a natural three-phase coordinate system and allowing for the simulation of eccentricity caused by both shaft bending and bearing unit failure.

For the mathematical model of an asynchronous electric motor, we will take as a basis the equivalent multi-circuit equivalent circuit shown in Fig. 1.

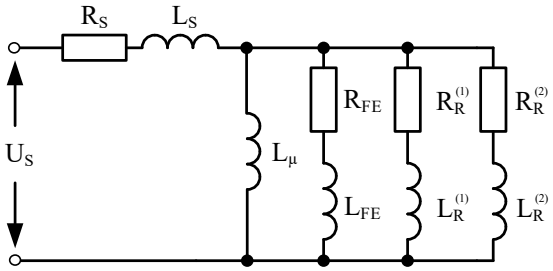

Figure 1. *Equivalent multi-circuit equivalent circuit of an asynchronous electric motor*

As can be seen from Fig. 1, the equivalent circuit of an asynchronous electric motor includes the active resistance and inductance of the stator (R_S, L_S,), the active resistance and inductance of the steel (R_{FE}, L_{FE},), the active resistance and

inductance of the first (R_{R1}, L_{R1}) and second (R_{R2}, L_{R2}) rotor circuits, as well as the value of mutual inductance (Lμ). The methodology for determining the parameters of a multi-circuit equivalent circuit is given in sufficient detail in [9].

Let us write the equations of the mathematical model of an asynchronous motor for stator currents in a three-phase natural coordinate system, and for rotor currents in a two-phase rectangular coordinate system. In this case, it is necessary to take into account the dependences of the flux linkages and inductances of an asynchronous motor on the rotor position angle γ. Then the matrix of inductances between the phase windings of the stator and rotor of the asynchronous motor $L(\gamma)$ can be represented in the form of four submatrices: stator-stator L_{S-S}, stator-rotor $L_{S-R}(\gamma)$, rotor-rotor L_{R-R}, rotor-stator $L_{R-S}(\gamma)$. The described matrix of inductances has the following form:

$$L(\gamma)=\begin{bmatrix} L_{S-S} & L_{S-R}(\gamma) \\ L_{R-S}(\gamma) & L_{R-R} \end{bmatrix};\quad L(\gamma)^{-1}=\begin{bmatrix} \tilde{L}_{S-S} & \tilde{L}_{S-R}(\gamma) \\ \tilde{L}_{R-S}(\gamma) & \tilde{L}_{R-R} \end{bmatrix};\quad L_{S-R}(\gamma)=L_{R-S}(\gamma)^{tr};$$

$$L_{S-S}=\begin{bmatrix} L_S+L_\mu & \frac{-L_\mu}{2} & \frac{-L_\mu}{2} \\ \frac{-L_\mu}{2} & L_S+L_\mu & \frac{-L_\mu}{2} \\ \frac{-L_\mu}{2} & \frac{-L_\mu}{2} & L_S+L_\mu \end{bmatrix};\quad L_{R-R}=\begin{bmatrix} L_{\alpha1}+L_\mu & L_\mu & 0 & 0 \\ L_\mu & L_{\beta1}+L_\mu & 0 & 0 \\ 0 & 0 & L_{\alpha2}+L_\mu & L_\mu \\ 0 & 0 & L_\mu & L_{\beta2}+L_\mu \end{bmatrix};$$

$$L_{S-R}(\gamma)=L_\mu\cdot\begin{bmatrix} \cos(\gamma) & \cos(\gamma) & -\sin(\gamma) & -\sin(\gamma) \\ \cos(\gamma-\frac{2}{3}\pi) & \cos(\gamma-\frac{2}{3}\pi) & -\sin(\gamma-\frac{2}{3}\pi) & -\sin(\gamma-\frac{2}{3}\pi) \\ \cos(\gamma+\frac{2}{3}\pi) & \cos(\gamma+\frac{2}{3}\pi) & -\sin(\gamma+\frac{2}{3}\pi) & -\sin(\gamma+\frac{2}{3}\pi) \end{bmatrix}$$

The system of differential equations of an asynchronous motor, written in matrix form in phase coordinates for stator currents and in a two-phase coordinate system for rotor currents, will have the form:

$$\begin{bmatrix} pI_S \\ pI_R \end{bmatrix}=L(\gamma)^{-1}\cdot\left[\begin{bmatrix} U_S \\ 0 \end{bmatrix}-\begin{bmatrix} R_S & 0 \\ 0 & R_R \end{bmatrix}\cdot\begin{bmatrix} I_S \\ I_R \end{bmatrix}-\omega\cdot\frac{dL(\gamma)}{d\gamma}\cdot\begin{bmatrix} I_S \\ I_R \end{bmatrix}\right];$$

$$\frac{d\omega}{dt}=\frac{1}{T_j}\left[M_{ep}(i,\psi)-M_c(\omega)\right];$$

$$\frac{d\gamma}{dt}=\omega;$$

where: $p=\frac{d}{dt}$ - differentiation operator, $\frac{dL(\gamma)}{d\gamma}$ - matrix of derivatives of stator and rotor inductances, U_S - vector of stator and rotor winding voltages, $I_S=[i_A,i_B,i_C]^T$ - stator current vector, $I_R=\left[i_{\alpha1},i_{\beta1},i_{\alpha2},i_{\beta2}\right]^T$ - rotor current vector, ω - rotor speed. The matrices of active resistances of the stator and rotor windings are diagonal and have the form: $R_S=diag[R_S,R_S,R_S]$, $R_R=diag\left[R_{\alpha1},R_{\beta1},R_{\alpha2},R_{\beta2}\right]$.

The electromagnetic torque of an asynchronous electric motor and its moment of resistance are determined by the following formulas:

$$M_{ep}=\frac{1}{\sqrt{3}}\left[(i_B-i_C)\psi_A-(\psi_B-\psi_C)i_A\right];\quad M_c=K_{ЗАГР}\cdot\omega^2.$$

Mechanical damage, leading to the occurrence of both static and dynamic eccentricity, leads to a change in the size of the air gap between the inner surface of the stator and the outer surface of the rotor of an asynchronous electric motor, and as a consequence to a change in the value of mutual induction L_μ depending on the value of the rotor position angle γ.

The change in the air gap value in the event of static eccentricity is a function of the air gap dependence on the rotor position angle and is described by the following formula:

$$\delta(\gamma)=\delta_0-\varepsilon_s\cos(\gamma)$$

where: δ_0 - nominal air gap value,

ε_s - static eccentricity value, γ - rotor rotation angle.

The change in the air gap when dynamic eccentricity occurs is a function of the air gap dependence on the rotor position angle, its rotation speed, and time, and is described by the following formula:

$$\delta(\gamma,t)=\delta_0-\varepsilon_d\cos(\omega_r t-\gamma)$$

where: ε_d - the magnitude of dynamic eccentricity,

ω_r - rotor speed, γ - angle of rotation of the rotor.

In the case of static and dynamic eccentricities, the change in the air gap between the outer surface of the rotor and the inner surface of the stator of an asynchronous electric motor will be described by the formula:

$$\delta(\gamma)=\delta_0-\varepsilon_s\cos(\gamma)-\varepsilon_d\cos(\omega_r t-\gamma)$$

The magnitude of mutual induction when eccentricity occurs for the proposed mathematical model of an asynchronous electric motor is determined by the formula:

$$L_\mu(\gamma)=\frac{L_\mu}{\delta(\gamma)}$$

Thus, by setting the value of static and dynamic eccentricity, it is possible to model the occurrence of both mixed eccentricity for an asynchronous electric motor, and only static or only dynamic eccentricity. Fig. 2 shows graphs of the

change in stator phase currents, the generalized vector of stator currents, the rotor speed and the electromagnetic torque when static eccentricity (rotor shaft bending) occurs in an asynchronous electric motor, obtained using the proposed mathematical model.

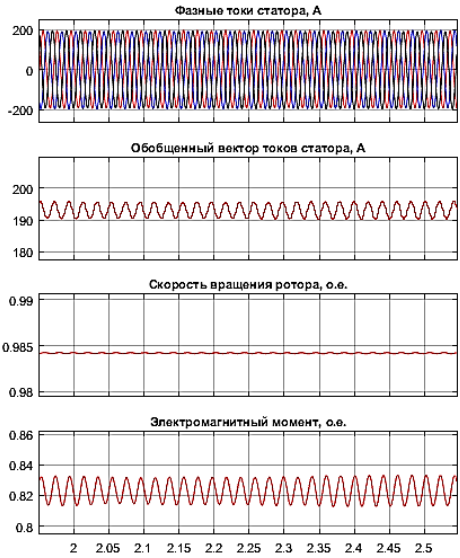

Figure 2. *Graphs of changes in stator phase currents, generalized vector of stator currents, rotor speed and electromagnetic torque when static eccentricity occurs*

As can be seen from Fig. 2, in the case of rotor shaft bending, oscillations occur in the stator currents caused by the appearance of higher harmonics, which subsequently leads to oscillations in speed and electromagnetic torque, as shown in Fig. 2, and as a consequence to the appearance of vibrations in the operating mode of an asynchronous electric motor.

Fig. 3 shows graphs of changes in stator phase currents, generalized vector of stator currents, rotor speed and electromagnetic torque when dynamic eccentricity occurs in an asynchronous electric motor, obtained using a mathematical model of an asynchronous electric motor.

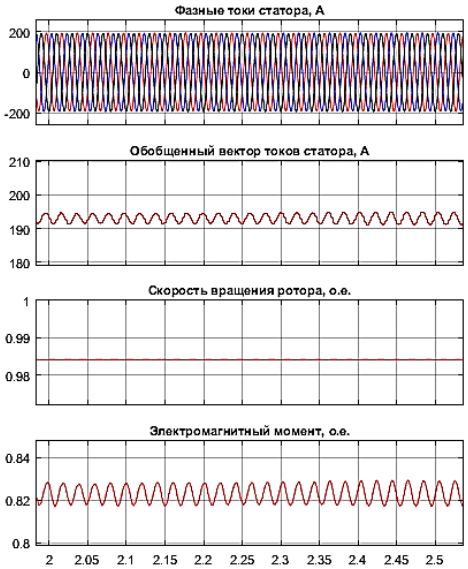

Figure 3. *Graphs of changes in stator phase currents, generalized vector of stator currents, rotor speed and electromagnetic torque when dynamic eccentricity occurs*

From Fig. 3 it is evident that in case of bearing damage, oscillations occur in stator currents caused by the appearance of higher harmonics, which subsequently leads to oscillations in speed and electromagnetic torque, as in the case of static eccentricity, which leads to the appearance of vibrations in the operating mode of an asynchronous electric motor.

Fig. 4 shows graphs of changes in stator phase currents, generalized vector of stator currents, rotor speed and electromagnetic torque when mixed eccentricity occurs in an asynchronous electric motor, obtained using the proposed mathematical model of an asynchronous motor.

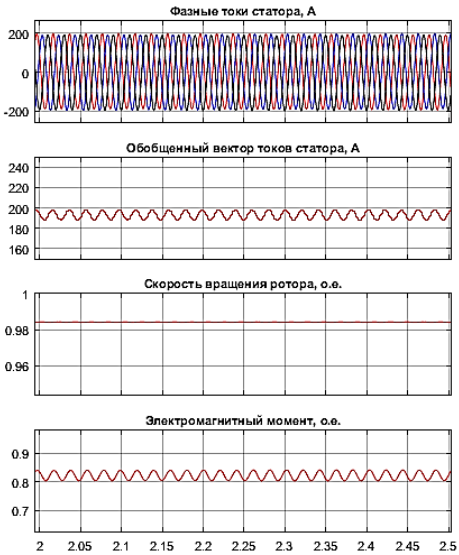

Figure 4. *Graphs of change in stator phase currents, generalized vector of stator currents, rotor speed and electromagnetic torque when mixed eccentricity occurs*

The results of modeling mixed eccentricity shown in Fig. 4 show that in the case of bearing damage and rotor shaft bending, oscillations occur in the stator currents, causing vibrations caused by the occurrence of higher harmonics. In this case, the resulting oscillations have a larger amplitude of change than when only static or only dynamic eccentricity occurs.

The following conclusions can be drawn from the obtained results:

1. A mathematical model of an asynchronous electric motor has been obtained, allowing modeling of eccentricity caused by bearing unit failure or rotor shaft bending, recorded in a three-phase coordinate system for stator currents, which allows a higher-quality analysis of stator currents when mechanical damage occurs for the purpose of their identification.

2. The use of the proposed mathematical model allows us to analyze existing methods for diagnosing eccentricity and their effectiveness, as well as to develop new criteria and methods for diagnosing the actual state of the mechanical part of an asynchronous electric motor.

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植物原料在功能性产品生产中的应用：抗氧化性能研究
VEGETABLE RAW MATERIALS FOR THE PRODUCTION OF FUNCTIONAL PRODUCTS: RESEARCH OF ANTIOXIDANT PROPERTIES

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注释。本文介绍了贝加尔湖自然区内生长的植物原料的研究结果和获取干燥功能成分的方法的选择。研究了所得样品的抗氧化活性。证明了将所得产品用于功能性产品（干饮料和坚果和浆果棒）设计的可能性。

关键词：植物原料、干饮料、棒、提取、浓缩、干燥、工艺参数、抗氧化性能。

Annotation. *The article presents the results of research of plant raw materials growing in the Baikal natural territory and selection of methods for obtaining dry functional ingredients. Antioxidant activity of the obtained samples is studied. The possibility of using the obtained products in the design of functional products - dry drinks and nut and berry bars - is proved.*

Keywords: *plant raw materials, dry drink, bars, extraction, concentration, drying, technological parameters, antioxidant properties.*

The human need for various nutritional substances depends on many factors: environmental impact (including emotional), type and nature of service and labor activity, age, body weight and height, sex, physical condition and development, etc. The works of many domestic and foreign scientists [1, 2, 3] are devoted to the problem under study in its various aspects.

In this regard, the development of specialized products with antioxidant properties due to the content of a large number of native vitamins, minerals and easily digestible proteins is necessary and in demand today. The above-mentioned biologically active substances are contained in significant amounts in plant raw materials.

About 3000 species of plants grow in the Baikal natural territory, among which there are medicinal (about 520 species) and food (about 150 species) plants with unique chemical properties and biologically active substances. Resources of plant raw materials of the Republic of Buryatia include biological harvest of berries, which may amount to about 10 thousand tons with economically possible harvest of 3.5 thousand tons, as well as industrial harvest of medicinal plants of about 8.5 thousand tons.

When analyzing the demand for plant products, it was found that plant extracts, which are concentrated extracts obtained using various solvents (extractants), are gaining popularity. The most preferable are dry forms, the advantages of which over other forms of plant extracts are convenience of use and stability during storage.

The aim of the study is to obtain functional ingredients from plant raw materials growing in the Baikal natural territory, which can be used as ingredients in the production of products with high antioxidant capacity.

In order to achieve the objective, the following tasks were carried out:

1. To carry out the selection of plant raw materials for obtaining dry functional ingredients;
2. Obtain dry functional ingredients using microwave and precritical extraction, microwave vacuum and convective drying;
3. To study the antioxidant potential of the obtained dry functional ingredients.

When solving the first problem we used plant raw materials with high antioxidant activity and in significant quantities growing in the Baikal natural territory [4, 5] - fruits and leaves of sea buckthorn, black currant leaves, Ivan-tea leaves, thyme herb

When solving the second problem for obtaining dry ingredients, we carried out selection of extraction methods and extractants, drying methods, as well as determined the operating parameters of technological processes [6-8]. The conducted researches on determination of working parameters of extraction, concentration and drying processes allowed to develop technology for obtaining dry ingredients.

Testing of the technology was carried out in real production conditions on the basis of the industrial partner - LLC "IPI "BaikalEcoProduct", the head of which is A.G. Khanturgaev. As a result of testing, prototypes of 4 types of dry plant extracts were obtained: from thyme, sea buckthorn leaves, black currant leaves, Ivan-tea leaves (Fig. 1).

Figure 1. *Dry functional ingredients:*
a) from sea buckthorn leaves; b) from blackcurrant leaves;
c) from Ivan-tea leaves; d) from thyme herb.

The obtained dry ingredients (Fig. 1) had high organoleptic characteristics: pleasant herbaceous aroma, peculiar to the type of raw materials used, without extraneous odor, completely dissolved in hot water and were loose homogeneous fine crystalline powders. The moisture content of the samples was 4-6%, which predicts a fairly long shelf life of the samples

Further studies of the obtained dry functional ingredients were aimed at solving the third problem, namely the determination of antioxidant activity.

Fig. 2 shows the data of determination of the total antioxidant content (TAC) in the obtained plant extracts, which are planned to be used as components in the development of formulation solutions of functional products.

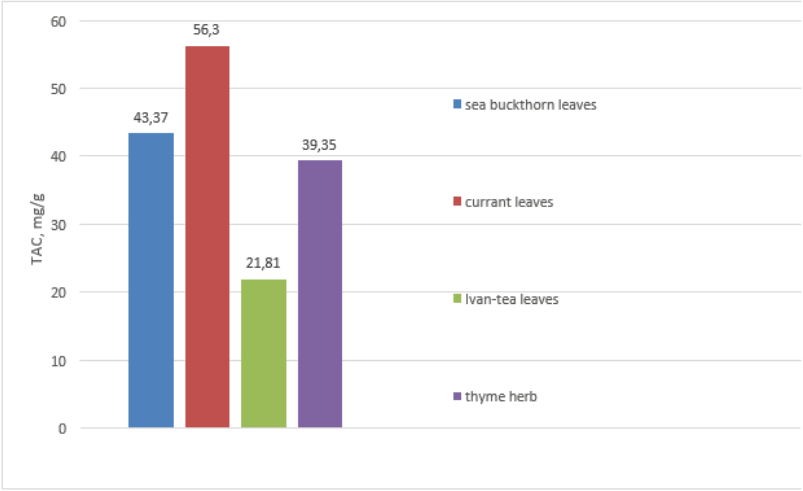

Figure 2. *TAC indices of plant extracts*

As follows from the data presented above, among the plant extracts, the highest SSA is found in blackcurrant and sea buckthorn leaves.

As a result of the conducted research the possibility of obtaining dry extracts from plant raw materials of the Baikal region - thyme, sea buckthorn leaves, black currant leaves, Ivan-tea leaves using modern methods of extraction and drying been studied

Using microwave and precritical extraction, microwave vacuum and convective drying, dry functional ingredients were obtained and the total antioxidant content (TAC) was determined, which in the future will allow their use in the development of formulation and component solutions of functional products (beverages, bars, etc.).

This work is an important step in the development of advanced technologies for processing plant raw materials and making a significant contribution to the conservation and rational use of the wealth of the Baikal natural territory.

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俄罗斯联邦西北部一种很有前景的豆科植物，可用于生产饲料

A PROMISING LEGUM PLANT FOR FORAGE PRODUCTION IN THE NORTHWEST OF THE RUSSIAN FEDERATION

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摘要。本文探讨了在列宁格勒地区条件下，使用不同豆科植物来创建高产草场的问题。直到最近，俄罗斯联邦西北部和列宁格勒地区的主要豆科植物都是红三叶草，其特点是可塑性强、适应该地区土壤和气候条件的特点、播种后再生速度快、草场使用第一年就能形成高水平的牧草量。然而，红三叶草也有一个明显的缺点：其生产寿命仅为 2-3 年，这阻碍了其用于创建长期草场。因此，近年来，在该地区农场种植豆科植物和豆科谷物草林时，人们更加关注紫花苜蓿、东方山羊豆等有前途的物种。尽管这些物种比最常见的草地三叶草有许多优点，但它们也有许多缺点。例如，紫花苜蓿对土壤酸度高度敏感，东方山羊豆的特点是头几年生长速度非常慢，而且容易受到严重污染。因此，该部门的研究目的是选择豆科植物，研究草林形成的特征及其在列宁格勒地区的条件下的形成特征。从 2009 年到现在，在圣彼得堡国立农业大学的实验田中，对不同豆科植物进行了比较评估，以在碳酸盐土壤上种植牧草。 2009 年建立的实验性豆科草林以红三叶草、紫花苜蓿和东部山羊豆为基数，以纯种和双混种方式建立，为了建立豆科-谷类草林，在与豆科植物的草种混合物中包括猫尾草、猫尾草 + 草甸羊茅、猫尾草 + 草甸羊茅 + 无芒雀麦草。播种时使用的草种品种如下：红三叶草 - 品种 Suydinets；紫花苜蓿 - 品种 Vega 87；东部山羊豆 - 品种 Nadezhda；猫尾草 - 品种 Juno；草甸羊茅 - 品种 Suydinskaya；无芒雀麦草 - 品种 Dragon。纯种和草种混合物播种时，播种量按 I.V. Larin 建议。对红三叶草参与创建的草地生产力的比较评估表明，在产量方面，豆科-谷类草地与猫尾草混合的草地具有明显的优势，两年内平均产量为 9.8 吨/公顷，比单一品种红三叶草播种高 2.4 吨/公顷，比播种红三叶草和可变苜蓿高 1.9 吨/公顷。对苜蓿草地产量的计算表明，平均而言，两年使用期间，单一品种苜蓿播种（16.2 吨/公顷干物质）产量最高，与东部山羊豆混合（13.3 吨/公顷产量最低）。前两年纯种东部山羊豆草地产量最低（4.1 吨/公顷），这是由其生物学特性决定的。东部山羊豆与其他豆科植物以及谷物混合播种可显著提高产量：例如，将其与可变苜蓿一起播种时，两年内平均产量达到 11.1 吨/公顷。因此，正确选择豆科植物可以从使用的第一年开始创造高产草场，这无疑可以作为该地区农场编制草混合物的指南。

关键词：豆科植物、家养品种、草混合物、植物组成、豆科植物和豆科谷物草场。

Abstract. *This article examines the issues of creating highly productive grass stands for forage purposes with the participation of different legume species in the conditions of the Leningrad Region. Until recently, the main legume species both in the North-West of the Russian Federation and in the Leningrad Region has been red clover, which is characterized by high plasticity, adaptability to the peculiarities of the soil and climatic conditions of the zone, rapid regrowth rates after sowing and the formation of a high level of forage mass already in the first year of using the grass stand. However, red clover also has a significant drawback: its productive longevity is calculated at only 2-3 years, which prevents its use in creating long-term grass stands. Therefore, in recent years, when creating legume and legume-cereal grass stands in the farms of the region, more attention has been paid to such promising species as alfalfa, eastern goat's rue, etc. Despite the fact that the listed species have a number of advantages over the most common meadow clover, they also have a number of disadvantages. Thus, alfalfa is highly sensitive to soil acidity, and eastern goat's rue is characterized by very slow growth rates in the first years and is subject to severe contamination. Therefore, the purpose of the department's research was the selection of legume species and the study of the features of the formation of grass stands with their participation in the conditions of the Leningrad Region. From 2009 to the present, a comparative assessment of different legume species has been carried out to create forage grass stands on sod-carbonate soil in the experimental field of St. Petersburg State Agrarian University. Experimental legume grass stands established in 2009 were created on the basis of red clover, variable alfalfa and eastern galega both in pure form and in double mixtures, and to create legume-cereal grass stands, timothy grass, timothy grass + meadow fescue, timothy grass + meadow fescue + awnless brome grass were included in the grass mixtures with legume species. The following grass varieties were used for sowing: red clover - variety Suydinets; variable alfalfa - variety Vega 87; eastern galega - variety Nadezhda; timothy grass - variety Juno; meadow fescue - variety Suydinskaya; awnless brome grass - variety Dragon. The seeding rate recommended by I.V. Larin when sowing in pure form and in grass mixtures. A comparative assessment of the productivity of grass stands created with the participation of red clover showed that a clear advantage in terms of yield is a mixed legume-cereal grass stand with timothy grass, which on average over 2 years provided 9.8 t / ha s.m, which is 2.4 t / ha higher than a single-species sowing of red clover and 1.9 t / ha higher than a sowing of red clover and variable alfalfa. The calculation of the yield of grass stands with alfalfa shows that, on average, over 2 years of use, the highest yield is provided by single-species alfalfa sowing (16.2 t/ha d.m.) and mixed with eastern*

goat's rue (13.3 t/ha provide the lowest yield). Grass stands with eastern goat's rue in the first two years, when sown in pure form, provide the lowest yield (4.1 t/ha), which is explained by its biological characteristics. Mixed sowing of eastern goat's rue with other legume species, as well as with cereals, leads to a significant increase in yield: for example, when sowing it together with variable alfalfa, the yield on average over 2 years reached 11.1 t/ha with m. Thus, the correct selection of legume species allows the creation of highly productive grass stands from the first years of use, which can undoubtedly serve as a guide for farms in the region when compiling grass mixtures.

Keywords: *legume species, domestic varieties, grass mixtures, botanical composition, legume and legume-cereal grass stands.*

Relevance. The intensification of livestock farming is directly related to the production of high-protein feed and the expansion of their range. This problem is especially relevant for farms in the Leningrad Region, where highly productive dairy livestock is concentrated: the average annual milk yield per forage cow in the region is approaching 10 thousand kg of milk. Therefore, further development of livestock farming in the region must be solved by eliminating the protein deficiency in domestically produced feed by expanding legume and legume-cereal grass stands in the structure of perennial grasses [1]. According to the agro-industrial complex of the Leningrad Region, the main legume species in the creation of such grass stands today is red clover, which occupies more than 85% in the structure of legume-cereal grass stands. This legume species has a number of advantages, but it also has a significant disadvantage - its short productive life, which is accompanied by a sharp decrease in its share in the herbage already in the second year of use [2]. Therefore, the solution to the protein problem of feed should be based on a wider use of long-lived legume species that can provide cheap high-quality protein without the introduction of nitrogen fertilizers, which is an important link in the transition to organic farming and obtaining environmentally friendly products [3, 4]. Therefore, studying the possibility of using such long-lived legume species as alfalfa and eastern goat's rue to create highly productive legume and legume-cereal herbage in the conditions of the Leningrad Region is a very relevant area of scientific research [5].

Research results.

Experimental work on this topic began on the experimental field of St. Petersburg State Agrarian University in 2009 - 2011, which served as the foundation for the expansion and continuation of scientific research in this direction to the present day. The experimental design included 18 variants, where single-species crops, two-component legume and legume-cereal grass mixtures were laid out on the basis of red clover from Suydinets, variable alfalfa from Vega 86 and eastern goat's rue from Nadezhda (Table 1).

Table 1.

Experimental design

Single-species crops	**Grass mixtures, ratio of species in grass mixtures, %**				
Red clover	Red clov. + varieg. alfalfa 50+50	Red clov. + Eastern gal. 50+50	Red clov. + timothy grass 50+50	Red clov. + timothy grass + meadow fescue 50+25+25	Red clov..+ timothy grass + meadow fescue.+ awnless brome 50+ 17+17+16
Variegated alfalfa	Varieg. alfalfa + red clov. 50+50	Variegated alfal. + Eastern gal. 50+50	Varieg. alfalfa + timothy grass 50+50	Varieg. alfalfa + timothy grass + meadow fescue 50+25+25	Varieg. alfalfa.+ timothy grass + meadow fescue.+ awnless brome 50+ 17+17+16
Eastern galega	East. galega + red clov. 50+50	Eastern gal. + Variegated alfal. 50+50	Red clov. + timothy grass 50+50	Eastern gal. + timothy grass + meadow fescue 50+25+25	Eastern gal. + timothy grass + meadow fescue.+ awnless brome 50+ 17+17+16

This experiment was conducted on sod-carbonate soil on July 2, 2009. Grasses were sown coverless, in rows. Before sowing, the seeds of legume species were scarified and treated with rhizotorphin. In the year of sowing, two mowings of weed vegetation were carried out as it grew back, which significantly reduced the infestation of the studied grass stands. In the years of using red clover and eastern goat's rue on grass stands in 2010 and 2011, 2 mowings were carried out, and on the grass stand of variable alfalfa in 2010 - 2 mowings, and in 2011 - three. The field experiment was laid out using the random repetition method, the experiment was repeated four times, the area of the experimental plot was 9 m² [6]. Every year in early spring at the beginning of grass growth, additional fertilization with mineral fertilizers was carried out at a dose of P60K60 in the form of double superphosphate and potassium chloride.

During the research period, phenological observations and yield records were carried out according to the guidelines for conducting field experiments with forage crops developed by the V.R. Williams All-Russian Research Institute of For-

age Crops (1997). Energy assessment was carried out according to the methodology of B.P. Mikhailichenko et al. (1985) [7,8] /

Weather conditions during the years of the study were quite optimal and differed little from the average long-term indicators, which contributed to the formation of 2-3 cuts of the studied grass stands.

Botanical composition of the studied grass stands. One of the main indicators of the forage value of the studied grass stands is the botanical composition. It determines the biological value of the feed, the stability of grass yields and the productive longevity of the meadow [5]. The dynamics of the botanical composition of the grass stands depends on the composition of the sown species, their age and weather conditions. The botanical composition of the studied single-species legume grass stands in the first year of use indicates a high share of unsown species in their composition, especially in the 1st cut. Thus, in the composition of the single-species sowing of red clover, the content of unsown species reached 52%, and in the composition of the single-species sowing of alfalfa this figure was 25.7%, and the single-species sowing of eastern goat's rue was represented by single specimens of the sown species. In the formation of the 2nd cut, even in the first year of use, the studied sown species had a clear advantage: thus, the content of red clover increased to 90%, and that of sowing alfalfa to 97%. At the same time, the content of eastern goat's rue and in the 2nd cut remained at an extremely insignificant level - 12%. Sowing red clover with other legume species (alfalfa and galega) contributes to a high content of legume components in the grass stands and a significant reduction in unsown species already in the first year of use. When sowing red clover with variable alfalfa, the share of legumes in the first cut reaches 87.5%. And when sowing with eastern galega - 91%. Sowing red clover with eastern galega has a clear advantage, since the slow development of eastern galega has a favorable effect on the fast-growing red clover. Moreover, this trend is also reflected in the second cut.

When sowing alfalfa with red clover, the content of the first species was significantly lower than in single-species sowing and amounted to only 35%, which is quite natural due to the obvious superiority of fast-growing red clover, where its share accounted for 52%. However, the positive aspect of this option is the sharp decrease in unseeded species (12.5%), which is 2 times lower compared to single-species sowing of variable alfalfa.

A study of the dynamics of the botanical composition of legume-cereal herbages showed that for all the studied legume species, the most favorable conditions for growth are formed by joint sowing with timothy grass.

In the second year of use, significant changes occurred in all the studied grass stands. Thus, in all variants with red clover, the content of the legume species decreased, especially in single-species sowing (up to 9.4% in the first cut and up

to 32% in the second). This circumstance of the loss of red clover from the grass stand in the second year of use is associated with its biology (young age) and fully confirms the inexpediency of its cultivation in single-species crops. When clover was sown together with other legume species and cereals, its content also decreased sharply, but in this case, the advantage in the composition of the grass stands belonged to other legume species (alfalfa) and cereal species. Analysis of the botanical composition of grass stands formed on the basis of alfalfa showed that this legume species, unlike red clover, increases its share in all studied variants by the second year of use, so it can be cultivated both in single-species crops and in grass mixtures with other legume species and cereals.

The dynamics of the botanical composition of grass stands created with the participation of eastern goat's rue indicates the impossibility of forming high-quality grass stands with a high content of this legume species in the first years of use, since it accounted for only 3 to 23% of the total mass.

Yield of legume and legume-cereal grass stands

The main integral indicator of the efficiency of cultivation of meadow grass stands is the yield [8,9,10] / A comparative assessment of the productivity of grass stands with the participation of red clover showed that mixed grass stands, especially legume-cereal ones, have a clear advantage in terms of yield. At the same time, the highest level on average over 2 years was provided by mixed sowing of red clover and timothy grass - 9.8 t / ha, which is 2.4 t / ha higher than a single-species sowing and 1.9 t / ha higher than a mixed sowing of red clover and variable alfalfa (Table 2).

Table 2.

Yield of grass stands with red clover, t / ha of dry weight

Variants	2010			2011			Average for 2 years	
	1 hay crop	2 hay crop	Totally	1 hay crop	2 hay crop	Totally	t/ha	%
Red clover	5,5	4,4	9,9	0,7	4,3	5,0	7,4	100
Red clover + Variegated alfalfa	5,6	4,3	9,9	1,5	4,5	6,0	7,9	106
Red clover + Eastern galega	4,9	2,7	7,6	1,9	2,7	4,6	6,1	82
Red clover + timothy grass	6,3	5,1	11,4	4,2	4,1	8,3	9,8	132
Red clover + timothy grass + meadow fescue	6,4	4,7	11,1	3,7	3,2	6,9	9,0	121

Red clover + timothy grass + meadow fescue + awnless brome	5,2	2,6	7,8	3,3	3,8	7,1	7,4	100
HCPo5	0,4	0,3	0,6	0,2	0,3	).4		

The addition of a second loose-bunch grass, meadow fescue, to clover with timothy, although it provided an increase in yield compared to all legume grass stands, was significantly lower compared to a two-component legume-grass grass stand, by 0.8 t/ha d.m. The four-component mixture with the addition of a third rhizomatous grass, awnless brome, did not have a significant effect on the yield (Table 2).

Taking into account the yield of the studied grass stands with variable alfalfa shows that all legume-grass grass stands with the participation of this legume species in the first year of use were significantly inferior in yield to all the studied legume grass stands. Thus, the two-component alfalfa-timothy mixture formed 8.8 t/ha d.m., which is 4.3 t/ha lower compared to a single-species sowing of alfalfa (Table 3).

Table 3.

Yield of grass stands with variable alfalfa, t/ha dry mass

Variants	**2010**			**2011**				**Average for 2 years**	
	1 hay crop	**2 hay crop**	**Totally**	**1 hay crop**	**2 hay crop**	**3 hay crop**	**Totally**	**t/ha**	**%**
Red clover	6.8	6,3	13,1	8.0	5,9	5,4	19,3	16.2	100
Red clover + Variegated alfalfa	5,6	4,3	9,9	1,5	4,5	3,9	9,9	9,9	61
Variegated alfalfa + Eastern galega	5,5	4,4	9,9	7,3	5,1	4,4	16,8	13,3	82
Variegated alfalfa + timothy grass	5,0	3,8	8,8	6,1	3,2	2,9	12,2	10,5	64
Variegated alfalfa + timothy grass + meadow fescue	3,2	2,8	6,0	4,0	3,3	2,9	10,2	8,1	50
Variegated alfalfa + timothy grass + meadow fescue + awnless brome	3.3	2.8	6.1	4.4	3.8	3.6	11.8	8.9	54
HCP05	0.4	0.3	0.5	0.3	0.3	0.3	0.7		

Three- and four-component legume-cereal mixtures provided the same yield level - 6.0 and 6.1 t/ha, which is more than 2 times lower than the single-species sowing of alfalfa. Thus, it was found that for variable alfalfa, the best cereal component in the first year of use is timothy grass. Accounting for the yield of grass stands with variable alfalfa in the second year of use showed that this legume species not only increases its potential, and in all experimental variants, but also forms 3 full-fledged mowings. As in the previous year, the highest yield level was provided by single-species sowing of alfalfa (19.3 t/ha), which is 6.2 t/ha higher compared to the first year of use. A high yield was also provided by the combined sowing of alfalfa with galega - 16.8 t/ha, but when sowing alfalfa with red clover, the lowest yield was obtained - 9.9 t/ha, which can be explained by the phytocenotic incompatibility of these two legume species.

On average, over 2 years, the highest yield from legume herbages was provided by single-species sowing of alfalfa (16.2 t/ha) and combined sowing with eastern galega - 13.3 t/ha, and from legume-cereals, the option with timothy grass can be distinguished, where the yield was more than 10 t/ha (Table 3).

A comparative assessment of the yield of grass stands with eastern goat's rue shows that this legume species, when sown in its pure form, provides an extremely low level in the first two years - 4.1 t/ha, which is explained by its biological characteristics (Table 4).

Table 4.

Variants	2010			2011			Average for 2 years	
	1 hay crop	2 hay crop	Totally	1 hay crop	2 hay crop	Totally	t/ha	%
Eastern galega	1,6	1,4	3.0	2,6	2,7	5,3	4,3	100
Eastern galega + Red clover	4,9	2,7	7,6	1,9	2,7	4,6	6,1	148
Eastern galega + Variegated alfalfa	5,5	4,4	9,9	7,3	5,1	12,4	11,1	270
Eastern galega + timothy grass	2,6	2,2	4,8	3,3	2,5	5,8	5,3	120
Eastern galega + timothy grass + meadow fescue..	3,4	3,0	6,4	4,2	3,4	7,6	7,0	170
Eastern galega + timothy grass + meadow fescue.+ awnless brome	2,1	1,8	3,9	2,7	2,0	4,7	4,3	104
HCP05	0,2	0,3	0,4	0,2	0,2	0,4		

Mixed sowing of eastern goat's rue with other legume species leads to a significant increase in yield, this was especially evident in the joint sowing with alfalfa, where an average of 11.1 t/ha s. m was obtained over 2 years, which can be explained by the powerful development of alfalfa. Sowing of goat's rue with cereals, although it does not provide a high level of yield in the first two years, but contributes to a noticeable decrease in weed infestation of crops.

Thus, of all the studied legume species in the first two years on sod-carbonate soil in the conditions of the Leningrad Region, alfalfa has a clear advantage, both in yield and in the stability of the resulting crop.

Conclusions. 1. The correct selection of grass species allows to create highly productive legume and legume-cereal grass stands with a high participation of legumes in field and forage crop rotations, providing over 10 t/ha of dry mass, already from the first year of use.

2. A comparative assessment of the three studied legume grass species for the first years of use revealed a clear advantage of variable alfalfa in creating both legume and legume-cereal mixtures on sod-carbonate soil. In this case, the highest participation of alfalfa in all grass stands is observed, over 90%.

3. The use of red clover in creating legume and legume-cereal grass stands is justified only in the first year of use, when its share was high enough and reached up to 90% in the 2nd mowing. In the second year of use, due to the loss of clover from the grass stands, they are transformed into cereals or even forb-cereals, which is quite natural.

4. Goat's rue in the first two years of use does not provide high-quality grass stands, the content of this legume species in all studied grass stands was extremely low - from 3 to 33.1%.

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基于玻璃碱粘合剂的非高压硅酸盐混凝土
NON-AUTOCLAVED SILICATE CONCRETE BASED ON GLASS-ALKALI BINDER

Vorontsov Victor Mihailovich
Candidate of Technical Sciences, Associate Professor
Yaremchuk Maksim Vitalevich
Postgraduate
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注释。本文介绍了一种基于碎玻璃、碱性溶液和增塑剂的无水泥、非烧制、非高压釜粘合剂的开发信息。这些成分在球磨机中进行联合细磨。所得物质具有高度触变性，容易因冲击或振动而液化，并表现出其粘合性能。玻璃碱粘合剂在热处理条件下（在 85-90ºC 的温度范围内）在 5-6 小时内硬化。在这种情况下，强度达到 25 MPa 或更高。在开发的粘合剂的基础上，获得了非高压釜硅酸盐细颗粒混凝土。

关键词：碎玻璃、碱性活化剂、增塑剂、湿磨、物理和机械性能、非高压釜硅酸盐混凝土、微观结构。

Annotation. *The article provides information on the development of a cementless, non-firing and non-autoclaved binder based on cullet, a caustic alkali solution and a plasticizer. These components are subjected to joint fine grinding in a ball mill. The resulting mass is highly thixotropic, easily liquefied by shock or vibration, and its adhesive properties are manifested. The glass-alkali adhesive mass hardens under heat treatment conditions (in the temperature range of 85–90ºC) within 5–6 hours. In this case, a strength of 25 MPa or more is achieved. On the basis of the developed binder, non-autoclave silicate fine-grained concrete was obtained.*

Keywords: *cullet, alkaline activator, plasticizer, wet grinding, physical and mechanical properties, non-autoclaved silicate concrete, microstructure.*

Currently, one of the urgent problems of the construction industry is the use of solid municipal waste, in particular cullet, which accumulates in large quantities

in landfills, polluting the soil and the environment. In this regard, active research is being conducted to find ways to utilize cullet. Of all the variety of glass waste, it is necessary to highlight by-products of glass production (primary waste), which are reused in melting glass. Secondary glass waste includes cullet of sheet and container glass, which, due to the heterogeneity of its chemical composition, is not used in the glass industry. In world practice, a wealth of experience has been accumulated in the use of cullet. Crushed cullet is used as a filler in concrete, plastics and other building materials and products, in the production of foam glass, for the production of facing and floor tiles, panels, roofing materials, in road construction. It was found that cullet can be used not only as a filler or filler in cement composites, but also as a component of a binder, on the basis of which materials for various purposes can be obtained.

The objective of the upcoming experiments was to develop an optimal composition of the binder suspension, grinding and heat treatment modes in order to obtain a binder of increased strength with minimal energy consumption. In our experiment, we used window and container glass cullet (the average chemical composition is given in Table 1). The glass fragments were passed through a laboratory jaw crusher with an outlet jaw opening of 2.5–5 mm, then the 0–2.5 mm fraction was sifted out, which was subsequently subjected to grinding.

Table 1.

Average chemical composition of cullet

Oxides	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**CaO**	**MgO**	**Na_2O+K_2O**
Window	69,0–72,5	1,5–4,2	0,1–0,8	7,5–8,7	2,5–3,5	13,2–14,0
Container	71,5–73,7	0,2–3,3	0,8–1,7	5,2–9,1	0,1–0,6	14,0–14,8

The purpose of the first stage of the research was to establish the optimal time for grinding cullet. For this purpose, the selected mass of crushed cullet (500 g) was ground in different time modes (2, 4, 6 and 8 hours), while the specific surface area of the grinding product and the average size of its particles were recorded.

Table 2.

Change in cullet dispersion from grinding time

№	**Grinding time, h**	**Specific surface area, m^2/kg**	**Average particle diameter, μm**
1	2	386,4	5,9
2	4	516,6	4,6
3	6	541,2	4,3
4	8	550,8	4,2

The results of the experiment showed (Table 2) that an intensive increase in the specific surface area is observed during 6 hours of milling, then it slows down and becomes ineffective by 8 hours. Therefore, in further experiments, the milling of the specified amount of cullet was carried out in a six-hour mode. The second stage was devoted to studying the process of cullet grinding during wet milling in various concentrations of alkaline solutions. For milling, 500 g of crushed cullet and 100 ml of an alkali solution with a concentration of 9 to 17 wt. %. Granulated alkalis were used - NaOH or KOH (reagents of chemically pure grade). A hyperplasticizer was added to the alkaline solutions. - Melflux 2651 F. The additive of the latter was 0.8 g (determined experimentally). All components were loaded into a porcelain ball mill, where they were ground together. During the milling process, a viscous adhesive mass is formed, which has high thixotropy under impact and vibration effects. The hyperplasticizer has a liquefying effect on the binding mass, reduces the amount of mixing water and simultaneously increases the concentration of alkali in the solution. During the milling process, the mass is saturated with amorphous silica, the molecules of which, entering into a polycondensation reaction, form polymer chains of polysilicic acid sol, which are transformed into silica gels during heat treatment and harden. After milling, the binding mass was transferred to metal forms - cubic cells with a 3 cm edge size and compacted on a shaking table. The number of blows during molding was constant and for each composition was 200 blows. The molded samples were kept in the molds until the next morning in order to acquire stripping strength (15–16 hours) and after stripping were subjected to heat treatment (drying) in a drying cabinet. After the heat treatment, the hardened samples were subjected to physical and mechanical tests. The test results are given in Table 3.

Table 3.

Dependence of physical and mechanical properties of binder samples on the concentration of the alkaline solution

№	Concentration of alkali solution, %	Average density, kg/m^3	Compressive strength, MPa
1	9	1830,1	16,7
2	11	1836,4	20,2
3	13	1841,3	25,7
4	15	1832,5	18,0
5	17	1823,6	14,8

As the test results showed, the samples after hardening have a compressive strength of 14.8 to 25.7 MPa. The optimal (showing the highest strength) was composition No. 3 with a caustic alkali solution concentration of 13%, and the

result was practically the same for both NaOH and KOH solutions. The next stage of the research was to establish the optimal temperature and time of heat treatment of the glass-alkali binder. For this purpose, a large batch of samples was prepared and subjected to heat treatment at various temperatures in a laboratory drying chamber. The temperature varied from 50 to 200ºC with a step of 50º. The time was chosen arbitrarily - 6 hours, but subsequently, after verification experiments, it did not change. The test results of the samples after treatment in various temperature modes are given in Table. 4.

As the results showed (Table 4), when processing binder samples from 50 to 100ºC, an increase in their density and strength is observed. With further heating (from 100ºC and above), these indicators decrease.

Table 4.

Dependence of physical and mechanical indicators of binder samples on the processing temperature

№	Processing temperature, ºC	Average density, kg/m^3	Compressive strength, MPa
1	50	1830,4	18,2
2	100	1838,5	22,7
3	150	1826,3	16,5
4	200	1822,2	14,0

According to the updated data, the optimum heat treatment mode for the glass-alkali binder turned out to be in the temperature range of 85–90ºC and the time of 5–6 hours. In this case, the strength reaches a value of more than 25 MPa, the water resistance coefficient is 0.85–0.89.

Thus, a composition of a non-fired and cementless binder with minimum hardening times, having a mechanical strength of 25 MPa and higher, was developed. Two patents for invention were received for the development (RU Patents Nos. 2778880 and 2786468).

As numerous studies have shown [1-4], glass does not exhibit binding properties under natural conditions. This is explained by the fact that under normal conditions, amorphous silica, as well as crystalline silica, is a substance that is practically insoluble in water. However, its solubility increases linearly with increasing temperature, as well as in a strongly alkaline solution. It is the alkaline environment that has a great influence on the solubility of silica and the subsequent polycondensation of silicic acids [5]. As a result of polycondensation, silica sols are formed, which at elevated temperatures (85–90ºC) quickly transform into polysilicic acid gels. They glue together the incompletely dissolved glass particles and filler grains into a monolith. Then, after a certain period of time, the gels par-

tially crystallize. The crystallization of the gel is explained by the fact that it is in a metastable state and at elevated temperatures in the presence of alkali tends to transform into more stable crystalline forms.

In order to obtain fine-grained silicate concrete, a glass-alkali binder (GAB) was used with the following composition (wt.%):

Cullet – 80.0–84.5;

Caustic alkali – 1.6–2.7; Hyperplasticizer – 0.2;

Water 12.5–17.5.

Quartz sand and crushed cullet were used as fine aggregate. Both aggregates had a grain size of 1.25–0 mm.

Sand or cullet (each of the aggregates was used separately) was mixed with fine-grained silicate concrete, the binder: aggregate ratio was 3:1 (25 mass parts of aggregate per 75 mass parts of fine-grained silicate concrete). The water-solid ratio (W/S) varied from 0.15 to 0.25. The sample preparation method and heat treatment regime were the same as in the previous experiments. The heat-treated samples were subjected to physical and mechanical tests, the results of which are shown in Table 5.

Table 5.

Results of physical and mechanical tests of fine-grained silicate concrete samples

№	Solid components, mass %			W/S	Density, kg/m^3	Strength, MPa
	GAB	Sand	Broken glass			
1	75	25	-	0,15	1929	23,3
2	75	-	25	0,15	1926	22,4
3	75	25	-	0,18	1943	25,0
4	75	-	25	0,18	1938	24,5
5	75	25	-	0,20	1906	20,7
6	75	-	25	0,20	1884	18,8
7	75	25	-	0,25	1844	14,4
8	75	-	25	0,25	1836	14,1

The results of the experiment showed (Table 5) that fine-grained concrete with strength characteristics of 24–25 MPa can be obtained on a cementless glass-alkaline binder using quartz sand or crushed cullet as a fine filler. The concrete curing mode is drying at a temperature of no more than 90ºC. Heat-moisture and autoclave treatments are ineffective here, since they require high energy costs and a large steam consumption, and do not provide an increase in strength. At the same time, the optimal value of the water-solid ratio was found to be 0.18. In the micrographs taken with a scanning electron microscope, the structure of the samples is a

stone-like body with inclusions of partially crystallized silica gel (filamentary and plate-like fragments), between which the filler grains are located tightly adjacent to them. This arrangement allows for the creation of a compacted and reinforced structure, providing the concrete with high strength (Fig. 1).

a *b*

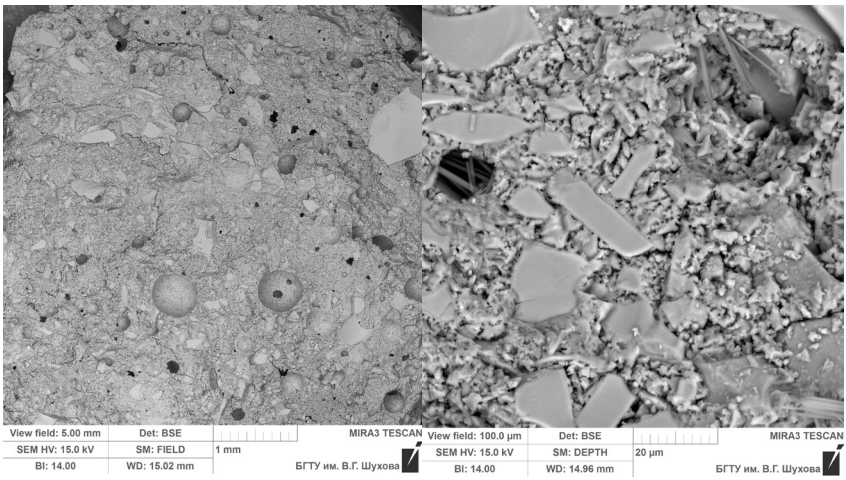

Figure 1. *Microstructure of samples on aggregates: a – sand (fine-grained concrete); b – cullet (glass concrete)*

The conducted studies allow us to conclude that in the production of fine-grained concrete (aggregate – quartz sand) and glass concrete (aggregate – cullet), cement-free and unfired binders can be used, and the technology itself is characterized by low energy consumption.

The use of a clinker-free binder based on cullet will significantly expand the raw material base of materials used in the production of mineral binders, increase the range of manufactured products and save such expensive materials as cement, lime, etc.

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