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

Proceedings of the International Conference

Date: December 9

Beijing, China 2023

上合组织国家的科学研究：协同和一体化国际会议

参与者的英文报告

International Conference “Scientific research of the SCO countries: synergy and integration”

Part 1

2023 年 12 月 9 日。中國北京
December 9, 2023. Beijing, PRC

Proceedings of the International Conference
“Scientific research of the SCO countries: synergy and integration” - Reports in English

(December 9, 2023. Beijing, PRC)

ISBN 978-5-905695-82-7

这些会议文集结合了会议的材料 – 研究论文和科学工作者的论文报告。 它考察了职业化人格的技术和社会学问题。一些文章涉及人格职业化研究问题的理论和方法论方法和原则。
作者对所引用的出版物，事实，数字，引用，统计数据，专有名称和其他信息的准确性负责

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

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

ISBN 978-5-905695-82-7

CONTENTS

DOI 10.34660/INF.2023.10.76.033

國家安全的科學支援：創建經濟安全與風險管理系經濟安全與風險管理科學學院

SCIENTIFIC SUPPORT OF NATIONAL SECURITY: CREATION OF THE SCIENTIFIC SCHOOL OF ECONOMIC SECURITY AND RISK MANAGEMENT OF THE DEPARTMENT OF ECONOMIC SECURITY AND RISK MANAGEMENT

Bezdenezhnykh Viacheslav Mikhailovich
Doctor of Economic Sciences, Full Professor
Financial University under the Government of the Russian Federation

抽象的。 這項工作以金融大學科學流派（SS）為例進行分析，顯示科學流派的形成是研究實踐中系統觀察到的現象，它有助於新知識的創造、積累和傳播，推動對週邊世界的深入了解，推動STP在經濟實踐中的發展，回應她的迫切需求。 分析的目標首先是確定科學研究在科學理論和實踐發展中的地位和作用，其次評估ES和RM系的研究狀況，作為形成科學理論和RM系的基礎。經濟安全和組織風險管理的適當科學學校。

關鍵字：科學辦學、集群編隊、經濟安全、風險管理。

Abstract*. The work, using the example of an analysis of a scientific school (SS) of the Financial University, shows that the formation of scientific schools is a systematically observed phenomenon in research practice, it contributes to the creation, accumulation and dissemination of new knowledge, promotes in-depth knowledge of the surrounding world, the development of STP in economic practice, responding to her urgent needs. The goals of the analysis were, firstly, to determine the place and role of scientific research in the development of scientific theory and practice, and secondly, to assess the state of research of the Department of ES and RM as the basis for the formation of an appropriate scientific school of Economic security and risk management of organizations.*

Keywords: *Scientific school, cluster formations, economic security, risk management.*

Let’s start with the first issue announced for discussion: scientific schools and their place in the development of theory and practice.

Research into the causes and conditions for the emergence of scientific schools (for example,[1]) showed that scientific schools are, basically, informal teams, voluntary communities of interested scientists. “Being the creative and developing core of the scientific community, SS also play a special role in the formation of civil society in general,” concludes Doctor of Philol. Cand. T.Yu. Pavelev, since the scientific school, unlike formal work activity, is an essential element of civil society”[2] .

It can also be noted that for various reasons in the Western methodology of science the concept of a scientific school is not found, but the similar concept of a “scientific program”, in some cases, a “scientific paradigm” is used (see the works of F. Lakatos, M. Blaug, etc.) .

Review of various scientific sources[3] showed that scientific schools are a complex social phenomenon of joint organization of scientific work, which is studied from different subject sides by specialists in different fields, philosophers, sociologists, psychologists, mathematicians, economists, historians of science.

Let us highlight some signs and conditions for the formation of SS.

Firstly, as experience, including Russian, shows, to study the processes of formation of a scientific school, a history of development is necessary. According to the work of the Nobel Prize laureates, the SS should be integral, traceable on the basis of publications, reviews of colleagues, and representative for statistical calculations. Therefore, the analysis period should be sufficient for the response of scientists to each new work of a colleague to manifest itself in scientific publications. The intervals covered by citation statistics should correspond to the duration of the period when more and more new links appear on the article. This is apparently 15-20 years, at least, necessary for the advancement of new knowledge, in particular in the field of economics.

[1] Scientific schools in the system of science: philosophical analysis. Dissertation, Ph.D. Paveleva, T. Yu. – 2012.

[2] Ibid.

[3] See: Abalkin L.I. Russian school of economic thought: the search for self-determination // Questions of Economics. - 2001. - N 2. - P.4-18; Avtonomov V. History of economic thought and economic analysis: the place of Russia // Ibid. - P.42-48; Academic economists of Russia / Ch. ed. L.I. Abalkin. 2nd ed. - M., 1999; Anikin A. Russian economic science: enlightenment and first schools // Ibid. - P.63-67; Voeikov M. About the concept of the “Russian school of economic thought” // Ibid. - P.67-72; Vorobyov Yu.F., Semenkova T.G. Features of the formation and characteristic features of the “Russian school” of economic thought. - M.: Institute of Economics RAS, 2000; Knyazev Yu. About scientific economic schools // Society and Economics. - 2003. - N 12. - P. 108-132; Olsevich Yu. On the specifics of the national school of economic thought in Russia // Ibid. - P.27-42; Faltsman V.K. Russian scientific schools in the 60-80s: Notes of an economist. - M.: Delo, 1995; Shirokorad L.D. Is there a Russian school of economic thought? // Economic history of Russia: problems, searches, solutions: Yearbook. - M., 2002. - Issue 4. - P.51-57; Shishkin M.V. Scientific schools in domestic economic theory // Vestn. of Saint Petersburg. un-ty. Series 5: Economics. - 1997. - Issue 3. - P.20-37.

Secondly, the SS is considered by many authors as a social organization, and as such corresponds to the properties of other social groups. It is characterized by relatively close communication between leading scientists, clustering and centralization around the leader(s). Moreover, if a leader loses his position for various reasons and a new passionate leader does not appear, then most often, students fail to maintain the NS unless the scientific school nominates a new leader. Thus, the organization of a scientific school shows signs of clustering and centralization (with the presence of a leader), as well as blurred boundaries and a dynamic, adaptively changing structure.

Thirdly, a scientific school must be an integral and essential part of general scientific knowledge. This is verified not only by the presence of scientific titles and honorary titles, but also in the process of exchanging information about the results and their use, in the creation of new knowledge, manifested in scientific citations.

Further, fourthly, the SS must include a noticeable number of young employees and graduate students, and even a mandatory part of interested students. The role of smart administration of this process is great here, but let's leave this only at the level of a comment so as not to be distracted from the topic of the report.

Further, fifthly, scientific schools are characterized by a number of special distinctive features, special requirements and indicators that distinguish a specific scientific field of research, a set of quantitative data that characterize the content of a given scientific school. Let's look at these indicators using the example of the scientific school of the Department of Economic Security and Risk Management.

Thus, a scientific school is a social phenomenon that solves a number of important problems in the development of scientific research methodology. In particular, this is the institutionalization and clustering of active groups of researchers. Let's look at some intermediate conclusions.

The advantage of a scientific school due to the clustering effect is higher creative amateur activity (scientific productivity) in work, better organization of work and sustainability of ideas in creative competition. Finally, close communication between scientists, which leads to the development of complementary and synergistic (not to be confused with systemic) effects, participation in discussions, forums, conferences, joint (collective) work, discussions and disputes inevitably manifest themselves in better results.

The target task of these groups of researchers of a scientific school is not commercial interest (primarily), but the increment and accumulation of new scientific fundamental and applied knowledge (isoteric, i.e. internal process) and the promotion of this new increment of knowledge into scientific circulation and the transfer of this initially closed knowledge to a new generation of researchers and practitioners. Thus, the formation of scientific schools is systematically observed in research practice, it contributes to the creation, accumulation and dissemina-

tion of new knowledge, promotes in-depth knowledge of the surrounding world, the development of scientific and technological progress in economic practice, responding to its acute needs.

The second issue addressed in the report: to assess the state of research of the Department of ES and RM as the basis for the formation of an appropriate scientific school of Economic Security and Risk Management of Organizations.

Taking into account the listed characteristics and conditions for the formation of SS, let us consider the main indicators that characterize the scientific school of the Department of Economic Security and Risk Management.

Firstly, the main area of scientific interests is economics and management of the national economy, namely, such an area as economic security as the most important component of national security. It confidently entered the limited set of main scientific areas of the Financial University under the Government of the Russian Federation.

The name of the scientific school - "Economic security based on systemic risk management of a complex socio-economic system (CSES)" fully fits into one of the five key areas of scientific responsibility of the Financial University, namely: "Scientific support of national security." The scientific leader of this direction is Full Prof., Doctor of Law. V.I. Avdiysky, who has many years of practical experience in the national economy of the country. Note that security issues, and more specifically, economic security, have been the focus of attention of many researchers and research centers over the past decades. The distinctive approach of the developed scientific direction of DE&RM, which has not been reflected in any other scientific school of this scientific field in Russia and abroad, is the essential integration of combining the goal setting of regulating the processes of ensuring ES, mechanisms and tools for achieving the established goal.

Not immediately, but gradually this fundamental position began to find understanding in the scientific community and, moreover, reflected in real actions. In particular, in the "Strategy for Ensuring the Economic Security of Russia until 2030", adopted in 2017, clause 24 was specifically introduced with a precise indication of the existence of such a connection between the goal and the mechanism for ensuring economic security. And in general, over the past 2-3 years, it has been impossible to come across a government document that did not have a separate section assessing the risks of implementing this decision. Not all methodological issues have now been resolved, but certain results can be highlighted and at least a short list of them can be given. Numerous publications of this school (more than 1200 publications) consolidate these results and convincingly show that:

- essentially there are no other mechanisms that ensure the economic security of organizations with the necessary efficiency;

- on the basis of risk regulation, the opportunity arises to assess and rank possible risk situations due to threats and dangers, identify weaknesses and vulner-

abilities, evaluate events and possible risk outcomes for informed, informed management decision-making;

- thereby creating a calculated and assessed possibility of choosing a regulatory impact, taking into account the possible consequences, the available regulatory resource, the environmental context and other factors;

- the opportunity arises to choose not only a regulatory decision, but also the necessary resource for solving risk management problems, and methods (options) for this management;

- provides the opportunity for informed strategic planning, which without estimated data may turn out to be very approximate and require constant adjustment;

- and other opportunities to increase the efficiency of providing ESE.

Secondly, this scientific direction "Economic security based on systemic risk management of a complex socio-economic system (CSES)" has certain theoretical advantages that have been developed over these decades and reflected in numerous works by members of this community.

These distinctive qualities include the following:

- in-depth development of the theory and methodology of risk management, including a system of theorems, axiomatics, postulates that define an independent system of modeling and assessment and aimed at establishing the boundaries of adjustability, choosing a method of regulation, establishing monitoring control points and other issues of constructing a risk management system;

- the theoretical difference of this approach is the consideration of possible risk events and the outcomes of these events not as statistical calculation models, but as individual, fractal or ensemble probabilistic models. This makes it possible to increase the accuracy of assessments and the level of decisions made and the quality of regulatory actions;

- systematic methodological and methodological elaboration of systemic risk management as a mechanism for ensuring electronic security (including the development of a draft standard for ensuring electronic security, the analogue of which is not yet available in other scientific standards);

- the presence of unique scientific and methodological publications on these issues, such original ones as RMS design, risks of documenting RMS, RMS workshop (more than 50 monographs, textbooks and teaching aids, about 850 articles, reports, speeches in the press, as well as more than 1000 students and graduate students who have completed their studies in this educational and scientific direction (profile);

- development of proprietary teaching materials, curricula and programs for this profile Economic security and risk management), as well as the professional standard "risk management specialist", "economic security specialist";

- successful functioning at the DES and RM MEE on the subject of the department, the opening at the Financial University of a graduate school and a disserta-

tion council on ES, and already in a short period of time the graduation of highly qualified specialists and other methodological differences discussed in the first part of the report.

Thirdly, as a result of research in this area obtained by members of the Department's research group, new scientific results were obtained, in particular, it was shown that:

- some of the known methods for assessing threats and risks in conditions of increasing uncertainty, turbulence and high variability of processes in the economy no longer achieve a given level of accuracy, give a large error, and can be used to a limited extent in a number of individual areas of the economy. The task is to determine the limits of applicability of assessment methods and develop new methods for assessing and selecting solutions for ensuring energy security, and new approaches to solving these problems are proposed;

- the uniqueness of the economic activities of individual enterprises and their characteristics determine the need to adapt methods and means in each individual case, both to a given enterprise and taking into account the high instability of the context of the operating environment;

- it has been justifiably shown that the probability of an event occurring in risk theory changes its nature from mathematical probability to situational probability (when the probability of the occurrence of not individual, but interconnected events is considered), which allows for a more in-depth understanding of the effect of certain regulatory methods and to increase them efficiency;

- the palette is expanding, a methodology for assessing the level of security of a complex system is being developed, a methodological apparatus for combining quantitative and qualitative assessments with the addition of a humanitarian component of social, environmental, psychological and other indicators;

- the importance and obligation of developing a goal-setting methodology is substantiated at the doctrine level, taking into account the provision of energy security and security in general, especially in terms of strategic planning. This obligation is enshrined in practice in Presidential Decrees and Government Resolutions establishing the need for risk assessment in establishing the goals of national projects and government programs in 2021-2023.

Fourthly, another group of issues that characterize the methodological difference of the scientific school of DESaRM is the disclosure of the concept of risk in the activities of business entities not as a managerial, but as an economic category. In traditional risk management as a category of management, the tasks of determining risk management goals are not set, but are limited to production goals; the focus of management is aimed at management weaknesses. A new methodological approach explores human relationships and actions in socio-economic processes, risk as a property and quality inherent in any human activity, including economic

activity in the system of a functioning enterprise. This methodological approach considers a risk event and its consequences as a result:

- risk in functional content is the adoption and implementation of a management decision in conditions of uncertainty and awareness of this uncertainty, thereby such a definition of the content of risk reveals the subject, object, subject and way of regulating possible risk situations;

- implementation risk is a phenomenon inherent only in future purposeful human activity; the nature of risks is also the result of human activity;

- risk in philosophical content is an element of future development and a reflection of a conflict of interest as a development factor in various forms;

- risk, unlike uncertainty, threats, dangers, has the quality of a metric (one of these metrics is the probability or possibility of implementation), must be measured quantitatively, even for the case of difficult-to-control risks (political, social, cultural, natural, etc.);

- risk, based on current and past experience, is a predictive (probabilistic, situational) characteristic of the future state of a complex system. At the same time, vulgar experience does not allow it to be used in full due to the asymmetry of the past and the future; - - other methodological features of risk as an economic category.

Conclusion.

Thus, the system of knowledge accumulated by researchers of the Department of Economic Security and RM of the Financial University under the Government of the Russian Federation has the necessary features and qualities inherent in such a social and cultural phenomenon as the scientific school of the Department. The results of the work of this team are widely known and recognized both by domestic scientific and educational centers and abroad in Russia (only in the last two or three years - these are China, Belarus, Kazakhstan, Uzbekistan, Azerbaijan, Ukraine, Moldova, etc.).

Preserving and strengthening the active work of this creative scientific team is the task of creating a new development of scientific knowledge in this scientific field of activity, the relevance of which is obvious even to the uninitiated.

References

1. Avdiysky V.I. Theory and practice of risk management of an organization / Avdiysky V.I., Bezdenezhnykh V.M. Textbook, / - M.: Knorus, Moscow, 2021. – P. 267.

2. Avdiysky V.I. Problems and trends in the development of management of complex socio-economic systems taking into account the risk-based approach: overcoming / Avdiysky V.I., Bezdenezhnykh V.M.// Development and Security. 2021. No. 2 (10). pp. 42-54.

3. Avdiysky V.I. Economic security as a system-forming factor in the stability of complex socio-economic systems / Avdiysky V.I., Bezdenezhnykh V.M. // Business security. 2020. No. 1. P. 2-15.

4. Bezdenezhnykh V.M. Synergetic approach to assessing the sustainability of complex economic systems. Monograph. - M., Alpha-M, 2006.

5. Bezdenezhnykh V.M. Economic security, financial stability and sustainability as a quality of efficiency of an economic entity / Bezdenezhnykh V.M., Dadalko V.A. // Questions of Economics, 2009, No. 12.

6. Avdiysky V.I. Theoretical prerequisites for studying the causes and consequences of the global financial crisis and its impact on the activities of economic entities and the transformation of the global financial architecture of post-crisis development conditions. Monograph. Ed. Avdisky V.I. / Avdiysky V.I., Bezdenezhnykh V.M., Bauer V.P., Truntsevsky Yu.V. – M.: Publ. house Financial University, 2012.

7. Avdiysky V.I. Priority measures to combat corruption in federal executive authorities / Avdiysky V.I., Bezdenezhnykh V.M. – M.: FU, in the 2nd departmental collection of works "Economic security of enterprises", 2017, p. 6-16.

8. Avdiysky V.I. Problems of managing uncertainty and risk in the functioning of complex systems – the theorem of limiting uncertainty. / Avdiysky V.I., Bezdenezhnykh V.M. – M.: FU, in the 2nd departmental collection of works "Economic security of enterprises", 2017, pp. 151-164.

9. Avdiysky V.I., Modern scientific approaches to the development of risk minimization systems in the activities of business entities. Monograph. / Avdiysky V.I., Bezdenezhnykh V.M., Sinyavsky N.G. - Moscow, 2019.

10. Formation of institutions for regulating risks of strategic development. Monograph. Auto. Col. Avdiysky V.I., Baryshnikov P.Yu., Bauer V.P., Bezdenezhnykh V.M., et al. - M.: FU, 2019.

DOI 10.34660/INF.2023.37.61.034

在工業企業實施產品系列規劃資訊系統的一些方面

SOME ASPECTS OF IMPLEMENTING AN INFORMATION SYSTEM FOR PRODUCT RANGE PLANNING AT AN INDUSTRIAL ENTERPRISE

Tregubov Yury Markovich
Candidate of Economic Sciences, Associated Professor
Kazan National Research Technical University named after A. N. Tupolev,
Kazan, Russia

抽象的。 在工業企業中，由於並非所有資訊系統都已完全實施並充分運行，因此存在資訊系統之間的資料傳輸問題。 整合IS中主、輔流程的集成，IS各個功能模組的整合是在EAI類系統的基礎上進行的（Enterprise Application Integration—應用整合工具—資訊交換的組織。資訊整合涉及整合使用資料一次輸入系統，解決任意數量的相互關聯的任務，消除資訊流不受控制的重複，進行資訊轉換操作，同時對資訊儲存、傳輸和呈現的形式和方法形成統一的要求——定義了資訊處理的單一標準。

關鍵字: 整合、資訊系統、EAI類系統、規劃系統架構、工作原型。

Abstract. *At industrial enterprises, there is a problem of data transfer between information systems due to the fact that not all information systems are fully implemented and work in full. Integration of main and auxiliary processes in integrated IS, integration of separate functional modules of IS is carried out on the basis of systems of the EAI class (Enterprise Application Integration-application integration tools—, organization of information exchange. Information integration involves the integrated use of data entered once into the system to solve an arbitrary number of interrelated tasks, eliminate uncontrolled duplication of information flows, and perform information transformation operations. At the same time, uniform requirements are formed for the forms and methods of storing, transmitting and presenting information — a single standard of information processes is defined.*

Keywords: *Integration, information systems, EAI class systems, planning system architecture, working prototype.*

Integration of information systemsis the process of establishing links between the information systems of enterprises and organizations to obtain a single infor-

mation space and organize support for end-to-end business processes of enterprises.[2]

At the enterprise under study, there is a problem of data transfer between information systems (IS) due to the fact that not all information systems are fully implemented and work in full. Integration problems are not limited only to software, they cover the entire enterprise infrastructure, which should provide the ability to integrate not only the software components of the enterprise information system, but also its users, and provide information exchange across serving business processes without losing flexibility and scalability.[1]

Integration is not a banal process of merging databases. This is a complex organizational, technological and even psychological process aimed at reducing transaction costs, namely the cost of collecting information, increasing the speed of access to it and speeding up its processing, as well as improving the quality of management accounting and making optimal decisions at the enterprise. Combining complex automated systems inevitably entails a restructuring of the work of all departments, whether they are directly integrated or somehow depend on the integrated systems, a change in a significant part of the organization's functioning processes and, importantly, in some cases, a radical change in the interaction patterns between employees.

Integration of main and auxiliary processes in integrated IS, integration of individual functional modules of IS is carried out on the basis of systems of the EAI class (EnterpriseApplicationIntegration-application integration tools), organization of information exchange. Information integration involves the integrated use of data entered once into the system to solve an arbitrary number of interrelated tasks, eliminate uncontrolled duplication of information flows, and perform information transformation operations. At the same time, uniform requirements are formed for the forms and methods of storing, transmitting and presenting information — a single standard of information processes is defined. This is necessary to ensure that economic and other data are unambiguously interpreted in any part of the IP. In modern information systems of enterprise management, information integration is carried out on the basis of electronic document management systems and CALS technologies, technological data management systems at the production enterprise PDM. Effective data and process management is the core of integrative solutions in the field of organization automation.[3]

An information management system enables collaborative operation of applications based on different platforms that use different business models and data management technologies. As a technological basis for implementing these principles, IISUP (Integrated Production Management Information System) today uses a service-oriented architecture (ServiceOrientedArchitecture — SOA).

Any IT solution allows you to get results by significantly improving the information support of employees. The enterprise automating the business process

of product planning benefits by reducing the time and resources for entering, processing and using corporate information, and eliminating duplication of work. This leads to higher productivity and lower costs.

But to achieve such a result from the implementation of an information planning system, it is necessary to:

- Ensure that the project's target setting is tightly linked to the goals of the organization's strategy.
- Accurately determine the range of tasks to be solved.
- Develop methodologies for solving these problems and train staff in these methodologies.
- Build your organization's business processes in strict accordance with established regulations.
- Develop and implement a system for monitoring the company's performance indicators and an enterprise management system in accordance with the indicators.
- Develop requirements for the future planning information system that are consistent with business process indicators.
- Involve the organization's management in the implementation project.

Clearly follow the project's calendar and resource plan.

Do not allow significant changes in the subject matter and essence of the project.

Involve only high-quality specialists in the project.

As a result of modeling the information system at one of the leading industrial enterprises of the Russian Federation, the prerequisites for its implementation and implementation were created. Due to the special importance of the enterprise management system and the product range planning process, the process of creating and implementing its automated version is carried out in several stages using a built-in algorithm.

The final version of the system, of course, will be repeatedly tested in the real operating conditions of an aviation enterprise, as a result of which the necessary changes will be made to the system. The working version of the system also implies possible changes, so characteristics such as flexibility and adaptability of the system come to the fore.[1]

First, a group of models is developed and analyzed, starting with the conceptual model and ending with the structural and functional model, to understand the goals and tasks that are being solved with the help of the system being created, as well as to take into account its technological features. Based on the results of the simulation, the main volume of information materials for the development of the technical task will be formed. After the model system is formed, an unconditional transition is made to the next block - modeling of the planning information sys-

tem. The terms of reference define the requirements for each required part of the system.

At one of the leading industrial enterprises of the Russian Federation, the information system for planning products (products) should provide:

- formation of orders for disassembly, defect detection, repair, production and assembly of products based on orders for shipment, decisions on modernization and results of defect detection;
- maintaining production plan variants;
- calculation (or recalculation) of the production and support plan;
- analysis of options for production and supply plans in terms of deadlines, resource requirements, purchased materials and components;
- adjustment of production and support plans;
- approval of a variant of the production and support plan, and launching orders.

Dispatching at the level of production units (workshops) should ensure:

- plan-the fact of orders to the shop by industrial visits, deadlines, and priorities.
- complete set control, formation of vacation requirements;
- start of work on redevelopment with the reservation of materials, purchased components and parts of assembly units;
- disassembly and defecation;
- accounting of output and defects upon completion of batch processing in the shop (at the redevelopment stage);

Based on the results of modeling, the range of goals and tasks solved by the system is determined. [2]

Based on the results obtained, a technical task for the development of an automated system is formed and documented in accordance with the accepted standards, which represents a document approved in accordance with the established procedure.

Based on the terms of reference, a step-by-step scheme of software and methodological implementation of an information system in the form of a technological design network (TSP) is constructed. To do this, one of the possible methods of designing an information system is preliminarily determined.

Based on the list of comments and suggestions, after testing the working prototype of the system, a new package of requirements is formed, which is intended for correcting the technical task. After that, go to the initial block - to finalize the technical task.

Based on the built architecture of the design planning system, a working prototype of the future system is created. It differs from a real system in a limited number of functions, which are represented by the most characteristic of them, a

limited amount of processed information, and simple software tools for its processing. As a result, a prototype of the system is formed, which can be used in practice to evaluate the effectiveness of the system being developed. After completion of the work, an unconditional transition is made to the block-testing of a working prototype.

Testing a working prototype.

The developed prototype of the system is put into operation on a small amount of information. At the same time, the main characteristics of the designed system are evaluated: processing speed, information limits, user-friendliness, reliability, completeness and content of working documentation, necessary parameters of communication tools, etc. Based on the results of the work, a list of comments and suggestions is formed, after which a transition is made to the block for evaluating the results of testing.

Evaluation of results.

If the results of testing are found to be satisfactory, the transition is made to the block of implementation and implementation of the information system in the final version. If the results are found to be unsatisfactory, we proceed to the block for making changes to the original versions of the technical task in order to upgrade the working prototype.

Revision based on implementation results.

Necessary changes and improvements are made to the working project based on the results of a trial operation of the working version of the information system. In the future, an unconditional transition is made to the block for the new implementation of the information system.

Implementation and implementation of the information system planning information system.

Based on the results of using a working prototype and debugging all the main operating modes of the system, the entire information and software package is developed in its final form. Usually, this part of system development is assigned to a group of professional developers who, based on a working project, create a version of the information system that can be used in real-world conditions. The created version of the system is implemented in production in all divisions of the enterprise or holding. After the implementation of the information system, the system is synchronized with production and after implementation, an unconditional transition is made to the block for evaluating the implementation results.

Evaluation of results.

If the implementation results are found to be satisfactory, a transition is made to complete the development and implementation activities provided for by the algorithm. Otherwise, you will go to the block for system refinement based on the implementation results.

Moving to a qualitative assessment from the implementation of this algorithm, the company will be able to achieve the following results::

- increase the transparency of planning processes.
- increase the efficiency of interaction with customers and suppliers;
- significantly increase the flexibility of production;
- simplify and speed up the production process of finished products;
- improve the unified information environment.
- improve organizational discipline.

The production cycle of new product development will be shortened by using modeling tools based on the system's technological data.

The system will provide production workers and managers with tools for self-preparation of documentation, including reports.

The reduction of manufacturing defects will be due to the use of process control methods to improve product quality. When developing business processes, a mandatory stage will be defined at which quality control will be carried out.

The range planning information system is a very effective enterprise management tool that will allow you to receive timely reliable and complete information about the company's activities and products in real time, thereby optimizing the management decision-making process, and adapt to constant changes in the organization's conditions by increasing the flexibility of the enterprise.

References

1. Tregubov Yu. M., Moiseev R. E., Nikolaeva A. B.. - Introduction of lean production tools in the non-production sector at an industrial enterprise-Bulletin of the Kazan State Technical University named after A. N. Tupolev, Kazan (2017)

2. Moiseev R. E.,Tregubov Yu. M. Methodological aspects of assessing the economic efficiency of measures for the development of the production system of industrial enterprises. Bulletin of the Kazan State Technical University named after A. N. Tupolev, 2015, vol. 71, p. 173, p. 178

3. Moiseev R. E., Tregubov Yu. M., Nikolaeva A. B., Sibagatullina L. I.- Implementation of the SMED fast readjustment method smedat an industrial enterprise-Bulletin of the A. N. Kazan State Technical University..H Tupolev, Kazan, 2017

DOI 10.34660/INF.2023.30.89.035

數位轉型背景下的產業生態系統概念
THE CONCEPT OF INDUSTRIAL ECOSYSTEMS IN THE CONTEXT OF DIGITAL TRANSFORMATION

Dudareva Olga Vladimirovna
Candidate of Economic Sciences, Associate Professor
Moscow State Technological University "STANKIN", Moscow, Russia

Korshunova Elena Dmitrievna
Doctor of Economic Sciences, Professor
Moscow State Technological University "STANKIN", Moscow, Russia

抽象的。 本文從工業生態系的概念、原理、類型、主要構成、概念和顯著特徵等方面闡述了工業生態系統的概念。 結論：產業共生是產業生態系的主要特徵，將產業生態系與永續發展的概念連結起來。 已確定了三種類型的產業生態系：年輕型、組合型、成熟型。 產業生態系的一個顯著特徵是其空間、地理定位。 產業生態系的組織表現是生態工業園區和產業共生網絡。

關鍵字：產業生態系統、永續發展、數位轉型、數位平台、數位經濟。

Abstract. *The article presents conceptual aspects of industrial ecosystems in terms of concepts, principles, types, main components, concepts, and distinctive features of industrial ecosystems. It is concluded that industrial symbiosis is the main distinguishing feature of the industrial ecosystem, connecting the concepts of industrial ecosystems and sustainable development. Three types of industrial ecosystems have been identified: young, combined, mature. A distinctive feature of the industrial ecosystem is its spatial, geographic localization. The organizational forms of manifestation of industrial ecosystems are eco-industrial parks and networks of industrial symbiosis.*

Keywords: *industrial ecosystem, sustainable development, digital transformation, digital platform, digital economy.*

In policy development and achieving sustainable development goals, the concept of industrial ecosystems is of greatest importance. Within the framework of the concept of ecosystems, we will highlight two main approaches to defining the concept of an industrial ecosystem: consideration of an industrial ecosystem based on the principles of industrial symbiosis and consideration of an industrial ecosystem as a type of economic system.

Industrial symbiosis in the context of this study is understood as an approach that unites several actors (economic systems, organizations or enterprises) based on the physical exchange of materials, energy and production waste, creating economic benefits for the actors and environmental benefits for society. In a general sense, industrial symbiosis can be seen as a circular economy approach within the more general concept of industrial ecology.

1 Industrial ecosystems based on the principles of industrial symbiosis

For the first time, industrial ecosystems began to be considered in the context of industrial ecology. As noted above, this concept gained popularity after the publication of a paper in 1989 by R. Frosh and N. Gallopoulos [1]. An industrial ecosystem, like any economic ecosystem, functions similarly to biological ecosystems, where plants synthesize nutrients used by herbivores, which in turn feed a chain of carnivores, whose wastes and bodies feed subsequent generations of plants.

A biological ecosystem processes essential nutrients using only solar energy to power the system. This idea is the basis of industrial ecosystems. Thus, proponents of industrial ecology used the ecosystem approach to take a new approach to the fundamental question of the causes of the environmental crisis [3]. Unlike the biological [4], the industrial ecosystem is not completely sustainable.

The cyclical flow of substances and energy, typical for a stable biological ecosystem, is the ideal state of an industrial ecosystem, and the path to achieving sustainability lies through waste processing (recycling) and energy sharing between industrial entities [2].

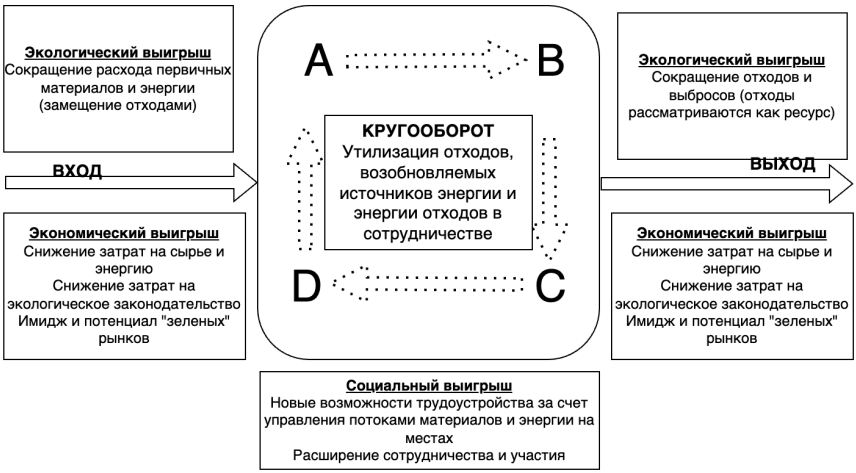


Figure 1. *Classic representation of an industrial ecosystem [2.9]*

The industrial ecosystem has, differs and is characterized by a number of properties and features that can be divided into two main groups: 1) physical flows of matter and energy, occurring on the principles of recycling, energy saving, recycling and/or cascading; 2) structural and organizational properties/features: diversity (in participating actors); interdependence (in their relationship); location (in the space of use, resource use, product life cycles, etc.).

The classic view, the vision of the industrial ecosystem, proposed by J. Korhonen back in the 2000s, is presented in Figure 1.

As can be seen from Figure 1, within the industrial ecosystem there is a cycle of collaborative use of waste, renewable energy and raw materials. The synergistic effect of substitution consists in replacing the original non-renewable resources with waste, by-products from production, and energy surpluses of other actors in the industrial ecosystem [2]. Depending on this, three types of industrial ecosystems [5] are distinguished:

– *the first, "young"* type of industrial ecosystems is characterized by a complete lack of circularity, that is, the required resources can enter unlimitedly at the input, and unlimited waste can be generated at the output;

– *the second, "combined"* type of industrial ecosystems often has signs of circularity: at the input of such ecosystems there are combined resource flows (for example, unlimited energy and limited resource flows), and at the output - only limited waste flows;

– *the third, "mature"* type of industrial ecosystems is characterized by complete circularity, when input material and output flows are completely absent, and only input energy resources are present.

A distinctive feature of the industrial ecosystem, functioning on the basis of industrial symbiosis, is its *spatial, geographic localization*. Industrial symbiosis is mainly cooperation between local companies. In addition, the creation and maintenance of industrial symbiosis is often a direct consequence of local and regional policies.

2 Platform approach to considering the industrial ecosystem

Like any ecosystem, an industrial ecosystem is like an orchestra. To achieve sustainable development of industrial ecosystems, an appropriate ecosystem orchestration mechanism is required, with the obligatory highlighting of the fundamental role of the ecosystem orchestrator. The platform approach makes it possible to geographically expand the localization of industrial ecosystem actors for the virtual exchange of resource flows, most often information, including those based on digital platforms and digital ecosystems. However, in order to exchange material flows (energy, water, raw materials), the actors of the industrial ecosystem must continue to be localized.

The concepts of an industrial ecosystem from the point of view of industrial symbiosis and the platform approach are similar, but, at the same time, differ in a certain way.

In the authors' opinion, it is industrial symbiosis, as part of the concepts of a circular economy and the broader concept of industrial ecology, that is the main distinguishing feature of the industrial ecosystem and connects the concepts of industrial ecosystems and sustainable development (Figure 2).

Figure 2. *Trichotomous paradigm for sustainable development of industrial ecosystems*

One of the organizational forms of manifestation of industrial ecosystems is networks of industrial symbiosis. Industrial symbiosis that supports nature is the key idea of the *concept of eco-industrial parks*, within which, by joining their efforts, companies can also exchange experience in the use of environmentally friendly technologies, the use of resource-efficient technologies, methods of reusing energy resources and waste as secondary raw materials [6].

Eco-industrial parks promote the transition to closed economic cycles, water conservation, efficient recycling, sustainable waste management, and the introduction of synergies in industry. The creation of eco-industrial parks contributes to the scaling and expansion of activities aimed at introducing resource-efficient and environmentally cleaner industries with the prospect of going beyond eco-industrial parks and their inclusion in the system of "sustainable cities", in which economic and social symbiosis can be achieved in all aspects of sustainable urban planning. In such systems, it is possible to exchange waste streams on a regional scale with the expansion of the infrastructure elements involved, logistics and methods of using waste for energy production [6]. Eco-industrial parks improve industrial integration in cities by creating shared economic opportunities, preserving ecosystem resilience, and enhancing innovative opportunities for socially responsible businesses. Thus, eco-industrial parks provide triple ESG benefits: environmental, social and economic [6]: Modern eco-industrial parks are designed to dramatically reduce the negative environmental impact of industrial operations through environmentally efficient management and the implementation of pollution prevention

systems; Eco-industrial parks provide social benefits, including improved local living standards through the development of shared infrastructure and improved education through the introduction of new training programs, as well as higher standards of health and safety for employees and employees of enterprises; the creation of eco-industrial parks leads to increased competitiveness of companies, reduced resource consumption, reduced dependence on coal and increased sales through green and segment marketing. It can be said that any industrial ecosystem can be an eco-industrial park, but not every eco-industrial park is an industrial ecosystem. In other words, an eco-industrial park has the greatest opportunity over time to turn into an industrial ecosystem than, for example, a cluster or technopark. UNIDO's first pilot project on eco-industrial parks was implemented in 2010 in India, in the state of Gujarat (Gujarat is the westernmost state of India, where the country's five largest million-plus cities are located). An eco-industrial park has grown up in the industrial area of Vadodara-Ankleshwar and Dahej (an investment region for petroleum, chemical and petrochemical industries) [6]. One of the most successful operating eco-industrial parks in China is the Shenyang [7] Development Zone, established by the Circular Economy Promotion Fund with a total cost of US$4.8 million to support critical development projects industrial symbiosis. The bulk of the investment is aimed at supporting public infrastructure in the eco-industrial park in relation to water supply systems, gas pipelines and heat pumps. This has led to increased competitiveness of companies, reduced resource consumption, reduced dependence on coal and increased sales through green and segment marketing [6]. It is worth noting that in the literature there are a number of terms closely related to industrial ecosystems, emphasizing their interdisciplinary nature, for example, innovation-active clusters, eco-platforms, eco-industrial parks, etc. The transformation of terminology within the concept of industrial ecosystems is presented in Figure 3.

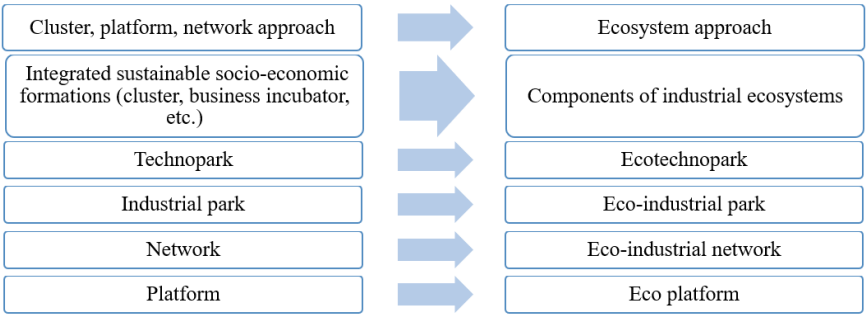


Figure 3. *Transformation of terminology within the concept of industrial ecosystems*

The change in terminology confirms the fact of transformation of linear types of industrial ecosystems into their more mature forms (of the second or third type according to the above classification of industrial ecosystems of three types).

The differences between an ecosystem and a cluster, from networks, from platforms, from business incubators are discussed in detail in the works of G.B. Kleiner, for example, in a project supported and financed by the Russian Science Foundation in 2019-2021 [7]. Cluster forms are considered by G.B. Kleiner as organizational (structural) components of the ecosystem; platforms - as infrastructure components; networks - as business process components, and business incubators - as innovative components of the ecosystem [8]. A component in this context is considered as a discrete actor or infrastructure that can be considered an asset or an integral part of an industrial ecosystem. Thus, clusters, networks, platforms and business incubators are the main components of industrial ecosystems.

In addition, it is necessary to distinguish between industrial ecosystems and various objects of innovation infrastructure (industrial parks, technology parks, clusters (including innovation territorial clusters (ITC), industrial clusters of the Ministry of Industry and Trade), special economic zones of industrial production, technical innovation types, technological platforms, nanocenters, certification centers and testing laboratories, business incubators, information and consulting infrastructure centers, regional engineering centers, accelerators, technology transfer centers, collective use centers, territories of advanced socio-economic development). All of the listed innovation infrastructure objects can become components of a national or regional industrial ecosystem. The infrastructure of an industrial ecosystem is considered as a system of objects, equipment and services necessary for the functioning and development of the ecosystem. Industrial ecosystem infrastructure is a relational concept: a resource becomes infrastructure when it is needed to provide a service that could not otherwise be offered. An industrial ecosystem is distinguished by its desire for sustainability, the ability of the ecosystem to develop successfully without external influence or assistance, the absence of barriers to entry, a fickle and changing composition of actors, strong cross-functional and cross-industry communications, self-organization and self-involvement, evolution and others [9] .

The conceptual differences between the cluster and ecosystem approaches are also considered by T. Tolstykh, N. Shmeleva, Yu. Vertakova and V. Plotnikov [10]. Scientists conducted a comparative analysis of the cluster and ecosystem approaches based on the criteria of the coordination mechanism, goals of cooperation, boundaries of the association of actors, the nature of relations between actors, etc. As a result, it was concluded that “self-organization, the absence of management institutions and the intellectual environment are the main differences between the industrial ecosystem and clusters or networks” [10]. Generally agree-

ing with this statement, we can add that clusters, technology parks, platforms and networks are focused on achieving full circularity based on industrial symbiosis, and industrial ecosystems are more focused on achieving sustainability than circularity.

In the authors' opinion, there are a number of differences between different organizational components and industrial ecosystems themselves, similar to the differences between the circular economy and the concept of sustainable development. The value approach is not typical for the circular economy, unlike the concept of sustainable development. The same analogy can be drawn between organizational components and the industrial ecosystem. Other distinctive features of the industrial ecosystem are reflected in Figure 4 when considering conceptual aspects.

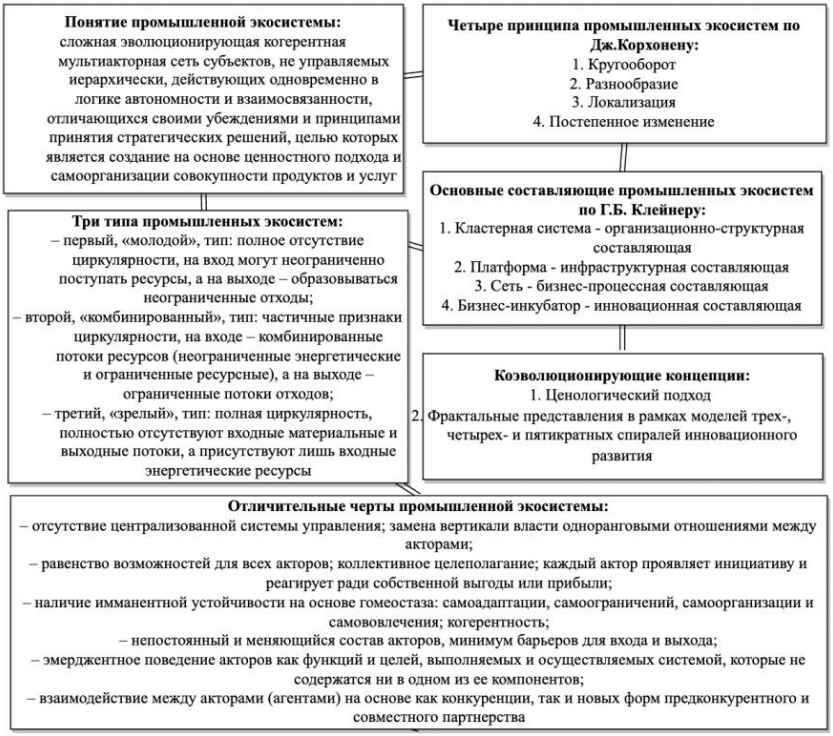


Figure 4. *Conceptual aspects of industrial ecosystems*

Thus, the essence of the industrial ecosystem should be considered in the form of an emergent model of industrial activity, on the basis of which operates a lo-

calized complex evolving coherent network of multiple actors, not hierarchically controlled, acting simultaneously in the logic of autonomy and interconnectedness, self-organization and homeostasis, differing in their beliefs and decision-making principles, the goal of which is to achieve sustainable development and create additional values for each actor of the current and future generations based on the principles of industrial symbiosis (mutualization) and recycling. In the context of industrial ecosystems and industrial symbiosis, it is mutualism, as a beneficial relationship for both types, that acquires particular relevance. In the context of this study, the goal of creating an industrial ecosystem is not aimed at simply reducing or eliminating flows and replacing input and output resources (full circularity), but at creating shared ecosystem value based on the emergent behavior of [11] actors. It is concluded that industrial symbiosis is the main distinguishing feature of the industrial ecosystem and connects the concepts of industrial ecosystems and sustainable development. A distinctive feature of the industrial ecosystem is its spatial, geographic localization. The most objective organizational forms of manifestation of industrial ecosystems are eco-industrial parks and networks of industrial symbiosis. Thus, it is worth noting that the purposeful, intentional creation of an industrial ecosystem is an extremely complex and long-term process.

References

1. Frosch R. A., Gallopoulos N. E. Strategies for manufacturing //Scientific American. – 1989. – T. 261. – №. 3. – C. 144-153.

2. Korhonen J. Industrial ecosystem: using the material and energy flow model of an ecosystem in an industrial system. – University of Jyväskylä, 2000. – №. 5.

3. Soldak M. A. et al. Industrial ecosystems and digitalization in the context of sustainable development // Industrial Economics. – 2020. – No. 4 (92).

4. Shkarupeta E.V., Dudareva O.V. Conceptual representation of the industrial ecosystem during the evolution of sustainable development // Digital and industrial economics. 2021. No. 1 (22). pp. 5-8.

5. Korhonen J., Snäkin J. P. Analysing the evolution of industrial ecosystems: concepts and application //Ecological Economics. – 2005. – T. 52. – №. 2. – C. 169-186.

6. Eco-industrial parks: promoting shared prosperity and environmental protection. UNIDO. 2017. https://www.unido.org/news/eco-industrial-parks-creating-shared-prosperity-and-safeguarding-environment.

7. System optimization of the structure of the modern economy: ecosystems, clusters, networks, business incubators, platforms. RSF project 19-18-00335. Head – Doctor of Economics G.B. Kleiner. https://rscf.ru/project/19-18-00335/.

8. Kleiner G. B. Ecosystem economics: a step into the future // Economic revival of Russia. – 2019. – No. 1 (59). – P. 40-45.

9. Soldak M. A. Industrial ecosystems and technological development // Industrial Economics. – 2019. – No. 4 (88).

10. Tolstykh T. et al. The entropy model for sustainability assessment in industrial ecosystems //Inventions. – 2020. – T. 5. – №. 4. – C. 54.

11. Maier M. W. Architecting principles for systems-of-systems //Systems Engineering: The Journal of the International Council on Systems Engineering. – 1998. – T. 1. – №. 4. – C. 267-284.

DOI 10.34660/INF.2023.56.39.036

俄羅斯和中國的創新中小企業：制度決定因素

INNOVATIVE SMALL AND MEDIUM-SIZED ENTERPRISES IN RUSSIA AND CHINA: INSTITUTIONAL DETERMINANTS

Barunova Anastasia Aleksandrovna
Student
Southern Federal University

註解。　在現代研究中，經濟學家越來越多地求助於制度經濟學所提供的工具。　本文從制度主義的角度分析了俄羅斯和中國創新創業研究領域現有的限制和激勵的主要規定、問題和製度，並提出了改進和支持創新中小企業的建議。以及整個國家的創新發展水平。

關鍵字：中小企業、國家創新體系、俄羅斯創新體系、中國創新體系、制度經濟學、創新發展。

Annotation. *In modern research, economists are increasingly resorting to using the tools provided by institutional economics. This article presents an analysis of the main provisions, issues and system of existing restrictions and incentives of the studied world of innovative entrepreneurship in Russia and China in the context of institutionalism, as well as recommendations for improving and supporting innovative small and medium-sized enterprises and the level of innovative development of countries as a whole.*

Keywords: *small and medium-sized enterprises, national innovation system, Russian innovation system, Chinese innovation system, institutional economics, innovative development.*

Innovation is one of the main drivers of competitiveness at both the micro and macro levels. A well-developed and systematically implemented innovation strategy is a source of increasing the value of the enterprise and its competitiveness in the long term, and the support and development of innovative technologies at the regional levels contributes to building the potential of countries and their promotion in the international arena. The policy implemented by states, taking into account the unstable situation of the economy around the world, should remain focused on the development of innovative technologies and the preservation of unique national specifics, which implies the need to consider the concept of national innovation systems demonstrating the peculiarities of the functioning of the

apparatus for the development and implementation of innovations in each country. Based on the three-factor model of national innovation systems coordinated by the state, science and business, this article will consider the work of Russian small and medium-sized enterprises in the innovation sector with their subsequent comparison to the Chinese specifics of this sector through the prism of institutional economics. This economic trend is the most relevant for research, since its tools make it possible to identify and structure repetitive social interactions between people and even make accurate predictions necessary to identify the causes of "stagnation" of innovative development or, conversely, to activate a positive trend in the growth of the level of innovation, using the analysis of institutions as a definition of the way of life of society.

Institutional economics has been studied in various fields of science for more than a hundred years, but the period of greatest development occurred in the second half of the XX century within the framework of economic theory. Such researchers as R. Coase, J. Buchanan, D. North, E. Ostrom, O. Williamson, as well as G. Simon, D. Kahneman, R. Schiller, J. Akerlof, and J. Stiglitz, who are well-known in modern economics, contributed to the popularization of institute research.

The definition of institutions is given by quite a large number of economists from different periods of development of this direction, which is why several interpretations will be presented below for a better understanding and more holistic perception of this term.

T. Veblen defines institutions as a widespread way of thinking in relation to individual relations between society and the individual and individual functions performed by them; and the system of society's life, which consists of a set of actions at a certain time or at any moment in the development of any society, can be psychologically characterized in general terms as a prevailing spiritual position or a common view of the way of life in society (Veblen, 1992, pp. 201-202).

D. North, in turn, as a neo-institutionalist, gives the most common formulation of institutions today, understanding them as rules and mechanisms that ensure their implementation, as well as norms of behavior that structure repetitive interactions between people (North, 1993, p.73).

The idea of institutionalism is to consider a particular economic system as a set of interdependent formal and informal institutions that determine the behavioral patterns and actions of economic agents, such as the state, academy, and business. Formal institutions are broadly defined as rules and norms that are adopted by the state or related institutions and organizations; they are part of the market infrastructure, which is a fundamental condition for the development of the national innovation system (Volchik, Maslyukova, 2022, p. 86). A special feature of formal institutions is the different degree of influence on the behavior of actors, depending on the scope of their activities (Hirao, Hoshino, 2020, p. 307). Informal

institutions are rules of conduct that are not fixed at the legislative level. They are usually expressed in certain traditions, stereotypes of thinking and represent a system of social connections (Volchik, Maslyukova, 2022, p. 88).

It is necessary to note the existing conflict between ceremonial and instrumental values in the context of institutional economics. A person cannot be completely free in his behavior due to the influence of the socio-cultural context, which imposed various patterns, practices and values on him. These values have an impact on society as a whole. In this structure of values, there is a dichotomy of culture: ceremonial values support private privileges and preferences, most often they are set by the socio-cultural context and inherited, are considered natural and eternal, but do not contribute to progress. Instrumental values, on the contrary, are capable of modification, competition, and their characteristic feature is the possibility of falsification and substitution. The most important aspect here is the problem of economic and technical efficiency. Instrumental values can assume the shell of ceremonial values, but the reverse process cannot occur due to the non-instrumentality of ceremonial values. Ceremonial behavior is considered useless and hinders development, although in various systems such institutions are present and regulation and interaction with them is a significant difficulty (Volchik, Maslyukova, Demakhina & Barunova, 2023, pp. 36-38).

At the institutional level, the aspect of innovative entrepreneurship is defined through the concept of the national innovation system, which emerged in modern economics in the 80s of the 20th century. Its fundamental principles were laid down in the works of such economists as B. Lundvall, Ch. Freeman and R. Nelson (Barunova & Demakhina, 2022, p. 74). The meaning of the concept is that the national innovation economy is an approach to the study of science, technology and innovation through the prism of the interaction of certain actors - the state, business and the scientific sphere, for an effective innovation process. “New solutions” (technologies, products, social practices and all processes actively implemented in society), as well as the diversity of participants in the creation, dissemination and use of innovations in general, contribute to the development of the national innovation system and its improvement in the long term (Volchik, Maskaev, 2021, p.574).

In the authoritative sources, the definition of an innovation system is interpreted as follows: it is a scientific system whose main goal is to create innovations that affect such large sectors as “government, education and industry, and the external environment”. The main role here is assigned to the interrelationships between the elements of a larger system, including the above-mentioned sectors, which are the basis for the effectiveness of the national innovation system (Gaudin, 2010, p. 38).

The direction of development of the national innovation system in Russia is largely determined by historical aspects, in particular, the specifics of the Soviet

economy and state development plans (Barunova & Demakhina, 2022a). However, maintaining such an approach to regulating modern innovation activity leads to a discrepancy between the interests of "universities and the domestic business community". The resulting isolation of the system is the result of the gap between "accumulated innovation potential and low final efficiency", as well as the widespread use of quantitative indicators of "innovativeness" and social qualities, which are influenced by public discourse. The Russian innovation system can be most fully characterized by the statement about the "average level" of its innovation activity, which leads to the above-mentioned characteristics (Shiryaev, Kurysheva & Volchik, 2021, p. 90).

However, in such rhetoric, it is necessary to highlight positive aspects directly related to the innovative business in Russia. Recently, more and more companies understand the importance of introducing innovations in the production process to maintain competitiveness and develop technologies in the country. Most of all, the growth in the use of innovations can be traced in high-tech sectors, such as the production of computer equipment and electronic products, the creation of medicines and products used for medical purposes, etc., as well as medium-tech industries –electrical equipment, the production of petroleum products; the share of industrial waste sent for processing has increased; the role of innovative small and medium-sized businesses in healthcare - domestic medicines and devices are being actively developed; fast targeted delivery of medicines is being developed, etc.

Describing China's national innovation system, it is impossible not to refer to the main theme of the 20th National Congress: "holding high the great banner of socialism with Chinese characteristics, fully implement the ideas of socialism with Chinese characteristics of the new era, develop the great spirit of the founding of the CCP, strengthen self-confidence and strive for self-improvement, uphold the fundamental principles and innovate, work with enthusiasm, boldly and resolutely move forward, fight together for the comprehensive construction of a modernized socialist state and the comprehensive promotion of the great rebirth of the Chinese nation" (Xi, 2022).

The most fundamental elements in the functioning of the innovation system of the People's Republic of China are the principle of "double circulation", which consists in combining domestic demand and exports, with quantitative stimulation of the domestic market; construction of new and high-class laboratories with the latest equipment; support for scientists and researchers in the form of grants, a variety of interesting educational and scientific programs; stable interaction of the main actors in the face of business, science and the state among themselves, leading to the creation of a particularly favorable atmosphere for the development of certain areas, including R & D, etc . (Barunova & Demakhina, 2022a, p. 674).

A deep institutional context can also be traced in the "14th five-year plan for the development of small and medium-sized enterprises" for 2021-2025, which assumes prioritization of increasing innovation activity, improving environmental indicators, strengthening social stability through better management of the urbanization process and combating poverty, the achievement of which will lead to stabilization of the growth of the number and quality of small and medium-sized enterprises, in particular the creation of new high-tech innovative enterprises. This effect is also demonstrated by the already well-known results of digitalization - the emergence of new digital technologies, such as big data, artificial intelligence (AI) and blockchain, business-oriented Internet applications, 5G communication networks-which have expanded opportunities for the development of innovative entrepreneurship of small and medium-sized enterprises in various sectors of industry and services, new types of business, this includes cross-border e-commerce, online delivery, provision of medical, educational and cultural services online and offline, etc. The Chinese model of economic digitalization has described the state as an" innovative type of state " that successfully overcomes economic difficulties and competes in the international market of digital services and technologies (Pikover, 2023, p.98).

As a final note, it would be like to note that small and medium-sized enterprises, considered in this article through the institutional aspect, play a key role in production chains and are the most important source of innovation. They are the foundation for further development of the world's countries in critical areas of innovation and high technologies.

The root cause of all innovative development in general is the demand for innovation, and it is precisely on its formation that we need to focus attention. In order to correctly use the experience of the People's Republic of China in stimulating the activity of innovative small and medium - sized businesses and for the subsequent development of the domestic innovation system while preserving the national specifics as a whole, it is necessary to fully understand the three components of the demand for innovation – entrepreneurial initiative, stability in politics and economy, and increasing returns. Only on their basis is it possible to build a well-established mechanism with the possibility of self-regulation in the future.

References

1. Barunova, A. A. & Demakhina, O. V. (2022a). The Chinese innovation system in the context of the institutional economy. XI INTERNATIONAL YOUTH SYMPOSIUM ON MANAGEMENT, ECONOMICS AND FINANCE, 1(1), 670-676.

2. Barunova, A. A. & Demakhina, O. V. (2022b). Development patterns for the Russian innovation system. Strategies for the development of society and the economy in the new reality, 1(1): 72-80.

3. Gaudin, B. (2010). Conceptual foundations of scientific, technological and innovation policy. Foresight, 4(2), 34-43.

4. Hirao, T. & Hoshino, Y. (2020). Transition of innovation context: Text mining of newspaper editorials in Japan. Proceedings of the European Conference on Innovation and Entrepreneurship, ECIE, 304–311. Doi: 10.34190/EIE.20.045

5. North, D. (1993). Institutions and economic growth: a historical introduction. THESIS: Theory and History of Economic and Social Institutions and Systems, (2), 69-91.

6. Pikover, A.V. (2023). The leading trends in the informatization of China. In I. A. Maksimtseva (Ed.), X International Forum "Eurasian Economic Perspective": Collection of materials on December 1-2, 2022 (pp. 97-101). St. Petersburg: St. Petersburg State University Publishing House.

7. Shiryaev, I. M., Kurysheva, A. A. & Volchik, V. V. (2021). "Narrative institutional analysis and the Russian innovation system". Journal of Institutional Studies, 13(3), 81–101.

8. The Institute of China and modern Asia of the Russian Academy of Sciences (Eds.). (2023). The People's Republic of China: politics, economics, culture: a monograph. Moscow: ICA RAS.

9. Veblen, T. (1984). The theory of the leisure class. Moscow: Progress.

10. Volchik, V. V. & Maslyukova, E. V. (2022). The influence of formal and informal institutions on the innovative development of the economy. Economic and Social changes: Facts, Trends, forecast, 15(5), 77-94. Doi: 10.15838/esc.2022.5.83.4

11. Volchik, V. V., Maslyukova, E. V., Demakhina, O. V., Barunova, A. A. (2023). Technological and institutional change in the context of Veblen's dichotomy. Journal of Economic Regulation, 14(1), 86-99. Doi: 10.17835/2078-5429.2023.14.1.034-048

12. Xi, J. (2022). CARRYING THE GREAT BANNER OF SOCIALISM WITH CHINESE CHARACTERISTICS HIGH, WE WILL WORK TOGETHER FOR THE COMPREHENSIVE CONSTRUCTION OF A MODERNIZED SOCIALIST STATE. Report at the XX National Congress of the Communist Party of China on October 16, 2022.

DOI 10.34660/INF.2023.94.25.037

性別對英語教學過程的影響
THE INFLUENCE OF GENDER ON ENGLISH LANGUAGE TEACHING PROCESS

Scientific supervisor **- Iplina Antonina Aleksandrovna**
PhD
Namangan State University

Ommonulayeva Gulnoza
Student
Namangan State University

抽象的。 正在討論的文章涉及性對英語教學過程的影響。 它探討了女性和男性與納曼幹州立大學教授的學生互動方式的差異。 數據於 2023 年在該地點的 2 組男女教師中收集。 它揭示英語教學過程中不同性別對談話風格的態度、表達思想的策略、使用手勢、表現自然性格的風格、生物和情感感受的影響、被動和主動、國家的社會制度。 也揭示了女性對家庭關係、人性、對學習者的熟悉程度的傾向，男性在社會體系中的地位依賴事實、注重紀律、以正確答案為導向、主導言論。

關鍵字：「男性」與「女性」、互動方式、烏茲別克人心態、父權體制、情感感受、手勢。

Abstract. *The article under discussion deals with the influence of gender on English language teaching process. It explores differences in females' and males' styles of interaction with students of Namangan State University professors. The data collected in 2023 in 2 groups of men and women teachers at this place. It is to reveal to attitudes towards style of conversation different gender in English language teaching process, strategies to express ideas, using gestures, style of showing natural characters, impacts of biological and emotional feelings, passiveness and activeness, social system of country. It is also revealed that women's tendency to family relationship, humanity, familiarity with learners, men's position in social system dependency on facts, focusing on discipline and orienting on right answers, dominating on speech.*

Keywords: *"male" and "female", style of interaction, Uzbek mentality, patriarchal system, emotional feeling, gestures.*

Introduction

As a result of our analysis of a number of articles on gender shows that there still have differences of opinion among researchers on teaching and learning English language on gender as an example, there is still existing widespread notion and rights understanding of "male" and "female". According to studies of Robin Tolmach Lakoff, who is a professor of linguistics at the University of California, Berkeley [1, p.46] and Deborah Frances Tannen, an American author and professor of linguistics at Georgetown University in Washington, D.C. [2, p.6] on English spoken countries, illuminated the conception of female's language which points out the differences of men and women in communication. As claimed by their research women are more polite than men and passive as well. Another American researcher in this field P.Hobbs [3, p.243] notes that when talking with the same sex peers, women will use many positive politeness strategies. R.Lakoff also states that 'women tend to speak with reference to the rules of politeness conservation implicature, interpersonal exploration men tend to speak with reference to the rules of conversation and straight factual communication'[1, p.74].

Research methods

As a basis of our research such methods as comparison and observation were used. We compared two groups of four-year students (XTA-SR-419 and XTA-TR-420) and the professors teaching them at Namangan State University, and observed how men's and women's teachers' styles of interaction influence the students in a learning process.

Analysis and results

The purpose of the influence of gender on English language teaching process is finding roles of without traditional and religious prohibition of the development of personal potential depending on gender, understanding and self-creation inner ability of learners both boys and girls. By observing, C.Tymson [4, p.8] classified differences in female and male in communication (see Table 1):

Table 1.

Male Style	Female Style
Focus on information	*Focus on relationship*
Report style of speaking	*Rapport style of speaking*
Goal driven	*Process oriented*
Single task approach	*Multi-task approach*
Succinct language	*Storytelling style of speech*
Working toward a destination	*On a journey*
Need to know the answers	*Work to ask the right questions*

Taking into consideration the above information, we observed the group of four-year students at Namangan State University and the teachers who gave the lectures for them during the two-month period. The data of observation showed that women and men teachers and professors of Namangan State University have had some differences in communication in comparison with the results given by C.Tympson in Table 1. In the table below we suggest our notes (see Table 2):

Table 2.

women style of interaction with the students	**men style of interaction with the students**
Family relationship	*Basis on facts*
Familiarity	*Focus on discipline*
Emotional tendency	*Oriented on right answers*
Humanity	*Accuracy in task approach*
Tendency on gestures	*Being dominant on speech*

Thus, in women style of interaction with the students we noticed that family relationship can be impact positively and negatively. In positive way, the students can opine freely without stress and nervous. Furthermore, they could easily interact with others with the help of familiarity of professors and can in easy way ask any question which interest him or her without any barriers. In negative way, we can say that teachers sometimes do not notice the mistakes of students and respect of family relationship incline to students and cause being unprofessional specialist. Some teachers do not notice the other learners besides their relation. Consequently, for other candidates their abilities and talents may not be shown, and it starts to cease interest to subject as well.

In turn, it was noticed by us that familiarity with dean's office greatly influence not to the teachers, even for learners as well. Teachers, who give the best skills with strong discipline and the dean's officer can affect to the situation.

Moreover, in women style of communication with student's emotional tendency impact a lot. Female teachers more prone to be emotion by reason of mother feelings, or mercy.

Humanity the most of the dominant feelings of women compared to men. In as much as men have naturally stricter and serious appearance.

The powerful effect of gestures was also shown in communication between teachers and learners. Gesticulating in communication indicates as warm, agreeable and energetic, vs. people do not use gesture to be viewed as cold and analytical. Based on above data we also can find out how gestures effect to professors and learners interaction according to their gender.

As a matter of fact, in men style of communication with students they tend to report style on their speech that contains facts, data and aims to fix problems. Owners of this gender prefer to leave out personal information and anecdotes.

Being defined as a "stronger gender" with serious appearance and behavior, male tends to be more discipline. By nature, men are having military characters so that most of them do not like disorders in work and other activities.

Considering female prone to emotional feelings (e.g PMS) opposite owners of gender mostly oriented to right answers and clarity, facts as well. On account of responsibility to their work tough connection with job life accuracy in task approach is one of the basic point of their characters.

According to the data were given above by us men also appropriate to dominate in a conversation. Considering the dominance of the patriarchal system in our country, students obey and listen to them more, even if women have more knowledge and skills than the opposite sex.

Conclusion

According to the analysis we have done in our research, the following was noticed such as the Uzbek mentality of the country, which is different from the other countries, especially European ones. Another factor of influences of gender in teaching process is importance of characters by nature, behavior, social system of place. Dominance of the patriarchal system of country may allow women being expected position on working with students. Some emotional and biological condition can interrupt female interact with learners as well. Thus, varieties sharply are shown in this article.

References

1. Lakoff, R. T. Language and Woman's place. - Octagon Books,1976. - 83 p.

2. Tannen, D. You Just Don't Understand : Women and Men in Conversation. - New York : Morrow, 1990. - 156 p.

3. Hobbs, P. The Medium is the Message: Politeness Strategies in Men's and Women's Voice Mail Messages. - Journal of Pragmatics, 2003. - p. 243-262.

4. Tymson, C. Gender Games: Doing Business with the Opposite sex. - Australua: Tymson Communication, 1998. - 182 p.

DOI 10.34660/INF.2023.17.94.038

技術學生雙元培養中輔導在人力資本發展中的作用

THE ROLE OF MENTORING IN THE DEVELOPMENT OF HUMAN CAPITAL IN THE DUAL TRAINING OF TECHNICAL STUDENTS

Aleksandrov Aleksandr Vavilovich
Teacher
Interregional Competence Center – Cheboksary Electromechanical College

註解。 在當今瞬息萬變的世界中，社會的技術需求正在迅速增長。 而製造業企業在轉型為新的技術結構時，需要具備非標準化思維、事先決策能力的員工。 這似乎是每個雇主的白日夢。 但有一些方法和工具可以幫助您解決這些問題。

其中一個解決方案是指導——這是一種現代教育趨勢，即在更有經驗的員工的監督下向年輕專家傳授經驗。 重要的是，不僅要讓學生為某些工作條件做好準備，為他提供必要的知識、技能和能力，從而增加他的人力資本，而且要揭示他的認知能力，教會他找到解決方案的能力在工作過程中。

指導是一種有效的技術，用於培訓具有必要能力的有競爭力的專家。

關鍵字：中等職業教育，雙元製教育，輔導。

Annotation. *In today's rapidly changing world, the technological demands of society are growing rapidly. And manufacturing enterprises, when transitioning to a new technological structure, need employees who are ready for non-standard thinking, capable of making decisions ahead of time. It would seem like every employer's pipe dream. But there are methods and tools that allow you to solve these problems.*

One of these solutions is mentoring - a modern educational trend, where the transfer of experience to young specialists occurs under the supervision of a more experienced employee. It is important not only to prepare a student for certain working conditions, to provide him with the necessary knowledge, skills and abilities, thereby increasing his human capital, but also to reveal his cognitive abilities, to teach him the ability to find solutions that arise in the process of work.

Mentoring is an effective technology for training competitive specialists with the necessary competencies.

Keywords: *secondary vocational education, dual education, mentoring.*

The main task of secondary educational professional organizations is to train qualified specialists in working specialties, who are constantly in demand in the

labor market and are the driving force of a production enterprise, in addition to designers and intellectual developers.

Educational organizations invest in students the standard knowledge, skills and abilities they need for further development and improvement of professional skills, but each student has their own special human capital - which they can use depending on their preferences, talents, values and potential. A student's human capital is the totality of his specific competencies, in addition to standard knowledge, skills and abilities. And the ultimate goal of an educational organization should not be limited to simple training or the creation of labor reserves, but should teach students to unlock their potential and increase their own human capital, adding to it the human capital of the educational organization.

Modern smart managers of large enterprises understand that yesterday's graduates of technical colleges are their future employees. And they are interested in young specialists being qualified and possessing the necessary competencies, because they are the ones who create added value. The further success and development of the enterprise largely depends on them. The human capital of a company's employees creates the market value of the enterprise and increases competitiveness. The share of influence of human capital on business value ranges from 30 to 80% - depending on the sector of the economy. But one way or another, the contribution of people to the profitability of the organization is the determining factor [8].

Therefore, in dynamically developing enterprises there are mentoring institutions and their functioning is taken very seriously. Training and education takes place for both the administration and middle managers, starting from the shop manager to industrial training foremen, foremen and mentors.

Industrial training masters play an important role in the preparation of students and their development as professionals. They are the necessary connecting participants in the organization of educational and industrial activities of students together with the administration, teachers, mentors, and representatives of employers. A modern industrial training master, according to a number of researchers, "must not only be able to design the educational process, but also effectively interact with social partners, and above all, the employer, practice mentors at the enterprise." The authors of the monograph "Industrial training masters as a professional group: current state and problems of development" clearly determine that the level of professional and pedagogical education of an industrial training master has a decisive influence on the level of the entire subject-subject interaction in a vocational education institution [6, p.79]. That is why modern researchers consider the master's competence as one of the pedagogical problems and assert that it is necessary for each master to master "a certain set of the most important competencies for his professional activity, an integral set of knowledge, abilities, skills, abilities and

personality traits that allow successfully solve problems, including pedagogical ones, in the field of educational and production activities" [4]. This means that every master should not only be competent in their profession, but also have a "pedagogical mindset". [2, p.28].

Of great importance in increasing the level of efficiency of the formation and development of the special human capital of mid-level students is their educational and industrial practice under the guidance of industrial training masters. This is the period of the highest quality training for future specialists with a fairly high level of development of professional competencies..

As part of the dual education aimed at enhancing the development of specialized human capital, students of technical colleges play the role of mentors, especially those from high-tech production companies. Mentorship as a form of education allows for a combination of flexible and practical training with the economy and efficiency of the process. Today, it is impossible to find another form of education that can be fully targeted and closely related to the real conditions of the enterprises.

The history of the mentoring system in our country is diverse and tied to the historical events of the development of our fatherland. Researchers on the history of mentoring M.A. Galaguzova and A.V. Golovnev proposed the following periodization of "its development: 20–40 years - the emergence of patronage, its rapid and partly chaotic development; 50–60 years - the emergence of mentoring, the beginning of study and development, its systematization as a social phenomenon, legislative regulation of mentoring; 70–90 years - the mentoring system becomes part of state policy, awards for mentoring appear, it also receives scientific justification and becomes part of professional pedagogy as a science. Methods are emerging for conducting mentoring activities and for training mentors themselves. This was the peak of the development of mentoring in our country" [3, p.20]. They believe that the collapse of the Soviet country had a bad impact on the development of the mentoring system; only in the late 90s, in the context of corporate training of technical specialists, they started talking about mentoring again. And the end of the 90s until 2005 was characterized by a period of sustainable development of modern models of in-house professional training for individual training of managers, team training and retraining of personnel, and a learning organization.

In the 21st century, corporate training of technical specialists has received new development. This training is a process of improving the knowledge, skills and competencies of enterprise personnel through specialized educational programs aimed at satisfying the interests of enterprises in competent personnel for the accumulation of intellectual, innovative capital in order to ensure the competitiveness of these specialists and the competitiveness of the enterprise as a whole.

M.V. Clarin, characterizing the new features of modern mentoring, identifies the following forms of mentoring: buddying, shadowing, coaching, secondment - developmental business trip [5, p. 105–107].

Foreign companies emphasize the importance of the mentoring system and reveal the possibilities of new forms of mentoring such as Peer Mentoring, Group Mentoring, Situational Mentoring, Flash Mentoring, short-term or goal-oriented mentoring (Short-Term or Goal-Oriented Mentoring), Speed Mentoring, Self-Directed Mentoring, Virtual Mentoring, Reverse Mentoring [7].

The methodological foundations of modern mentoring are well and thoroughly described in the article by V.I. Blinova, E.Y. Yesenina, and I.S. Sergeev "Mentoring in education: you need a well-sharpened tool" [1]. The structure of interaction between a mentor and a follower described by them is tied to "the basic activity of the mentor – support activity" [1, p.7].

Interesting from the perspective of this study is that the authors of this methodology emphasize that the focus of the mentor should be, first of all, "the personality of the person being accompanied and his inner world, the basic processes of personal development, socialization, self-determination, identification, ..., system social relations of the person being accompanied, in which he is included in the context of his activities," and not just teaching him the basics of some profession in the workplace of the enterprise. This confirms the role of the mentor in the system of interaction we organize between participants in dual education at a technical college in the development of human capital in the most general terms.

The authors (V.I. Blinov, E.Y. Yesenina, I.S. Sergeev) identify nine types of mentoring for different levels of education. In our case, this is "an industrial mentor, a mentor" [1, p.9].

They identified five types of mentoring: individual, group, collective, peer, online.

All presented forms of mentoring can be used depending on the circumstances that developed at a certain point in time. Also, depending on the current situation, when communicating with the person being accompanied, the mentor can use any method listed in the article;

– "methods of organizing the activities of the accompanied person (group of accompanied persons), which serves as a factor in his development and accumulation of personally significant experience;

– organization of discussion (conversation, group reflection), during which the assessment and comprehension of the experience gained from the activity are carried out;

– creation of special situations (developmental, activity-based, communicative, problematic, conflictual), expanding the experience of the person being accompanied and activating the processes of its development;

– creation of external conditions, an environment for mastering activities (including a subject-spatial environment that is optimal for the development of a mentor);

– methods of diagnostic, developmental and monitoring assessment (including "participant observation", conversation, questioning, sociometry, etc.);

– methods of managing interpersonal relationships in a group of accompanied persons;

– networking is a method of organizing contacts and interaction with current and future significant social partners (for example, schoolchildren with representatives of professional educational organizations, universities, employer enterprises);

– methods of updating individual motivation and facilitation;

– personal example (mentor as a bearer of the image of "successful adulthood", effective strategies for self-education and self-development, professionalism, possessing certain competencies and demonstrating certain patterns of activity);

– information (including in the form of instructions);

– consulting."

In the context of the organization of dual education in a technical college, the role of the administration of a vocational education institution (college) is strengthened and deepened. Its main function is to direct all available management levers and resources to transfer the educational space of the organization of vocational education into the state of a dynamically developing system in order to optimally and reliably facilitate the organization of interaction between all participants in the educational, cognitive and accompanying production process: teachers, students, industrial training masters, mentors, employers. And then, interaction with employers will need to be organized on the principles of effectiveness (in the implementation of common goals and obtaining positive results), integrity ("unity and consistency of the methodological and regulatory framework of interaction participants"), voluntariness and openness ("the possibility of entry of new participants, and also a way out of it"). Speaking about the need for dynamically developing connections with employers, two reasons for this need are put forward. Firstly, "in the context of modern technological transformations in production, the requirements of employers and, accordingly, professional standards will constantly undergo changes, so professional educational organizations must quickly and flexibly respond to new requests from employers in order to keep up with the times." Secondly, a comparative analysis of the latest educational standards shows a tendency towards their practice-oriented nature, which means this "determines the need to develop a joint policy for enterprises and educational organizations."

The process of organizing interaction with employers in college should be implemented in four interconnected sequential stages.

The first stage is organizational, at which the following are discussed and prescribed: Regulations on the organization and implementation of educational and production activities according to the dual education model, an Agreement on

practical training of college students and employers, Regulations on the department, Regulations on mentoring, and a long-term cooperation plan is being drawn up. All these documents must be prepared and agreed upon based on a study of the needs of the labor market.

The second stage is methodical. He must undergo coordination of the programs of academic disciplines and programs of educational and practical training.

The third stage - practical - is focused on the joint implementation of educational and industrial practice, as well as participation of employer representatives in assessing the quality of student training during the final certification and in the employment of graduates.

The fourth stage is reflective in analyzing the results mutual cooperation on the development of human capital of technical college students.

Thus, it can be stated that for the effective operation of an integrated system of student training, it is necessary to interact with all its participants at each stage and promptly coordinate joint actions. And the efforts of modern professional education should ensure the disclosure of the student's potential, his hidden abilities, and provide motivation for self-development and the creation of his own human capital.

By creating a mentoring system, we help mentees, since students can independently determine their next steps in their professional career, form their own paths of self-realization, and acquire the necessary competencies, which is vital in today's rapidly changing world.

References

1. Blinov, V.I. Mentoring in education: you need a well-sharpened tool / V.I. Blinov, E.Yu. Yesenina, I.S. Sergeev // Methodology. - 2019. - No. 3.- P.4-18.

2. Vlasova, O.I. Social portrait of a vocational training master: Collective monograph / Under scientific. ed. T.V. Permyakova, V.A. Kopnova. - Ekaterinburg: Publishing house Ros. state prof.-ped. unta, 2015. - 129 p.

3. Galaguzova, M.A. Mentoring: from the past to the present / M.A. Galaguzova, A.V. Golovnev //Pedagogical Journal of Bashkortostan. – 2018. - No. 6(79). – P.16-22.

4. Gitman, E.K. Increasing the professional pedagogical competence of an industrial training master as a social and pedagogical problem / E.K. Gitman, A.P. Torbeev // Modern studies of social problems (electronic scientific journal). - 2012. - No. 10(18).

5. Clarin, M.V. Modern mentoring: new features of traditional practice in organizations of the 21st century / M.V. Clarin // Stage: economic theory, analysis, practice. - 2016. - No. 5.- P.92-112.

6. Industrial training masters as a professional group: current state and development problems: monograph / O. I. Vlasova [etc.]; under scientific ed. T. V. Permyakova, V. A. Kopnova. - Ekaterinburg: Publishing house Ros. state prof.-ped. University, 2016. - 149 p.

7. Esaulova, I.A. New models of mentoring in the practice of training and development of personnel of foreign companies / I.A. Esaulova // Business strategies. - 2017. - No. 6 (38). URL: https://www.strategybusiness.ru/jour/article/download/329/299 (access date: 05/16/2023).

8. Report on human development in the Russian Federation for 2017 / ed. S.N. Bobylev and L.M. Grigorieva. M.: Analytical Center under the Government of the Russian Federation, 2017. 292 p.

DOI 10.34660/INF.2023.92.39.039

利用俄羅斯在蒙古專業和法律領域對調查員進行心理培訓的經驗
USING THE RUSSIAN EXPERIENCE OF PSYCHOLOGICAL TRAINING OF AN INVESTIGATOR IN THE PROFESSIONAL AND LEGAL SPACE OF MONGOLIA

Berkovich Olga Efimovna
Candidate of Pedagogical Sciences, Associate Professor
National Research Nizhny Novgorod State University named after N. I. Lobachevsky

Matreshina Evgeniya Borisovna
Candidate of Psychological Sciences, Associate Professor
National Research Nizhny Novgorod State University named after N.I. Lobachevsky

Igilik Umirgul
Student
National Research Nizhny Novgorod State University named after N.I. Lobachevsky

抽象的。 在所提交的科學出版物中，根據俄羅斯聯邦此類培訓的經驗，考慮蒙古調查員的專業和心理培訓問題似乎是適當的。 對專業和心理學文獻的科學分析，包括對調查員職業圖和心理圖的編制問題的分析，可以強調該問題的相關性。

關鍵字：專業與心理訓練、調查員的個性、職業圖、心理圖、調查員的官方活動、特別專業的大學。

Abstract. *In the presented scientific publication, it seemed appropriate to consider the problem of professional and psychological training of an investigator in Mongolia based on the experience of such training in the Russian Federation. The scientific analysis of the professional and psychological literature, including on the problems of compiling a professionogram and a psychogram of an investigator, allowed to highlight the relevance of this problem.*

Keywords: *professional and psychological training, personality of the investigator, professionogram, psychogram, official activity of the investigator, specially professional universities.*

A special need for psychological influence arises when the investigator conducts investigative actions in the presence of opposition not only from the defendants, but also from other participants in the criminal process, as well as the need to make up for the insufficient evidence base or its absence at all.

At its core, psychological influence is defined as one of the tactical techniques used in investigative actions.

The activities of an investigator include performing professional tasks, including conducting investigative actions, with the active use of psychological influence on participants in criminal proceedings. Investigators perform their functions and tasks in accordance with the Constitution and other legal acts of Mongolia, in various conditions, including both ordinary and special.

In Mongolia, there is an urgent need to develop the personality of an ATS investigator. This is due to the progressive development of the legal framework of the state, the process of reforming law enforcement agencies and the complexity of the tasks that they solve in the field of creating conditions for democratic changes in society. All this requires a new approach to training specialists who must have the necessary set of professional skills and abilities.

When it comes to the profession of a law enforcement investigator in Mongolia, special attention is paid to determining the required professional qualities, due to the characteristics of investigative activities. In the process of studying at a higher educational institution in Mongolia, attention is also focused on the formation and development of the professional qualities of an investigator. Various ways to achieve this goal are now being sought, exploring various approaches and methods.

Such Mongolian authors as S. Erdenechimeg, M. Narantuya and others studied the psychological characteristics of investigative activity in their scientific research.

Thus, Sh. Erdenechimeg in the work “Khuuliyn setgel sudlal ba setgel zuyn zөvlөgөө” - “Legal psychology and psychological counseling” does not provide a detailed description of the profession of an investigator and does not report on the specific requirements for the executor. It attempts instead to determine the nature and proportion of mental properties that the investigator must possess. [1]

For example, in the work “Khuuliin setgel sudlal” - “Legal Psychology” M. Narantuya gives a psychological description of investigative actions in the most general form. In the work of an investigator, in addition to procedural and psychologically significant features, an integral part that must be taken into account includes the exercise of powers, detailed legal regulation, active participation, great

[1] Sh. Erdenechimeg Khuuliyn setgel sudlal ba setgel zuyn zөvlөgөө - Textbook., edited by Ch. Zhadamba, B. Bolor, D. Erdenechimeg, Ch. Onorzhargal; Ulaanbaatar ., – 2020, – 213 p. - P. 69

labor intensity, a non-standard approach, and many different psychological tasks that are solved in the course of work. [2]

Taken together, the professional occupation of an investigator has a number of important characteristics, such as detailed legal regulation, procedural independence, personal responsibility, activity, significant labor intensity and a variety of psychological tasks that the investigator faces.

Showing a creative nature and possessing powerful and obligatory signs of professional authority, he tirelessly fights with interested parties. Suffering from a lack of time and forced to maintain official secrets, his activities are extreme.

According to the laws of Mongolia, all actions and activities of the investigator are completely subject to legal regulation. This process is associated with the emergence and termination of legal relations with various people, which is both his right and obligation. Strict compliance with the law is the main feature of the investigator's profession. Except in cases where the consent and sanction of the prosecutor or a court order is required, the investigator bears full legal responsibility for the investigation and conduct of investigative actions during the preliminary investigation, as well as for their results.

The investigator has every right to independently make decisions about the direction of the investigation. This is stated in paragraph 2, article 6.2 of the Code of Criminal Procedure of Mongolia. [3]

Persons authorized to perform government functions, including investigators, are directly subject to a number of articles providing for severe punishment for abuse of their powers, for example, Articles 22.21 and 22.23 of the Code of Criminal Procedure of Mongolia. [4]Each action of the investigator has significant consequences and requires strict compliance with the Criminal Procedure Code and by-laws, since this will immediately lead to a violation of a specific law. The investigator's performance of his official duties with precision down to the smallest detail and control of actions and operations are the key features of this profession.

The work of the investigator is under strict regulatory control, which governs the entire investigation process. The law prescribes not only special requirements for individual investigative actions, such as inspection, exhumation and examination, search and interrogation, but also outlines the procedure for conducting a preliminary investigation in general terms. In addition, at various stages of the investigation, certain actions are required, specified in the article on the suspension and resumption of the preliminary investigation, and deadlines are also established for its completion. All these norms give the work of the investigator a clearly defined normative character.

[2] M. Narantuya Huuliin setgel sudlal. Training manual., 2022, 132-p., p.45

[3] Criminal Procedure Code of Mongolia dated May 18, 2017

[4] Criminal Procedure Code of Mongolia dated May 18, 2017

The legal specifics of investigative activities play a very important role in determining the professionally significant qualities of an investigator. The study of the psychological aspects of investigative activity, together with taking into account legal regulation, helps to successfully solve this problem. These qualities are necessary both for conducting individual investigative actions and for carrying out all activities.

The issues of developing a professional profile and psychogram for an investigator in Russia have been studied, presented and tested quite widely. The professional and psychological training of investigators in the Russian Federation has the experience of in-depth study, established traditions and fairly rich practice, in particular, in special professional higher educational institutions.

The degree of expression of professionally important qualities of an investigator's personality is directly dependent on the requirements for the conditions of his official activity[5].

The group of individual psychological qualities of the investigator's personality consists of 7 groups, which were identified following Bovin B.G., Myagkikh N.I., Safronov A.D., Berkovich O.E.[6], based on the professional requirements for the personality of the investigator. Their list includes the following: communication qualities and skills, intellectual qualities, memory characteristics, attention and observation, volitional personality traits, emotional characteristics, motor skills.

To assess the criteria for a person's psychological qualities, it was proposed to use a number of specially selected or developed psychodiagnostic methods.

References

1. M. Narantuya Huuliin setgel sudlal. (Legal psychology). Textbook, Ulaanbaatar, – 2022.,– 113 p.https://legaldata.mn/book/view/171 (access date: 11/25/2023)

2. Sh. Erdenechimeg Khuuliyn setgel sudlal ba setgel zuyn zөvlөgөө - Textbook, edited by Ch. Zhadamba, B. Bolor, D. Erdenechimeg, Ch. Onorzhargal;

Ulaanbaatar ., – 2020, – 213 p.http://catalog.naog.gov.mn/cgi-bin/koha/opac-detail.pl?biblionumber=24536 (access date: 11/25/2023)

[5] Main types of activities and psychological suitability for service in the system of internal affairs bodies: Reference manual / Ed. B.G. Bovina, N.I. Myagkikh, A.D. Safronova. – M., 1997. – 344 pp., p. 9

[6] System of indicators for assessing the effectiveness of professional performance of civil servants. Monograph //Berkovich O.E., Galanov A.S., Glukhova A.A., Grachev S.A., Zhuk O.O., Marinin S.A. edited by Sharov V.I. - AT the Ministry of Internal Affairs of Russia, Nizhny Novgorod, 2014, 184 pp., - P. 52.

3. Criminal Procedure Code of Mongolia dated May 18, 2017https://legalinfo.mn/mn/detail/12694 (access date: 11/25/2023)

4. Law on Forensic Examination of Mongolia dated December 23, 2022 (new edition)https://legalinfo.mn/mn/detail?lawId=16532614235741 (access date: 11/28/2023)

5. Main types of activities and psychological suitability for service in the system of internal affairs bodies: Reference manual / Ed. B.G. Bovina, N.I. Myagkikh, A.D. Safronova. – M., 1997. – 344 p.https://search.rsl.ru/ru/record/01001803362 (access date: 11/28/2023)

6.System of indicators for assessing the effectiveness of professional performance of civil servants. Monograph //Berkovich O.E., Galanov A.S., Glukhova A.A., Grachev S.A., Zhuk O.O., Marinin S.A. edited by Sharov V.I. - AT the Ministry of Internal Affairs of Russia, Nizhny Novgorod, 2014, 184 p.https://search.rsl.ru/ru/record/01007559129(access date: 12/01/2023)

DOI 10.34660/INF.2023.12.86.040

大戲幕後：中國、南海與全球政治
BEHIND THE SCENES OF THE GREAT DRAMA: CHINA, THE SOUTH CHINA SEA AND GLOBAL POLITICS

Skorokhod Igor Aleksandrovich
Student
Al-Farabi Kazakh National University,
Almaty, Kazakhstan

抽象的。　中國作為世界主要大國，在全球政治、經濟、軍事領域佔有中心地位。 它的影響力顯著決定世界發展趨勢，影響地區和全球動態。 本文旨在深入探討南海鬥爭背景下中國在塑造全球新力量平衡中所扮演的角色。 對南海地緣政治動態進行了詳細分析，明確了參與國的經濟和戰略利益，並考慮了美國對地區緊張局勢形成和發展的影響。 研究的理論意義在於揭示全球因素對太平洋地區進程的影響，而實踐價值則在於分析南海的經濟意義、衝突各方的軍事潛力以及南海地區的軍事潛力。考慮到事態發展的未來前景，以及在南海背景下對影響中美複雜關係的因素進行全面檢視。

關鍵字：南海、中國、美國、超級大國、升級、習近平、緊張局勢、AUKUS、外交政策。

Abstract. *China, as a leading world power, occupies a central position in global politics, economics, and the military sphere. Its influence significantly determines the trends of world development, affecting regional and global dynamics. This article aims to deeply explore China's role in shaping a new global balance of power in the context of the struggle for the South China Sea. A detailed analysis of the geopolitical dynamics of the South China Sea has been carried out, the economic and strategic interests of the participating countries have been identified, and the influence of the United States on the formation and development of regional tensions has been considered. The theoretical significance of the study is expressed in revealing the impact of global factors on regional processes in the Pacific region, while the practical value lies in the analysis of the economic significance of the South China Sea, the military potential of the conflict participants and the consideration of future prospects for the development of events, as well as a comprehensive review of factors affecting the complex relations between the US and China in the context of the South China Sea.*

Keywords: *South China Sea, China, USA, superpower, escalation, Xi Jinping, tension, AUKUS, foreign policy.*

In the 21st century, a unipolar political system is an integral part of the global order, and at the moment, public attention is increasingly attracted by the dynamics of China's rise to superpower status. A particularly noteworthy aspect of this development is the influence of Beijing's policy on the South China Sea, a region fraught with historical tensions and strategic interests. Against the backdrop of geopolitical changes and rapid economic growth, the analysis of China's influence on the South China Sea becomes a key aspect of understanding contemporary global dynamics.

China has undergone significant transformation over the past decade, demonstrating the substantial efforts of the Communist Party of China in reforming and renewing the state. Given that China's economy is second only to the US, China is first in terms of purchasing power parity and the largest exporter of goods in the world, these circumstances oblige China to take an active part in world affairs to maintain authority and promote its sphere of interests. 'To conduct a policy of protectionism is the same as locking oneself in a dark room, you will protect yourself from wind and rain, but also deprive yourself of light and air,' said the Chairman of the PRC, Xi Jinping, at the plenary session of the World Economic Forum in Davos in 2017 [1]. The manifestation of uncertainty and hesitation in actions for a country with the highest level of economy is unacceptable in the modern context, as such behavior instantly raises questions from the world community regarding the demonstration of selfishness and inability to effectively solve global problems. Moreover, such processes can undermine the perception of this state regarding its important role in world affairs. Such a situation with respect to China occurred during the adoption of UN Security Council Resolution No. 1973 in 2011, when the PRC government abstained from the issue of resolving the conflict in Libya, which immediately led to the above-mentioned points [2].

The South China Sea is a region that is currently under constant discussion and observation in modern politics, as it is one of the main battlegrounds for China's geopolitical interests and the US's efforts to restrain China from its ambitions and theoretical emergence as a superpower in the near future.

With the collapse of the USSR in 1991, US supremacy on the planet became the norm of the global political system. The United States has held and continues to hold both economic and military-political supremacy in the world. Being one of the first founders of the International Monetary Fund, the World Bank, and the UN, the US exerts significant influence on modern politics, which Washington controls with a firm hand and does not allow any state to express its demands and interests too broadly. But over the past decade, China has announced itself on the geopolitical arena as a new, rapidly developing competitor, which, according to the analysis of many experts, will undoubtedly challenge the United States in order to create new rules for managing the global political and economic system,

as well as to organize new institutions that will challenge existing international organizations.

In international relations, there is a so-called “Power Transition Theory” created by Abram Organski, a professor at the University of Michigan. The theory emphasizes that one current hegemon will constantly press on a potential rival, war from the superpower in this case is always possible, but the rival can also achieve to overthrow the hegemon [3:22]. The current situation in the South China Sea (SCS) also demonstrates how the United States, being the only superpower, restrains China, attracting as many countries as possible to conclude military-political agreements and alliances to establish its dominance and supremacy over China. The head of the Department of International Relations at Tsinghua University, Professor Yan Xuetong, also notes that the United States will defend its status as a hegemon on the political arena against any state opposing their influence, therefore the developing China will still be the main adversary of the United States in the field of political-economic domination in the future, but military actions can be avoided through agreements [4].

Beijing’s foreign policy has begun to encounter problems and failures, especially since the late 2000s, when disputes over the South China Sea became difficult to resolve quickly. China’s rapid economic growth and military modernization, its growing dependence on maritime trade and resources, the developing nationalism and assertiveness of government elites, as well as strategic competition with the United States, their allies and partners in the region - all this contributes to the escalation of tensions and conflicts in the South China Sea. The 21st century has become the most heated period for the disputing countries, when China began to more aggressively participate in the control and supervision of territories, actively stopping passing foreign ships and building a large number of artificial islands and naval bases.

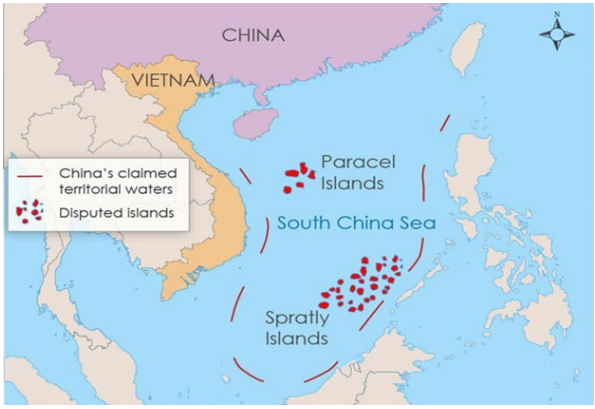
The South China Sea, being semi-enclosed geographically and having an area of more than 3.5 million square kilometers, is currently divided among such countries as China, Taiwan (unrecognized state), the Philippines, Malaysia, Brunei, Indonesia, Singapore, Cambodia, Vietnam, and Thailand. Most of them are strategic partners of the United States, which, together with Japan, the Republic of Korea, Australia, have literally surrounded the PRC with a line of military bases in the Pacific Ocean, exerting pressure and heating up the race for dominance in the region. The countries of the South China Sea are actively confronting China, not afraid to speak out or act directly, as in the event of the start of military clashes or escalations, the USA will inevitably stand up for allies against the PRC. China, in turn, due to its constantly growing economic and military power, is not afraid to dictate demands and is ready for any consequences, as it has sufficient capabilities to defend its position.

At present, the South China Sea represents certain interests:

Economic: It is a vital corridor for international trade, as a significant portion of the world's merchant fleet and a third of all maritime shipments pass through its waters, accounting for $3.37 trillion in global trade turnover [5]. According to the U.S. Energy Information Administration, proven and probable reserves of natural resources in the South China Sea are estimated at 11 billion barrels of oil and 190 trillion cubic feet of natural gas [6:2]. These resources are mainly located in the disputed territories of the Spratly (Nansha) and Paracel (Xisha) islands, which are claimed by China, Vietnam, and the Philippines respectively. The sea is also rich in fish stocks, which provide millions of people with food and income.

Strategic: The South China Sea connects the Indian and Pacific Oceans and has several strategic chokepoints, such as the Malacca, Singapore, and Taiwan Straits. These narrow passages are vital for the transportation of goods between Asia, Europe, Africa, and America. Disputes over dominance in the sea lead to constant tension and militarization in the region, posing a threat to regional stability and security. The U.S. urges all conflicting states to resolve their disputes peacefully in accordance with international law, but in practice often conducts naval and air operations with allies to challenge China's excessive claims and defend their hegemonic ambitions in the region. In 2021, the U.S., despite protests from the Chinese side, conducted more than 12 military exercises in the South China Sea, among which the "Large Scale Exercise 21" involving tactical and strategic aviation, with the participation of 25,000 servicemen from the U.S., Australia, Britain, and Japan, was the largest in the region's history [7]. China also observes that the number of such provocative exercises in the area of China's interests is only growing.

According to the 1982 UN Convention on the Law of the Sea, the expansion of territorial waters beyond 12 nautical miles (~22 km) is not allowed, but it is permitted to have 'Exclusive Economic Zones' (EEZ) within a distance of 300-350 km. To account for historical fairness in terms of dividing maritime borders, China, represented by the Kuomintang party and then the PRC government, put forward demands in the 1940s for full control of the waters in the sea under the name 'nine-dash line', which covers more than 80% of the entire territory of the South China Sea. In 2016, the Permanent Court of Arbitration (PCA) in The Hague issued a decision on the dispute that arose between the Philippines and China. This decision established that the PRC's claims to historical rights within the '9-dash line' have no legal basis and in every way violate the stability of international waters in the South China Sea, protected by the UN Convention [8].



Source: United Nations Convention on the Law of the Sea (UNCLOS)

However, in reality, the USA, due to its involvement in the South China Sea, is the largest aggressor in the region, violating all principles of peaceful cooperation, actively inciting China's neighbors against it. Entering into confrontation with the PRC, Southeast Asian countries - the Philippines, Indonesia, and Australia - do not have enough strength to counteract the interests of the PRC due to low state budget expenditures on expanding military potential. In total, China surpasses all the listed countries combined in military terms. According to the world military power rating "Global Firepower Index" 2023, China ranks third, Vietnam - 19th, the Philippines - 32nd, Indonesia - 13th [9]. According to calculations, China has 2.19 million military personnel compared to 482,000 in Vietnam, 140,000 in the Philippines, and 395,500 in Indonesia. China also has a much larger defense budget - 261 billion dollars, while Vietnam spends 7.9 billion dollars, the Philippines - 3.6 billion dollars, and Indonesia spends 10.7 billion dollars on its armed forces. As for the navy, the PRC has more than 700 ships, which is several times more than the number of ships of the three above-mentioned countries combined. This military potential of China suggests that in case of escalation, they will practically have no chance to offer significant resistance, and there is only hope for military support from the USA.

The implementation of the "Maritime Silk Road of the 21st Century" within the framework of the "One Belt, One Road" initiative without any privileges in the South China Sea appears to be a challenging task. This region, as the world's maritime artery, allows thousands of ships with goods and resources to pass through many countries of the world, among which there are countries claiming the South China Sea, where China actively invests in the development of infrastructure, construction of ports, and establishment of a competent logistics system. On the other

hand, the desire of the Philippines, Vietnam, Thailand, and Indonesia to seek support from the United States to resolve these disputes is fundamental in light of the prospective influence of regional resources on the economic growth of these countries. Increased US intervention may contribute to a decrease in China's activity, and the removal of China's military facilities in the South China Sea will moderate the strained relations, mitigating possible conflicts of these countries with Beijing.

Overall, China's strategy in this context appears more justified, as the South China Sea is a vital place for control to enhance China's economic potential and improve its national security system. Given the historical animosity between the two states, the US and China are rapidly building up forces in the region, but initially, in the 20th century after the Taiwan crisis, it was Washington's initiative to surround China with extensive lines of fortifications, military bases, and constant naval patrolling of China's coasts, which posed a catastrophic danger for the latter. The US intends to actively pressure Beijing's growing dominance, that is, in no way allow China to become the world's first economy and superpower respectively, because then the world community and influence will come under the control of the PRC.

The US political elite and the entire government as a whole are ready to decisively respond to Beijing's ambitions in the South China Sea. Current American sentiments can be seen from the 2020 quote from former US Secretary of State Mike Pompeo: "The world will not allow Beijing to treat the South China Sea as its maritime empire. America supports our allies and partners in Southeast Asia in defending their sovereign rights to marine resources in accordance with their rights and obligations under international law." [10].

Referring to the "Taiwan issue" and the shift in strategic and political paradigms across the entire Indo-Pacific region, the United States, in conjunction with Australia and the United Kingdom, announced the creation of the AUKUS alliance on September 15, 2021. This alliance aims to maintain security and order throughout the Pacific region, and combat terrorism and piracy. However, in reality, for such a range of objectives, there is no need to provide a continental country (Australia) with nuclear submarines, and from this, it can be concluded that the alliance is aimed at collective presence and pressure on China in the South China Sea. The alliance is expected to facilitate the coordination and integration of other partners and allies, such as Japan, India, France, and ASEAN countries, to form a more unified and consistent front against China's actions. According to the US government, this will reduce China's ability to exploit disagreements and weaknesses in the regional order and impose its unilateral and territorial claims in the South China Sea. Also, by developing and exchanging advanced technologies, AUKUS members will enhance qualitative advantages and innovative potential within the alliance, as well as their partners in the face of China's rapid mili-

tary modernization and technological progress. This will allow alliance members to counter and deter China's growing capabilities in the fields of cybersecurity, space, artificial intelligence, quantum energy, and in the development of hypersonic missiles, which are of great importance for future conflicts and security issues in the region.

The U.S. stance is clear. China is a formidable adversary, breathing down its neck in this geopolitical and economic competition. America does not entirely welcome China's presence among the permanent members of the UN Security Council, which allows China to actively promote its interests and weaken the claims and indignation of the international community towards its aggressive policy in the South China Sea. However, as history has it, China is one of the founders of the United Nations, and actively opposing it, attracting as many countries as possible, is an insurmountable task even for the number 1 superpower. There have been attempts by the States to accuse China of multiple pseudo-crimes regarding human rights, cybersecurity, technology theft, etc., but China unhesitatingly turns a blind eye to such provocations that the U.S. arranges for any state that goes against Washington's interests.

The determination of the Chinese government and the intention to engage in dialogue can be underscored by a quote from the current Chinese Foreign Minister Wang Yi at the 77th UN General Assembly when he addressed Antony Blinken: "The United States must stop trying to restrain and suppress China and avoid creating obstacles in the relations between the two countries" [11].

The current geopolitical situation in the world raises many concerns about the future of all countries. Conflicts that multiply day by day, escalations and tensions at the borders have become commonplace in the 21st century. The current conflicts in Palestine and Ukraine further inflame the relations between the US and China, which do not have exactly common interests in resolving these issues, but theoretically can come to a common compromise. Xi Jinping spoke about the fact that in the process of its own rise, China will avoid the "Thucydides trap", but unlike the Peloponnesian War between Athens and Sparta, the United States and China have the opportunity to sit down at the negotiating table and prevent a complete split in relations, to maintain peace and stability on the planet as leading powers. After a sufficiently long period of absence of negotiations at the highest level, a meeting of the leaders of the two states took place at the Asia-Pacific Economic Cooperation (APEC) summit on November 15, 2023, in San Francisco [12]. The meeting showed that Xi Jinping and Joe Biden are really ready to alleviate the current contradictions between the two countries, exchanged various agreements and thus give hope for the future warming of relations. However, this lull in confrontation will be temporary, and as soon as stability in the world normalizes, China and the US will return to prolonged conflicts and contradictions, which are unlikely in a

positive outcome, but the US struggle to suppress China's chances of becoming a superpower will continue.

References

1. USA locked themselves in an isolated dark room // Russian.china.org.cn 2018-04-23 URL: http://russian.china.org.cn/exclusive/txt/2018-04/23/content_50954435.htm

2. Where Does China Stand on the Libya Conflict? // The Diplomat. 2019-06-18. URL: https://thediplomat.com/2019/06/where-does-china-stand-on-the-libya-conflict/

3. Lemke, Douglas, (2002). Regions of War and Peace. Cambridge University Press (January 21, 2002)

4. U.S.-China Competition Will Intensify, but War Can Be Avoided // Fairbank Center for Chinese Studies. 2023-05-17. URL: https://fairbank.fas.harvard.edu/research/blog/u-s-china-competition-will-intensify-but-war-can-be-avoided/

5. How Much Trade Transits the South China Sea? // ChinaPower. URL: https://chinapower.csis.org/much-trade-transits-south-china-sea/

6. South China Sea // U.S. Energy Information Administration. 2013.

7. Increased US activity in South China Sea raises risk of conflict, Chinese researchers warn // South China Morning Post (SCMP). 2022-03-27. URL: https://www.scmp.com/news/china/diplomacy/article/3171975/increased-us-activity-south-china-sea-raises-risk-conflict?campaign=3171975&module=perpetual_scroll_0&pgtype=article

8. Beijing rejects tribunal's ruling in South China Sea case // The Guardian. 2016-07-12. URL: https://www.theguardian.com/world/2016/jul/12/philippines-wins-south-china-sea-case-against-china

9. 2023 Military Strength Ranking // Global Firepower Index. URL: https://www.globalfirepower.com/countries-listing.php

10. US declares 'most' of China's maritime claims in South China Sea illegal // CNN. 2020-07-14. URL: https://edition.cnn.com/2020/07/13/politics/south-china-sea-pompeo-announcement/index.html

11. U.S. should stop trying to suppress China, says Wang Yi // Reuters. 2022-11-01. URL: https://www.reuters.com/world/china/china-tells-us-stop-containment-suppression-against-it-2022-10-31/

12. Predictability triumphed in San Francisco - US and Chinese leaders discussed problems in bilateral relations // 2023-11-16. URL: https://www.rbc.ru/newspaper/2023/11/17/6555def99a794775dc163dbd

DOI 10.34660/INF.2023.54.54.041

奥農河上游左岸瞪羚（Procapra gutturosa）定居群體的形成與適應方式（俄羅斯聯邦外貝加爾地區基林斯基區）

WAYS OF FORMATION AND ADAPTATION OF THE SEDENTARY GROUP OF GAZELLE (PROCAPRA GUTTUROSA) ON THE LEFT BANK OF THE UPPER REACHES OF THE ONON RIVER (KYRINSKY DISTRICT, TRANS-BAIKAL TERRITORY, RUSSIAN FEDERATION)

Malkov Evgeniy Eduardovich
Candidate of Biological Sciences, Researcher
Institute of Natural Resources, Ecology and Cryology, S
iberian Branch of the Russian Academy of Sciences, Chita, Russia
Alkhanay National Park,
Duldurga, Russia

註：本文對東外貝加爾南部奧農河上游左岸定居群體的形成和適應方式進行了分析。 自2010年起，這裡就形成了定居群體。今年冬季遷徙期間，一群瞪羚沿著遷徙通道越過埃爾曼山脊，定居在其左岸的奧農河谷。

關鍵字：原羚（Procapra gutturosa），額爾曼嶺，遷徙通道，斡南河上游，定居群。

Annotation.*The article provides an analysis of the ways of formation and adaptation of the sedentary group on the left bank of the upper reaches of the river Onon of the south of Eastern Transbaikalia. A sedentary group has been formed in this place since 2010. This year, during the period of winter migrations, a herd of gazelle crossed the Erman ridge along the migration channel and then settled in the Onon River valley, on its left bank.*

Keywords: *Mongolian gazelle (Procapra gutturosa), Erman ridge, migration channel, upper reaches of the river Onon, sedentary group.*

The description of the ways of forming a sedentary group of gazelle on the territory of the Russian Federation is relevant. The Mongolian gazelle is listed in the Red Book of Russia [1] with rarity status 1 (endangered), endangered status - U (endangered), conservation status - I (requiring immediate adoption of comprehensive measures, including the development and implementation of a conservation strategy and action plan). In addition, Mongolian gazelle is included in the Red Books of the Altai Republics [2], Buryatia [3] and Trans-Baikal Territory [4].

Also, in pursuance of the Federal project "Preservation of biological diversity and development of ecological tourism" of the national project "Ecology", the gazelle is classified as a priority species requiring priority measures for restoration and reintroduction.

The material was collected using the example of a population of gazelle that lives in the valley of the river. Uldzi (Uldz-Gol) of the Eastern aimag of Mongolia. Some eastern tributaries of the Uldza flow from the Erman Ridge (which itself crosses the state border) and serve as migration channels for gazelle to the southern regions of Eastern Transbaikalia.

For field research, data from the results of pedestrian and automobile route surveys were used. Observations were carried out during the migration period from the beginning of the migration, during its duration and until its completion. Automobile routes were laid out along the habitats of the gazelle and its migrations, both on the Russian side and, if possible, on the Mongolian side. Observational data for the period 2000-2020 was analyzed.

Mongolian gazelle migrating from Mongolia to the territory of the south of Eastern Transbaikalia belong to the North Kerulen group of Mongolian gazelle, which lives southeast of the Torey Lakes, in the steppes of Kerulen and Uldza (Uldz-gol) of the Eastern aimak of Mongolia. Facts of Mongolian gazelle crossing the Erman ridge and entering the upper reaches of the Onon are known since the time of the expeditions of P.S. Pallas [5, 6].

Migration of the gazelle to the upper reaches of the Onon, to the territory of the Kyrinsky district of the Trans-Baikal Territory, where a sedentary group of gazelle currently lives, until the early 2000s were sporadic. However, since the beginning of the 2000s mass movements of Mongolian gazelle into this area began to be observed (Table 1) [7-9].

Table 1

Dynamics of gazelle migrations in winter (December-February) to the Kyrinsky district through the migration channel on the Erman ridge

Years, winter period	Number of gazelle, individuals
2000-2001	500
2001-2002	0
2002-2003	200
2003-2004	0
2004-2005	0
2005-2006	0
2006-2007	0
2007-2008	0
2008-2009	15000

2009-2010	10000
2010-2011	0
2011-2012	0
2012-2013	30000
2013-2014	0
2014-2015	0
2015-2016	50000
2016-2017	1000
2017-2018	2000
2018-2019	0
2019-2020	50000
2020-2021	12000
2021-2022	3500
2022-2023	7000

The routes of all these migrations are marked through the Erman ridge from the Uldz-Gol valley to the Onon valley in the same place. This is a permanent migration channel and it begins where the steppe protrudes most deeply into the ridge from the Uldz-Gol side (Fig. 1.), providing the shortest path between these valleys. This area is located between the valleys of the Duchin-Gol and Turgen-Gol rivers with all their tributaries; in the vicinity of the villages of Turgen and Mikhailo-Pavlovsk, Kyrinsky district, Trans-Baikal Territory. From here onwards, the migratory path of the gazelle to Onon runs along the valleys of the Mangutka and Kurtsa rivers, sometimes using the slopes of the ridges between them for crossings.

Picture 1. *Migration corridor of the Mongolian gazelle through the Erman ridge to the valley of the upper Onon River*

The reason for the massive movements of gazelle lies in changes in climatic conditions in this region, which especially affected the steppe Dauria. Changes in the hydrological regime led to the fact that the period 1992-2017 was recorded as dry. It is characterized by an increase in average annual air temperature and a decrease in the level of summer precipitation [10]. At the same time, in the winter months (November-February), in contrast to the previous period, heavy snowfalls became more frequent (Fig. 2.).

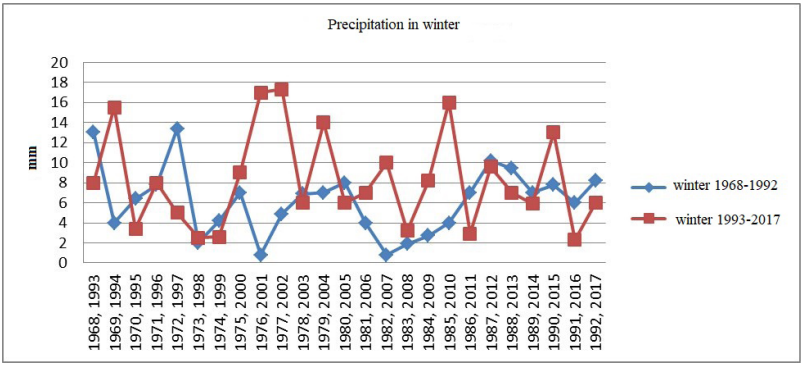


Figure 2. *Comparative indicators for precipitation in the winter months (mm) for two periods*

The increase in snow cover on the winter pastures of the gazelle pushed him to search for accessible pastures. Many gregarious ungulates find such pastures in the foothills, on the slope steppe, where snow disappears faster under the influence of wind and solar radiation [11, 12].

In this case, the natural geographical conditions of the Erman Ridge served as the basis for the functioning of a permanent migration corridor of the gazelle here.

The feeding grounds of the ridge (extent, forbs, etc.) allow the gazelle to feed itself throughout the winter, until the snow completely disappears. The mountain pastures of the Erman ridge are located in close proximity to the river valley. Uldzy and are connected by it geographically, which allows the gazelle to return the other way. The steepness of the slopes is up to 40-50°, the direction of mountain folds is from NW to SE or from W to E, coinciding with the usual direction of winds, and also promoting rapid thawing; Deposits and vegetation of the mountain steppe, practically not used by agriculture, have the properties of rich and accessible feeding grounds for the gazelle.

In 2010, during the next winter migration, several herds of gazelle crossed this corridor, and under pressure from subsequent herds, descended into the valley of the river. Onon and crossed to its left bank. Being a natural border, Onon, 30-50 m wide in the

spring, did not allow the gazelle herd to cross it in the opposite direction. As a result, a group of gazelle, numbering about 200 individuals, established itself on the left bank of the Onon [8]. Subsequently, it was fueled by migrants in the winter and calving in the summer. In 2022-2023 its number was already over 4000 heads.

The flora and vegetation of the Onon valley and surrounding ridges (Onon Dauria), where the sedentary group lives, are unique and diverse. Threaded steppes and harganatniks (thickets of Siberian apricot, spirea and elm) are typical here. Turf grasses are not as numerous as perennial forbs, represented by Dauro-Mongolian and South Siberian-Mongolian plant species. Steppe communities are widely represented by polydominant forb prairie steppes [13-15].

In these living conditions, taking into account the influence of livestock farming in the area, the gazelle group over time has developed behavioral adaptations to permanent residence here. For example, the behavior of the gazelle at the sight of potential danger began to resemble the behavior of the Siberian roe deer, when individuals in a small herd hide in the nearest ravine, and do not run ahead of the vehicle, crossing the direction of movement. Also, the entire group, due to the cramped territory, was divided into separate groups that live in various gullies and valleys. Pastures often change, moving, for example, from active hayfields to abandoned ones or from snow-covered to thawing or less snow-covered. They try to avoid the proximity of farms (because of dogs); graze with livestock in remote areas. In case of calving or potential danger, the group actively uses the so-called “migration pocket” between the Kyra and Onon rivers, which is located on Mongolian territory and is directly connected with permanent habitats in the Kyrinsky region. In winter, the group is constantly fed by migrants, i.e. maintaining contact with the main group, and thus behaves like a small population. The very change from lowland pastures to mountain ones, in an extreme situation, and further adaptation of the species to new conditions characterizes its successful adaptive abilities, allowing the species to survive.

In the formation of a sedentary group of gazelle on the left bank of the Onon River in its upper reaches in the south of Eastern Transbaikalia, the natural physical and geographical conditions of gazelle habitat in the vicinity of the Erman Ridge played a huge role; the presence of a natural permanent migration channel that connects the main population with a sedentary group; pasture and forage properties of the channel and new habitat, ensuring the vital activity of the gazelle during migration and permanent residence, as well as the adaptive abilities of the gazelle.

References

1.Red Book of the Russian Federation, volume “Animals”. 2nd edition. M.: FSBI “VNII Ecology”, 2021. - 1128 p.

2. Red Book of the Altai Territory. Rare and endangered animal species. Volume 2. – Barnaul: JSC "IPP "Altai", 2006. – 211 p.

3. Red Book of the Republic of Buryatia: Rare and endangered species of animals, plants and fungi. — Ed. Z-e, reworked. and additional / answer ed. N.M. Pronin. - Ulan-Ude: Publishing house BSC SB RAS, 2013. - 688 p.: ill.

4. Red Book of the Trans-Baikal Territory. Animals. Novosibirsk: LLC Novosibirsk Publishing House, 2012. – 344 p.

5. Kirilyuk V.E. First results and prospects for the restoration of the Mongolian gazelle (Procapra gutturosa) in Russia. – Chita: Express Publishing House, 2007. – 36 p.

6. Kirilyuk, V.E., Lushchekina, A.A. Current status of gazelle (Procapra gutturosa: Bovidae) in Russia // Nature Conservation Research. Reserve Science, 2017. Vol. 2 (Suppl. 1). pp. 81–99.

7. Website of the Sokhondinsky Nature Reserve. URL:http://www.Sokhondinsky State Natural Biosphere Reserve (sokhondo.ru)(access date: 11/28/2023).

8. Belov I.N. Migration of the Mongolian gazelle in the Khentei-Chikoy highlands at the beginning of the 21st century // Flora and fauna of a transboundary specially protected area. Proceedings of the Sokhondinsky Nature Reserve. - Chita: Express Publishing House, 2012. - Vol. 5. - pp. 44-48.

9. Malkov E.E., Bayarmagnay Ts., Aldarmaa B. Assessment of the status of rare animal species in the transboundary territory "Sources of the Amur" based on the results of joint activities // Study and conservation of biodiversity of Southern Siberia and Central Asia in transboundary territories. Collective monograph. Edited by V.V. Rozhnova. M.: Partnership of Scientific Publications. KMK, 2018. pp. 67-83.

10. Report on research work on the topic: Hydrology of land waters as a factor in the evolution of biogeochemical systems (intermediate). Priority direction of fundamental and exploratory scientific research: 1.5.11. Water resources, land hydrology. Chita: IPREK, 2022.

11. Danilkin A.A. Bovids. Series "Mammals of Russia and adjacent regions". Partnership of Scientific Publishing Houses KMK, 2005. – 552 pp.

12. Kazmin V.D. Ecological and biological foundations for managing the population density of ungulates in various natural zones. Abstract of the dissertation for the degree of Doctor of Biological Sciences. Pos. Orlovsky, Rostov region. – 2016. – 42 p.

13. Galanin A.V., Belikovich A.V. New types of vegetation of Dauria // Plants in the monsoon climate. Vladivostok: BSI FEB RAS, 2003. pp. 37-45.

14. Belikovich A.V., Galanin A.V. Transbaikal harganate as a type of vegetation // Komarovskie readings. Vladivostok: Dalnauka, 2005. Vol. 52. pp. 98-126.

15. Golovina E.O. Threaded steppes of the western part of the Onon Dauria // Botan. magazine 2009. T. 94. No. 2. P. 244-266.

DOI 10.34660/INF.2023.47.60.042

低濃度對氨基苯甲酸（PABA）對魚類胚胎發育過程中存活的影響
THE INFLUENCE OF LOW CONCENTRATIONS OF PARA-AMINOBENZOIC ACID (PABA) ON THE SURVIVAL OF FISH DURING EMBRYOGENESIS

Kotov Ilya Alekseevich
Assistant
Pak Irina Vladimirovna
Doctor of Biological Sciences, Head of Department
Torgasheva Ekaterina Viktorovna
Student
Tyumen State University

抽象的。 這項工作的目的是研究低濃度對氨基苯甲酸對魚類個體發育不同階段生存的影響：原腸胚階段、器官發生階段和幼蟲孵化階段。 研究表明，0.0001%至0.0008%的劑量範圍內的PABA可使鯉魚、帶皮魚、白鮭、小貂等不同魚類的存活率顯著提高，與對照組相比提高1.08-1.68倍。 值得注意的是，刺激魚類胚胎和幼體存活的效果是穩定的，並且無論工業繁殖過程中的孵化條件如何，都會表現出來。

關鍵字：對氨基苯甲酸 (PABA)、白魚、鯉魚、帶皮魚、小公魚、胚胎、幼體。

Abstract. *The purpose of the work is to study the effect of low concentrations of para-aminobenzoic acid on the survival of fish at different stages of ontogenesis: at the stages of gastrula, organogenesis and hatching of larvae. It has been shown that PABA in the dose range from 0.0001% to 0.0008% causes a significant increase in the survival rate of different fish species: carp, peled, whitefish, sterlet by 1.08-1.68 times compared to the control. It was noted that the effect of stimulating the survival of fish embryos and prelarvae is stable and manifests itself regardless of incubation conditions during industrial reproduction.*

Keywords: *para-aminobenzoic acid (PABA), whitefish, carp, peled, sterlet, embryos, prelarvae.*

The problem of increasing aquaculture productivity is one of the most difficult in the artificial reproduction of fish. Industrial breeding of valuable fish species in fish hatcheries, in installations of closed water use (ICWU), in farms on cooling ponds of state district power plants is associated with a sharp change in

the living conditions of fish. Temperature instability, water chemistry, frequent transplants and artificial feed create stressful conditions for fish. These conditions have a particularly strong negative effect on fish during embryogenesis. Various approaches are being developed to improve the viability of fish: the possibility of using genomics, proteomics and transcriptomics in increasing the efficiency of aquaculture (Abdelrahman et al., 2017), the use of epigenetic factors is attracting great attention (Gavery, Roberts, 2017; Granada et al., 2018). Along with these approaches, non-hereditary methods of increasing the most important characteristics of aquaculture: productivity and stability of fish through phenotypic activation using genetically active substances (reparagens), for example, PABA, can also be highly effective. Previously, the effectiveness of using PABA to increase survival and productivity was shown in other animal species: chickens, rats, whitefish (Shangin-Berezovsky et al., 1983; Tsoi, Sergienko, 1992; Goodwin et al., 2018).

The purpose of this study was to assess the effect of PABA on the survival of embryos and larvae of four fish species: carp, peled, broad whitefish and sterlet.

Materials and research methods

The studies were carried out in 2019-2023. at fish hatchery enterprises in the city of Tyumen, the Tyumen region (Tyumen fish hatchery, aquafarm "Fish Farm"; Tobolsk fish hatchery) and in the city of Surgut (KhMAD) (warm water farm at State District Power Plant 1).

The object of the study was 4 species of fish at the early stages of embryogenesis (gastrula, early organogenesis) and during the hatching of prelarvae: whitefish (Coregonus nasus (Pallas), peled Coregonus peled (Pallas), carp Cyprinus carpio L. and sterlet Acipenser ruthenus.

After fertilization, eggs were treated with PABA solutions in the following concentrations: carp – 0.0008%; other types – 0.0001%. PABA solutions were prepared in warm (70ºC) physiological solution. The duration of exposure was 2 hours. The control was caviar that was not exposed to PABA. Processing of eggs with PABA coincided with the degumming process. After processing, the eggs were incubated in Weiss apparatus. Counting of developing embryos at the gastrula and organogenesis stages was carried out using a binocular magnification at a magnification of 20 times (obv. 2 x approx. 10). At hatching, the number of prelarvae was counted in the control and experimental variants. The experiments were carried out in five repetitions. Statistical data processing was carried out using the Statistica application package.

Results and discussion

We studied the effect of low doses of PABA on the survival of fish in the early stages of ontogenesis in different years from 2019 to 2023. on different fish species: common broad (*Coregonus nasus (Pallas*), peled *Coregonus peled (Pallas*) and carp *Cyprinus carpio L.* Data on three species were previously published (Pak, Sergienko, Trofimov et al, 2020; Pak, Kotov, Artemenko, 2021), data on sterlet are presented for the first time.

Generalization of data on assessing the effect of PABA on the survival of fish at different stages of embryonic development and during hatching of larvae made it possible to evaluate the stimulating effect of low doses of this reparagen. Whitefish and peled differ significantly from carp in the characteristics of their reproduction, which occurs at low temperatures (October-November in the Khanty-Mansi Autonomous District). Carp is a heat-loving species that breeds in May in the south of the Tyumen region. However, despite the differences, in these three species, small doses of PABA cause the same effect: they increase the survival of fish in the early stages of development. The same stimulating effect was noted in our studies on sterlet (Table 1). Sterlet is an object that is very sensitive and demanding regarding the conditions of incubation of eggs, therefore it is difficult to breed it in industrial conditions, in installations of closed water use (ICWU). However, the use of PABA can significantly increase the survival of embryos during embryogenesis and the yield of prelarvae upon hatching under these conditions.

Aggregate data on different fish species allowed us to conclude that the stimulating effect of PABA is universal. On carp, when testing in contrasting conditions: in the north, the city of Surgut, a farm at the cooling pond of State District Power Plant 1 and in the south of the Tyumen region, in the Tyumen fish hatchery, the stimulating effect of PABA was clearly manifested at the stage of prelarval emergence. When eggs were exposed to PABA at a concentration of 0.0008%, the percentage of developing embryos at the stage of organogenesis in the Surgut farm increased by 1.35 times compared to the control. Carp eggs obtained from females kept in cages in the cooling pond of the Surgut State District Power Plant were not of high quality, but the use of PABA significantly increased the number of developing embryos at the stage of organogenesis in the experimental version compared to the control (Table 1). As studies conducted at the Surgut farm and the Tyumen fish hatchery have shown, the yield of prelarvae when treating eggs with PABA was significantly higher in comparison with the control. It should be noted that the stimulating effect of PABA was evident on low-quality caviar. On a warm-water farm, when carp are kept in the water of a cooling pond, the eggs obtained from females are not of good quality, as evidenced by the low percentage of developing eggs at the stage of organogenesis (68.4%) and the percentage of prelarvae emerging (46.2%) in the control option (Table 1). In the Tyumen fish hatchery, low-quality caviar received from producers in the last incubation production round was used to conduct experiments with PABA.

When peled and whitefish eggs were treated with PABA, a significant increase in the yield of prelarvae from fertilized eggs laid for incubation was observed in comparison with the control (Table 1). Table 1 shows the result obtained when caviar was treated with PABA at a concentration of 0.0001%. This dose demonstrated the maximum stimulating effect, however, the range of effective doses of PABA was wider in whitefish: from 0.005% to 0.00001%, and in peled - from 0.001% to

0.00001% (Pak, Sergienko, Trofimov et al, 2020). The use of a 0.0001% PABA solution causes a significant increase in the yield of prelarvae in peled - 1.33 times more than in the control. In whitefish, the same concentration of PABA causes an increase in the survival of embryos at the stage of organogenesis by 3.7% (1.04 times) and the yield of prelarvae by 14.5% (1.30 times) compared to the control.

Table 1

The effect of processing eggs of different fish species on the viability of embryos

Species	Experience Option	Eggs used, thousand pieces.	% of developing embryos at the stage of organogenesis	Prelarvae obtained	
				thousand pieces.	% of developing eggs
Carp *Cyprinus carpio L.* (Surgut farm)	0.0008% PABA	0,600	92,6±2,28*	0,467	77,8±2,88*
	Control	0,600	68,4±2,16	0,277	46,2±4,14
Carp *Cyprinus carpio L.* (Tyumen fish hatchery)	0.0008% PABA	0,600	97,3±1,77	0,522	87,0±1,37*
	Control	0,600	95,5±1,99	0,483	80,5±1,61
Peled	0.0008% PABA	12,56	92,9±1,05	10,55	90,4±0,20*
	Control	25,76	91,9±1,11	16,30	68,2±0,25
Cheer	0.0008% PABA	18,44	96,1±0,79*	11,24	63,4±0,32*
	Control	23,40	92,4±1,08	10,58	48,9±0,34
Sterlet	0.0008% PABA	1,00	55,40±1,10 (гаструла)	0,542	97,83±0,44*
	Control	1,00	55,00±1,11	0,413	75,09±0,15

Note: *differences with control are statistically significant ($p \leq 0.01$)

Obviously, the smaller stimulating effect of PABA in broad whitefish is associated with the genetic instability of this species in comparison with peled (Pak, 2004). It is known that PABA increases the volume of enzymatic repair (Rappoport, 1989), which obviously underlies the stimulating effect even in a species with a high level of chromosomal mutability.

In our studies conducted on sterlet, PABA at a concentration of 0.0001% also turned out to be effective. When eggs were treated with PABA, the percentage of prelarvae released increased by 1.30 times compared to the control (Table 1).

Conclusion

Thus, studies conducted on different fish species: carp, peled, common fish and sterlet have demonstrated the positive effect of PABA on the viability of embryos and prelarvae. An increase in the survival rate of embryos and prelarvae was shown when fertilized eggs were treated with PABA in low concentrations (0.0001% and 0.0008%). Regardless of the species and incubation conditions, PABA in low concentrations showed a stable effect of increasing the survival rate

of fish during periods of embryonic development (at the gastrula and organogenesis stages) and at the hatching stage of prelarvae. This indicates the universality of the stimulating effect of low concentrations of PABA.

References

1. Rappoport I.A. Action of PABA in connection with genetic structure. Chemical mutagens and para-aminobenzoic acid in increasing the yield of agricultural plants. M.: Science. 1989. pp. 3-37.

2. Pak I.V. Cytogenetic approach to assessing the stability of development of natural whitefish populations // Ontogenesis. 2004. V. 35. No. 1. P. 37-40.

3. Shangin-Berezovsky G.N., Moloskin S.A., Rykhletskaya O.S., Adamov V.Ya. Comparative study of the effects of NDMM and PABA in experiments to stimulate the development of chickens // Chemical mutagenesis and the quality of agricultural products. M.: Science. 1983. pp. 252-257.

4. Tsoi R.M., Sergienko L.L. 1992. The effectiveness of the use of para-aminobenzoic acid in the reproduction of cold-water fish of the genus Coregonus // Issues of ichthyology. 1992. V. 32(1). pp. 186-190.

5. Abdelrahman H., ElHady V., Alcivar-Warren A. et al. Aquaculture genomics, genetics and breeding in the United States: current status, challenges, and priorities for future research// BMC Genomics. 2017. V.18:191 P. 2-23. DOI 10.1186/s12864-017-3557-1.

6. Gavery M.R. , Roberts S.B. 2017. Epigenetic considerations in aquaculture// PeerJ. 2017. 2017. V.12, Article number e4147. PubMed 29230373

7. Granada L., Lemos M.F. L., Cabral H.N., Bossier P., Novais S.C. Epigenetics in aquculture - the last frontier// Reviews in Aquaculture. 2018. V.10 (4). P. 994-1013. DOI: 10.1111/raq.12219

8. Goodwin P.H., Trueman C., Loewen S.A., Tazhoor R. Variation in the responsiveness of induced resistance against Pseudomonas syringae pv. tomato by Solanum lycopersicum treated with para-aminobenzoic acid// Physiological and Molecular Plant Pathology. 2018. V. 104. P. 31-39. DOI: 10.1016/j. pmpp.2018.08.007.

9. Pak I.V., Sergienko L.L., Trofimov O.V., Artemenko S.V., Kotov I.A. Low concentrations of para-aminobenzoic acid increase the viability of fish in early stages of ontogenesis under different environmental conditions. Aquaculture. 2020; T. 519, p. 734-738. DOI: 10.1016/j.aquaculture.2019.734758.

10. Pak I. V., Kotov I. A., Artemenko S. V., Trofimov O. V. Increasing the productivity of Cyprinus carpio L. carp in the context of warm-water nurseries using PABA (para-aminobenzoic acid). Basic Clin. Pharmacol. Toxicol. 2021. 128 (Suppl.2). 0106. P.5 URL: https://onlinelibrary.wiley.com/toc/17427843/2021/128/S2

DOI 10.34660/INF.2023.33.89.043

7.1~18歲急性腎衰竭脈搏血壓晝夜節律
CIRCADIAN RHYTHM OF PULSE BLOOD PRESSURE IN ACUTE RENAL FAILURE AT THE AGE OF 7.1-18 YEARS

Muhitdinova Hura Nuritdinovna
Doctor of Medical Sciences, Full Professor
Center for the Development of Professional Qualifications of Medical Workers

Hamrayeva Gulchehra Shahobovna
Doctor of Medical Sciences, Head of Department
Center for the Development of Professional Qualifications of Medical Workers

Alauatdinova Gulhan Inyatdinovna
Assistant
Center for the Development of Professional Qualifications of Medical Workers

抽象的。 根據 20 名急性腎衰竭兒童血流動力學參數監測數據的研究，得出以下結論。 在第 1 組和第 2 組患者的整個觀察過程中，注意到 PAP 晝夜節律中位數指標有增加的趨勢。第 3 組中 PAP 晝夜節律中位數指標相對接近正常波動（結果不良） ）在患者全身狀況較嚴重的情況下，更有可能是心臟衰竭的徵兆。在第1 組中檢測到PAP 晝夜節律倒置2 天，在第2 組中檢測到5 天，在第3 組中檢測到11 天，這證實了第3 組中PBP 晝夜節律紊亂的最明顯的應激性質。

關鍵字：晝夜節律，脈壓，急性腎衰竭，兒童。

Abstract. *Based on a study of data from monitoring hemodynamic parameters in 20 children with acute renal failure, the following was revealed. A tendency towards an increase in the mesor indicator of the circadian rhythm of PAP was noted throughout the observation in patients of groups 1 and 2. Relatively closer to normal fluctuations in the mesor indicator of the circadian rhythm PAP in group 3 (with an unfavorable outcome) in conditions of a more severe general condition of the patients were more likely a sign of heart failure. An inversion of the circadian rhythm of PAP was detected for 2 days in group 1, 5 days in group 2, and 11 days in group 3, which confirmed the most pronounced stressful nature of the disturbance in the circadian rhythm of PBP in group 3.*

Keywords: *circadian rhythm, pulse pressure, acute renal failure, children.*

Relevance. An increase in blood pressure that occurs against the background of pathologies of the heart, kidneys or disorders of the endocrine system, as a result of damage to the heart and disorders of the nervous system, is usually called secondary hypertension. One of the simplest and most accessible markers of vascular damage in arterial hypertension and an increase in their stiffness is increased pulse arterial pressure (PAP). The dependence of the PAP indicator on age, height and body mass index is shown. A connection has been established between high blood pressure in overweight children and signs of vascular wall remodeling. To date, an extensive evidence base has been accumulated regarding the ability of changes in PBP to cause disturbances in the central nervous system, lead to damage and death of neurons, and thereby contribute to the onset and progression of cognitive impairment. Excessive PAP causes disruption of the integrity of the blood-brain barrier, can intensify the production of reactive oxygen species in the central nervous system, lead to endothelial dysfunction, microhemorrhages, and directly stimulate the formation of β-amyloid, the substrate of Alzheimer's disease and dementia associated with it. Due to the important role of elevated PAP in impaired cognitive functioning, an important aspect of the effects of antihypertensive drugs is their effect on PAP and the ability to reduce it, since this may reduce the risk of the onset and worsening of existing cognitive impairment. Therefore, among antihypertensive drugs, according to the authors, the fixed combination of amlodipine/indapamidretard deserves special attention, since it has an evidence base for its powerful potential in reducing PAP in patients with arterial hypertension, which, in turn, can help improve their quality of life. Children often suffer from similar pathologies, as a result of which they experience both abrupt and constant increases in blood pressure. However, in the literature there is insufficient information on the characteristics of the pulse arterial pressure (PAP) response during the anuric phase of acute renal failure in children aged 7.1 to 18 years [1-4].

Goal of the work. To study and give a comparative assessment of the response of the circadian rhythm of pulse blood pressure in acute renal failure at school age.

Material and research methods. Data from hourly monitoring of body temperature were studied in 20 children aged 7.1 to 18 years with acute renal failure who were admitted to the ICU of the Russian Research Center for Emergency Medicine with anuria. Before admission to the clinic, all patients received therapy aimed at treating pneumonia, acute glomerulonephritis, acute intestinal infection, and MODS. Due to severe progressive respiratory failure, patients received invasive mechanical respiratory support (MRS) on the first day as indicated. All patients underwent hemodialysis under the control of hemodynamics, acid-base balance, respiratory system, supportive, antibacterial, anti-inflammatory, syndromic corrective intensive therapy in accordance with existing protocols and recommendations in the literature. A favorable outcome with restoration of full functional activity of the kidneys and discharge from the hospital was observed in 12 children

(groups 1 and 2), an unfavorable outcome – in 7 children (group 3). The first group consisted of patients who received intensive therapy in an ICU for up to 10 days (6 patients), the second group included children with a favorable outcome after intensive therapy for 11–45 days (7 patients), the third group included 7 patients with an unfavorable outcome. The results of the identified changes in the components of the circadian rhythm were carried out by deducing mesor indicators - the average daily level of the studied indicator, the amplitude of circadian fluctuations, the range of daily fluctuations, indicators of acrophase and bathyphase of the circadian rhythm, the duration of the inversion of the circadian rhythm of the studied hemodynamic parameters. The research data were processed by the method of variation statistics using the Excel program by calculating arithmetic means (M) and errors of means (m). To assess the significance of differences between two values, the parametric Student's test (t) was used. The relationship between the dynamics of the studied indicators was determined by the method of paired correlations. The critical significance level was taken equal to 0.05.

Table 1.

Characteristics of clinical material, % of the total number of patients

Diagnosis	1 group	2 group	3 group	boys	girls	Total
glomerulonephritis	6 % (3)	20% (4)		15% (3)	20% (4)	30% (6)
Gl-nt+pneumonia	5% (1)	5% (1)		5% (1)	5% (1)	10% (2)
Gl-nt+SPON	5% (1)	10% (2)	10% (2)	10% (2)	15% (3)	25% (5)
Gl-nt+GUS	5% (1)				5% (1)	5% (1)
Gl-nt+AII+pneumonia			5% (1)	5% (1)		5% (1)
Gl-nt+ONMChemor.			10% (2)	5% (1)	5% (1)	10% (2)
Pneumonia+DCMP			5% (1)		5% (1)	5% (1)
Systenmlupus			5% (1)		5% (1)	5% (1)
Total	30% (6)	35% (7)	35% (7)	40% (8)	60% (11)	100% (20)

In groups 1 and 2, patients with acute glomerulonephritis predominated, amounting to 30% (6), glomerulonephritis with acute pneumonia - 10% (2), glomerulonephritis complicated by MODS in the compensated stage - 15% (3), and GUS - 5% (1). The main disease complicated by acute renal failure in children of group 1 in 100% (5) was the renal form of acute glomerulonephritis, complicated by acute pneumonia in 20%, compensated stage MODS in 20%, and GUS in 20% of cases. In group 2, one of the leading causes of acute renal failure was acute glomerulonephritis in 57% (4), in 14% it was combined with acute pneumonia (1), in 29% (2) children acute renal failure developed against the background of grade 2-3 MODS. It was not always possible to determine the primary focus of the inflammatory reaction of infectious or viral etiology, as well as the sequence

of development of decompensation of organ function in children admitted to the clinic in serious condition. No significant differences were found by gender (Table 1). An unfavorable outcome was observed in 28% (2) of children with glomerulonephritis complicated by grade 3 MODS, hemorrhagic stroke - 28% (2), AII - 14%, severe pneumonia with newly diagnosed dilated cardiomyopathy - 15% (1), systemic lupus erythematosus - 15% (1).

Table 2.

Dynamics of mesor PAP

Days	1 group	2 group	3 group
1	45,7±3,7	47,1±3,1	40,1±3,2
2	44,5±4,0	45,8±2,8	42,5±2,4
3	45,6±3,1	45,0±2,0	44,3±3,4
4	43,2±2,5	46,3±3,5	47,4±3,1
5	44,6±2,7	45,6±3,2	46,3±4,4
6	40,4±3,9	44,2±3,5	40,5±3,0
7	45,0±3,6	44,4±3,2	43,4±3,2
8	48,0±2,1	46,5±2,0	43,8±5,0
9	43,0±2,3	46,4±1,9	42,5±3,0
10	41,3±4,4	47,0±2,4	40,6±3,1
11		47,2±2,0	42,4±3,4
12		46,0±2,7	45,7±4,1
13		44,8±2,1	43,2±4,0
14		44,3±3,5	43,0±6,1
15		43,5±2,2	43,8±4,6
16		44,4±4,9	40,1±4,5
17		41,8±2,3	37,5±2,2
18		45,3±3,1	40,0±5,1
19		45,6±2,9	42,1±5,9
20		42,5±3,0	40,5±3,1
21		43,1±3,5	41,6±3,8
22		42,8±3,8	44,3±7,1
23		46,8±4,9	44,8±8,1
24		44,3±3,2	40,8±5,5
25		43,3±2,7	40,8±4,0
26		43,7±2,6	41,3±7,9
27		41,8±3,2	37,2±6,4
28		38,9±3,3*	35,6±9,8
29		41,4±4,1	37,7±6,6
30		40,9±3,8	39,4±4,4

Table 3

Average circadian rhythm PAP

Hours	1 group	2 group	3 group
8	43±5	43±4	40±6
9	45±4	44±4	41±5
10	42±4	43±4	41±6
11	43±3	44±4	41±4
12	44±4	45±4	42±4
13	43±5	44±4	44±5
14	44±5	44±3	41±5
15	44±3	44±4	39±6
16	45±3	44±4	42±4
17	43±4	45±3	41±6
18	43±3	44±5	43±6
19	44±3	44±3	41±5
20	46±2	45±2	41±5
21	43±4	44±3	43±6
22	43±4	44±3	40±5
23	45±4	44±3	41±5
24	44±3	45±3	43±5
1	46±2	45±4	42±5
2	47±3	45±3	41±4
3	44±4	45±3	45±5
4	44±5	45±3	44±5
5	45±2	45±3	44±5
6	47±3	45±3	41±7
7	43±5	44±4	41±4

*- the dynamics are reliable relative to the indicator for 1 day

A tendency to increase the mesor index of the circadian rhythm of PAP was noted on day 1 in patients of groups 1 and 2 (Table 2). Monitoring of the studied indicator during intensive therapy made it possible to detect a decrease in PAP only on day 28 in children of group 2 by 17% (Fig. 1).

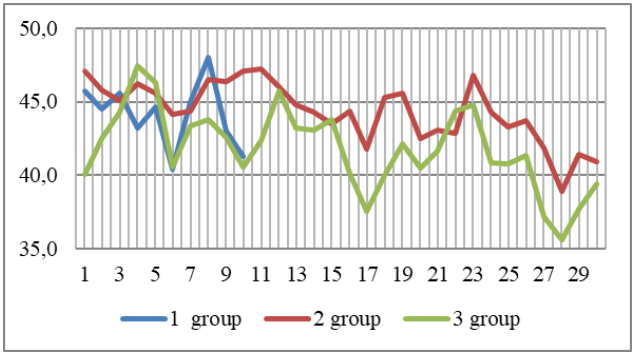


Figure 1. *Dynamics of the mesor of the circadian rhythm PAP, in mm Hg.*

In group 1, the period of the weekly PAP rhythm was 8 days; in group 2, low-amplitude deformed waves formed periods of oscillations with wavelengths of 4,4,6,4,4 days. There was some synchronicity in the fluctuations of the mesor of the circadian rhythm of PAP after the 15th day in children of groups 2 and 3 with a difference in PAP of 3 - 5 mmHg. (Fig. 1).

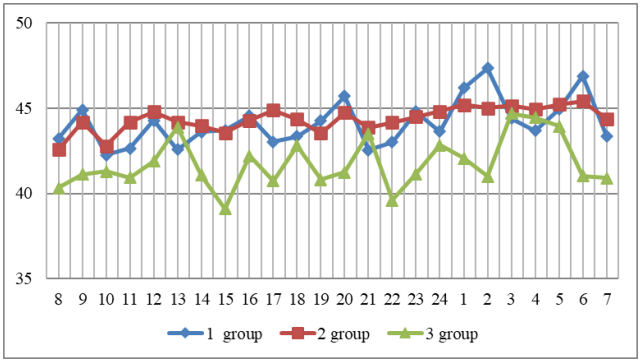


Figure 2. *Average circadian rhythm PAP in mm Hg.*

The average circadian rhythm of PAP in group 1 was characterized by inversion - a shift in the projection of acrophase at 2 am, bathyphase at 9 am (Fig. 2). The studied indicator in group 2 presented a low-amplitude wave-like curve with a slight tendency to increase, which apparently indicated a tendency to increase vascular stiffness even with a favorable outcome. Relatively closer to normal fluctuations in the mesor indicator of the circadian rhythm PAP in group 3 in conditions of a more severe general condition of the patients were more likely evidence of a decrease in cardiac output, a sign of heart failure.

It is noteworthy that the hourly values of the average circadian rhythm of PAP in children of group 3 turned out to be less than in groups 1 and 2, with no significant differences in the indicator during the day and night hours (Fig. 2).

Table 4.

Average values of indicators of the phase structure of the circadian rhythm PAP, mm Hg.

Groups	Mezor, mmHg	Amplitude, mm Hg.	Daily fluctuations, mm Hg
1	44±3	8,9±3,7	17,8±5,6
2	44±3	8,9±2,3	15,6±3,9
3	42±5	12,6±4,4	23,5±7,2

As presented in Table 4, a tendency was found to increase the amplitude and daily range of PAP fluctuations in group 3, which corresponds to the most pronounced instability of hemodynamic parameters, which may be one of the pathogenetic mechanisms of negative state dynamics, progressive failure of the regulatory function of the central nervous system, pituitary-adrenal system (Fig. 3,4). One of the known mechanisms for the development of functional failure of organs and systems is an energy deficiency state or mitochondrial failure. In order to restore adaptive capabilities, correct impaired compensatory reactions of central and peripheral hemodynamic parameters, one of the real opportunities to maintain the viability of the body in a terminal state is to maintain the functional activity of the remaining intact cells in a state of reversible ischemia, to support and restore intracellular metabolism with appropriate intensive therapy. The latter is quite widely used in clinical practice for the management of patients in other critical situations and terminal conditions.

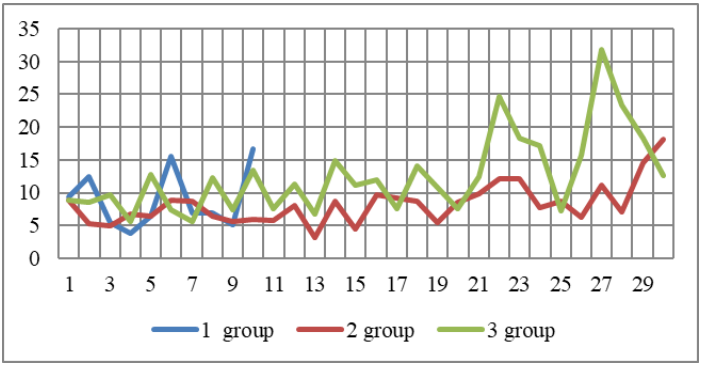


Figure 3. *Dynamics of the amplitude of the circadian rhythm PAP, mm Hg.*

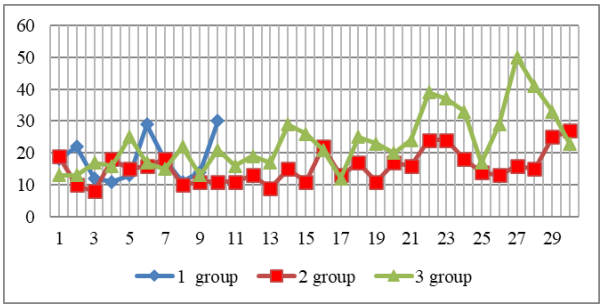


Figure 4. *Daily range of blood pressure fluctuations, mm Hg.*

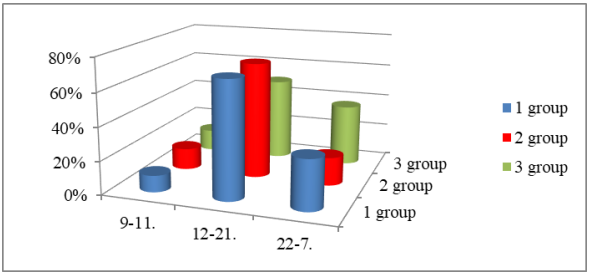


Figure 5. *Duration and severity of acrophase shift in the circadian rhythm of PAP.*

An inversion of the circadian rhythm of PAP was detected for 2 days in group 1, 5 days in group 2, and 11 days in group 3, which confirmed the most pronounced stressful nature of the disturbance in the circadian rhythm of PAP (Fig. 5). The identified feature confirms the assumption of a tendency towards vascular stiffness mainly at night in group 3. In this regard, it is noted that it is advisable to enhance hemodynamic correction by administering vasodilators in the dark.

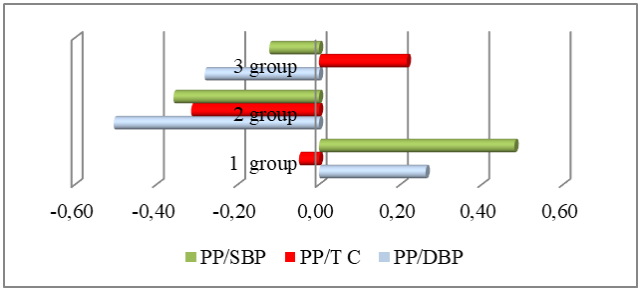


Figure 6. *Correlation connections of the mesor of the circadian rhythm of PAP*

In group 1, the tendency for a direct correlation between the dynamics of PAP and SBP slightly prevailed (0.48), in group 2 there was an inverse correlation between changes in PAP and DBP (-0.55) (Fig. 6).

Conclusion. A tendency towards an increase in the mesor indicator of the circadian rhythm of PAP was noted throughout the observation in patients of groups 1 and 2. Relatively closer to normal fluctuations in the mesor indicator of the circadian rhythm PAP in group 3 in conditions of a more severe general condition of the patients were more likely a sign of heart failure. Inversion of the circadian rhythm of PBP was detected for 2 days in group 1, 5 days in group 2, and 11 days in group 3, which confirmed the most pronounced stressful nature of the disturbance in the circadian rhythm of PAP

References

1. Ostroumova O.D., Kochetkov A.I., Ostroumova T.M. Pulse blood pressure and cognitive impairment. Russian Journal of Cardiology. 2021;26(1):4317. https://doi.org/10.15829/1560-4071-2021-4317

2. https://cyberleninka.ru/article/n/pulsovoe-davlenie-u-zdorovyh-podrostkov/viewer

3. https://meduniver.com/Medical/profilaktika/opn_u_detei.html

4. https://medaboutme.ru/articles/simptomaticheskie_gipertenzii_u_detey_problemy_pochek_serdtsa/

DOI 10.34660/INF.2023.54.55.044

7.1~18歲急性腎衰竭患者平均動脈壓晝夜節律
CIRCADIAN RHYTHM OF MEAN ARTERIAL PRESSURE IN ACUTE RENAL FAILURE AT THE AGE OF 7.1-18 YEARS

Muhitdinova Hura Nuritdinovna
Doctor of Medical Sciences, Full Professor
Center for the Development of Professional Qualifications of Medical Workers

Hamrayeva Gulchehra Shahobovna
Doctor of Medical Sciences, Head of Department
Center for the Development of Professional Qualifications of Medical Workers

Alauatdinova Gulhan Inyatdinovna
Assistant
Center for the Development of Professional Qualifications of Medical Workers

抽象的。 對 20 名 7.1-18 歲急性腎衰竭兒童的平均動脈壓每小時監測數據進行了研究。 第1組和第2組在第1天的MAP晝夜節律或隨後觀察天的動態沒有顯著偏差。經過20天的強化治療，第3組的晝夜節律中位數MAP仍顯著高於第3組2. 在最嚴重的組別中發現了MAP 波動幅度和每日範圍的最大值 3. 在第3 組的兒童中檢測到了最長的MAP 晝夜節律反轉。對平均動脈壓水平的主要影響第1組和第2 組的收縮期射血量在第3 組的兒童中顯著中和。

關鍵字：晝夜節律、血壓、急性腎衰竭、兒童。

Abstract. *Data from hourly monitoring of mean arterial pressure in 20 children with acute renal failure aged 7.1-18 years were studied. There were no significant deviations in the circadian rhythm of MAP on day 1 or in the dynamics on subsequent days of observation in groups 1 and 2. After 20 days of intensive therapy, the circadian rhythm mesor MAP in group 3 remained significantly higher than in group 2. The maximum values of the amplitude and daily range of MAP fluctuations were found in the most severe group 3. The longest inversion of the circadian rhythm of MAP was detected in children of group 3. The predominant effect on the level of mean arterial pressure of systolic ejection in groups 1 and 2 turned out to be significantly neutralized in children of group 3.*

Keywords: *circadian rhythm, blood pressure, acute renal failure, children.*

Relevance. Based on statistics, only half of people are aware of their condition, and even fewer are treated. The main danger of chronic hypertension is damage to target organs (heart, kidneys, retina, brain). Hypertension also significantly increases the risk of cardiovascular events such as stroke and heart attack. As hypertension progresses, symptoms of target organ damage develop - vision deteriorates, urination becomes more frequent, pain in the heart appears, and symptoms of brain hypoxia appear. Often, it is in childhood that conditions that lead to arterial hypertension in adults develop, and one of the many triggering factors for the formation of arterial hypertension in childhood is kidney disease.

Despite the variety of etiological factors of acute renal failure, its pathogenesis consists of the following main links: renal vasoconstriction, causing tissue ischemia; decreased permeability of glomerular capillaries, leading to a drop in glomerular filtration rate (GFR); obstruction of the tubules by cellular debris; transepithelial reverse flow of filtrate into the peritubular space. The hemodynamic factor plays a dominant role in the pathogenesis of the syndrome. There is an opinion that in the oligoanuric stage the hemodynamic factor does not play such an important role, since damage has already occurred and attempts to improve renal blood flow do not produce an increase. In children, the normal dynamics of blood pressure growth over the age of 7 years slows down, SBP stabilizes at 110 - 120 units, diastolic - from 70 to 90, average arterial pressure fluctuates between 83-100 mm Hg. During this period of the child's growing up, blood pressure numbers may change throughout the day. During the day and evening they reach a peak, and by night they fall. From one to five in the morning, normal blood pressure levels are minimal. For the purpose of early diagnosis of parenchymal and renovascular arterial hypertension in children and adolescents, it is advisable to evaluate the results of measuring blood pressure using the Korotkoff method in the upper and lower extremities, daily monitoring of blood pressure (DMBP), blood hormone levels (renin, aldosterone, cortisol), ultrasound of the kidneys in a horizontal and vertical position of the patient with assessment of the volume of the kidneys, excretory urography and Dopplerography of the renal vessels in the horizontal and vertical position of the patient, dynamic renoscintigraphy and dynamic renoscintigraphy induced by Capoten, magnetic resonance imaging or computed tomography of the kidneys.

However, in the literature there is insufficient information on the characteristics of the response of the circadian rhythm of mean arterial pressure (MAP) during the oligoanuria phase in acute renal failure, which developed in children aged 7.1 to 18 years [1-5].

Goal of the work. To study and give a comparative assessment of the response of mean arterial pressure in acute renal failure at school age.

Material and research methods. Data from hourly monitoring of mean arterial pressure were studied in 20 children with acute renal failure who were admitted to the ICU of the Russian Research Center for Emergency Medicine with anuria at the age of 7.1 to 18 years from the ICU of regional children's hospitals and

branches of the Republican Research Center for Emergency Medicine. Patients received invasive mechanical respiratory support on the first day as indicated due to severe progressive respiratory failure. All patients underwent hemodialysis, under the control of hemodynamics, acid-base balance, respiratory system, supportive, antibacterial, anti-inflammatory, syndromic corrective intensive therapy in accordance with existing recommendations in the literature. A favorable outcome with restoration of full functional activity of the kidneys and discharge from the hospital was observed in 13 children (groups 1 and 2), an unfavorable outcome – in 7 children (group 3). The first group consisted of patients who received intensive therapy in an ICU for up to 10 days (6 patients), the second group included children with a favorable outcome after intensive therapy for 11–45 days (7 patients), the third group included 4 patients with an unfavorable outcome.

Results and its discussion.

Table 1.

Dynamics of the circadian rhythm mesor MAP

Days	1 group	2 group	3 group
1	103±3	98±6	92±8
2	98±4	93±2	89±3
3	101±2	99±2	96±3
4	102±3	96±4	96±4
5	99±3	97±3	99±4
6	98±3	98±2	97±4
7	97±2	98±3	102±3
8	94±2	98±2	100±4
9	76±2	96±3	99±4
10	83±2	97±3	100±3
11		97±2	98±4
12		96±3	102±4
13		98±3	98±4
14		99±3	101±2
15		98±4	92±3
16		98±4	96±5
17		103±5	102±4
18		100±3	99±6
19		101±2	95±7
20		103±4	112±7
21		100±4	114±6”
22		102±3	139±10” ●
23		101±4	134±7” ●
24		103±6	132±10” ●

25		105±2	139±6” ●
26		104±2	127±11”
27		103±5	136±7” ●
28		102±4	130±7”
29		103±3	136±7” ●
30		103±3	131±3”

Table 2.

Average circadian rhythm

	1 group	**2 group**	**3 group**
8	96±7	102±5	113±16
9	95±8	101±4	111±15
10	93±6	102±4	110±17
11	95±6	101±5	108±15
12	96±7	100±4	110±16
13	97±8	101±4	111±16
14	97±9	100±4	110±15
15	95±7	100±4	109±15
16	94±9	99±4	110±15
17	95±7	99±5	110±5
18	95±8	99±3	110±18
19	96±8	101±4	111±16
20	95±8	100±4	109±16
21	95±7	100±4	110±16
22	96±7	99±4	108±14
23	93±7	98±4	110±17
24	96±6	99±4	109±16
1	94±6	98±4	108±15
2	93±6	97±4	107±15
3	93±6	97±4	109±17
4	94±6	98±4	109±16
5	95±7	100±4	109±14
6	96±8	100±4	111±14
7	97±6	99±4	108±13

”-significant relative to the indicator in group 2

● – reliable relative to the indicator on 1 day

As presented in Tables 1 and 2, no significantly significant deviations of the circadian rhythm mesor of MAP on day 1 were detected in the dynamics on subsequent days of observation in groups 1 and 2. After 20 days of intensive therapy,

the circadian rhythm mesor MAP in group 3 remained significantly higher than on the first day and was higher than in group 2 by 14 – 33 mm Hg. (Fig. 1).

Table 3.

Average circadian rhythm parameters MAP

Group	Mezor MAP, mm Hg.	MAP in acrophase, mm Hg.	Indicator in bathyphase, mm Hg.	Amplitude, mm Hg	Daily range, mm Hg.
1	95±3	102±8	88±6	7±2	14±3
2	100±3	108±4*	91±3*‴	8±3	17±5
3	109±5	124±19	96±12	15±7	28±11

* - deviation is reliable relative to the mesor index

‴ - reliable relative to the indicator in acrophase

A reliably significant excess of the mean MAP indicator over the study period relative to the mesor of the circadian rhythm in the acrophase by 8 mmHg was found. ($p<0.05$), as well as in the bathyphase by 9 mmHg. ($p<0.05$) in children of group 2 (Table 3). Only in patients of group 2, a significant difference was revealed between MAP in acrophase and bathyphase, amounting to 17 mmHg. ($p<0.05$). An interesting fact is the maximum amplitude and daily range of MAP fluctuations in the most severe group 3, when the amplitude of the circadian rhythm MAP was 8 mmHg greater than in group 1. and 14 mmHg. and by 7 mmHg. and 11 mmHg. more than in patients of group 2 (Fig. 3,4). The difference is unreliable due to the large scatter of the indicator, but the identified feature in the most severe patients has significant clinical significance in assessing the adequacy of compensatory reactions during the adaptation process and clinical assessment of the severity of the condition. Thus, the greater the amplitude of the circadian rhythm of MAP and the range of daily fluctuations in the indicator, the more likely the unfavorable prognosis of the disease. The findings are fully consistent with the existing idea of a worsening prognosis due to unstable hemodynamics in critical conditions.

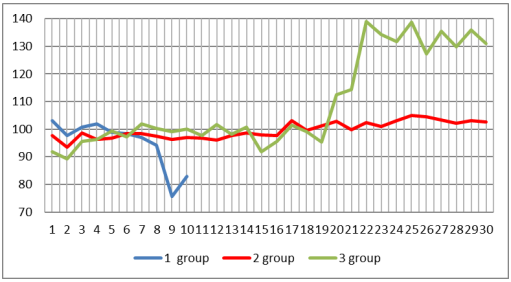


Figure 1. *Dynamics of the circadian rhythm mesor MAP, mm Hg.*

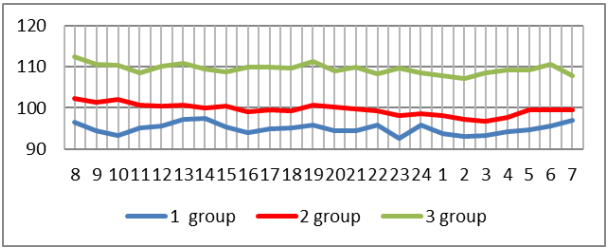


Figure 2. *Average circadian rhythm of mean arterial pressure, mmHg.*

Circadian fluctuations in the average circadian rhythm of MAP were characterized by low amplitude, and an increased level of fluctuations was found in children of group 3 (Fig. 2).

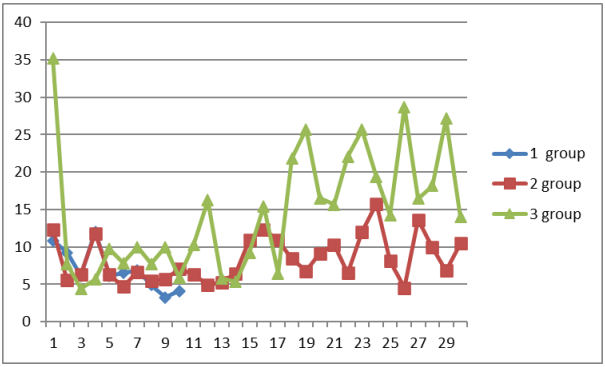


Figure 3. *Amplitude of circus rhythm MAP*

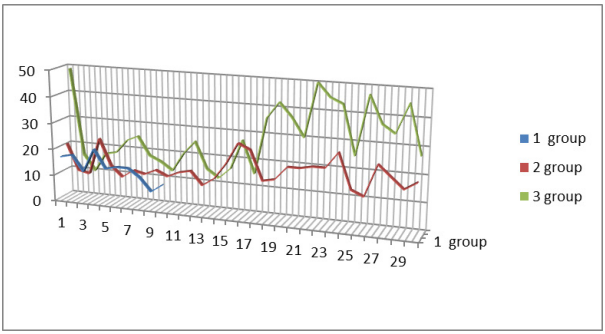


Figure 4. *Daily fluctuations in MAP over time depending on the severity of the condition, mm Hg.*

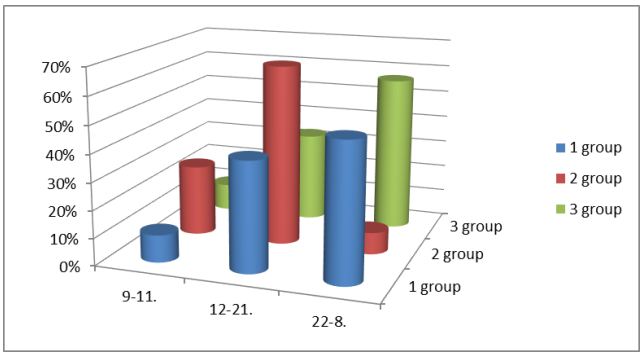


Figure 5. *Duration of circadian rhythm inversion MAP at the age of 7.1-18 years*

The longest inversion of the circadian rhythm of MAP was detected in children of group 3 (17 days), which amounted to 57% (Fig. 5) of the duration of intensive care.

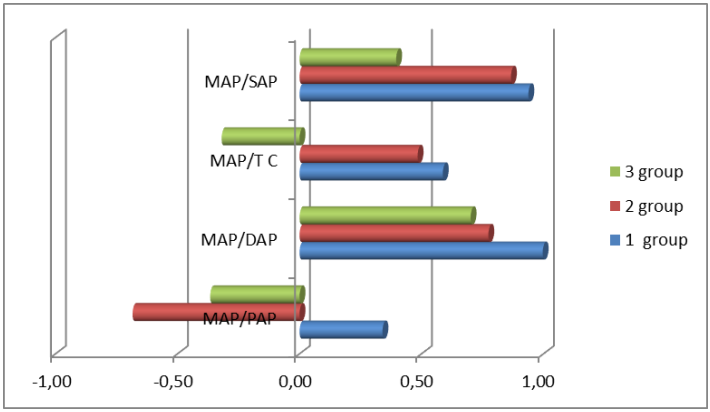


Figure 6. *Correlation connections MAP*

A strong direct correlation between MAP and DBP was found in all groups (0.99; 0.77; 0.7, respectively, across groups), that is, the level of MAP directly depended on the tone of peripheral vessels and other factors that determine the value of DBP. A direct strong correlation between MAP and SBP in groups 1 and 2 (0.94; 0.87) indicated a predominant influence on the level of mean arterial pressure of systolic emission, which was significantly neutralized in children of group 3 (0.4) (Fig. 6).

Conclusion. There were no significant deviations in the circadian rhythm of MAP on day 1 or in the dynamics on subsequent days of observation in groups 1 and 2. After 20 days of intensive therapy, the circadian rhythm mesor MAP in group 3 remained significantly higher than in group 2. The maximum values of the amplitude and daily range of MAP fluctuations were found in the most severe group 3. The longest inversion of the circadian rhythm of MAP was detected in children of group 3. The predominant effect on the level of mean arterial pressure of systolic ejection in groups 1 and 2 turned out to be significantly neutralized in children of group 3.

References

1. Konyushenko A.A., Beridze R.M. Current issues in the management of children with high blood pressure // FORCIPE, 2019. https://cyberleninka.ru/article/n/aktualnye-voprosy-vedeniya-detey-s-povyshennym-arterialnym-davleniem

2. Khaidarova L.R., Ganiev A.G. Blood pressure in school-age children depending on the circadian rhythm // Re-healthjournal, 2019. https://cyberleninka.ru/article/n/arterialnoe-davlenie-u-detey-shkolnogo-vozrasta-v-zavisimosti-ot-sutochnogo -rhythm-1

3. Kulichenko M.P., Petrushina A.D., Ushakov S.A. Regional indicators of high blood pressure in adolescent children // Russian Bulletin of Perinatology and Pediatrics, 2021. https://cyberleninka.ru/article/n/regionalnye-pokazateli-povyshennogo-arterialnogo-davleniya-u-detey-podrostkovogo-vozrasta

4. Sharshova O.G., Zhdanova O.A. Chubarov T.V. Characteristics of blood pressure levels in children with different body weights // Obesity and Metabolism, 2022. https://cyberleninka.ru/article/n/harakteristika-urovnya-arterialnogo-davleniya-u-detey-s-razlichnoy-massoy-tela

5. Ledyaeva A.M., Dedyaev M.Ya. Circadian organization of vascular tone as the basis for the formation of the circadian rhythm of blood pressure in pediatric patients // Bulletin of Volgograd State Medical University, 2020. https://cyberleninka.ru/article/n/tsirkadnaya-organizatsiya-sosudistogo-tonusa-kak-osnova-formirovaniya-sutochnogo -ritma-arterialnogo-davleniya-u-detey

DOI 10.34660/INF.2023.96.17.045

解决非酒精性脂肪肝診斷難題的現代觀點
MODERN VIEW ON SOLVING DIFFICULTIES OF DIAGNOSING NON-ALCOHOLIC FATTY LIVER DISEASE

Sobirova Guzal Naimovna
Dc.S, Senior Researcher, Professor
Tashkent Medical Academy, Tashkent, Republic of Uzbekistan
ORCID: 0000-0003-1928-3218,
SCOPUS ID 57221094940;

Shadmanova Diyora Alisherovna
Ph.D., Head of Department
Center for Therapy and Medical Rehabilitation, Tashkent, Republic of Uzbekistan
ORCID: 0009-0008-0004-9003

抽象的。 目的一對現代診斷非酒精性脂肪肝患者前景的科學數據進行薈萃分析。 材料和方法。 對過去 10 年獲得的科學數據進行了分析，並使用「Web of Science、Scopus、eLibrary、RSCI 和 Google Scholar」進行分析。 結果。 科學資料的統合分析確定了 500 多項研究，其中僅選擇了 40 個來源作為研究對象。 結論。 因此，對科學數據的分析表明，儘管了解非酒精性脂肪肝的發病原因及其複雜性，但肝臟活檢仍然是評估肝臟健康的黃金標準。 在這方面，有必要引入易於使用的非影像工具和準確的生物標記物，借助它們不僅可以做出充分的診斷，而且可以在臨床試驗中有效評估 NAFLD 的新療法。

關鍵字：非酒精性脂肪肝（NAFLD）； 非酒精性脂肪肝的診斷。

Abstract. Objective *– meta-analysis of scientific data on prospects of modern diagnostics patients with non-alcoholic fatty liver disease.* ***Materials and methods.*** *Analysis of obtained scientific data was carried out over past 10 years and was carried out using «Web of Science, Scopus, eLibrary, RSCI and Google Scholar».* ***Results.*** *Meta-analysis of scientific data identified more than 500 studies, of which only 40 sources were selected as object of study.* ***Conclusion.*** *As a result, analysis of scientific data revealed that despite understanding of pathogenetic causes of non-alcoholic fatty liver disease and complexity of this disease, liver biopsy still remains gold standard for assessing liver health. In this regard, there is a need to introduce accessible non-imaging tools and accurate biomarkers, with help of which it will be possible not only to make an adequate diagnosis, but also, in clinical trials, to effectively evaluate new treatments for NAFLD.*

Keywords: *non-alcoholic fatty liver disease (NAFLD); diagnosis of non-alcoholic fatty liver disease.*

Introduction. Non-alcoholic fatty liver disease (NAFLD) is one of most common chronic liver diseases in industrialized countries, in regions such as Europe, Asia and United States [1]. Prevalence of liver pathology is rapidly progressing, with presence of NAFLD worldwide accounting for 25.0% of adult population. And ratio incidence of NAFLD among men and women is 1:1, with most common age among patients in this category being 45 years [2]. Clinically, NAFLD ranges from a fairly innocuous, benign condition to nonalcoholic fatty liver disease (NAFL) or nonalcoholic steatohepatitis (NASH). In addition, there is clinical evidence that NAFLD can progress to liver fibrosis and cirrhosis [3, 4]. Despite unfavorable risks of more severe or even life-threatening conditions during course of NAFLD, today there is no universal method of therapeutic intervention for NAFLD depending on stage of pathological process [5]. On the one hand, choice of drugs that are potentially effective for treatment of NAFLD remains controversial; on other hand, type of conservative therapy directly depends on stage and advanced stage of NAFLD [6]. As a rule, diagnosis of NAFLD is based on ultrasound examination of liver and biochemical indicators of liver enzymatic activity. However, there are increasingly more publications on use of ultrasound elastography of liver, radiological diagnostic methods and some forms of genetic testing, which largely encourages prospects for improvement in approaches to comprehensive medical care for patients suffering from NAFLD. This meta-analysis focuses on laboratory diagnostic options, including genetic tests and imaging techniques, used to diagnose different stages of NAFLD.

Objective is to evaluate status and capabilities of modern types of diagnostics of non-alcoholic fatty liver disease as part of a meta-analysis of scientific data.

Materials and methods. Design and structure of study was organized in accordance with international protocol for systematic reviews and meta-analyses “PRISMA-2009”. A search for scientific publications devoted to study of diagnosis of patients with NAFLD was carried out in «Web of Science, Scopus, eLibrary, RSCI and Google Scholar». Analysis of obtained data was carried out among scientific papers published between 2013 and 2023 (the error, in form of later studies, was used in isolated cases when it came to fundamental scientometric data). Study included 693 scientific articles; after an audit procedure for comparison of topics and absence of duplicates, 40 sources were included.

Results. In clinical practice, NAFLD is defined as fatty infiltration of liver accounting for more than 5.0% of liver weight, or presence of more than 5.0% of hepatocytes loaded with large fat vacuoles [7]. Basic condition for diagnosing NAFLD is absence of a cause of fatty liver disease such as alcohol and fact

that NAFLD has a heterogeneous development and many manifestations, including hepatocellular carcinoma [8]. When a diagnosis of NAFLD is suspected, it is important to exclude alternative causes of fat accumulation in liver or to rule out signs of liver dysfunction. At the moment, gold standard for diagnosing NAFLD is a liver biopsy, but its implementation carries a lot of inconvenience for both specialists and patients [9]. In general, a comprehensive clinical examination of patients with suspected NAFLD includes collection of a complete medical history, including exclusion of systematic alcohol consumption, certain groups of medications, family history and presence of viral liver diseases. Laboratory diagnostics basically include biochemical screening, serological testing of hepatitis B and C markers, determination of liver autoantibodies, immunoglobulins, concentration of α-1-antitrypsin, ferritin and ceruloplasmin in patients under 50 years of age. NAFLD is most often suspected clinically when a person with features of metabolic syndrome exhibits elevated serum aminotransferase levels, but nearly 80.0% of patients with NAFLD do not have biochemical abnormalities, which has several possible explanations. Thus, when analyzing ALT, experts often overestimate upper limit of normal, since calculation of hematological indicator is carried out without taking into account data from undiagnosed liver diseases, including NAFLD [10]. In the largest study, D.Prati et al. (2002), biochemical parameters of ALT were analyzed, subject to mandatory exclusion from study of persons at risk of liver dysfunction, obesity or diabetes. As a result, authors suggested that most sensitive ALT value for diagnosing NAFLD would be 30 U/L for men and 19 U/L for women. In addition, aminotransferase levels usually decrease significantly as NAFLD progresses and liver fibrosis develops. Consequently, in later stages of disease, biochemical indicators of liver function may be within normal limits [11].

Metabolic syndrome and its components are closely associated with occurrence of NAFLD. In almost two-thirds of obese people with T2DM, as well as in half of patients with hyperlipidemia and hypertension, liver ultrasound reveals fat deposition in parenchymal area [12]. To specifically identify NAFLD and its association with metabolic syndrome, diagnostic tools have been developed that have proven themselves in clinical practice. The most popular of these methods is index of steatosis or fatty degeneration of liver parenchyma (Fatty Liver Index - FLI). This diagnostic method includes, in addition to ultrasound, assessment of BMI, waist circumference, gamma-glutamyltransferase (GGT), and TG. Second diagnostic tool is Liver Fat Score (LFS). LFS score for NAFLD includes assessment of predictors such as metabolic syndrome, type 2 diabetes, fasting serum insulin, aspartate aminotransferase (AST) and ALT, as well as ratio of these enzymes. Both diagnostic algorithms are widely used in clinical practice and have a close correlation with more objective indicators of steatosis observed with ultrasound [13, 14].

At the moment, various methods of imaging liver are available, but abdominal ultrasound is the most pragmatic, radiation-free and relatively inexpensive

diagnostic method. Liver ultrasound is widely used and is a routine first-line diagnostic method [15]. Ultrasound has several significant advantages, which include non-invasiveness, lack of radiation exposure, accessibility and relative ease of use. In addition, ultrasound can be used to assess changes in parenchymal structure and identify various liver lesions. In cases with severe NAFLD or development of NSG, ultrasound has good sensitivity (85.0%) and specificity (95.0%). However, in initial forms of NAFLD, when number of steatotic hepatocytes varies from 20.0% to 30.0%, ultrasound is an ineffective diagnostic method [16]. Another problem with ultrasound diagnosis of NAFLD is liver fibrosis [17]. Since fibrosis phenomena can be cause of increased echogenicity of liver, which largely reduces ability to visualize fatty deposits [18]. More advanced techniques are being used to overcome limitations of ultrasound in assessing early manifestations of NAFLD. For example, Controlled Attenuation Parameter (CAP™), which uses vibration electrography to measure degree of ultrasound attenuation due to liver fat. V. eLedinghen et al. (2014) conducted a study in which they found that use of CAP could detect a milder degree of hepatic steatosis compared with conventional ultrasound. In addition, authors state that SAR correlates well with liver biopsy for diagnosing NAFLD [19]. Another innovation has been computer-assisted quantitative methods, such as combined liver echo intensity ratio followed by estimation of rate of decay of echo intensity. This method has a high level of sensitivity and specificity, and also allows you to detect steatosis if less than 15.0% of liver is affected. In recent years, a diagnostic method for NAFLD, such as computed tomography (CT), has become widely used. Like ultrasound, CT is easy to use and has relatively widespread use in clinical practice. Reliability of CT is due to its high specificity and sensitivity in diagnosis of NAFLD with moderate and severe steatosis. Unfortunately, this method is also unreliable when level of hepatic steatosis is low. In addition, potential hazard of ionizing radiation makes CT unsuitable for longitudinal follow-up of patients with NAFLD [20].

Most accurate and preferred method for diagnosing NAFLD is magnetic resonance imaging (MRI). MRI methods are very accurate in detecting hepatic steatosis, only limitation is examination modes. Thus, for diagnosis of NAFLD and visualization of steatosis, T1-weighted, T2 mode is used, which makes it possible to achieve interference of proton signal in adipose tissue [21]. With time and clinical experience with MRI, several methods have been developed with higher accuracy than classical MRI modes. One such method is MR spectroscopy (MRS), which measures fat fraction in liver with proton density. At the moment, MRS is not a publicly available method and is time-consuming [22, 23]. Another modernized method, Liver Multi Scan (LMS), uses traditional MRI technology but combines two or more quantitative methods to assess LIF liver inflammation and fibrosis. According to research by M. Pavlides et al. (2017), LMS with LIF assessment

demonstrated high diagnostic accuracy, even in comparison with morphological methods for diagnosing NAFLD. Unlike acoustic methods, LMS is not affected by central obesity, and this method can accurately visualize parts of liver involved in process of steatosis [24]. MR elastography (MRE), particularly 3D MRE imaging modality, has demonstrated superiority over ultrasound techniques for assessing fibrosis in NAFLD [25]. MRE has a significant drawback, which is that this diagnostic method is available only to specialized medical institutions in developed countries. This makes MRE practically unsuitable for widespread use.

Given understanding that NAFLD can develop among patients without clinical metabolic syndrome, introduction of genetic testing has recently become increasingly popular. In case of NAFLD, main attention is paid to identification of patatin-like phospholipase protein gene (PNPLA-3). Which is responsible for encoding membrane-binding function of hepatocytes and adipocytes. Main role of this protein structure is hydrolysis of TG in liver and concomitant excretion of low-density lipoproteins (LDL), [26]. According to SSLee et al. (2014), PNPLA-3 single nucleotide polymorphism “I-148M” (rs738409) is observed in approximately 20.0% of patients suffering from NAFLD. Also, presence of PNPLA-3 polymorphism indicates a violation of enzymatic activity of liver, hydrolysis of triglycerides and, as a consequence, a violation of LDL secretion [27, 28]. As a consequence, PNPLA-3 polymorphism indicates increased steatosis and inflammatory phenomena in liver [29]. There are a number of genes that have been reliably proven to be associated with NAFLD, including TM6SF2 gene (rs58542926), polymorphism of which reflects excessive secretion of oLDL . TMF6SF2 is a transmembrane gene and plays a critical role in enrichment of triglycerides to apoliprotein state. Thus, sequencing of this gene can be guaranteed to reflect a disorder in form of excess liver triglycerides and an inevitable decrease in level of circulating lipoproteins, which indicates disorders likely associated with NAFLD [30, 31]. LYPLAL1 gene, in rs12137855 variation, which has function of triglyceride catabolism, is however under study. Several variants (rs780094 and rs1260326) of GCKR gene polymorphism, reflecting degree of de novo regulation of lipogenesis. This genetic marker reflects level of glucose influx into hepatocytes, simultaneously controlling actions of glucokinase in liver. GCKR missense mutation encoding p446L protein is a marker of association of fat accumulation in liver and allows early differentiation of NAFLD [32]. LPIN1 gene and its variation rs13412852 reflect regulatory function of lipid metabolism. LPIN1 gene is a phosphatide phosphatase and regulates lipid metabolism by participating in synthesis of phospholipids and triglycerides, acting as an inducible transcriptional coactivator of fatty acid metabolism. These properties of LPIN1 make it possible to determine with high probability presence of NAFLD in patients [33, 34]. Variants of mitochondrial associated genes SOD2 (rs4880) and UCP2 (rs695366), responsi-

ble for function of mitochondrial antioxidant and mitochondrial lipid metabolism (OxPhos), allow us to determine a violation in mechanism of fatty acid oxidation. Violations of these functions can lead to a lack of protection of hepatocytes from free fatty acids, which in turn leads to accumulation of reactive oxidative elements and development of NAFLD. As well as variations (rs1044499 and rs1801278) for ENPP1 and IRS1 genes, respectively, which demonstrate an inhibitory response to insulin signaling pathway. Since polymorphism of these genes involved in interaction between insulin receptors in liver and direct transmission of signals from them, and signaling pathway itself is directly associated with fibrosis, sequencing data for ENPP1 and IRS1 are of particular importance in diagnosis of NAFLD as markers of insulin resistance and fibrosis [35].

Recently, a type of diagnosis such as epigenetics has become increasingly popular, due to emergence of data on gene expression and phenotypic variations that are not associated with changes in DNA chain sequence, but lead to NAFLD. One of these methods includes tests of non-invasive biomarkers, namely non-coding RNA (nc-RNA) test - F. Nassir et al. (2022), [36]. Need to develop non-invasive biomarkers is due to possibility of differentiating simple hepatic steatosis from NAFLD, NSG and early fibrosis. Most human RNA transcripts do not encode proteins; ncRNAs include short RNAs (<30 nucleotides) such as microRNAs (m-RNAs) and long non-coding RNAs (>200 nucleotides) such as circular RNAs (circular RNAs). [37, 38]. ncRNAs regulate cell physiology and function through epigenetic gene silencing and post-transcriptional regulation of mRNA stability. According to X.Qian et al. (2022) dysregulation of this process and abnormal expression of nc-RNA are directly associated with occurrence of NAFLD [39]. What is noteworthy is that in a recent study by Z. Fang et al. (2021), provide data and pay special attention to analysis of role of exosomal m-RNAs in NAFLD. Circulating m-RNAs, including m-RNA-122, m-RNA-34, m-RNA-192 and m-RNA-375, were increased in NAFLD and positively correlated with disease severity [40]. Specific for patients with NAFLD is a change in m-RNA-122 (more than 70.0% of total liver m-RNA pool). In large clinical studies, mRNA-122 levels were significantly increased in serum of patients with NAFLD and have been proposed as a potential biomarker for NAFLD and its progression [41, 42].

The most accurate method for diagnosing NAFLD and NSG still remains a liver tissue biopsy. Although biopsy is standard of care for diagnosing NAFLD, its use poses a clinical challenge in management of patients with NAFLD. Performing serial liver biopsies is expensive and completely unacceptable for both patients and healthcare professionals. Of course, liver biopsy should be considered in all cases that pose problems associated with risk of developing liver malignancies. Additionally, in individuals with a high likelihood of liver fibrosis, a biopsy may be used to confirm diagnosis.

Conclusions. NAFLD is a highly common disease that is prevalent in most countries of the world. Pathogenesis of NAFLD is associated with insulin resistance and hyperlipidemia, which lead to development of damage not only to liver, but also to other organs and systems. In particular, blood vessels, heart and pancreas, thus exacerbating life prognosis of this group of patients. Thereby emphasizing characteristics of patients, importance of diagnosis and complexity of choosing therapeutic tactics for treatment of NAFLD. Often low sensitivity of standard diagnostic methods does not lead to an adequate diagnosis, and this is due to multifactorial nature of causes of NAFLD, as well as complete lack of accessible and inexpensive imaging tools and lack of adequate non-invasive biomarkers. This literature review summarized modern types of diagnostic mechanisms, including epigenetics, as a potentially effective option for diagnostic screening of NAFLD.

Conclusion. Despite these limitations and high risk of sampling error, liver biopsy remains standard of care for evaluation of NAFLD. In this regard, there is a need to introduce accessible non-imaging tools and accurate biomarkers, with help of which it will be possible not only to make an adequate diagnosis, but also, within framework of clinical trials, to analyze effectiveness of modern methods of treating NAFLD.

Financial and other conflicts: the authors of study declare that there is no conflict of interest in preparation and conduct of study

References

1. Jennison E, Patel J, Scorletti E, Byrne CD. Diagnosis and management of non-alcoholic fatty liver disease. Postgrad Med J. 2019 Jun;95(1124):314-322. doi: 10.1136/postgradmedj-2018-136316

2. Volkova NI, Porksheyan MI. Nonalcoholic fatty liver disease: What do we know and what will we have to learn? Terapevticheskii Arkhiv. 2017;89(2):91-98. (In Russ.) doi:10.17116/terarkh201789291-98

3. Younossi ZM, Stepanova M, Younossi Y, Golabi P, Mishra A, Rafiq N, Henry L. Epidemiology of chronic liver diseases in the USA in the past three decades. Gut. 2020 Mar;69(3):564-568. doi: 10.1136/gutjnl-2019-318813

4. Younes R, Bugianesi E. NASH in Lean Individuals. Semin Liver Dis. 2019 Feb;39(1):86-95. doi: 10.1055/s-0038-1677517

5. Volkova NI, Porksheyan MI. Nonalcoholic fatty liver disease: What do we know and what will we have to learn? Terapevticheskii Arkhiv. 2017;89(2):91-98. (In Russ.) doi:10.17116/terarkh201789291-98

6. Alonso C, Fernández-Ramos D, Varela-Rey M, Martínez-Arranz I, Navasa N, Van Liempd SM, Lavín Trueba JL, Mayo R, Ilisso CP, de Juan VG, Iruarrizaga-Lejarreta M, delaCruz-Villar L, Mincholé I, Robinson A, Crespo

J, Martín-Duce A, Romero-Gómez M, Sann H, Platon J, Van Eyk J, Aspichueta P, Noureddin M, Falcón-Pérez JM, Anguita J, Aransay AM, Martínez-Chantar ML, Lu SC, Mato JM. Metabolomic Identification of Subtypes of Nonalcoholic Steatohepatitis. Gastroenterology. 2017 May;152(6):1449-1461.e7. doi: 10.1053/j.gastro.2017.01.015

7. Younossi Z, Anstee QM, Marietti M, Hardy T, Henry L, Eslam M, George J, Bugianesi E. Global burden of NAFLD and NASH: trends, predictions, risk factors and prevention. Nat Rev Gastroenterol Hepatol. 2018 Jan;15(1):11-20. doi: 10.1038/nrgastro.2017.109

8. Cai J, Zhang XJ, Li H. Progress and challenges in the prevention and control of nonalcoholic fatty liver disease. Med Res Rev. 2019 Jan;39(1):328-348. doi: 10.1002/med.21515

9. Friedman SL, Neuschwander-Tetri BA, Rinella M, Sanyal AJ. Mechanisms of NAFLD development and therapeutic strategies. Nat Med. 2018 Jul;24(7):908-922. doi: 10.1038/s41591-018-0104-9

10. Cotter TG, Rinella M. Nonalcoholic Fatty Liver Disease 2020: The State of the Disease. Gastroenterology. 2020 May;158(7):1851-1864. doi: 10.1053/j.gastro.2020.01.052

11. Prati D, Taioli E, Zanella A, Della Torre E, Butelli S, Del Vecchio E, Vianello L, Zanuso F, Mozzi F, Milani S, Conte D, Colombo M, Sirchia G. Updated definitions of healthy ranges for serum alanine aminotransferase levels. Ann Intern Med. 2002 Jul 2;137(1):1-10. doi: 10.7326/0003-4819-137-1-200207020-00006

12. López-Suárez A, Guerrero JM, Elvira-González J, Beltrán-Robles M, Cañas-Hormigo F, Bascuñana-Quirell A. Nonalcoholic fatty liver disease is associated with blood pressure in hypertensive and nonhypertensive individuals from the general population with normal levels of alanine aminotransferase. Eur J Gastroenterol Hepatol. 2011 Nov;23(11):1011-7. doi: 10.1097/MEG.0b013e32834b8d52

13. Koehler EM, Schouten JN, Hansen BE, Hofman A, Stricker BH, Janssen HL. External validation of the fatty liver index for identifying nonalcoholic fatty liver disease in a population-based study. Clin Gastroenterol Hepatol. 2013 Sep;11(9):1201-4. doi: 10.1016/j.cgh.2012.12.031

14. Kotronen A, Peltonen M, Hakkarainen A, Sevastianova K, Bergholm R, Johansson LM, Lundbom N, Rissanen A, Ridderstråle M, Groop L, Orho-Melander M, Yki-Järvinen H. Prediction of non-alcoholic fatty liver disease and liver fat using metabolic and genetic factors. Gastroenterology. 2009 Sep;137(3):865-72. doi: 10.1053/j.gastro.2009.06.005

15. Hernaez R, Lazo M, Bonekamp S, Kamel I, Brancati FL, Guallar E, Clark JM. Diagnostic accuracy and reliability of ultrasonography for the detection of fatty liver: a meta-analysis. Hepatology. 2011 Sep 2;54(3):1082-1090. doi: 10.1002/hep.24452

16. Ballestri S, Nascimbeni F, Baldelli E, Marrazzo A, Romagnoli D, Targher G, Lonardo A. Ultrasonographic fatty liver indicator detects mild steatosis and correlates with metabolic/histological parameters in various liver diseases. Metabolism. 2017 Jul;72:57-65. doi: 10.1016/j.metabol.2017.04.003

17. Strauss S, Gavish E, Gottlieb P, Katsnelson L. Interobserver and intraobserver variability in the sonographic assessment of fatty liver. AJR Am J Roentgenol. 2007 Dec;189(6):W320-3. doi: 10.2214/AJR.07.2123

18. Saverymuttu SH, Joseph AE, Maxwell JD. Ultrasound scanning in the detection of hepatic fibrosis and steatosis. Br Med J (Clin Res Ed). 1986 Jan 4;292(6512):13-5. doi: 10.1136/bmj.292.6512.13

19. de Lédinghen V, Vergniol J, Foucher J, Merrouche W, le Bail B. Non-invasive diagnosis of liver steatosis using controlled attenuation parameter (CAP) and transient elastography. Liver Int. 2012 Jul;32(6):911-8. doi: 10.1111/j.1478-3231.2012.02820.x

20. Zhang B, Ding F, Chen T, Xia LH, Qian J, Lv GY. Ultrasound hepatic/renal ratio and hepatic attenuation rate for quantifying liver fat content. World J Gastroenterol. 2014 Dec 21;20(47):17985-92. doi: 10.3748/wjg.v20.i47.17985

21. Noureddin M, Lam J, Peterson MR, Middleton M, Hamilton G, Le TA, Bettencourt R, Changchien C, Brenner DA, Sirlin C, Loomba R. Utility of magnetic resonance imaging versus histology for quantifying changes in liver fat in nonalcoholic fatty liver disease trials. Hepatology. 2013 Dec;58(6):1930-40. doi: 10.1002/hep.26455

22. Georgoff P, Thomasson D, Louie A, Fleischman E, Dutcher L, Mani H, Kottilil S, Morse C, Dodd L, Kleiner D, Hadigan C. Hydrogen-1 MR spectroscopy for measurement and diagnosis of hepatic steatosis. AJR Am J Roentgenol. 2012 Jul;199(1):2-7. doi: 10.2214/AJR.11.7384

23. Idilman IS, Aniktar H, Idilman R, Kabacam G, Savas B, Elhan A, Celik A, Bahar K, Karcaaltincaba M. Hepatic steatosis: quantification by proton density fat fraction with MR imaging versus liver biopsy. Radiology. 2013 Jun;267(3):767-75. doi: 10.1148/radiol.13121360

24. Pavlides M, Banerjee R, Tunnicliffe EM, Kelly C, Collier J, Wang LM, Fleming KA, Cobbold JF, Robson MD, Neubauer S, Barnes E. Multiparametric magnetic resonance imaging for the assessment of non-alcoholic fatty liver disease severity. Liver Int. 2017 Jul;37(7):1065-1073. doi: 10.1111/liv.13284

25. Loomba R, Wolfson T, Ang B, Hooker J, Behling C, Peterson M, Valasek M, Lin G, Brenner D, Gamst A, Ehman R, Sirlin C. Magnetic resonance elastography predicts advanced fibrosis in patients with nonalcoholic fatty liver disease: a prospective study. Hepatology. 2014 Dec;60(6):1920-8. doi: 10.1002/hep.27362

26. Chamoun Z, Vacca F, Parton RG, Gruenberg J. PNPLA3/adiponutrin functions in lipid droplet formation. Biol Cell. 2013 May;105(5):219-233. doi: 10.1111/boc.201200036

27. Lee SS, Byoun YS, Jeong SH, Woo BH, Jang ES, Kim JW, Kim HY. Role of the PNPLA3 I148M polymorphism in nonalcoholic fatty liver disease and fibrosis in Korea. Dig Dis Sci. 2014 Dec;59(12):2967-74. doi: 10.1007/s10620-014-3279-z

28. Romeo S, Sentinelli F, Dash S, Yeo GS, Savage DB, Leonetti F, Capoccia D, Incani M, Maglio C, Iacovino M, O'Rahilly S, Baroni MG. Morbid obesity exposes the association between PNPLA3 I148M (rs738409) and indices of hepatic injury in individuals of European descent. Int J Obes (Lond). 2010 Jan;34(1):190-4. doi: 10.1038/ijo.2009.216

29. Luukkonen PK, Zhou Y, Nidhina Haridas PA, Dwivedi OP, Hyotylainen T, Ali A, et al. Impaired hepatic lipid synthesis from polyunsaturated fatty acids in TM6SF2 E167K variant carriers with NAFLD. J Hepatol 2017;67:128–136.

30. Kim DS, Jackson AU, Li YK, Stringham HM, Kuusisto J, Kangas AJ, et al. Novel association of TM6SF2 rs58542926 genotype with increased serum tyrosine levels and decreased apolipoprotein B-100 particles in Finns. J Lipid Res 2017;58:1471–1481.

31. Valenti L, Alisi A, Nobili V. Unraveling the genetics of fatty liver in obese children: additive effect of P446L GCKR and I148M PNPLA3 polymorphisms. Hepatology 2012;55:661–663.

32. Kumari M, Schoiswohl G, Chitraju C, Paar M, Cornaciu I, Rangrez AY, et al. Adiponutrin functions as a nutritionally regulated lysophosphatidic Acid acyltransferase. Cell Metab 2012;15:691–702.

33. Valenti L, Motta BM, Alisi A, Sartorelli R, Buonaiuto G, Dongiovanni P, et al. LPIN1 rs13412852 polymorphism in pediatric nonalcoholic fatty liver disease. J Pediatr Gastroenterol Nutr 2012;54:588–593.

34. Fares R, Petta S, Lombardi R, Grimaudo S, Dongiovanni P, Pipitone R, et al. The UCP2 -866 G>A promoter region polymorphism is associated with nonalcoholic steatohepatitis. Liver Int 2015;35:1574–1580.

35. Al-Serri A, Anstee QM, Valenti L, Nobili V, Leathart JB, Dongiovanni P, et al. The SOD2 C47T polymorphism influences NAFLD fibrosis severity: evidence from case-control and intra-familial allele association studies. J Hepatol 2012;56:448–454.

36. Nassir F. NAFLD: Mechanisms, Treatments, and Biomarkers. Biomolecules. 2022 Jun 13;12(6):824. doi: 10.3390/biom12060824

37. Panni, S.; Lovering, R.C.; Porras, P.; Orchard, S. Non-coding RNA regulatory networks. Biochim. Biophys. Acta Gene Regul. Mech. 2020, 1863, 194417.

38. Khalifa, O.; Errafii, K.; Al-Akl, N.S.; Arredouani, A. Noncoding RNAs in Nonalcoholic Fatty Liver Disease: Potential Diagnosis and Prognosis Biomarkers. Dis. Markers 2020, 2020, 8822859.

39. Qian, X.; Zong, W.; Ma, L.; Yang, Z.; Chen, W.; Yan, J.; Xu, J. MM-associated circular RNA downregulates microRNA-19a through methylation to suppress proliferation of pancreatic adenocarcinoma cells. Bioengineered 2022, 13, 9294–9300.

40. Fang, Z.; Dou, G.; Wang, L. MicroRNAs in the Pathogenesis of Nonalcoholic Fatty Liver Disease. Int. J. Biol. Sci. 2021, 17, 1851–1863.

41. Pirola, C.J.; Fernández Gianotti, T.; Castaño, G.O.; Mallardi, P.; San Martino, J.; Mora Gonzalez Lopez Ledesma, M.; Flichman, D.; Mirshahi, F.; Sanyal, A.J.; Sookoian, S. Circulating microRNA signature in non-alcoholic fatty liver disease: From serum non-coding RNAs to liver histology and disease pathogenesis. Gut 2015, 64, 800–812.

42. Romeo S, Kozlitina J, Xing C, Pertsemlidis A, Cox D, Pennacchio LA, Boerwinkle E, Cohen JC, Hobbs HH. Genetic variation in PNPLA3 confers susceptibility to nonalcoholic fatty liver disease. Nat Genet. 2008 Dec;40(12):1461-5. doi: 10.1038/ng.257

DOI 10.34660/INF.2023.18.46.046

復健治療對腦性麻痺兒童神經營養因子濃度動態的影響

INFLUENCE OF REHABILITATION THERAPY ON DYNAMICS OF NEUROTROPHIC FACTORS CONCENTRATION IN PEDIATRIC PATIENTS WITH CEREBRAL PALSY

Larina Natalya Valerievna
Candidate of Medical Sciences, Associate Professor
V.I. Vernadsky Crimean Federal University,
Medical Academy named after S.I. Georgievsky, Simferopol,
Russian Federation
ORCID ID: 0000-0002-6996-4823

抽象的。 介紹。 腦性麻痺兒科患者的復健治療採用「非侵入性介面腦機外手-2」醫療技術，旨在刺激神經發生過程。 確定復健治療結束前後患者周邊血液中神經營養因子（NTF）濃度的動態變化有望證實復健治療的有效性。

目的：透過引入軟硬體綜合體“非侵入性介面腦-機-exohand-2”，研究分析腦性麻痺兒科患者在復健治療過程中血液中NTF水平的變化。

患者和方法。 腦性麻痺兒科患者接受上肢運動活動、痙攣和日常技能能力水準的評估。 結果與對照組（n=25）相關。 主要組別由年齡在 12 至 18 歲之間的患者 (n=52) 組成，他們接受了復健治療療程，其中包括帶有生物回饋的「非侵入性介面腦機-exohand-2 複合體」訓練。 主治組及對照組患者在治療前及治療結束後第10天測定週邊血NTFs濃度。

結果。 使用「非侵入性腦機介面-exohand-2」進行治療後，神經營養因子BDNF、FGF1、FGF2、NT3、NT4/5濃度顯著下降，具有統計意義。 同時，由於痙攣程度的降低以及肌肉力量的增強，上肢的活動範圍增加，這促進了更廣泛的家庭技能和自我照顧的機會，認知功能和情緒健康的改善。

結論。 所獲得的結果表明 NTF 積極參與神經可塑性和神經發生過程，導致大腦消耗其增加，從而導致周邊血液濃度下降，這可以被視為治療效率的預測指標。

關鍵字：神經營養因子，腦性麻痺，復健治療，神經可塑性，生物回饋，外伸。

Abstract. Introduction. *Restorative treatment of pediatric patients diagnosed with cerebral palsy, which comprised the medical technology “non-invasive interface brain-computer-exohand - 2”, is aimed at stimulating neurogenesis processes. Determination of the dynamics of neurotrophic factors (NTFs) concentration in the peripheral blood of patients before and after the end of*

rehabilitation treatment is promising for substantiating the effectiveness of the rehabilitation therapy.

Aim: *to study and analyze changes in the level of NTF in the blood of pediatric patients with cerebral palsy with introduction of the software and hardware complex "non-invasive interface brain-computer-exohand-2" during rehabilitation therapy.*

Patients and methods. *Pediatric patients with cerebral palsy were exposed to assessment of the level of the upper limb motor activity, spasticity, and the ability to perform everyday skills. The results were correlated with the comparison group (n=25). The main group consisted of patients aged 12 - 18 years (n=52), who received a course of rehabilitation therapy which included training on the "non-invasive interface brain-computer -exohand-2 complex" with a biological feedback. For patients in the main and comparison groups, the level of NTFs in the peripheral blood was determined before treatment and on the 10th day after completion of treatment.*

Results. *A statistically significant decrease in the concentration of neurotrophic factors BDNF, FGF1, FGF2, NT3, NT4/5 was revealed after the applied therapy with the use of "non-invasive interface brain-computer -exohand-2". At the same time, there was an increase in the range of movements of the upper extremities due to decrease in the level of spasticity as well as an increase in muscle strength which facilitated a wider range of household skills and opportunities for self-care, with an improvement of cognitive function and emotional well-being.* **Conclusion.** *The results obtained indicate the active involvement of NTF in the processes of neuroplasticity and neurogenesis, leading to its increased consumption by the brain and, accordingly, a decrease in concentration in peripheral blood, which can be considered as a predictor of the therapy`s efficiency.*

Keywords: *neurotrophic factors, cerebral palsy, rehabilitation therapy, neuroplasticity, biofeedback, exohand.*

Introduction. Cerebral palsy remains one of the most important problems of modern rehabilitation medicine. Existing modern methods of rehabilitation treatment do not make it possible to completely restore impaired motor and cognitive functions in cerebral palsy. However, given the potentially high plasticity of the child's cerebral cortex, we can make attempts to induce reorganization of neuronal networks. The search for new rehabilitation techniques that allow patients with cerebral palsy to expand the scope of existing everyday skills by reducing spasticity and increasing strength in the limbs is a promising direction in the development of rehabilitation medicine. In the rehabilitation treatment of children with cerebral palsy, methods using various types of robotic technology based on the principle of forming an external biofeedback circuit are being actively introduced nowadays.

Thus, the innovative rehabilitation technique "non-invasive brain-computer interface" is based on the creation of stable connections between intact areas of the brain using robotic devices that restore impaired motor and sensory functions of the body. The introduction of the medical technology "non-invasive interface brain-computer -exohand-2" into the process of rehabilitation therapy of children with cerebral palsy, in accordance with the author's program, has led to an increase in muscle strength, a decrease in muscle spasticity, an increase in the range of motion in the paretic hand, and, as a result, an increase in self-care skills. Also a significant positive effect is emotional rise as well as improvement in cognitive functions, in particular increased level of concentration and attention span. The resulting clinical effects led to improved socialization of children in the family, children's groups, increased academic performance and the confidence in their abilities and future expectations [1].

Based on the results obtained, we put forward a theory to explain the above-stated effects. We assume that during rehabilitation therapy, the mechanisms of neuroplasticity and neurogenesis, which were inactive before the start of the rehabilitation course, get activated. We hypothesized that one of the leading roles in this process belongs to the rebuilding of the structure and activity of neurotrophic factors in the brain. Thus, determining changes in the level of neurotrophic factors in the peripheral blood of patients with cerebral palsy may be promising for substantiating the effectiveness of rehabilitation therapy

The purpose of this research was to examine, analyze and substantiate the differentiated nature of changes in the level of neurotrophic factors in the blood during the rehabilitation therapy of children with cerebral palsy after the use of the complex "non-invasive interface brain-computer -Exohand-2".

Materials and methods

Children whose average age was 14.5±1.4 years (ranging from 12 to 18), matched by gender, were examined. All those examined had a verified diagnosis of cerebral palsy; patients were diagnosed with hemiparesis or tetraparesis, in some cases in combination with hyperkinetic or ataxic syndromes. Parents or legal guardians of the children signed informed consent to participate in this study.

The main group (n=52) - patients with cerebral palsy who received a course of rehabilitation treatment (massage, physical therapy) in combination with training on the hardware and software complex "non-invasive interface brain-computer -Exohand-2". The comparison group (n=25) - patients with cerebral palsy who received a course of standard rehabilitation treatment. A limitation of this study is the lack of randomization when forming patient groups.

The level of motor activity was assessed according to the classification criteria for Gross Motor Functions Classification System for Cerebral Palsy (GMFCS). The Modified Ashworth Scale for Grading Spasticity (MASGS) assessed the degree of spastic-

ity based on resistance to passive movements on a 5-point scale. The Modified Tardieu Scale (MTS) is a 5-level assessment of muscle resistance during fast and slow passive movement. The British Medical Research Council scale assessed muscle strength. The Modified Franchay Scale (MFS) was used to assess the ability to perform daily living motor skills (in points). The ABILHAND-Kids test allows to analyze the motor function of a child's hand in everyday life (parents evaluate the degree of ability to perform the skill: "impossible", "difficult", "easy"). For the Ashworth, Tardieu scales and assessment of muscle strength, only motor indicators of the hand (flexion and extension at the wrist joint) were taken into account.

For restorative treatment of motor function of the upper limb, the "non-invasive interface brain-computer -Exohand-2" complex was used. The essence of the method is based on the use of analysis of changes in the electroencephalogram pattern using a neural interface. EEG patterns arise from the representation of hand movement. The suggested course of treatment consisted of 10 sessions according to the scheme: one session was split into 3 periods of 10 minutes each and was carried out once a day. The break between training periods was at least five minutes. The patient is placed vertically in a chair at a distance of 1 metre in front of the monitor screen. On the monitor, the patient was presented with commands in the form of visual images, to which the patient had to respond by imagining the movement of the left or right hand or by relaxation. If the patient performed the task correctly, the white mark (fixing the gaze) turned green and determined visual feedback; as a result, the exoskeleton glove led to the extension of the hand which indicated the implementation of kinesthetic feedback. If there were errors in completing the task, the mark remained white, the exoskeleton did not work. The dynamics of recovery of motor functions of the upper limb were recorded using neurological scales 10 days after completion of the rehabilitation procedure.

To study blood serum parameters, blood samples were taken before treatment and on the 10th day after its completion. Venous blood samples, 10 ml, were stabilized with K3-EDTA to determine NTP concentration by enzyme-linked immunosorbent assay according to the manufacturer's instructions.

For statistical processing of the obtained data, the STATISTICA 10 program was used. The results are presented as the median (Me), as well as the 1st and 3rd quartiles (Q1; Q3). When comparing the statistical significance of differences between dependent samples (before and after rehabilitation), the nonparametric Wilcoxon T-test was used to test the null hypothesis. To test the statistical significance of differences between the indicators of independent samples (indicators of the comparison group and the main group), the Wilcoxon W test was used.

Results.

Studying the effectiveness of rehabilitation therapy with the use of "Non-invasive interface brain-computer -Exohand-2" complex (on the 10th day) in children

with cerebral palsy, a statistically significant decrease in spasticity and an increase in hand muscle strength were revealed (Table 1). The use of mental training contributed to improving the quality of everyday self-care skills, which significantly improved the quality of life of these patients.

Managing the "Non-invasive interface brain-computer -Exohand-2" complex requires significant concentration of attention from patients, and therefore the dynamics of attention indicators were assessed using the number placement test and Schulte`s tables (Table 2). An improvement in this function was shown in terms of "workability" (proportion of time spent completing the first of five tables), "psychological stability" (proportion of time spent completing the last of five tables), "work efficiency" (average time to complete the table) . Parents also noted an increase in the socialization of children, the emergence of confidence in their abilities, easier communication with peers, a significant improvement in the emotional background, indicators of well-being, activity, and mood. In the comparison group, no significant changes in similar indicators were detected.

The concentration of neurotrophic factors (BDNF, NT-3, NT-4/-5, FGF-1 and FGF-2) in the venous blood was reduced in children of the main group after a course of training using the "NIMC-exohand-2 PA Non-invasive interface brain-computer -Exohand-2" complex K. The reduction was 41% for NT-4/-5 and FGF-1, 38% for BDNF, 33% for FGF-2, 16% for NT-3. At the same time, children of the comparison group, whose treatment did not involve "the Non-invasive interface brain-computer - Exohand-2 complex", no change in neurotrophic factors concentration was detected (Table 3).

Discussion.

The results of the study show that the improvement of motor, cognitive functions and emotional status of patients after a course of rehabilitation treatment was obtained. It has been proved that a significant drop in the level of neurotrophic factors in the peripheral blood was observed, while neurotrophic factors demonstrated different levels of involvement in the rehabilitation process: BDNF, NT-3, NT- 4/-5, FGF-1 and FGF-2 showed a decrease by 30-40% of the initial level, while NGF, IGF1, GDNF, CNTF did not show a significant change in concentration. One of the most important questions to consider is how to determine the causes of differential changes in the concentrations of various neurotrophins in the peripheral blood in response to therapy. We analyzed factors that might explain the involvement of responder factors and also explain differences in changes in neurotrophin concentrations.

The key issue of the research is to determine the ratio between the concentration of neurotrophic factors in the blood plasma and in the brain structures. However, throughout patients' lifetime, it is not possible to evaluate the correlation between changes in the concentration of neurotrophic factors during therapeutic

and rehabilitation measures in various structures of the brain with changes in their serum content. Thus, it is important to provide a pathogenetic substantiation of the participation of neurotrophic factors in the process of multicomponent functional restructurization based on currently available data. The study of differentiated changes in the content of neurotrophic factors in the peripheral blood after a course of mental training in children with cerebral palsy has not been previously carried out, so in this work we analyzed data from various previous studies in vitro and in vivo, which allowed us to answer the questions posed and substantiate the results obtained.

Neurotrophic factors and the Blood-Brain Barrier. The question of the relationship between the levels of neurotrophins in the brain and peripheral blood directly depends on their possibility of crossing the Blood-Brain Barrier. Neurotrophins are formed not only in the brain, but also in other target tissues; they act through intracellular transmission systems when interacting with receptors, showing a wide range of biological effects [3]. The dynamics of their formation and content in the peripheral blood indicate both tissue utilization and the degree of their penetration through the Blood-Brain Barrier. It has long been thought that large molecules do not penetrate well through the protective mechanisms of tight junctions. However, in recent years, a research involving animals has proved that the penetration of neurotrophins through the blood-brain barrier was possible and was assessed by means of radioactive isotopes.

There are reports of a positive correlation between peripheral BDNF protein levels and brain levels in rodents, suggesting that peripheral BDNF levels may reflect brain BDNF levels. The ability of BDNF to cross the blood-brain barrier was studied by means of the labeled isotope method. BDNF remained in the blood for up to 60 minutes after intravenous administration and had an early and rapid influx into the brain with signs of aggregation. By 10 min, most of the BDNF sequestered by the cortex was associated with parenchyma rather than endothelial cells, demonstrating passage through the blood-brain barrier. After intracerebroventricular injection, BDNF efflux from the brain into the blood occurred at a rate similar to that of cerebrospinal fluid reabsorption, and no evidence of self-inhibition was found. The authors concluded that intact BDNF in the peripheral circulation actively crosses the blood-brain barrier using a powerful saturable transport system [4]. Animal studies have also shown that circulating BDNF levels are associated with neurotrophin levels in hippocampal tissue, again demonstrating that neurotrophin in the blood may be a potential marker of levels in the brain [5].

A number of studies have shown that NGF penetrates the blood-brain barrier to a lesser extent [6], which may, to a certain extent, explain the less pronounced changes in the blood during treatment.

FGF peptides in the brain regulate a variety of metabolic, behavioral and compensatory phenomena. As multifunctional peptides present with spatiotemporal

variations in neurons, glia, and the microvasculature of the central nervous system, FGFs play vital roles in brain development, maintenance of its structural integrity, and progression of several neurodegenerative diseases. The peptides FGF1 (acidic) and FGF2 (alkaline) can penetrate through three major transport interfaces into the CNS: the blood-brain barrier, the choroid plexus, and the ependymal wall. The penetration of exogenous FGF through the blood-brain barrier, it can be accelerated to enhance neuroprotection during cerebral ischemia and injury as well as to stimulate neurogenesis [7].

It has been shown that IGF-1 can penetrate from the blood into the brain, fixing isotopes in the brain after peripheral administration [8]. Other research works have shown that CNTF rapidly crosses the blood-brain barrier with a permeation rate (Ki) of 4.60 (+/-0.78) x 10 (-4) ml/g min, which is significantly faster than the 99mTc-albumin control. The results show that CNTF is saturated by transport across the blood-brain barrier from the blood to the brain [9,10].

Thus, modern ideas about the permeability of the blood-brain barrier for neurotrophins provide grounds for the assertion that the correlation shown in our work between clinical data and the content of neurotrophins in the peripheral blood is confirmed by the possibility of them crossing the Blood-Brain Barrier. At the same time, there is an insufficient number of studies in the literature that can fully explain the differentiated changes in Neurotrophins concentration obtained in our work. There are studies showing in experiments on animals with labeled isotopes that the most responsive Neurotrophins in our study, BDNF, FGF1/2, NT3/4, can penetrate the blood-brain barrier. At the same time, for CNTF and IGF-1, which have the same properties of crossing the blood-brain barrier, we did not obtain reliable dynamics. It must be emphasized that there are few such studies, and comparative studies on the degree and speed of their penetration are sporadic and do not cover the entire spectrum of molecules.

The influence of neurotrophic factors on the functions under study. It is likely that the functional characteristics and differences of neurotrophins also play a role in their differential response obtained in our study. During the training process, we received the most significant positive dynamics in three functional systems: motor, cognitive and emotional spheres. There is evidence for the possibility of involving the Neurotrophins BDNF, FGF1, FGF2, NT3, NT4/5, which, according to our research, responded by restructurization of these systems.

Until recently, these findings were thought to reflect the assumption that any motor neuron has access to multiple trophic factors in vivo [11]. It can be confirmed by the fact that the vast majority of motor neurons in mice lacking any of the Neurotrophins were not damaged. However, more recent evidence strongly suggests that different pools of motor neurons depend on different trophic factors, and that there is a great diversity in this correlation [12].

The neuroprotective effects of BDNF extend to the corticospinal motor system. Lu P. et al. found that transplantation of BDNF-secreting fibroblasts into an aspirated cortical lesion increased the survival of motor neurons in the spinal cord [13]. Neuroprotective effects of BDNF were also observed in the primary motor cortex after spinal cord lesions at the Th9 level and transplantation of mesenchymal stem cells engineered to secrete BDNF [14]. Studies of the influence of BDNF-secreting cells at the site of injury indicate that its protective effects may operate over a long distance. This was most convincingly demonstrated in a study that found neuroprotective effects in macaque pyramidal neurons when cells secreting BDNF and NT-3 were implanted at the site of C7 injury, approximately 10 cm from the cell body [15].

Nowadays, NT-3 is the only isolated Neurotrophin with high affinity for the TrkC receptor, which is expressed by neurons of the corticospinal tract [16]. Local injection of NT-3 into putative CST targets results in increased CST collateral sprouting, which is necessary for target finding, innervation, and synapse formation [17].

In 2020, a Cochrane review was published assessing the importance of circulating neurotrophins for cognitive brain function [22,23]. A study by Egan et al. and other studies have shown that people with a gene variant that determines inefficient use of BDNF may demonstrate impairments in cognitive function and even hippocampal structure [24, 25]. Similarly, adults with certain variants of the NTRK3 gene, encoding the high-affinity receptor for NT-3, are associated with deficient white matter microstructure [26] and reduced right hippocampal activation during a picture encoding task [27], suggesting that potential negative changes in NT-3 may adversely affect brain structure and cognitive function.

An important issue is the possible participation of Neurotrophins in the formation of a positive emotional reaction of a child in the process of trainings we comduct. It must be emphasized that a neurological deficit was present in the life of a child with cerebral palsy for many years and inevitably formed in the patient and relatives a feeling of hopelessness and doom in relation to the functional inferiority of the hand. We believe that by provoking a model of acute stress during the training process, we were able to cause a significant emotional outburst, which also contributed to the positive effect of the ongoing rehabilitation. The influence of Neurotrophins on the formation of emotions and their antidepressant effect has been shown in a significant number of studies.

BDNF is a molecule that may play an important role in modulating mood [28, 29]; FGF1 and FGF2 have a similar effect [30].

BDNF and the serotonergic system interact with each other in the central nervous system and jointly modulate brain processes, playing a significant role in the pathogenesis of anxiety, depression, and cognitive dysfunction in humans [31, 32]. Direct administration of BDNF into the hippocampus and midbrain [33, 34]

has shown antidepressant-like effects. Despite the heterogeneity of studies, many studies have shown that serum BDNF levels are generally lower in patients with depression [35–38].

NT-3 is thought to play a role in neurobiological processes associated with mood and anxiety disorders. NT-3 is a potential pharmacological target for mood disorders due to its effects on monoamine neurotransmitters, regulation of synaptic plasticity and neurogenesis, enhancement of BDNF signaling, and modulation of the hypothalamic-pituitary-adrenal axis. There is evidence that there are key post-transcriptional RNA regulators of the Neurotrophin-3 receptor gene in anxiety disorders [39].

It must be emphasized that all neurotrophins participate to a certain extent in the functions discussed above, but each of them has its own prevailing goals and objectives. Targeting could have a role in the differentiation of the dynamics of their content during the trainings.

Conclusion. Our research has shown that the use of the Non-invasive interface brain-computer -Exohand-2" complex for the rehabilitation of children with cerebral palsy has a positive effect in the form of an increase in the range of movements by reducing the level of spasticity and increasing muscle strength, as well as expanding the scope of everyday skills and the ability to self-care alongside with the tendency of improving indicators of cognitive functions, primarily attention, and the emotional state of patients. At the same time, a significant decrease in the concentrations of BDNF, NT-3, NT-4/-5, FGF-1 and FGF-2 in the venous blood was noted on the 10th day after rehabilitation training. Analysis of the therapeutic targets of responder factors and their ability to cross the blood-brain barrier confirms the possibility of their participation in the processes of functional restructurization, leading to the obtained effects. Thus, the results obtained indicate the active involvement of NTPs and their role in the processes of neuroplasticity, leading to increased utilization in the brain and a parallel decrease in concentration in peripheral blood. In addition, this decrease can be considered as a predictor of the effect of the therapy.

Conflict of interest: the authors declare no conflict of interest. The study was supported by the Russian Science Foundation and Republic of Crimea 22-15-20035. https://rscf.ru/project/22-15-20035.

References

1. Larina N.V., Gordienko A.I., Korsunskaya L.L., Khimich N.V. The role of neurotrophic factors in the rehabilitation of children with cerebral palsy. Neurology, Neuropsychiatry, Psychosomatics. 2022;14(6):12-19. (In Russ.) https://doi.org/10.14412/2074-2711-2022-6-12-19

2. M.G. Sokolova, T.M. Alekseeva, S.V. Lobzin, V.S. Demeshonok, O.A. Nikishina, N.V. Ulyanova. Prospects of application of neurotrophic factors in clinical neurology. Mechnikov North-West State Medical University Bulletin, 2014;6(3):75-81 Available at: https://cyberleninka.ru/article/n/neyrotroficheskie-faktory-perspektivy-primeneniya-v-klinicheskoy-nevrologii

3. Mateos-Aparicio P, Rodríguez-Moreno A. The Impact of Studying Brain Plasticity. Front Cell Neurosci. 2019;13:66. https://doi.org/10.3389/fncel.2019.00066.

4. Pan W, Banks WA, Fasold MB, Bluth J, Kastin AJ. Transport of brain-derived neurotrophic factor across the blood-brain barrier. Neuropharmacology. 1998 Dec;37(12):1553-61 https://doi.org/ 10.1016/s0028-3908(98)00141-5.

5. Klein AB, Williamson R, Santini MA, Clemmensen C, Ettrup A, Rios M, Knudsen GM, Aznar S. Blood BDNF concentrations reflect brain-tissue BDNF levels across species. Int J Neuropsychopharmacol. 2011;14:347–353. https://doi.org/ 10.1017/S1461145710000738.

6. Xhima K, Aubert I. The therapeutic potential of nerve growth factor combined with blood-brain barrier modulation by focused ultrasound for neurodegenerative disorders. Neural Regen Res. 2021 Sep;16(9):1783-1785. https://doi.org/10.4103/1673-5374.306076.

7. Conrad Earl Johanso, John E. Donahue, Edward Stopa, Andrew Baird. Fibroblast Growth Factor And The Blood-Brain Barrier. In book: Handbook of Biologically Active Peptides, Second Edition, 2013, (pp.1449-1454) https://doi.org/ 10.1016/B978-012369442-3/50205-1

8. Pan W, Kastin AJ. Interactions of IGF-1 with the blood-brain barrier in vivo and in situ. Neuroendocrinology. 2000 Sep;72(3):171-8. https://doi.org/10.1159/000054584.

9. Pan W, Kastin AJ, Maness LM, Brennan JM. Saturable entry of ciliary neurotrophic factor into brain. Neurosci Lett. 1999 Mar 19;263(1):69-71. https://doi.org/ 10.1016/s0304-3940(99)00083-x.

10. Poduslo JF, Curran GL. Permeability at the blood-brain and blood-nerve barriers of the neurotrophic factors: NGF, CNTF, NT-3, BDNF. Brain Res Mol Brain Res. 1996 Mar;36(2):280-6. https://doi.org/ 10.1016/0169-328x(95)00250-v.

11. Huang EJ, Reichardt LF. Neurotrophins: roles in neuronal development and function. Annu Rev Neurosci. 2001;24:677-736. https://doi.org/ 10.1146/annurev.neuro.24.1.677.

12. Keefe KM, Sheikh IS, Smith GM. Targeting Neurotrophins to Specific Populations of Neurons: NGF, BDNF, and NT-3 and Their Relevance for Treatment of Spinal Cord Injury. International Journal of Molecular Sciences. 2017; 18(3):548. https://doi.org/10.3390/ijms18030548

13. Lu P, Blesch A, Tuszynski MH. Neurotrophism without neurotropism: BDNF promotes survival but not growth of lesioned corticospinal neurons. J Comp Neurol. 2001 Aug 6;436(4):456-70. https://doi.org/ 10.1002/cne.1080.

14.Sasaki M, Radtke C, Tan AM, Zhao P, Hamada H, Houkin K, Honmou O, Kocsis JD. BDNF-hypersecreting human mesenchymal stem cells promote functional recovery, axonal sprouting, and protection of corticospinal neurons after spinal cord injury. J Neurosci. 2009 Nov 25;29(47):14932-41 https://doi.org/10.1523/JNEUROSCI.2769-09.2009.

15.Brock JH, Rosenzweig ES, Blesch A, Moseanko R, Havton LA, Edgerton VR, Tuszynski MH. Local and remote growth factor effects after primate spinal cord injury. J Neurosci. 2010 Jul 21;30(29):9728-37. https://doi.org/ 10.1523/JNEUROSCI.1924-10.2010.

16.Maisonpierre PC, Belluscio L, Squinto S, Ip NY, Furth ME, Lindsay RM, Yancopoulos GD. Neurotrophin-3: a neurotrophic factor related to NGF and BDNF. Science. 1990 Mar 23;247(4949 Pt 1):1446-51. https://doi.org/ 10.1126/science.247.4949.1446.

17.Schnell L, Schneider R, Kolbeck R, Barde YA, Schwab ME. Neurotrophin-3 enhances sprouting of corticospinal tract during development and after adult spinal cord lesion. Nature. 1994 Jan 13;367(6459):170-3. https://doi.org/10.1038/367170a0

18.Gao Z, Feng Y, Ju H. The Different Dynamic Changes of Nerve Growth Factor in the Dorsal Horn and Dorsal Root Ganglion Leads to Hyperalgesia and Allodynia in Diabetic Neuropathic Pain. Pain Physician. 2017 May;20(4):551-561. Available at: https://www.painphysicianjournal.com/current/pdf?article=NDQxOA%3D%3D&journal=105

19.McArthur JC, Yiannoutsos C, Simpson DM, Adornato BT, Singer EJ, Hollander H, Marra C, Rubin M, Cohen BA, Tucker T, Navia BA, Schifitto G, Katzenstein D, Rask C, Zaborski L, Smith ME, Shriver S, Millar L, Clifford DB, Karalnik IJ. A phase II trial of nerve growth factor for sensory neuropathy associated with HIV infection. AIDS Clinical Trials Group Team 291. Neurology. 2000 Mar 14;54(5):1080-8. https://doi.org/ 10.1212/wnl.54.5.1080.

20.Tep, C.; Lim, T.H.; Ko, P.O.; Getahun, S.; Ryu, J.C.; Goettl, V.M.; Massa, S.M.; Basso, M.; Longo, F.M.; Yoon, S.O. Oral administration of a small molecule targeted to block proNGF binding to p75 promotes myelin sparing and functional recovery after spinal cord injury. J. Neurosci. *2013,* 33*, 397–410 doi: 10.1523/JNEUROSCI.0399-12.2013.*

21.Pehar, M.; Cassina, P.; Vargas, M.R.; Xie, Y.; Beckman, J.S.; Massa, S.M.; Longo, F.M.; Barbeito, L. Modulation of p75-dependent motor neuron death by a small non-peptidyl mimetic of the neurotrophin loop 1 domain. Eur. J. Neurosci. *2006,* 24*, 1575–1580. doi: 10.1111/j.1460-9568.2006.05040.x*

22.Numakawa, T.; Odaka, H. The Role of Neurotrophin Signaling in Age-Related Cognitive Decline and Cognitive Diseases. Int. J. Mol. Sci. 2022, 23, 7726. https://doi.org/ 10.3390/ijms23147726

23.McPhee GM, Downey LA, Stough C. Neurotrophins as a reliable biomarker for brain function, structure and cognition: A systematic review and meta-analysis. Neurobiol Learn Mem. 2020 Nov;175:107298. https://doi.org/ 10.1016/j.nlm.2020.107298.

24.Egan MF, Kojima M, Callicott JH, Goldberg TE, Kolachana BS, Bertolino A, Zaitsev E, Gold B, Goldman D, Dean M, Lu B, Weinberger DR. The BDNF val66met polymorphism affects activity-dependent secretion of BDNF and human memory and hippocampal function. Cell. 2003 Jan 24;112(2):257-69. https://doi.org/ 10.1016/s0092-8674(03)00035-7.

25.Gao L, Zhang Y, Sterling K, Song W. Brain-derived neurotrophic factor in Alzheimer's disease and its pharmaceutical potential. Transl Neurodegener 2022;11,4. https://doi.org/10.1186/s40035-022-00279-0

26.Braskie MN, Kohannim O, Jahanshad N, Chiang MC, Barysheva M, Toga AW, Ringman JM, Montgomery GW, McMahon KL, de Zubicaray GI, Martin NG, Wright MJ, Thompson PM. Relation between variants in the neurotrophin receptor gene, NTRK3, and white matter integrity in healthy young adults. Neuroimage 2013;82:146-53. 76. https://doi.org/10.1016/j.neuroimage.2013.05.095.

27. Otnaess MK, Djurovic S, Rimol LM, Kulle B, Kähler AK, Jönsson EG, Agartz I, Sundet K, Hall H, Timm S, Hansen T, Callicott JH, Melle I, Werge T, Andreassen OA.Evidence for a possible association of neurotrophin receptor (NTRK3) gene polymorphisms with hippocampal function and schizophrenia. Neurobiol Dis 2009;34:518-24 https://doi.org/ 10.1016/j.nbd.2009.03.011.

28.Sanwald, S, Montag, C, Kiefer M. Depressive Emotionality Moderates the Influence of the BDNF Val66Met Polymorphism on Executive Functions and on Unconscious Semantic Priming. J Mol Neurosci 2020;70, 699–712. https://doi.org/10.1007/s12031-020-01479-x

29. Quan R, Wu Z, Guo W, He L, Fang P, Gong P. The BDNF Val66Met polymorphism impacts victim's moral emotions following interpersonal transgression. Scand J Psychol. 2021 Feb;62(1):7-12. https://doi.org 10.1111/sjop.12678.

30. Yanlong Liu, Dongsheng Yu, Xiaofang Wang, Xiaohua Tan, Xianming Luo, Hongzhen Fan, Yimin Kang, Jian Xiao, Xiaokun Li, Fan Wang. Is Cerebrospinal Fluid Fibroblast Growth Factor 19 (FGF19) a mood regulator? Neuropsychiatry 2017;7(2):126-130 https://doi.org 10.4172/Neuropsychiatry.1000187

31.Cubillos S, Engmann O, Brancato A. BDNF as a Mediator of Antidepressant Response: Recent Advances and Lifestyle Interactions. Int J Mol Sci. 2022 Nov 21;23(22):14445. https://doi.org 10.1016/j.neuron.2012.08.037. 10.3390/ijms232214445.

32.Arosio B, Guerini FR, Voshaar RCO, Aprahamian I. Blood Brain-Derived Neurotrophic Factor (BDNF) and Major Depression: Do We Have a Translational Perspective? Front Behav Neurosci. 2021 Feb 12;15:626906. https://doi.org 10.3389/fnbeh.2021.626906.

33.Deltheil T, Guiard BP, Guilloux JP, Nicolas L, Deloménie C, Repérant C, Le Maitre E, Leroux-Nicollet I, Benmansour S, Coudoré F, David DJ, Gardier AM. Consequences of changes in BDNF levels on serotonin neurotransmission, 5-HT transporter expression and function: studies in adult mice hippocampus. Pharmacol Biochem Behav. 2008 Aug;90(2):174-83. https://doi.org 10.1016/j.pbb.2007.09.018.

34.Allen AP, Naughton M, Dowling J, Walsh A, Ismail F, Shorten G, Scott L, McLoughlin DM, Cryan JF, Dinan TG, Clarke G. Serum BDNF as a peripheral biomarker of treatment-resistant depression and the rapid antidepressant response: A comparison of ketamine and ECT. J Affect Disord. 2015 Nov1;86:306-11. https://doi.org 10.1016/j.jad.2015.06.033.

*35.*Castrén E, Monteggia L M. Brain-Derived Neurotrophic Factor Signaling in Depression and Antidepressant Action. *Biological Psychiatry: Volume 90, Issue 2, 15 July 2021, P. 128-136 https://doi.org/10.1016/j.biopsych.2021.05.008*

36.Yang T, Nie Z, Shu H, Kuang Y, Chen X, Cheng J, Yu S and Liu H . The Role of BDNF on Neural Plasticity in Depression. Front. Cell. Neurosci.2020;14:82. https://doi.org 10.3389/fncel.2020.00082

37.Miyanishi H, Nitta A. A Role of BDNF in the Depression Pathogenesis and a Potential Target as Antidepressant: The Modulator of Stress Sensitivity "Shati/Nat8l-BDNF System" in the Dorsal Striatum. Pharmaceuticals. 2021; 14(9):889. https://doi.org/10.3390/ph14090889

38. Nazareth, A. M. BDNF, A Focus to Major Depression. Open Journal of Psychology, 2021;1(1), 10–21. DOI: 10.31586/ojp.2021.161

39.De Miranda AS, de Barros JLVM, Teixeira AL. Is neurotrophin-3 (NT-3): a potential therapeutic target for depression and anxiety? Expert Opin Ther Targets. 2020 Dec;24(12):1225-1238. doi: 10.1080/14728222.2020.1846720

Application

Table 1.

Motor function of the upper limbs and everyday skills changes in children with cerebral palsy after rehabilitation using the Non-invasive interface brain-computer -Exohand-2" complex (Me (Q1; Q3).

Index	Exohand-2" complex		Comparison group	
	Before	After	Before	After
Ashworth scale, points, Right	3 (2;3)	2(1; 2)**	3 (2; 3)	3 (2; 3)
Ashworth scale, points, Left	2 (2;3,25)	1(1; 3)**	3 (2; 4)	3 (2; 4)
Tardieu scale, points, Right	2 (1; 2)	1 (1; 2)**	2 (1; 2)	2 (1; 2)
Tardieu scale, points, Left	2 (1; 2)	1(1; 2)**	2 (1; 2)	2 (1; 2)
Muscle strength scale (flexors), points, Right	3,5 (3; 4)	4 (3; 4)**	3 (3; 4)	3 (3;4)

Muscle strength scale (flexors), points, Left	3 (3; 4)	4 (3; 4)**	3 (3; 4)	3 (3; 4)
Abilhand-Kids Scale				
Impossible, Points	4 (1;8,25)	3 (0;6,25)**	5 (2; 8)	5 (2; 7)
Difficult, Points	10(4,25;13)	8 (3,5;10)**	8 (4; 10)	8(4; 9)
Easy, Points	5 (2; 11)	9 (5;12,5)**	9 (5; 11)	9 (5; 12)
Frenchay Scale	57,46(42;85)	74,9 (47; 90)**	68,04 (48;84)	68,24(48;84)

Note. * - significant differences compared to the indicator value before rehabilitation ($p < 0.05$), ** - significant differences compared to the indicator value before rehabilitation ($p < 0.01$)

Table 2.

Changes of the attention indicators in children with cerebral palsy after rehabilitation using the Non-invasive interface brain-computer -Exohand-2" complex software and hardware complex (Me (Q1; Q3).

Index	**Exohand-2" complex**		**Comparison group**	
Schulte test	Before	After	Before	After
Work Efficiency,sec	121 (53;241)	103 (51;184) **	122 (58;247)	118(59;193)
Degree Of Workability	1.1 (0.8;1.3)	0,98 (0,78;1.1) *	1.04 (0.9;1.2)	1.02 (1;1.1)
Mental Stability	1, 1 (0.9;1.3)	0,8 (0.7:1,1) *	1 (0.9;1.05)	1 (0.9:1)
Number Placement Test	15 (12;20)	21 (17;22)*	17 (15;20)	20 (17;22)

Note. * significant differences compared to the value of the indicator before rehabilitation ($p < 0.05$), ** significant differences compared to the value of the indicator before rehabilitation ($p < 0.01$)

Table 3.

Dynamics of the content of neurotrophic factors in the blood of children with cerebral palsy after rehabilitation using Non-invasive interface brain-computer -Exohand-2" complex, (Me (Q1; Q3).

Index	**Exohand-2" complex**		**Comparison group**	
	Before	**After**	**Before**	**After**
BDNF, pkg/ml	108,77(77,7;140,7)	67,6*** (39,3;88,3)	124,3 (82,5;150,5)	117,8 (65,9; 147,0)
FGF 1, pkg/ml	16,3 (9,3;23,2)	9,6* (6,07;15,6)	12,5 (7,0; 25,8)	12,6 (8,1; 22,3)
FGF 2, pkg/ml	24,9 (20,1; 30,0)	16,6* (14,1;18,5)	24,1 (20,7; 28,7)	25,8 (20,1; 130,5)
NT3,pkg/ml	97,4 (77,8;123,9)	82,4*** (64,9;99,4)	103,2 (86,2;129,5)	99,7 (76,4;130,1)

NT4/5, pkg/ml	53,3 (35,2;66,9)	31,4*** (22,2;42,4)	39,7 (28,1;59,8)	36,4 (24,4;58,3)
NGF ,pkg/ml	21,1 (13,3;28,6)	21,6 (12,6;26,9)	16,5 (12,8;25,1)	16,42 (10,5; 23,2)
IGF1, pkg/ml	0,20 (0,15;0,25)	0,21 (0,16;0,26)	0,18 (0,15; 0,25)	0,24 (0,19; 0,31)
GDNF , pkg/ml	1,56 (1,17; 2,11)	1,50 (1,28;206)	1,59 (1,19; 2,56)	1,64 (1,1; 2,33)
CNTF , pkg/ml	23,7 (19,6;30,3)	26,4 (20,4;34,9)	25,8 (19,4;30,8)	26,77 (23,3;35,2)

Note. * - significant differences compared to the indicator value before rehabilitation ($p<0.01$), ** - significant differences compared to the indicator value before rehabilitation ($p<0.05$), *** - significant differences compared to the indicator value before rehabilitation ($p<0.001$).

DOI 10.34660/INF.2023.18.44.047
UDC 616.9

根據心率變異性分析預測病毒感染病程嚴重程度的可能性
POSSIBILITIES OF PREDICTING THE SEVERITY OF THE COURSE OF VIRAL INFECTION ACCORDING TO THE ANALYSIS OF HEART RATE VARIABILITY

Pronin Sergey Vladimirovich
PhD, Associate Professor
Novosibirsk State Pedagogical University
Associate Professor
Novosibirsk State University of Economics and Management,
Novosibirsk, Russia

Chukhrova Marina Gennadievna
MD, Professor
Novosibirsk State Pedagogical University
Professor
Novosibirsk State University of Economics and Management,
Novosibirsk, Russia
ORCID: 0000-0001-5389-5897

Novikova Marina Vladimirovna
PhD, Assistant Professor
St. Petersburg State Pediatric Medical University
Head of Department
Russian Railways-Medicine Clinical Hospital in St. Petersburg,
St. Petersburg, Russia
SPIN code: 9869-6013

註解。 需要預測病毒感染過程的嚴重程度。 作者建議使用跨診斷指標—心率變異性，它表徵壓力的整體水平和階段。 同時，有必要考慮呼吸對包含連續記錄的心動週期持續時間的曲線形狀的影響，該曲線可以用作影響呼吸系統的病毒感染的預後指標的基礎。 此方法的診斷特徵是以新冠病毒感染為例，對臨床上重度、中度和輕度病程的目標群體進行調查後得出的。 所獲得的心率變異性指標透過特殊演算法進行解釋。 當使用根據上述公式計算的該指標時，顯示組別之間具有統計上的顯著差異。 這種方法可以更有效、非侵入性地快速診斷嚴重感染的可能性，從而可以及時啟動預防措施。

關鍵字：心率變異性，病毒感染嚴重程度的預測。

Annotation. *There is a need to predict the severity of the course of a viral infection. The authors suggest using a transdiagnostic indicator – heart rate variability, which characterizes the overall level and stage of stress. At the same time, it is necessary to take into account the influence of respiration on the shape of the curve those envelopes the sequentially recorded durations of cardiocycles, which can be used as the basis for a prognostic indicator for viral infections affecting the respiratory system. The diagnostic characteristics of the proposed method were obtained as a result of a survey of target groups with clinically severe, moderate and mild course of the disease, using the example of covid infection. The obtained heart rate variability indicators were interpreted by a special algorithm. Statistically significant differences between the groups are shown when using this indicator calculated according to the above formula. This approach makes it possible to more effectively, non-invasively and quickly diagnose the likelihood of severe infection, which allows timely preventive measures to be activated.*

Keywords: *heart rate variability, prediction of the severity of viral infection.*

The relevance of research. The need to develop non-invasive monitoring systems and the ability to predict the course of any viral infections is dictated by the complexity and ambiguity of the course of infections, the influence of a large number of difficult to take into account concomitant factors, and the lack of adequate etiological treatment methods. The most common methods for predicting the severity of a viral disease are biochemical analyzes of various blood parameters aimed at identifying disruptions in the functioning of the body and concomitant pathologies. The effectiveness of predicting the course of the disease is low [1]. What is needed is a method for diagnosing the severity of the disease that is suitable for widespread use, objective, non-invasive and low-cost.

Purpose of the study: development of a method for non-invasive assessment of the prognosis of the severity of viral infection.

Research methodology. Infection with a viral infection is accompanied by neurophysiological changes and neurochemical changes in the activity of monoamine mediator systems. This allows us to assess the degree of activation of central mechanisms associated with vagoinsular effects manifested through changes in heart rate variability (HRV). The pathobiological manifestations of this response are quite stable and last for a certain time, so differences in the assessment cannot be interpreted as random measurement error. As studies show, the measurement of these phenomena is quite reliable [2, 3].

Currently, it is proposed to consider HRV a transdiagnostic test. HRV is considered as a marker of general pathology and psychopathology [4]. Psychopathological changes correlate, according to the mechanisms of psychoneuroimmunomodulation, with a decrease/impairment of immune defense, which also determines the severity of the viral infection. It was previously shown that psycho-emotional

disorders in the form of excessive anxiety and inadequate situational depression aggravate the course of coronavirus infection [5, 6]. Currently available clinical observation data suggest that changes in some components of HRV may be associated with the prognosis of the patient's future condition [7].

Method of assessing the prognosis of the severity of a patient's condition is based on a mathematical analysis of heart rhythm as an integral indicator of a person's stress level [8]. This indicator is formed on the basis of five basic determinants:

1) the total effect of regulation, assessed by heart rate per minute;

2) the total activity of regulatory mechanisms, estimated by the standard deviation (SDNN - Standard Deviation of the Normal-to-Normal) and by the total power of the spectrum of the curve enveloping sequentially recorded cardiac cycles (TP - total power);

3) vegetative balance, assessed by a set of indicators: stress index (Si –stress index), indicator of trait diversity (RMSSD- "root mean square of successive differences"), spectral power of the high-frequency range (HF-High-frequency) curve, envelope sequence of cardiac cycles, index centralization (IC – index centralization);

4) activity of the sympathetic vasomotor center, which regulates vascular tone, assessed by the power of the spectrum of slow waves (LF-low frequency) of the curve enveloping the sequence of cardiac cycles;

5) activity of suprasegmental levels of regulation, assessed by the power of the spectrum of very slow waves (VLF - very low frequency) of the curve enveloping the sequence of cardiac cycles.

In our opinion, when calculating the integral indicator of the stress level based on a mathematical analysis of the heart rhythm, reflecting according to R.M. Baevsky level of stress, it is necessary to take into account the influence of breathing on the shape of the curve enveloping the sequentially recorded durations of cardiac cycles, which can be the basis for a prognostic indicator for viral infections that affect the respiratory system, in particular, lung tissue, as occurs with infection with COVID-19 and similar viruses. The recording of HRV itself, recorded using an ECG recording or a photoplethysmographic sensor, is made within 5 minutes, with the test subject first remaining in a calm state for 5-7 minutes. The resulting HRV indices are interpreted using a special algorithm, and a mathematical calculation of the prognosis of the severity of the disease is carried out using reference points obtained from patients in whom a certain severity of the disease was clinically recorded (using the example of covid infection).

Results and its discussion.

The diagnostic characteristics of the proposed method for predicting the severe course of covid infection were obtained as a result of a survey of target groups,

where group 1 – persons with a clinically severe course of the disease (N = 64); mean age 55.8 ± 2.8 years; men 64.4%; women 35.6%; Group 2 - patients with moderate disease (N=123); and group 3 – with a mild course of the disease (N=75).

A study of general variability was carried out, where statistical and spectral analysis of heart rate was used (Baevsky R.M., 2005). Data on HRV were obtained using a pulse detector (M.B. Stark). We carried out the background (initial) recording under resting conditions for 5 minutes. Based on the processing results, the spectral indicators of HRV necessary for study were obtained (HF, LF, VLF, nHF, nLF, Tr). The total effect of autonomic regulation of blood circulation was analyzed; state of the parasympathetic division of the autonomic nervous system; a normalized indicator of the total effect of regulation was assessed; activity of the parasympathetic regulation link; the degree of predominance of the parasympathetic link of regulation over the sympathetic one; the most likely level of functioning of the cardiovascular system; a reflection of the stabilizing effect of centralization of heart rhythm control, associated with the stage of activation of the sympathetic department of the central nervous system; the relative range of regulatory influences was measured; total level of activity of regulatory systems. VLF - slow waves of the second order, associated with central ergotropic influences, LF - vasomotor waves or waves of the 1st order were assessed; HF - respiratory waves; LF/HF - the ratio of the level of the central and autonomous regulatory circuits, the coefficient of vagosympathetic balance, which increases with activation of the SNS. The centralization index IC = (LF+ VLF) / HF was calculated, which shows the degree of centralization of heart rhythm control (the predominance of the activity of the central regulatory circuit over the autonomous one). The analysis also used normalized indicators: nLF% = (LF/(LF+HF))*100; nHF% = (HF/(LF+HF))*100; the share of the total power of the parasympathetic and sympathetic sections of the ANS in the total power of the spectrum nLH% = ((LF+HF) / PW)*100. Mathematical processing of the results was carried out using software, in accordance with Russian and European-American recommendations for the analysis of heart rate variability (Table 1).

Table 1.

Comparison of HRV spectral analysis indicators in groups with different severity of Covid infection (n=262)

HRV spectral analysis indicator	Severe (1) (n=64)		Medium severity (2) (n= 123)		P 1-2	Mild (3) (n=75)	
	M±SD	%	M±SD	%		M±SD	%
VLF, ms2	630±149	27	2270±1342	55	0.010	525±131	16
LF ms2	984±143	42	1397±747	34	0.482	773±153	24
HF ms2	718±143	31	496±165	11	0.693	1980±170	60
TF ms2	2332±34	100	4164±2255	100	0.172	3277±561	100

LF/HF	1.37		2.81		0.016	0.39	
IC	2.24		7.39		0.0001	0.40	
LFms2 – HFms2	270		901		0.002	- 1207	

Diagnostic value of HRV spectral characteristics in predicting disease severity SE=45%; SP=100%; prevalence = 78%, which indicates the reliability of the proposed method.

This method allows you to assess the dynamics of the autonomic nervous system during observations in patients infected with coronavirus or other viral infection (Table 1). The values of the HRV indices are substituted into the formula for assessing the prognosis of severe disease (given below), and the resulting values are compared with the corresponding range. After which a conclusion is made: "no deviations - minimal or high risk of severe illness or death":

Disease severity index= - 4.2 + TF*0.0+ VLF*0.0+ LF*0.0+ HF*0.0 + LF/HF*0.04 + means*0.02 + sdnn* - 0.06 + CV*0.0 + RMSSD*0.04 + PNN50*-0.04 + Mode* - 0.01 + Amoda* - 0.07

Table 2.

Clinical example of the initial data of a severe course of a viral infection compared with the indicators of a healthy patient

Patient	**Patient B. severe viral infection**	**Patient S. is healthy**
Age	25	22
Severe course of the disease	Yes	No
Accompanying illnesses	Yes	No
Vlf	416.17	614.51
lf	880.14	1822.46
hf	8244.38	1541.12
tf	9540.69	3978.08
lfdelhf	0.11	1.18
lf_hf	-7364.24	281.34
mean	852.26	726.67
sdnn	146.01	46.52
sem	5.81	3.59
cv	12.78	9.94
rmssd	146.01	46.52
sdsd	108.88	72.21
pnn10	4	33.42
pnn50	75.43	8.42
dx	451	530

mode	875	725
amode	17.09	31.6
baevsky	21.65	41.12
vbi	58.5	42.63
sat	20.48	98.49
lws	5.18	54.44
stgeorg	58.5	42.63
Disease severity index	-2.28	-0.18

Explanations for the table. 2:

The disease severity index is a complex indicator, formed on the basis of seven basic determinants:

LF/HF (arbitrary units), characterizes the autonomic balance (sympathetic/ parasympathetic tone), with increasing sympathetic tone the risk increases.

Means – average heart rate beats. per minute

Sdnn (ms) – the average of all SDNN 5-minute segments over the entire recording period. The higher the indicator is, the more unstable the physical condition.

CV - coefficient of variation is a normalized estimate of the standard deviation (standard deviation).

RMSSD (ms) – a standard (root mean square) deviation of the difference between successive N–N intervals. It is a measure of HRV with short cycle lengths. Reflects the influence of the parasympathetic nervous system: changes in heart rate with a short cycle duration.

PNN50 (%) - The proportion of adjacent N–N intervals, the difference between which is >50 ms. It is a measure of HRV with short cycle durations.

Mode (ms) is the most common cardiointervals in duration; based on the Mode (Mo) value, the dominant heart rate can be determined.

Amoda is R–R interval mode amplitude, negative relationship with VLF, LF, HF.

Table 3.

Disease severity index: assessment limits (in arbitrary units)

Index severity of the disease	Number of observations	Range of values
Short	75	< -1.74
Average	123	-1.75 ÷ - 0.87
High	64	>- 0.88

Table 4.

Table of analysis of variance (ANOVA-test) to identify differences between groups with mild, moderate and severe viral infection

Indexseverity of the disease	Sum of squares	St.St.	Middle square	F	Significance
difference between 1, 2, 3 groups	130.345	2	65.173	33,405	0.0001

There are statistically significant differences between the groups when using this indicator, calculated using the given formula (Table 4).

Conclusion. Reference points were obtained based on HRV measurements in patients with an initially high risk of severe conditions and on the basis of clinical observation, and can be used in clinical diagnostics. The strengths and capabilities of this approach in assessing the prediction of the severity of viral infection in the population, in general medical practice, at the outpatient stage, in the hospital and in risk groups (doctors and medical staff of emergency rooms and infectious diseases hospitals) lie in the possibility of preliminary enhanced therapy. The described method makes it possible to non-invasively increase the efficiency of early diagnosis of the severity of a viral infection. This approach makes it possible to more effectively, non-invasively and quickly diagnose the likelihood of a severe infection, which allows timely implementation of preventive measures.

References

1. Prishchepenko V.A., Yupatov G.I., Okulich V.K. Predicting the severity of the disease in patients with viral pneumonia presumably caused byCOVID-19.// Bulletin of VSMU. – 2020. – Volume 19, No. 3. – pp. 69-78. DOI:https://doi.org/10.22263/2312-4156.2020.3.69

2. Pronin S.V., Chukhrova M.G. Transdiagnostic biomarkers in assessing suicidal predisposition in drug addicts. Suicidology. 2018; 9 (4): 109-117. DOI.org/10.32878/suiciderus.18-09-04(33)-109-117

3. Litvinova A.A., Silinkina E.D., Safonova K.A., Litvinova I.A. Assessment of cardiac arrhythmia and conduction disturbances in patients with COVID-19. // Smolensk Medical Almanac - No. 3, 2021. - P.24-26. UDC: 616.12-008.318:616.98

4. Beauchaine T.P..,Thayer JF. Heart rate variability as a transdiagnostic biomarker of psychopathology.Int. J. Psychophysiol.2015 Nov; 98 (2 Pt 2):338-350. DOI: 10.1016/j.ijpsycho.2015.08.004. Epub 2015 Aug 11.

5. Gipaeva G.A. Mechanisms of psychoneuroimmunomodulation in COVID-19 // Science and society: materials of the XU All-Russian Scientific and Practical Conference with international participation (December 2, 2020) / ed. E.L. Sorokina. – Novosibirsk: Publishing house of ANO DPO "SIPPPISR", 2020. – p. 40-43. DOI 10.38163/978-5-6043859-4-4_2020_40

6. Aronov P.V., Belskaya G.N., Nikiforov I.A. Modern approaches to the diagnosis and treatment of anxiety disorders associated with new coronavirus infection. Medical advice. 2021;(10):66–79.https://doi.org/10.21518/2079-701X-2021-10-66-79

7. Akhmedov V.A., Livzan M.A., Gaus O.V. COVID-19 and heart rhythm disturbances – is there a connection? // South Russian Journal of Therapeutic Practice. 2022;3(3):17-24.

8. Baevsky R.M., 2005, RF patent No. 2392848, IPC A61B5/0205, publ. June 27, 2010

DOI 10.34660/INF.2023.79.14.048
UDC 616

ILIZAROV 器械對股骨下三分之一的計量伸展在治療脛腓神經創傷後神經病變的應用

THE USE OF METERED STRETCHING OF THE LOWER THIRD OF THE FEMUR BY THE ILIZAROV APPARATUS IN THE TREATMENT OF POST-TRAUMATIC NEUROPATHY OF THE TIBIAL AND FIBULAR NERVIS

Kazikhanov Raidin Mirzeakhmedovich
Lieutenant Colonel of the Medical Service, Head of the Hospital
Belogorsk military hospital,
Belogorsk, Russia

Grinev Sergey Aleksandrovich
traumatologist-orthopedist
Belogorsk military hospital,
Belogorsk, Russia

註解。 組織透過生長和再生（伊利扎羅夫效應）對計量拉伸做出反應的一般生物學特性，已證明其在治療腓骨和脛神經病變中的有效性。 建議在創傷科、神經外科和神經病學領域使用Ilizarov儀器的計量拉伸治療四肢骨折和神經病變的地雷爆炸損傷患者。 作者在治療地雷爆炸傷後股骨下三分之一骨折、脛骨和腓骨神經病變的患者中測試了這種方法。 該方法顯示出很高的效率。

關鍵字：Ilizarov 裝置計量拉伸、四肢地雷爆炸損傷後骨折和神經病變。

Annotation*. The general biological property of tissues to respond to metered stretching by growth and regeneration (Ilizarov effect), it has proven its effectiveness in the treatment of fibular and tibial nerve neuropathy. It is proposed to use metered stretching by the Ilizarov apparatus for treatment in traumatology, neurosurgery and neurology in the treatment of patients after mine-explosive injuries of limbs with fractures and neuropathies. The authors tested this method in the treatment of patients with a fracture of the lower third of the femur, tibial and fibular nerve neuropathy after mine-blast wounds. The method has shown high efficiency.*

Keywords: *metered stretching by Ilizarov apparatus, fractures and neuropathy after mine-explosive injuries of limbs.*

The closed traction mechanism of damage to the sciatic nerve during a fracture of the femur creates difficulties in assessing the extent of its damage. Diagnosis of this pathology is carried out on the basis of an analysis of clinical manifestations in the form of impaired motor and sensory function of the lower limb, as well as electrophysiological studies and radiographic patterns of the fracture. Frequent diagnostic and tactical errors in this type of combined injury, untimely and inadequate surgical treatment lead to unsatisfactory treatment results. As a rule, traumatologists perform the task of stable osteosynthesis of a bone fracture, then the patient is treated conservatively for a long time by a neurologist for traumatic neuropathy of the sciatic nerve. Unjustified wait-and-see tactics in case of traction damage to the sciatic nerve leads to the development of an irreversible denervation process of the neuromuscular apparatus of the limb [1, 2, 13,15,16].

Purpose of the study: to increase the effectiveness of treatment of patients with post-traumatic neuropathies.

Research methodology. According to the standards of treatment of peripheral nervous system injuries, the diagnosis of peripheral nervous system injury is made primarily on the basis of clinical data. Additional studies (ENMG, ultrasound, MRI, CT) only clarify the extent of the lesion and its location [10].

The main manipulations performed on nerve structures in order to restore their function are neurolysis, endoneurolysis, neurorhaphy and neurotransplantation.

Neurolysis is usually understood as the so-called “external” neurolysis - the separation of the nerve trunk from the surrounding scar tissue. It is believed that neurolysis is indicated for the clinical picture of incomplete conduction disturbance and minor anatomical changes in the nerve, accompanied by cicatricial degeneration of the tissues surrounding the peripheral nerve [10, 11].

Endoneurolysis (“internal” neurolysis) is the separation of the bundles of the nerve trunk after opening the epineurium with the release of individual nerve bundles in the damaged area. It is also possible to carry out endoneurolysis by introducing saline solution through a thin needle or diluted solution of local anesthetic into the thickness of the nerve in the area of commissures [10, 14].

Neuroraphy – suture of a nerve “end to end”, is performed under the condition that it is possible to bring the damaged nerve trunk together without tension, accurately contrast and keep the transverse ones in contact cuts of the central and peripheral ends (usually incised wounds).

Indications for this operation with a complete anatomical break peripheral nerve are obvious [2, 3, 10, 13, 14].

The general biological property of tissues to respond to dosed stresses that arise in them, mainly tensile stresses, with growth and regeneration caused by stimulation of biosynthesis processes in tissues (Ilizarov effect) has been experimentally and clinically established [4, 5, 8].

It was shown that with a distraction regime of 1 mm per day in 4 doses, on the 14th day of lengthening, signs of stretching of the myelin nerve fibers in the area of nodes of Ranvier consisted of some smoothing of myelin protrusions into the outer cytoplasm of the paranodal region and jaggedness of the paranodal axolemma. Only in individual nerve fibers were there invaginations of the myelin sheath into the area of the axon, detachment of the axolemma and adjacent myelin layers. The correct parallel course of neurofilaments and neurotubules was maintained in the axons. At this time, many mitochondria and structures providing biosynthetic reactions (ribosomes, polysomes, cisterns of the granular endoplasmic reticulum) were found in the cytoplasm of the lemmocytes of the nerve fibers. The number of lysosomes also increased. Taken together, all this indicates the activity of perestroika processes. In small-caliber pulp fibers, signs of arborization were noted - the appearance in one lemmocyg of an unmyelinated axon next to a myelinated one. Schmidg-Lanterman sectoral notches, characteristic of developing fibers, appeared in the myelin structure [7, 9, 11, 12].

During the fixation period (63 days of the experiment), the increase in the lengths of the internodal segments reached 20%. Only isolated short intercalated myelin segments were observed. The amplitude of the M response was the same as at the end of distraction; the duration and latent period increased slightly. After removal of the apparatus (days 131, 137 of the experiment), lemmocytes that did not contain axons were not found in the endoneurium. Visually, the ratio of the thickness of the myelin sheath to the diameter of the axon in nerve fibers did not differ from that in intact nerves. The process of restoration of M-response parameters at this time was much more intense than in the animals of the first series. Thus, latent periods and durations normalized after 1-2 months, and the amplitude reached 70-90% of the norm by 90 days after removal of the device [6, 7, 11,12].

Results.

At the Federal State Institution “FSI 411 MH” of the Ministry of Defense of the Russian Federation, we propose to use dosed stretching with the Ilizarov apparatus in traumatology, neurosurgery and neurology in the treatment of patients after mine blast wounds of the extremities with fractures and neuropathies.

We present three clinical cases where the treatment of one pathology also cured another, no less important and complex pathology.

These patients were admitted with mine blast wounds of the lower extremities, open fractures of the lower third of the femurs with displacement of fragments along the length and width, post-traumatic neuropathy of the peroneal nerves (two patients) and neuropathy of the peroneal and tibial nerves (one patient). There were complaints about the presence of fractures of the femurs, lack of dorsiflexion of the feet in the ankle joints, numbness along the anterior surface of the feet and legs.

The time period after injury is within 25-43 days.

In order to reposition bone fragments of the lower third of the femur, dosed stretching was performed using the Ilizarov apparatus with a distraction rate of 1 mm per day.

During the process of repositioning bone fragments in these patients, on days 6, 9 and 11, active dorsiflexion of the feet in the ankle joints appeared and numbness of the feet and legs disappeared. Consequently, when the nerve was stretched by 6, 9 and 11 mm, its function was restored. The function of the nerves was restored due to the dosed tensile stress occurring in them, which led to growth and regeneration due to the stimulation of biosynthesis processes in tissues. It is possible that the nerves were released from scar tissue; this also had a positive effect on the restoration of nerve conduction.

This treatment method is based on previously published scientific works and clinical recommendations [10, 1, 13], and has not been used by anyone before.

Conclusion. Thus, stretching the nerve led to the restoration of its function. Based on these clinical examples, when dosed stress-stretching restores nerve conduction, this method can be used in the treatment of neuropathies, both in combination with bone fractures and in the treatment of neuropathy. If treatment of neuropathy with impaired limb function (without accompanying fractures) conservatively or with neurolysis fails, the following method can be proposed: perform an osteotomy of the femur and then stretch it in doses using the Ilizarov apparatus, and after restoring nerve function, also return the bone in doses to its original position.

References

1. Bogov A.A., Ignatiev V.G., Zhuravlev M.R., Khannanova I.G., Gallyamov A.R., Bogov Jr. A.A. Tactics of surgical treatment of traction injury of the sciatic nerve in combination with a fracture of the femur // Practical Medicine, No. 1, 2018, p. 77-80.

2. Bersnev V.P. Surgery of the nerves of the lower extremities // Traumatology and Orthopedics. — St. Petersburg, 2006 — V. 3. — P. 862–884.

3. Grigorovich K.A. Surgical treatment of damaged nerves. — M.: Medicine, 1981. — 301 p.

4. Ilizarov G.A. Some questions of the theory and practice of compression and distraction osteosynthesis // Materials of the All-Union Symposium on compression and distraction in traumatology and orthopedics (Kurgan, November 24-26, 1970). - M. - 1970.- P. 14-19.

5. Ilizarov G.A. Some theoretical and clinical aspects of transosseous osteosynthesis from the standpoint of general biological patterns discovered by us // Experimental, theoretical and clinical aspects of transosseous osteosynthesis

being developed at KNIIEKOT: Abstracts of the International Conference (Kurgan, September 3-5, 1986). - Kurgan, 1986.- P .7-12.

6. Ilizarov G.A., Shchudlo M.M. Ultra structure of intercellular contacts of the perineural epithelium of the nerves of the leg during its lengthening in the experiment // Transosseous compression-distraction osteosynthesis according to Ilizarov in traumatology and orthopedics: Collection. scientific works of KNIIEKOT. - Vol. 10, - Kurgan, 1985.- P.10-17.

7. Ilizarov G.A., Shchudlo M.M., Kuznetsova A.B., Shreiner A.A. Recapitulation of signs of ontogenetic growth in the sheaths of nerve trunks during experimental limb lengthening in adult dogs // Problems of transosseous osteosynthesis in orthopedics and traumatology: Patterns of tissue regeneration and growth under the influence of tensile stress: Collection. scientific works of KNIIEKOT. - Vol. 8. - Kurgan, 1982.- P.72-79.

8. Ilizarov G.A. Diploma No. 355 of the USSR, General biological property of tissues to respond to dosed stretching with growth and regeneration (Ilizarov effect) / G.A. Ilizarov (USSR). - No. OT - 11271; Declared 12/25/1985; Publ. 23.IV. 1989; Bull. No. 15.- S.Z. Priority dated November 24, 1970

9. Ilizarov G.A., Shchudlo M.M., Karymov N.R., Sayfutdinov M.S. The importance of the distraction rhythm for the implementation of the "Ilizarov effect" in the nerves of the lengthened limb segment // Genius of Orthopedics, No. 1, 1995, pp. 12-18.

10. Clinical recommendations for the diagnosis and surgical treatment of injuries and diseases of the peripheral nervous system. Clinical recommendations were approved by the decision of the XXXX plenum of the Board of the Association of Neurosurgeons of Russia, St. Petersburg, April 15, 2015.

11. Karymov N.R., Petrovskaya N.V. Ultrastructure of nerve fibers at different lengthening values of the sciatic and tibial nerves lengthened according to G.I. Ilizarov's limbs // Youth of the Trans-Urals - scientific and technological progress: Abstracts of reports of the regional scientific and practical conference of young scientists and specialists. - Kurgan, 1986. - P.71-72.

12. Kochutina L.N., Kudryavtseva I.P., Reutov A.I. Reparative myohistogenesis and changes in the peripheral nerves of the lower leg in conditions of its lengthening by methods of mono- and bilocal distraction osteosynthesis // Reactivity of the body and tissue regeneration during compression-distraction. osteosynthesis: Sat. scientific Proceedings of the All-Russian Scientific Center "WTO". - Kurgan, 1991.- P.32-44.

13. Kubitsky A.A. Surgical treatment of injuries to the peripheral nervous system of the upper limb using traction lengthening and autonervoplasty methods. Abstract of the thesis of Candidate of medical sciences. Kazan. 03/04/2002

14.Puchkov V.L. Diagnosis and microsurgery of traumatic injuries of the nerve trunks of the lower extremities // Microsurgery of traumatic injuries of peripheral nerves: Collection of res. pap. — M., 1983. — P. 46–51.

15.Stetsula V.I., Lavrishcheva G.I., Shtin V.P., Mikhailova L.N. Biological aspects of limb lengthening // Orthopedist, traumatol.- 1984.- No. 9.- P.21-26.

16.Shchudlo M.M., Varsegova T.N., Vaganova S.N., Erofeev S.A., Filimonova G.N. Dependence of quantitative indicators of the tibial nerve on the conditions and timing of distraction osteosynthesis // Genius of Orthopedics No. 2, 2002, p. 1-5.

DOI 10.34660/INF.2023.80.99.049

從A.A.院士主導的生理學教學立場看秋明市二齡婦女合併冠心病和缺鐵性貧血的STANGE和GENCHA試驗的耐缺氧性 英國托姆斯基

RESISTANCE TO HYPOXIA ACCORDING TO STANGE AND GENCHA TESTS IN WOMEN OF THE SECOND MATURE AGE IN TYUMEN WITH THE COMBINATION OF CORONARY HEART DISEASE AND IRON DEFICIENCY ANEMIA FROM THE POSITION OF THE PHYSIOLOGICAL TEACHING ABOUT THE DOMINANT OF ACADEMICIAN A.A. UKHTOMSKY

Kamshilova Olga Aleksandrovna
Assistant
Tyumen State Medical University, Tyumen, Russia

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

Ananiev Vladimir Nikolaevich
Doctor of Medical Sciences, Full Professor, Leading Research Worker
Institute of Biomedical Problems of the Russian Academy of Sciences, Moscow, Russia
ORCID ID: 0000-0002-4679-6441

Romanova Svetlana Vladimirovna
Candidate of Biological Sciences, Associate Professor
Irkutsk State University, Irkutsk, Russia

Gurtovoy Elisey Sergeevich
Student
Tyumen State Medical University, Tyumen, Russia

抽象的。 該文章提出了在音樂伴奏的背景下提高女性抗缺氧能力的積極建議，之後利用 Stange 和 Gench 測試對秋明州第二成熟女性的抗缺氧能力進行了比較分析。 有人建議，占主導地位的互誠協會的創建。 Ukhtomsky將增強女性對缺氧的抵抗力。 我們檢查了因合併冠心病（CHD）和缺鐵性貧血（IDA）而接受門診治療的女性以及檢查時沒有任何軀體疾病的同齡女性。 在內科臨床上首次將第二個成年期分為5年時段：36歲至40歲、41歲至45歲、46歲至50歲、51歲至55歲。已經證實，隨著女性年齡的增長，呼吸系統的功能會下降。 在音樂伴奏的背景下積極的生理暗示是有助於增強缺氧抵抗力的主導因素。

關鍵字: 女性、第二成年期、冠狀動脈心臟病、缺鐵性貧血、耐缺氧、Stange 和 Gentsch 試驗、建議、顯性 A.A. 烏赫托姆斯基。

Abstract. *The article presents a comparative analysis of the study of resistance to hypoxia using the Stange and Gench tests in women of the second mature age in Tyumen after a positive suggestion about the possibility of increasing it against the background of musical accompaniment. It has been suggested that the creation of the dominant A.A. Ukhtomsky will increase women's resistance to hypoxia. We examined women receiving outpatient treatment for a combination of coronary heart disease (CHD) and iron deficiency anemia (IDA) and women of the same age who did not have any somatic diseases at the time of examination. For the first time in the clinic of internal medicine, the period of the second adulthood was divided into five-year periods of time: from 36 to 40 years, from 41 to 45 years, from 46 to 50 years and from 51 to 55 years. It has been established that as women increase in age, the functionality of the respiratory system decreases. Positive physiologically based suggestion against the background of musical accompaniment is the dominant factor that helps increase resistance to hypoxia.*

Keywords: *women, period of the second adulthood, coronary heart disease, iron deficiency anemia, resistance to hypoxia, Stange and Gentsch tests, suggestion, dominant A.A. Ukhtomsky.*

Relevance. The most common diseases on earth are IHD and IDA [21, 58, 62, 80]. Issues of clinical presentation, diagnosis and treatment of anemia, including the combination of coronary artery disease and iron deficiency anemia, have been the subject of discussion for many years [14, 15, 16, 44, 47, 61]. Thus, IHD was diagnosed in 126 million people around the world, and over 2 billion people suffer from IDA and 3.4 billion people have hidden iron deficiency. IHD is characterized by widespread prevalence and is one of the leading problems of modern medicine, which is associated not only with an unfavorable prognosis, but also with high financial costs for treatment [39, 57, 70, 71, 75]. In our practical work, we adhered to the functional classification of angina developed in 1976 by the Canadian Cardiovascular Society.

We emphasize that among currently known anemias, IDA is the most common [28, 35, 64, 65, 76]. IDA is an independent predictor of cardiovascular disease and adverse outcomes [45]. It has been shown that iron deficiency can lead to serious disturbances in oxidative metabolism and cellular energy mechanisms, which is reflected in the level of oxygen consumption and exercise tolerance - factors that are especially important for patients with diseases of the cardiovascular system (CVD) [22, 40]. Iron deficiency ranks first among the 38 most common human diseases, negatively affecting the activity of the cardiovascular system [41, 63, 66, 72, 74].

It is known that the presence of comorbid chronic diseases, including CVS and blood, aggravates the somatic status [9, 36, 55]. The term comorbidity was first introduced into clinical practice by the outstanding American physician Alvan R. Feinstein (1925 – 2001) in 1970, and the term was clarified by H.C. Kramer (1995) and van den M. Akker (1996), who proposed the first classification of comorbidity.

Alvan R. Feinstein.

In the concept of comorbidity, we mean the presence of two or more chronic diseases that are both etiologically and pathogenetically interrelated or are diagnosed simultaneously [10, 37]. In the available literature, we have not found studies that shed light on the function of external respiration in women of the second mature age of Tyumen when they combine coronary artery disease without signs of chronic heart failure, with moderately severe IDA, in which the hemoglobin concentration in the blood ranged from 89 up to 70 g/l. There are practically no publications reflecting the influence of suggestion as a dominant according to A.A. Ukhtomsky, with a combination of ischemic heart disease and iron deficiency anemia in women of the second adulthood, on the function of external respiration. At the same time, the study of suggestion is carried out at various methodological levels [19, 23, 27].

In 1969, Swedish psychologist Lars-Eric Uneståhl proposed a system of psychological training for athletes called Unestahl Mental Training, defended in the form of a doctoral dissertation at Uppsala University, which helps them, through hypnosis and self-hypnosis, enter an “ideal active state” [77 , 78, 79].

Lars-Eric Uneståhl

Having analyzed his methodology, we concluded that suggestive suggestion (hypnosis) to increase the functional capabilities of the female body can be used in clinical practice. Of course, we understand that the use of suggestion in clinical practice has a number of limitations [11, 12, 29, 38, 48, 67]. We especially note that we carried out suggestion only when we were convinced that the woman had reached the appropriate level of development of abstract thinking and had the skills of concentration and imagination. Let us especially emphasize that we consider suggestion not as a placebo, but as one of the effective and safe therapeutic and diagnostic procedures.

Purpose: in women of the second mature age of Tyumen, undergoing outpatient treatment for a combination of coronary artery disease and iron deficiency anemia, through suggestion from the standpoint of the physiological teachings of Academician A.A. Ukhtomsky about the dominant to study resistance to hypoxia.

Material and methods. External respiration function was assessed in two groups of women. The first group (MG – main group) included 28 women of the second mature age (48.4±2.9 years) undergoing outpatient treatment at RCH No. 2 in Tyumen for a combination of chronic ischemic heart disease without signs of heart failure and IDA. Arterial hypertension was diagnosed in 7 women from the MG; 3 women have type 2 diabetes mellitus, which does not require insulin; 4 women had grade 1-2 obesity. 18 women believe that the first symptom of coronary artery disease they had was angina pectoris, which correlates with the data of other researchers [33, 34]. The second group (CG - control group) using a random sampling method consisted of 30 women of the same age (47.8±2.7 years) who did not have clinically and instrumentally confirmed diseases of the cardiovascular system and blood at the time of the examination.

In women of these groups, against the background of positive-sounding music, we used hypnotic suggestion to create a dominant according to the method of Academician A.A. Ukhtomsky [2, 50, 51, 52].

Alexey Alekseevich Ukhtomsky.

We assumed that the human brain, while awake, operates on certain algorithms that require constant updating [4, 5, 25, 43]. Let us make the assumption that the suggestion we use, in other words, intelligently structured speech, is based, firstly, on the proximity of the auditory and articulatory zones of the cerebral cortex. We agree with the opinion of [1, 46, 60] and therefore perceive suggestion as a type of speech influence. Secondly, such proximity, which has direct connections in the deep structures of the cortex between receptor, i.e. auditory and motor, articulatory neurons according to the principle of proximity, creates the dominant that A.A. spoke about. Ukhtomsky and which we consider and use in this work. We have made the assumption that the process of updating neural connections in the brain will be more effective if it is stimulated with the help of breathing, in particular by voluntary retention of inhalation and exhalation under musical accompaniment and verbal hypnotic suggestion by creating the dominant A.A. Ukhtomsky. An unresolved issue in this situation is the identification of individual age-related functional characteristics of physiological adaptation of women suffering from a combination of IHD and IDA, by studying functional tests with holding the breath during inhalation and exhalation when using a positive verbal hypnotic suggestion against the background of musical accompaniment. For 10 minutes, the woman was calmly accompanied by musical accompaniment (most often women chose the music of W.A. Mozart “Rondo Alla Turca” - “Turkish Rondo”), firstly, that she could do it without much effort and, secondly, without visible physical stress will be able to hold your breath longer than usual. We made the assumption that, albeit short in time, but precisely the positive nature of suggestion against the background of musical accompaniment, can be that irritant for the brain, which, in accordance with the teachings of Academician A.A. Ukhtomsky about the dominant, programs it for more pronounced and time-stable preservation of the function of the respiratory system.

Modern anthropology describes several periodizations of human ontogenesis [6, 7, 26, 31, 68, 69]. When assessing the age of women, we adhered to the scheme of age periodization of human ontogenesis, adopted at the VII All-Union Confer-

ence on Problems of Age-Related Morphology, Physiology and Biochemistry of the Academy of Pedagogical Sciences of the USSR in Moscow in 1965. According to this periodization, the period of the second mature age lasts from 36 to 55 years, i.e. 20 years. It is quite natural to assume that during this period of life in women, for example, at the age of 36 years, morphofunctional indicators not only can, but should also differ from the age, for example, 54 years. Considering that in the literature available to us we have not found studies characterizing the function of external respiration in women living in Tyumen, we divided the second period of adulthood into 5-year intervals. MG: from 36 to 40 years (38.3±1.7; n = 8), from 41 to 45 (43.4±1.6; n = 6) years, from 46 to 50 (47.2±1 .5; n = 7) years and from 51 to the age of 55 (52.5±1.6; n = 7) years. CG: from 36 to 40 years (38.6±1.6; n = 8), from 41 to 45 (44.2±1.7; n = 8) years, from 46 to 50 (48.1±1 .7; n = 7) years and from 51 to 55 (52.8±1.5; n = 7) years (Fig. 1).

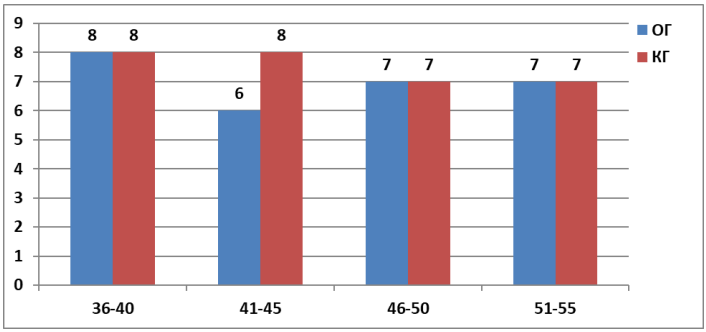


Figure 1. *Number and age composition of women in the compared groups.*

From the anamnesis it was revealed that due to illness and an increase in the passport age, the level of physical activity in all women decreased, which is expressed in the fact that women in the MG walked an average of 1.86 ± 0.32 km during daylight hours, and women in the CG 3.17 ±0.28 km ($p<0.05$). It was also found that 78% of women in the MG and 63% of women in the CG led a sedentary, mostly sedentary lifestyle associated with the conditions of professional activity. In addition, 57% of women in the MG and 34% of women in the CG noted the presence of domestic and work-related stressful situations. 18% of women in the MG and 21% of women in the CG had a night work schedule. The duration of night sleep in 53% of women in the MG was 8 hours, in 41% – 7 hours, and in 6% less than 7 hours. The duration of night sleep in 62% of women in the CG was 8 hours, in 33% – 7 hours and in 5% less than 7 hours.

It should be emphasized that the women's families have permanently lived in the south of Western Siberia in the city of Tyumen for three generations.

In accordance with the clinical examination rules adopted at RCH No. 2 in Tyumen, all women receiving outpatient treatment underwent a comprehensive clinical, biochemical and instrumental examination. In this report, we focus only on the results of studying resistance to hypoxia using standard functional tests of Stange and Gentsch in a state of physiological rest after a positive 8-10 minute verbal suggestion against the background of pleasant musical accompaniment.

We selected tests with arbitrary breath-holding during inhalation and exhalation due to two combined factors. Firstly, due to the fact that they allow you to quickly and safely determine the general functional state of the respiratory system, resistance to hypoxia and hypercapnia. Secondly, the samples are methodologically simple and accessible and do not require special equipment, which is important in conditions of mass examinations.

The research results were processed on a personal computer using modern electronic programs (STATISTIKA). The significance of differences was assessed using Student's t test [18].

The principles of voluntariness, individual rights and freedoms guaranteed by Articles 21 and 22 of the Constitution of the Russian Federation, as well as Order of the Ministry of Health and Social Development of Russia No. 774n of August 31, 2010 "On the Ethics Council" are observed. The study was conducted in accordance with the ethical standards set out in the Declaration of Helsinki and the European Community Directives (8/609EC) and the informed oral consent of the women.

Results and discussion.

Voluntary holding of breath while inhaling (Stange test).

We used a test proposed by the professor of physical methods of treatment at the Imperial Clinical Institute of Grand Duchess Elena Pavlovna, chairman of the St. Petersburg Medical Society, Vladimir Adolfovich Stange (1856–1918). We should note that in our country, close attention has been paid to the Stange test in clinical studies for many years [3, 13, 17, 24, 59].

Vladimir Adol'fovich Stange.

Regarding the normative values of voluntary breath holding during inspiration in women, we should note that the information in the available literature is contradictory. We adhere to the following values: less than 39 seconds - unsatisfactory; 40-49 seconds - satisfactory; over 50 seconds - good.

In the Stange test, we identified two phases, of which the first characterized the true duration of resistance to hypoxia, while the second indicated the so-called. volitional component (Table 1).

Table 1

Age values of the Stange and Gentsch tests in women from the MG and CG of the second mature age before (I) and after (II) suggestion (M±m)

Group	Stange (1 phase)	Stange	Gentsch
36 – 40			
MG (I)	23,64±1,05	42,87±1,23	23,06±1,06
CG (I)	26,93±1,12	46,29±1,19	25,49±1,13
Difference	3,29	3,42	2,43
MG (II)	23,97±1,07	43,51±1,23	26,13±1,08
CG (II)	27,36±1,10	46,12±1,19	29,38±1,11
Difference	3,39	2,61	3,25
41 – 45			
MG (I)	23,12±1,08	41,18±1,27	22,57±1,11
CG (I)	26,08±1,12	46,01±1,22	25,09±1,14
Difference	2,96	4,83	2,52
MG (II)	25,02±1,09	43,31±1,27	25,49±1,11
CG (II)	28,13±1,14	45,70±1,23	28,43±1,14
Difference	2,43	2,39	2,94
46 – 50			
MG (I)	22,73±1,16	40,37±1,26	22,11±1,19
CG (I)	24,82±1,10	45,22±1,28	24,22±1,16
Difference	2,09	4,85	2,11
MG (II)	25,23±1,13	42,72±1,24	25,01±1,19
CG (II)	28,98±1,15	45,09±1,26	27,62±1,16
Difference	3,75	2,37	2,61
51 – 55			
MG (I)	21,84±1,16	39,15±1,19	21,23±1,12
CG (I)	23,92±1,15	42,38±1,24	23,36±1,09
Difference	2,08	3,23	2,13
MG (II)	25,44±1,12	40,86±1,22	24,44±1,12
CG (II)	29,19±1,17	42,91±1,25	26,95±1,09
Difference	3,75	2,05	2,51

The study, firstly, established (Fig. 2) that the duration of voluntary breath holding during inhalation in women of the second mature age in a state of physical rest was at the level of normative values. Secondly, in absolute terms, the duration of the Stange test in women from the CG was shorter than in their peers from the CG. Thus, the difference in the duration of voluntary breath holding during inspiration between women in the MG and CG ranged from 3.23 to 4.85 seconds, which is statistically significant ($p<0.05$).

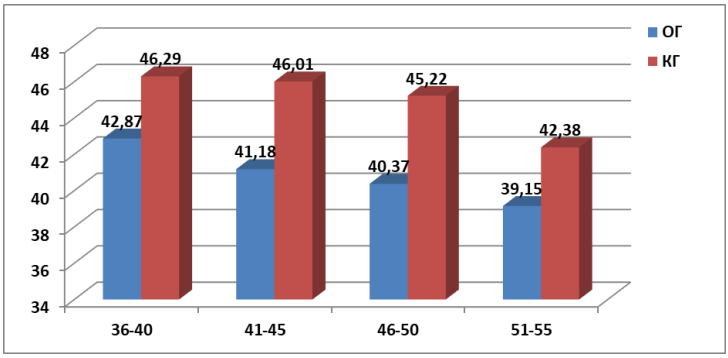


Figure 2. *Age-specific values of the duration of voluntary breath holding on inspiration using the Stange test in women of the second mature age in a state of physical rest.*

We should note that after verbal suggestion against the background of musical accompaniment, firstly, the duration of breath holding during inhalation increased according to the results of the Stange test (Fig. 3).

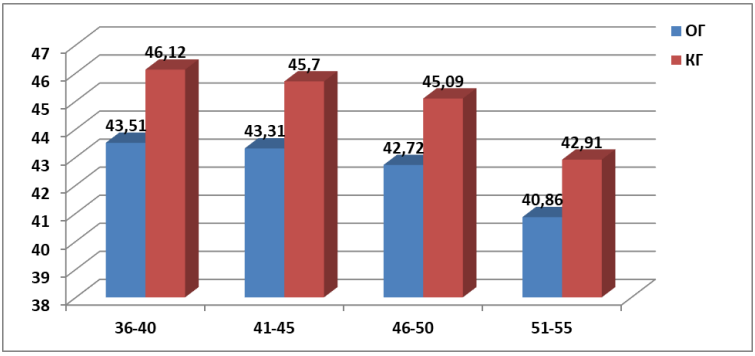


Figure 3. Age values of the duration of voluntary breath holding on inspiration using the Stange test in women of the second mature age after suggestion.

Secondly, in women from the CG during all periods of the examination, the duration of breath holding in absolute values was longer. Thirdly, due to an increase in the passport age, the duration of breath holding during inhalation decreased (Fig. 4).

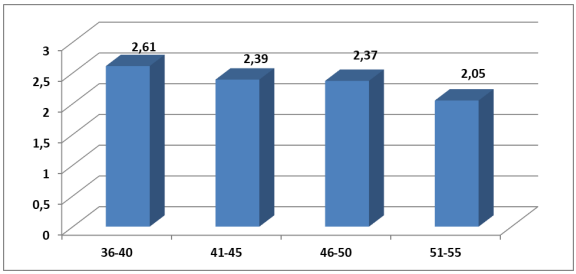


Figure 4. *Age-related differences in voluntary breath-holding during inhalation according to the results of the Stange test in women from the MG and CG.*

Voluntary holding of breath while exhaling (Gench test).

When assessing the duration of voluntary breath holding during exhalation, we used the test proposed in 1926 by the Hungarian physician Gönczy (Gench), which has found wide use in the clinic and sports [8, 20, 30, 42, 49]. We assessed the duration of breath holding as follows: less than 34 seconds - unsatisfactory; 35-39 seconds - satisfactory; over 40 seconds - good.

The results of studying the resistance of women to hypoxia using the Gench test indicated (Fig. 5) that, firstly, in all of them it was rated as unsatisfactory, because it did not reach standard values. Secondly, in absolute terms, breath holding during exhalation in women from the MG was less than in women from the CG. Thirdly, as the passport age increases, the resistance to hypoxia of women of the compared groups decreases in absolute values, especially among representatives of the MG, which is statistically significant ($p<0.05$).

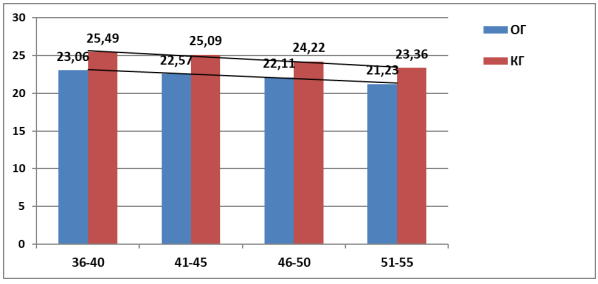


Figure 5. *Age values of the duration of voluntary breath holding on exhalation using the Gench test in women of the second mature age in a state of physical rest.*

After the suggestion, the duration of voluntary breath holding on exhalation, according to the results of the Gench test, indicated its increase (Fig. 6).

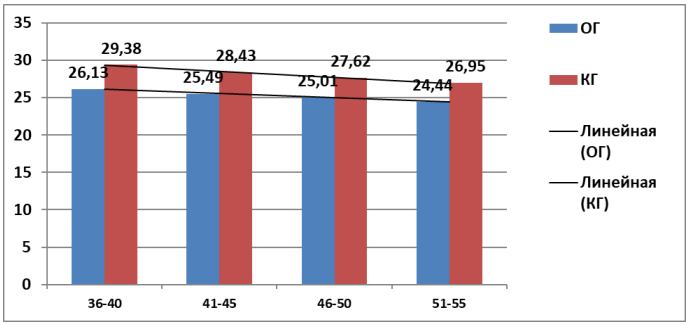


Figure 6. *Age values of the duration of voluntary breath holding on exhalation according to the results of the Gench test in women of the second mature age after suggestion.*

Differences in the age-related values of the duration of voluntary breath holding on exhalation were revealed according to the results of the Gench test in women of the second mature age of the compared groups after suggestion. They indicated that, due to an increase in the age at birth, there is a decrease in resistance to hypoxia (Fig. 7).

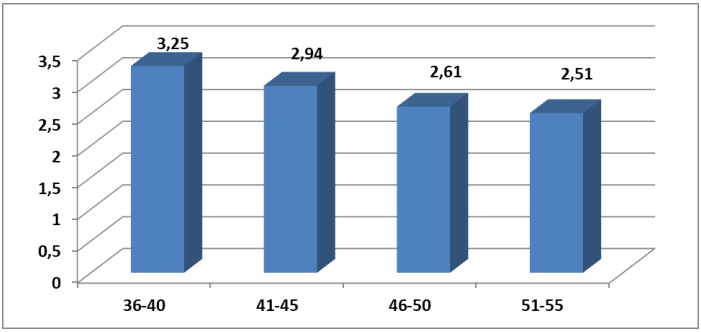


Figure 7. *Age differences in the duration of voluntary breath holding on exhalation according to the results of the Gench test in women from the MG and CG after suggestion.*

Limitations of the study. We believe that a relative limitation of the study is the relatively small number of women examined for each 5-year segment of the 9th period of ontogenesis. But, nevertheless, our personal contact with each woman

made it possible not only to increase the accuracy and reliability of the results obtained, but also to compensate for the relative small number of the studied groups.

Conclusion. Comorbid diseases have an increasing tendency to increase from year to year in almost all countries of the world, and cover almost a quarter of the adult population of the world. As scientific research shows, comorbidity leads not only to high rates of mortality and disability, but also to frequent side effects of treatment, significant financial costs of healthcare for rehabilitation, and low quality of life. The combination of coronary artery disease and iron deficiency anemia is a serious pathology, and the rehabilitation of patients is one of the most important tasks of modern medicine, since it is not only an important social, but also an economic problem. To implement it, multifaceted clinical studies are needed at various methodological levels, including patients with multiple chronic diseases living in different regions of our country. Practitioners should rely on such clinical recommendations for examination and treatment that will allow the primary care doctor not only safely, but also without significant material costs and quickly diagnose and prescribe appropriate treatment. Such accessible and safe methods of clinical research include the standard Stange and * tests, which, we believe, give an objective idea of the functional capabilities of the body. In our opinion, these tests should not be excluded from the doctor's arsenal at all stages of outpatient treatment of patients, especially with comorbid pathology. We believe that at the current stage of achievements of medical science, one should not neglect the methods of positive suggestion, the use of which is absolutely safe for humans, but allows from the standpoint of the physiological teachings of Academician A.A. Ukhtomsky about the dominant to increase the functional state of the body, especially against the background of a combination of a number of diseases.

References

1. Alimuradov A. The essence of the phenomenon of suggestion in media discourse and the main factors of the success of this process / A. Alimuradov // Language. Text. Discourse. 2010. No. 8. P. 363-375.

2. Ananyev V.N. Psychological mechanisms of increasing muscle dominance of academician A.A. Ukhtomsky / V.N. Ananyev, N.Ya. Prokopyev, A.M. Durov. // Physical culture: upbringing, education, training 2022. No. 6. P. 5-7.

3. Anzorov V.A. Functional state of the respiratory system of women during pregnancy / V.A. Anzorov, E.M. Ilyasova, Zh.M. Ataeva // News of the Chechen State University. A.A. Kadyrov. 2022. No. 4 (28). pp. 14-19.

4. Anokhin P.K. Fundamental questions of the general theory of functional systems / P.K. Anokhin // Principles of systemic organization of functions: M.: Nauka, 1973, pp. 5-61.

5. Anokhin P.K. Anticipatory reflection of reality // Philosophical aspects of the theory of functional systems. / P.K. Anokhin. M.: Nauka, 1978. P. 7-27.

6. Antropov Yu.A. Mature period of ontogenesis and some psychopathological phenomena / Yu.A. Antropov, A.Yu. Antropov // Current issues in psychiatry and narcology. Chisinau, 1992. pp. 18-21

7. Arshavsky I.A. Basics of age periodization /I.A. Arshavsky. // Age physiology. L.: Nauka, 1975. P. 5-67.

8. Astakhova M.S. Comparative analysis of the functional state of athletes using the Stange and Genchi tests / M.S. Astakhova, E.V. Chebunina // Current issues of physical education of youth and student sports: collection of proceedings of the VI All-Russian scientific and practical conference. Saratov, 2023. pp. 396-400.

9. Bakirova E.A. Analysis of the reasons for the formation of comorbid conditions in elderly people / E.A. Bakirov // Bulletin of the Medical Dental Institute. 2023. No. 1 (64). pp. 33-34.

10. Belyalov F.I. Treatment of internal diseases in conditions of comorbidity. / F.I. Belyalov. Irkutsk: RIO IGMAPO, 2013. 297 p.

11. Bekhterev V.M. Hypnosis, suggestion, psychotherapy and their therapeutic effects / V.M. Bekhterev. // Bulletin of knowledge. St. Petersburg, 1911. Issue. 4. 60 p.

12. Bekhterev V.M. Consciousness and its boundaries. / V.M. Bekhterev. Kazan: Type. Emperor un-ty. 1888. 32 p.

13. Boyarskaya L.A. Chronobiological indicators of resistance to hypoxia using the Stange and Gench tests in women of the second adulthood suffering from coronary heart disease during the covid-19 pandemic / L.A. Boyarskaya, N.Ya. Prokopyev, V.N. Ananyev // Current issues in the diagnosis and treatment of the most common diseases of internal organs. Materials of the XII therapeutic forum. Tyumen, 2022. pp. 28-29.

14. Bulkin M.D. Prevalence of coronary heart disease in the modern world / M.D. Bulkin, T.A. Konovaltseva, I.E. Trukhmaeva //Young scientist. 2023. No. 32 (479). pp. 19-21.

15. Vinogradova N.G. Iron deficiency conditions in cardiovascular diseases: impact on prognosis and features of correction / N.G. Vinogradova, A.I. Chesnikova //South Russian Journal of Therapeutic Practice. 2023. T. 4. No. 1. P. 7-18.

16. Volchkova N.S., Subkhankulova S.F. Diagnosis and treatment of anemia in general medical practice: connection with cardiovascular diseases. // International Journal of Heart and Vascular Diseases. 2022; 10 (34): 44-53. DOI 10.24412/2311-1623-2022-34-44-53

17. Voronin R.M. Experience in using the breath-hold test in psychological research / R.M. Voronin, V.I. Ogorodnikov // Applied legal psychology. 2022. No. 4(61). pp. 84–93. DOI: 10.33463/2072-8336.2022.4(61).084-093.

18. Glanz S. Medical and biological statistics. / S. Glanz. M: Praktika, 1999. 459 p.

19. Dikun N.V. Suggestion in medical-didactic discourse: concepts tortoise, turtle and teacher (based on the communicative practices of a medical college) / N.V. Dikun, I.G. Golubev, D.A. Demidenko //Modern science: current problems of theory and practice. Series: Humanities. 2021. No. 8. pp. 131-136.

20. Dynamics of indicators of Stange and Genchi tests of students of St. Petersburg State Forestry University named after S. M. Kirov, engaged in recreational walking / T.N. Bakhtina, T.A. Osechkina, N.S. Lesheva, S.S. Plotnikova // Physical culture and health. 2023. No. 3 (87). pp. 12-16.

21. Eliseeva R.S. Frequency and prevalence of different types of anemia in the Kursk region / R.S. Eliseeva // Youth science and modernity. Materials of the 88th International Scientific Conference of Students and Young Scientists. In 4 volumes. Kursk, April 20–21, 2023. pp. 465-468.

22. Zhorova V.E. Frequency and prevalence of iron deficiency anemia / V.E. Zhorova, E.G. Khilkevich //Medical Council. 2018. No. 13. pp. 78-81.

23. Zadorozhnyuk E.G. Are the concepts of "suggestion" and "counter-suggestion" in demand by modern social science? / E.G. Zadorozhnyuk, I.E. Zadorozhnyuk //Dialogue with time. 2021. No. 77. pp. 28-44.

24. Irzhak L.I. Determination of the functional residual capacity of the lungs in humans using the Genche and Stange tests. / L.I. Irzhak // Russian physiological journal. 2001. V.87, no. 2. pp. 279-281.

25. Kapitonov D.D. Development of an algorithm for prioritizing information based on the mechanisms of the brain and spinal cord / D.D. Kapitonov, K.E. Ushakov, T.A. Malkina // The future of mechanical engineering in Russia. 2022. collection of reports. XV All-Russian Conference of Young Scientists and Specialists (with international participation). Moscow, September 21–24, 2022. pp. 380-386.

26. Kahana M.S. Phases of ontogenesis, hypothalamus and the aging process. / M.S. Kahana, B.E. Miller. Chisinau: Cartea Moldavenasca, 1975. 102 p.

27. Kvitchasty A.V. Altered states of consciousness in sports psychology: hypnosis, suggestion and autosuggestion / A.V. Kvitchasty //Modern foreign psychology. 2021. V. 10. No. 3. P. 92-102.

28. Kichigin V.A. Modern views on anemia of chronic diseases / V.A. Kichigin // Healthcare of Chuvashia. 2022. No. 2. P. 16-26.

29. Kozlov V.V. Theory and practice of clinical hypnosis / V.V. Kozlov, N.A. Vlasov // Human factor: Social psychologist. 2019. No. 2 (38). pp. 3-18.

30. Kolunin E.T. Chronobiological indicators of resistance to hypoxia in boys during their second childhood in Tyumen during the covid-19 pandemic, involved in team sports / E.T. Kolunin, N.Ya. Prokopyev, D.S. Rechapov // Sports games in physical education, recreation and sports: materials of the XV International Scientific and Practical Conference. Smolensk, 2021. pp. 111-115.

31.Kon I.S. Age categories in the sciences of man and society / I.S. Con. // Sociological research. 1978. Vol. 3. pp. 76-86.

32.Koshlataya O.V. Frequency of occurrence of chronic kidney disease in elderly patients with chronic coronary heart disease / O.V. Koslataya, O.A. Sudzhaeva, O.N. Popel //Cardiological Bulletin. 2023. V. 18. No. 2-2. P. 131.

33.Kushelevsky B.P. Angina pectoris and their differentiated therapy / B.P. Kushelevsky, A.N. Coconuts. M.: Medicine, 2018. 316 p.

34.Lambich I.S. Angina pectoris / I.S. Lambich, S.P. Stozhinich. M.: Medicine, 2022. 432 p.

35.Lytkina K. A. Iron deficiency and immunity: what's new in the third decade of the 21st century? New possibilities of ferroceron. / Lytkina K. A. //Attending physician. 2022.No. 5. P. 70-76. doi: 10.51793/OS.2022.25.6.013.

36.Nasyrova Z.A. Features of the course of coronary heart disease in patients with comorbid pathologies / Z.A. Nasyrova, Yu.Yu.K. Kurbonova, D.A. Nasirova // Bulletin of science and education. 2020. No. 1 (79). pp. 97-100.

37.Nechaev O.I. Improving care for comorbid pathology (experience of the Russian Federation) / O.I. Nechaev // X annual international scientific and practical conference "Current issues in medicine" and "IV Satellite Forum on public health and health policy." Baku, April 27–28, 2023. pp. 28-29.

38.Pavlov I.P. On the mechanism of the hypnotic state of a person / I.P. Pavlov // Questions of psychology. 1969. No. 5. P. 158-159.

39.Panev N.I. Comparative assessment of the frequency of risk factors for the development of coronary heart disease and arterial hypertension in miners with anthracosilicosis / N.I. Panev, N.A. Evseeva //Medicine in Kuzbass. 2022. V. 21. No. 4. P. 30-34.

40.Perezhogin S.A. Relevance of anemia of chronic diseases / S.A. Perezhogin // News of the Russian Military Medical Academy. 2021. V. 40. No. S1-1. pp. 114-116.

41.Rumyantsev G.A. Prevalence of iron deficiency conditions and factors influencing it / G.A. Rumyantsev // Medical Council. 2015. No. 6. P. 62-66.

42.Semenenko K.S. The use of functional tests by Stange and Genche to assess the level of fitness of the respiratory system / Semenenko K.S., Lomako S.A., Novik G.V. // Current problems of medicine. Materials of the Republican Scientific and Practical Conference and the 27th final scientific session of the Gomel State Medical University. Editor A. N. Lyzikov. 2018. pp. 680-682.

43. Silkis I.G. Mechanisms of functioning of the connectome, including the neocortex, hippocampus, basal ganglia, cerebellum and thalamus. / I.G. Silkis // Journal of Higher Nervous Activity named after. I.P. Pavlov, 2022. V. 72. No. 1. P. 36-54.

44.Smirnova M.P. Factors associated with iron deficiency in patients with chronic heart failure / M.P. Smirnova, P.A. Chizhov //Cardiovascular therapy and prevention. 2023. T. 22. No. 2. P. 38-45.

45.A modern view of a therapist on the problem of iron deficiency anemia in patients with cardiovascular pathology. / G.N. Gorokhovskaya, A.I. Martynov, V.L. Yoon, M.M. Petina //Medical Council. 2020;(14):70-78. doi: 10.21518/2079-701X-2020-14-70-78

46.Sternin I.A. Introduction to speech influence. /I.A. Sternin. Voronezh: Istoki, 2001. 252 p.

47.Tarasova N.A., Khasanov N.R. Iron deficiency in patients with cardiovascular diseases. Practical medicine. 2023. V. 21, No. 2, pp. 15-20.

48.Tukaev R.D. Great Russian medical scientists, academicians I.P. Pavlov and V.M. Bekhterev and their contribution to the development of research and practice of domestic hypnosis, hypnotherapy, psychotherapy / R.D. Tukaev // Bulletin of psychotherapy. 2023. No. 85. pp. 15-27.

49.Resistance of students aged 18-22 years of various universities and training profiles to hypoxia / E.A. Semizorov, N.Ya. Prokopyev, D.G. Gubin, A.M. Durov, S.V. Solovyova //Science and sport: modern trends. 2019. V. 7. No. 3. P. 116-124.

50.Ukhtomsky A.A. Dominant. Articles from different years. 1887-1939. /A.A. Ukhtomsky. St. Petersburg: Peter, 2002. 448 p.

51.The doctrine of the dominant of academician A. A. Ukhtomsky in pedagogical practice in the sphere of physical culture and sports / N.Ya. Prokopyev, V.N. Ananyev, E.A. Semizorov, E.S. Gurtova, S.I. Khromina // Scientific and sports bulletin of the Urals and Siberia. 2020. No. 4 (28). pp. 71-75.

52.The doctrine of the dominant of academician A.A. Ukhtomsky and his role in modern medicine and biology / V.N. Ananyev, N.Ya. Prokopyev, L.A. Boyarskaya, O.V. Ananyeva, E.A. Semizorov // Natural and technical sciences 2022. No. 5 (168). pp. 93-102. DOI: 10.25633/ETN.2022.05.06

53.Functional state of the cardiovascular system in patients with chronic heart failure of coronary origin with concomitant iron deficiency anemia / 53, Osova, L.L. Sidorova, V.N. Tsaralunga, N.N. Sidorova //Heart and blood vessels. 2011. No. 3 (35). pp. 071-080.

54.Function of external respiration in male university students in Tyumen during hiking / N.Ya. Prokopyev, V.N. Ananyev, V.N. Prokopyev, E.S. Gurtova, E.A. Semizorov // Scientific and sports bulletin of the Urals and Siberia. 2021. No. 4 (32). pp. 3-11.

55.Khryapinskaya E.V. Pharmacotherapy of patients with coronary heart disease in conditions of comorbid pathology / E.V. Khryapinskaya, G.S. Mal, I.A. Gribovskaya // Biotechnology and biomedical engineering. Collection of scientific papers based on the materials of the X All-Russian scientific and practical conference with international participation, dedicated to the 25th anniversary of the Faculty of Biotechnology and the 20th anniversary of the Department of Biological and Chemical Technology. 2017. pp. 208-209.

56. Frequency and structure of complications in patients with coronary heart disease and acute myocardial infarction / A.I. Tabarov, M.E. Rajabzoda, Sh.M. Safaraliev, I.Kh. Emomzoda //Science and innovation. 2021. No. 4. P. 197-203.

57. Frequency of coronary heart disease against the background of resistant arterial hypertension in young and middle-aged patients. / H.Yo. Sharipova, D.D. Rakhimov, R.G. Sokhibov, R.M. Gulova, D.U. Kosimova //Bulletin of Avicenna. 2022;24(3):317-23. Available from: https://doi. org/10.25005/2074-0581-2022-24-3-317-323

58. Cherepanova V.V. Anemic syndrome in patients of a therapeutic hospital / V.V. Cherepanova // Medicine. 2017. Vol. 5. No. 3. pp. 180-187.

59. Chernysheva E.L. Dynamics of hypoxic test parameters in women aged 50 - 55 years old practicing the Pilates system / E.L. Chernysheva, D.S. Hours // Science-2020. 2016. No. 5 (11). pp. 245-248.

60. Shelestyuk E.V. Speech influence: ontology and research methodology. /E.V. Shelestyuk M.: FLINTA, 2020. 344 p.

61. Yangurchina Yu.G. Differential diagnosis of iron deficiency anemia and anemia of chronic diseases / Yu.G. Yangurchina, A.G. Yangurchin //My professional career. 2020. V. 2. No. 19. P. 38-41.

62. Yarzutkina E.V. Laboratory diagnosis of anemia / E.V. Yarzutkina, N.A. Slobodnyuk // Directory of the head of the KDL. 2020. no. 3. pp. 25-32.

63. Anaemia, iron status, and gender predict the outcome in patients with chronic heart failure / K. Kurz, L. Lanser, M. Seifert et al. // ESC Heart Fail. 2020. Vol. 7, No. 4. P. 1880-1890. DOI: 10.1002/ehf2.12755

64. Andrechgev N.A. Iron deficiency state and iron deficiency anemia / N.A. Andrechgev, A.V. Balesva // Journal of modern clinical medicine. - 2019. T. 2. No. 3. S. 60-62.

65. Anemia of chronic diseases: wider diagnostics-better treatment? / M. Wiciński, G. Liczne, K. Cadelski et al. //Nutrients. 2020;12(6):1784. DOI: 10.3390/ nu12061784

66. Association between norepinephrine levels and abnormal iron status in patients with chronic heart failure: is iron deficiency more than a comorbidity? / P. Moliner, C. Enjuanes, M. Tajes et al. // J. Am. Heart Assoc. 2019. Vol. 8, No. 4. P. e010887. DOI: 10.1161/JAHA.118.010887

67. Brown D.P., Fromm E. Hypnotherapy and hypnoanalysis. New York; London: Routledge Publ., 2013. 367 p

68. Buhler Ch. Der menschliche Lebenslauf als psychologisches Problem. / Ch. Buhler. Leipzig, 1933. 328 s.

69. Burger M. Altern und Krankheit als Problem der Biomorphose. / M. Burger Leipzig: Veb. G. Thieme, 1960. 784 s.

70.ESC Scientific Document Group. Fourth universal definition of myocardial infarction (2018). / K. Thygesen, J.S. Alpert, A.S. Jaffe, B.R. Chaitman, J.J. Bax, D.A. Morrow et al. //Eur Heart J. 2019;40(3):237-269.

71.Home measurement of blood pressure and cardiovascular disease: Systematic review and meta-analysis of prospective studies. / A.M. Ward, O. Takahashi, R. Stevens, C. Heneghan //J Hypertens. 2012;30(3):449-456.

72.Iron deficiency in 78 805 people admitted with heart failure across England: a retrospective cohort study / J.M. Beattie, R. Khatib, C.J. Phillips, S.J. Williams. // Open Heart. 2020. Vol. 7, No. 1. P. e001153. DOI: 10.1136/openhrt-2019-001153

73.Iron Deficiency in Heart Failure: Mechanisms and Pathophysiology. / R.I.S. Alnuwaysir, M.F. Hoes, D.J. van Veldhuisen, P.N. van der Meer //J Clin Med. 2022;11 (1): 125. doi: 10.3390/jcm11010125

74.Reinhold J. Iron deficiency for prognosis in acute coronary syndrome - A systematic review and meta-analysis / J. Reinhold // Int J Cardiol. 2021. Vol. 328. P. 46-54.

75.Self-monitoring of blood pressure in hypertension: A systematic review and individual patient data meta-analysis. / K.L. Tucker, J.P. Sheppard, R. Stevens, H.B. Bosworth, A. Bove, E.P. Bray et al. //PLoS Med. 2017;14(9):e1002389. Available from: https://doi.org/10.1371/journal.pmed.1002389

76.Strai S.K.S. Iron transport across cell membranes:molecular uder-standing of duodenal and placental iron uptake / S.K.S. Strai, A. Bomford, H.I. McArdle // Best Practise & Research Clin Haem. 2002; 15: 2: 243-259.

77.Unestahl L.E. Alert, eyes-open sport hypnosis //American Journal of Clinical Hypnosis. 2018. Vol. 61. № 2. P. 159-172. DOI:10.1080/00029157.2018.1491387

78.Uneståhl L-E (1973) Hypnosis and Posthypnotic suggestions (PhD thesis Uppsala University). Örebro, Sweden: VEJE International.

79.Uneståhl L-E (1996) Integrerad Mental Training Forlag, Stockholm. SISU ISBN 91 87660 11 3.

80.Vincent Jean-Louis. Transfusion thresholds: the dangers of guidelines based on random ized controlled trials / Vincent Jean-Louis. //Intens. Care Med. 2020. DOI:10.1007/s00134-019-05889-3

DOI 10.34660/INF.2023.73.95.050

從 A.A. 的角度來看，秋明州第二成年女性合併冠心病和缺鐵性貧血的飽和度 烏赫托姆斯基的主導生理學理論

SATURATION IN WOMEN OF THE PERIOD OF SECOND ADULTHOOD IN TYUMEN WITH COMBINATION OF CORONARY HEART DISEASE AND IRON-DEFICIENCY ANEMIA FROM THE STANDPOINT OF A.A. UKHTOMSKY'S PHYSIOLOGICAL THEORY OF THE DOMINANT

Kamshilova Olga Aleksandrovna
Assistant
Tyumen State Medical University, Tyumen, Russia

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

Ananiev Vladimir Nikolaevich
Doctor of Medical Sciences, Full Professor, Leading Research Worker
Institute of Biomedical Problems of the Russian Academy of Sciences, Moscow, Russia
ORCID ID: 0000-0002-4679-6441

Romanova Svetlana Vladimirovna
Candidate of Biological Sciences, Associate Professor
Irkutsk State University, Irkutsk, Russia

Gurtovoy Elisey Sergeevich
Student
Tyumen State Medical University, Tyumen, Russia

註解。 文章對兩組第二成年女性的飽和度作為耐缺氧指標的研究進行了比較分析。 第一組（OH － 主要組）包括永久居住在秋明州並因冠心病（CHD）和缺鐵性貧血（IDA）而接受門診復健治療的女性。 第二組（CG － 對照組）由檢查時未患有身體疾病的同齡女性組成。 假設透過創建 A.A. 占主導地位來增加飽和度的可能性。 在愉快的音樂伴奏下，烏赫托姆斯基提出了積極的建議。 作者在內科臨床首次將第二成年期分為五年時間間隔：36至40歲、41至45歲、46至50歲、51至55歲。 研究表明，隨著女性護照年齡的增加，...的功能可能性

關鍵字：女性、第二成年期、冠狀動脈心臟病、缺鐵性貧血、飽和度、建議、A.A. 烏赫托姆斯基占主導地位。

Annotation. *The article provides a comparative analysis of the study of saturation as an indicator of resistance to hypoxia in two groups of women of the second adulthood. The first group (OH – the main group) included women permanently residing in Tyumen and receiving outpatient rehabilitation treatment for a combination of coronary heart disease (CHD) and iron deficiency anemia (IDA). The second group (CG – control group) consisted of women of the same age who did not have somatic diseases at the time of the examination. An assumption is made about the possibility of increasing saturation by creating the dominant of A.A. Ukhtomsky after positive suggestion against the background of pleasant musical accompaniment. For the first time in the clinic of internal medicine, the authors divided the period of second adulthood into five-year time intervals: from 36 to 40 years, from 41 to 45 years, from 46 to 50 years, and from 51 years to 55 years. Studies have shown that as women's passport age increases, the functional possibilities of ...*

Keywords: *women, the period of second adulthood, coronary heart disease, iron-deficiency anemia, saturation, suggestion, A.A. Ukhtomsky's dominant.*

Relevance. Issues of diagnosis and treatment of coronary artery disease and iron deficiency anemia have been discussed for many years on the pages of journals, various congresses and conferences [8, 10, 16, 63]. As for ischemic heart disease, it is not only characterized by widespread prevalence, but is also one of the leading problems of modern medicine, which is associated with both an unfavorable prognosis and the high economic costs of treatment [43, 59, 60, 68, 69, 73]. Thus, according to statistics, IHD has currently been diagnosed in 126 million people around the world.

Among currently known anemias, IDA is the most common [7, 17, 28, 41, 44, 57]. According to WHO statistics, over 2 billion people suffer from IDA, and 3.4 billion people have hidden iron deficiency [7]. IDA is an independent predictor of cardiovascular disease and adverse outcomes [52]. It has been shown that iron deficiency can lead to serious disturbances in oxidative metabolism and cellular energy mechanisms, which is reflected in the level of oxygen consumption and exercise tolerance - factors that are especially important for patients with diseases of the cardiovascular system (CVS).

It is known that the presence of comorbid chronic diseases, including CVS and blood, aggravates the somatic status [3, 35, 58]. The term comorbidity was first introduced into clinical practice by the outstanding American physician Alvan R. Feinstein (1925 – 2001) in 1970, and the term was clarified by H.C. Kramer (1995) and van den M. Akker (1996), who proposed the first classification of comorbidity. The concept of comorbidity (polymorbidity) in the modern clinic of internal diseases includes the presence of two or more chronic diseases that are both

etiologically and pathogenetically interrelated or are diagnosed simultaneously [4, 18, 30, 36, 37, 46, 48, 50. 70, 74].

In the available literature, we have not found studies that shed light on the function of external respiration in women of the second mature age of Tyumen when they combine coronary artery disease without signs of chronic heart failure with moderately severe IDA, in which the hemoglobin concentration in the blood ranged from 89 to 70 g/l. There are practically no studies reflecting the influence of suggestion as a dominant according to A.A. Ukhtomsky, for pulse oximetry, with a combination of ischemic heart disease and iron deficiency anemia in women of the second adulthood. At the same time, the study of suggestion is carried out at various methodological levels [15, 19, 23].

In 1969, Swedish psychologist Lars-Eric Uneståhl proposed a system of psychological training for athletes called Unestahl Mental Training, defended in the form of a doctoral dissertation at Uppsala University, which helps them, using hypnosis and self-hypnosis, enter an “ideal active state” [76 , 77, 78]. Having carefully analyzed his methodology, we made the assumption that suggestive suggestion (hypnosis) to increase the functional capabilities of the female body can be used in clinical practice. Of course, we understand that hypnosis can be considered as a placebo [33, 38, 67], in other words, as an unconventional method of treatment, therefore the use of hypnosis in clinical practice is associated with a number of features, limitations, misunderstandings and even prohibitions [5, 6, 25, 32, 42, 54, 55, 66, 71]. We carried out suggestion only when we were convinced that the woman had reached the appropriate level of development of abstract thinking and had the skills of concentration and imagination. Let us especially emphasize that we consider suggestion not as a placebo, but as one of the effective and safe therapeutic and diagnostic procedures.

Purpose: in women of the second mature age of Tyumen with ischemic heart disease and iron deficiency anemia from the standpoint of the physiological teachings of academician A.A. Ukhtomsky about the dominant to study resistance to hypoxia using pulse oximetry.

Material and methods. External respiration function was assessed in two groups of women. The first group (MG - main group) included 28 women of the second mature age (48.4 ± 2.9 years), undergoing outpatient treatment at RCH No. 2 in Tyumen for a combination of chronic coronary artery disease without signs of heart failure (first functional class) and IDA. Arterial hypertension was diagnosed in 7 women from the MG; 3 women have type 2 diabetes mellitus, which does not require insulin; 4 women had grade 1-2 obesity. 18 women believe that the first symptom of coronary artery disease they had was angina pectoris, which correlates with the data of other researchers [29, 31]. For women in this group, we used hypnotic suggestion against the background of positive-sounding music to create a dominant according to the method of Academician A.A. Ukhtomsky [56].

We assumed that the human brain, while awake, operates on certain algorithms that require constant updating [1, 2, 22, 51]. Let us make the assumption that the suggestion we use, in other words, intelligently structured speech, is based, firstly, on the proximity of the auditory and articulatory zones of the cerebral cortex. We agree with the opinion of [53, 61] and perceive suggestion as a type of speech influence. Secondly, such proximity, which has direct connections in the deep structures of the cerebral cortex between receptor, i.e. auditory and motor, articulatory neurons according to the principle of proximity, creates the dominant that A.A. Ukhtomsky spoke about and which we not only consider in this work, but also expand the boundaries of its physiological capabilities. We have made the assumption that the process of updating neural connections in the brain will be more effective if it is stimulated with the help of breathing, in particular by voluntary retention of inhalation and exhalation under musical accompaniment and verbal hypnotic suggestion by creating the dominant A.A. Ukhtomsky. An unresolved issue in this situation is the identification of individual age-related characteristics of physiological adaptation of women suffering from a combination of IHD and IDA, by studying functional tests with holding the breath during inhalation and exhalation when using a positive verbal hypnotic suggestion against the background of musical accompaniment using pulse oximetry. To do this, for 10 minutes, the woman was calmly accompanied by musical accompaniment (most often women chose the music of W.A. Mozart "Rondo Alla Turca" - "Turkish Rondo"), firstly, that she could do it without much effort and, secondly, without visible physical exertion will be able to hold his breath longer than usual. We made the assumption that, albeit short in time, but precisely the positive nature of suggestion against the background of musical accompaniment, can be that irritant for the brain, which, in accordance with the teachings of Academician A.A. Ukhtomsky about the dominant, programs it for more pronounced and time-stable preservation of the function of the respiratory system. The second group (CG - control group) using a random sampling method consisted of 30 women of the same age (47.8±2.7 years) who did not have clinically and instrumentally confirmed diseases of the cardiovascular system and blood at the time of the examination.

When assessing the age of women, we adhered to the scheme of age periodization of human ontogenesis, adopted at the VII All-Union Conference on Problems of Age-Related Morphology, Physiology and Biochemistry of the Academy of Pedagogical Sciences of the USSR in Moscow in 1965. According to this periodization, the period of the second mature age lasts from 36 to 55 years, i.e. 20 years. It is quite natural to assume that during this period of life in women, for example, at the age of 36 years, morphofunctional indicators not only can, but should also differ from the age, for example, 54 years. Considering that in the literature available to us we have not found studies characterizing the function of

external respiration in women living in Tyumen, we divided the second period of adulthood into 5-year intervals. MG: from 36 to 40 years (38.3±1.7; n = 8), from 41 to 45 (43.4±1.6; n = 6) years, from 46 to 50 (47.2±1 .5; n = 7) years and from 51 to 55 (52.5±1.6; n = 7) years. CG: from 36 to 40 years (38.6±1.6; n = 8), from 41 to 45 (44.2±1.7; n = 8) years, from 46 to 50 (48.1±1 .7; n = 7) years and from 51 to 55 (52.8±1.5; n = 7) years (Fig. 1).

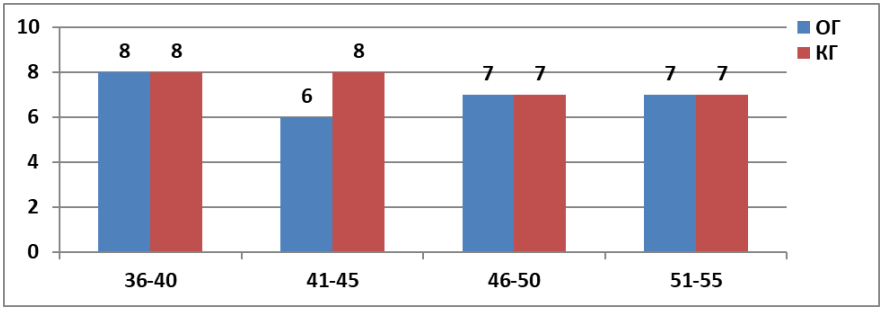


Figure 1. *Number and age composition of women in the compared groups.*

From the anamnesis it was revealed that due to illness and an increase in the passport age, the level of physical activity in all women decreased, which is expressed in the fact that women in the MG walked an average of 1.86 ± 0.32 km during daylight hours, and women in the CG 3.17 ±0.28 km ($p<0.05$). It was also found that 78% of women in the MG and 63% of women in the CG led a sedentary, mostly sedentary lifestyle associated with the conditions of professional activity. In addition, 57% of women in the MG and 34% of women in the CG noted the presence of domestic and work-related stressful situations. 18% of women in the MG and 21% of women in the CG had a night work schedule. The duration of night sleep in 53% of women in the OG was 8 hours, in 41% – 7 hours, and in 6% less than 7 hours. The duration of night sleep in 62% of women in the CG was 8 hours, in 33% – 7 hours and in 5% less than 7 hours.

It should be emphasized that the women's families have permanently lived in the south of Western Siberia in the city of Tyumen for three generations.

In accordance with the clinical examination rules adopted at RCH No. 2 in Tyumen, all women receiving outpatient treatment underwent a comprehensive clinical, biochemical and instrumental examination. Currently, a non-invasive method for assessing blood oxygen saturation, called pulse oximetry [11, 14, 20, 21, 24, 34, 39, 40, 45, 64], is increasingly being introduced into outpatient clinical practice. arterial hemoglobin oxygen and determination of heart rate. Considering that many women cover their nails with gel polishes of different colors, which

change the readings of the device [26], during the study we asked them to refrain from painting their nails. It is known that normal values of pulse oximetry (oximetry, hemoximetry) of arterial blood in a healthy person vary from 95 to 98%. We took into account that, from a practical point of view, an error of ±2% is allowed for pulse oximeters [65]. It is noted [72] that a survey of over 6000 people showed that in healthy people the probability of an SpO2 value below 95% is less than 3%. Similar data are provided by [65]. Back in 1992, it was noted that pulse oximetry is the only widely available method by which one can indirectly estimate the oxygen tension in arterial blood - PaO2. The editors of The Lancet [75] consider the threshold SpO2 value for prescribing oxygen therapy to be 93%.

With increasing age, the activity of the ciliated epithelium of the lungs, as well as the extensibility, elasticity and weight of the lungs, decrease, which cannot but affect the functional state of the body. In addition, the partial pressure voltage changes and decreases [13]. It is known that loss of vascular elasticity is one of the main factors in the progression of cardiovascular pathology [27, 47]. We took into account that the results of the pulse oximeter readings are influenced not only by the technical features of its device, but also by strict adherence to the rules of the study. These include: movement during the examination, bright light, comfortable room temperature, interference from nearby electrical equipment (for example, a cell phone). We paid attention to the fact that during the examination women did not have paint on their nails or an artificial nail. When measuring saturation, we strictly followed the operating instructions for the device and WHO recommendations on pulse oximetry [49, 62].

To study saturation, we used a finger pulse oximeter CMS 50E, as well as an individual finger pulse oximeter Fingertip Pulse Oximeter “Beurer PO40”. The devices comply with the requirements of the European Medical Devices Directive 93/42/EC, as well as the Medical Devices Act and DIN EN ISO 80601-2-61 (medical electrical devices). Saturation (SpO2) assessment was carried out in a state of physiological rest in a sitting position after a positive 8-10 minute verbal suggestion against the background of pleasant musical accompaniment.

The research results were processed on a personal computer using modern electronic programs (STATISTIKA). The significance of differences was assessed using Student’s t test [12].

The principles of voluntariness, individual rights and freedoms guaranteed by Articles 21 and 22 of the Constitution of the Russian Federation, as well as Order of the Ministry of Health and Social Development of Russia No. 774n of August 31, 2010 “On the Ethics Council” are observed. The study was conducted in accordance with the ethical standards set out in the Declaration of Helsinki and the European Community Directives (8/609EC) and the informed oral consent of the women.

Results and discussion. Studies have shown that the percentage of blood oxygen saturation in women from the CG was higher in absolute values than in women from the MG (Table 1, Fig. 2).

Table 1

Age values of saturation of women in the MG and CG period of the second mature age before (I) and after (II) suggestion (M±m)

Group	Saturation
36 – 40	
MG (I)	94,35 ± 0,85
CG (I)	98,27 ± 0,78
Difference	3,92
MG (II)	94,41 ± 0,84
CG (II)	98,36 ± 0,79
Difference	3,95
41 – 45	
MG(I)	94,18 ± 0,79
CG(I)	98,06 ± 0,84
Difference	3,88
MG (II)	94,22 ± 0,77
CG (II)	98,27 ± 0,89
Difference	4,05
46 - 50	
MG (I)	93,93 ± 0,70
CG (I)	97,71 ± 0,83
Difference	3,78
MG (II)	94,08 ± 0,81
CG (II)	97,86 ± 0,85
Difference	3,78
51 – 55	
MG (I)	93,82 ± 0,74
CG (I)	97,68 ± 0,86
Difference	3,86
MG (II)	93,64 ± 0,79
CG (II)	97,47 ± 0,83
Difference	3,83

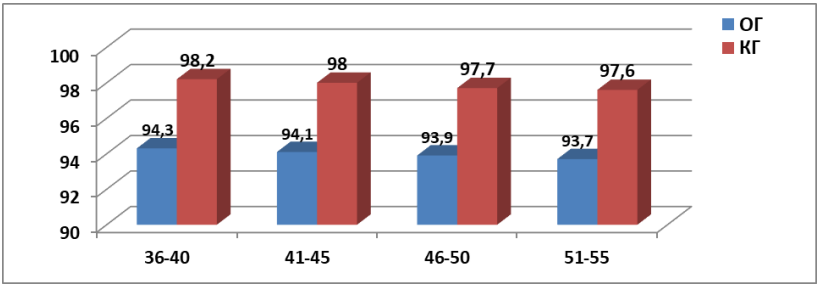


Figure 2. *Age-related values of blood oxygen saturation in women within the period of second adulthood in a state of physical rest.*

It can be concluded (Fig. 3) that in women from the CG, firstly, blood oxygen saturation over four 5-year periods of time is higher than in women from the MG. This difference was 4.50%. Secondly, as the passport age increases, the percentage of blood oxygen saturation decreases, which was confirmed in the materials of other researchers [39].

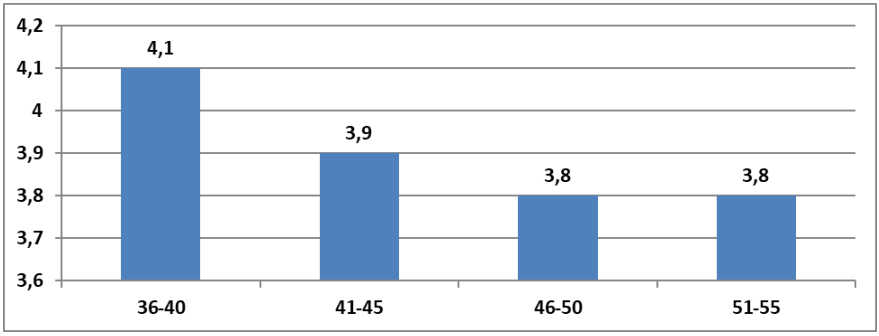


Figure 3. *Percentage age differences in blood oxygen saturation in women within the period of the second mature age of the MG and CG in a state of physical rest.*

When using suggestion, we did not find any significant differences in the percentage measurement of blood oxygen saturation in women of the compared groups (Fig. 4) ($p>0.05$). But, nevertheless, in comparative terms, a higher percentage of blood oxygen saturation can be traced in women from the GC compared to women from the MG.

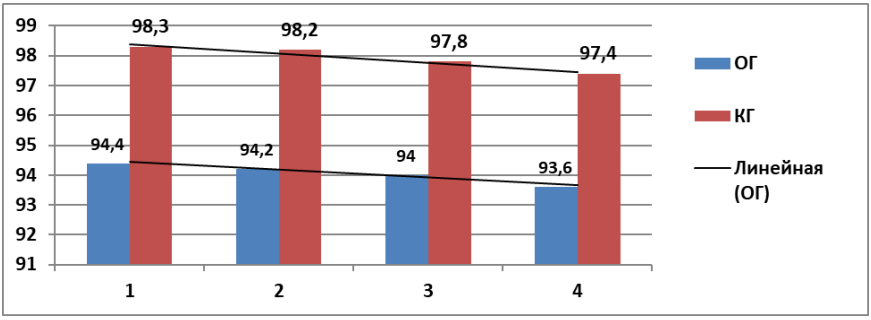


Figure 4. *Age differences in the percentage of blood oxygen saturation in women from the MG and CG within the period of the second mature age after suggestion against the background of music.*

Thus, among women aged 36 to 40 years the difference in absolute values was 3.9%, at the age of 41-45 years 4%, at the age of 46-50 years 3.6%, at the age of 51-55 years 3.8 % (Fig. 5).

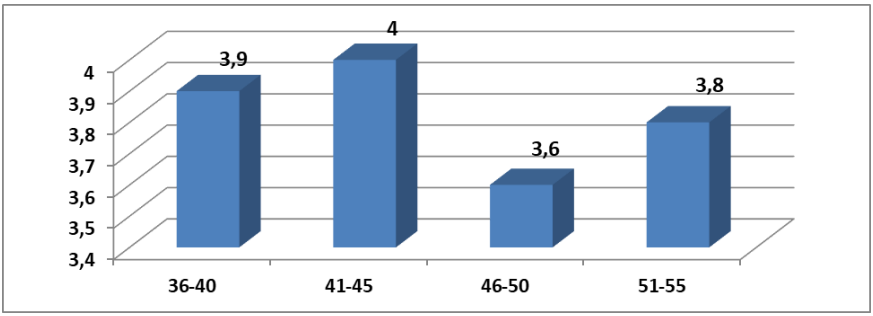


Figure 5. *Percentage age differences in blood oxygen saturation in women within the period of second adulthood in the OG and CG after suggestion.*

Conclusion. Comorbid diseases have an increasing tendency to increase from year to year in almost all countries of the world, and cover almost a quarter of the adult population of the world. Comorbidity leads not only to high rates of mortality and disability, but also to frequent side effects of treatment, significant financial health care costs for rehabilitation, and low quality of life. The combination of coronary artery disease and iron deficiency anemia is a severe comorbid pathology, and the rehabilitation of patients is one of the most important tasks of modern medicine, since it is not only an important social, but also an economic problem. To implement it, multifaceted clinical studies are needed at various methodologi-

cal levels, including patients with multiple chronic diseases living in different regions of our country. Practitioners should rely on such clinical recommendations for examination and treatment that will allow the primary care doctor not only safely, but also without significant material costs and quickly diagnose and prescribe appropriate treatment.

Thus, based on the study, the following conclusions can be drawn:

1. The period of the second mature age, approaching old age; the presence of long-term somatic diseases in the form of ischemic heart disease in combination with iron deficiency anemia and relative professional and everyday hypokinesia significantly contribute to reducing the resistance of the female body to hypoxia.

2. In assessing the functional state of the cardiorespiratory system in women of various age groups, pulse oximetry allows one to give an objective idea of the functional state of the body, which allows it to be widely used in outpatient clinical practice. It should be taken into account that the level of blood oxygen saturation decreases as the passport age increases. First of all, we associate this not only with social and everyday reasons and environmental factors, but with the physiological and chemical characteristics of the aging female body.

3. In recent years, the problem of comorbidity has become increasingly relevant in countries, especially in Russia, where the social and economic conditions of society contribute to an increase in the life expectancy of elderly and senile people. In turn, this dictates the need not only for its broad study, but also for the development of a unified view on the problem of combined pathology.

4. Dividing the period of the second adulthood into 5-year periods of time allows the doctor to objectively assess the changes in the functional state of the respiratory system characteristic of a given passport age.

Conflict of interest. The authors declare no conflict of interest.

Research transparency. The study had no sponsorship. The authors are solely responsible for submitting the final version of the manuscript for publication.

Declaration of financial and other relationships. All authors participated in the development of the topic, study design and writing of the manuscript. The final version of the manuscript was agreed upon and approved by all authors. The authors received no royalties for the study.

References

1. Anokhin P.K. Fundamental questions of the general theory of functional systems / P.K. Anokhin // Principles of systemic organization of functions: M.: Nauka, 1973, pp. 5-61.

2. Anokhin P.K. Anticipatory reflection of reality // Philosophical aspects of the theory of functional systems. / P.K. Anokhin. M.: Nauka, 1978. pp. 7–27.

3. Bakirova E.A. Analysis of the reasons for the formation of comorbid conditions in elderly people / E.A. Bakirov // Bulletin of the Medical Dental Institute. 2023. No. 1 (64). pp. 33-34.

4. Belyalov F.I. Treatment of internal diseases in conditions of comorbidity. / F.I. Belyalov. Irkutsk: RIO IGMAPO, 2013. 297 p.

5. Bekhterev V.M. Hypnosis, suggestion, psychotherapy and their therapeutic effects / V.M. Bekhterev. // Herald of Knowledge. St. Petersburg, 1911. Issue. 4. 60 p.

6. Bekhterev V.M. Consciousness and its boundaries. / V.M. Bekhterev. Kazan: Type. Imp. un-ty. 1888. 32 p.

7. Bogdanov A.N. Iron deficiency anemia in the 21st century / A.N. Bogdanov, V.I. Mazurov // Bulletin of the North-Western State Medical University. I.I. Mechnikov. 2016. Vol. 8. No. 4. pp. 106-112.

8. Bulkin M.D. Prevalence of coronary heart disease in the modern world / M.D. Bulkin, T.A. Konovaltseva, I.E. Trukhmaeva //Young scientist. 2023. No. 32 (479). pp. 19-21.

9. Vertkin A.L. Comorbidity / A.L. Vertkin M.A. Rumyantsev, A.S. Skotnikov // Clinical medicine. 2012. No. 10. P. 4-11.

10. Vinogradova N.G. Iron deficiency conditions in cardiovascular diseases: impact on prognosis and features of correction / N.G. Vinogradova, A.I. Chesnikova //South Russian Journal of Therapeutic Practice. 2023. V. 4. No. 1. P. 7-18.

11. Possibilities of using pulse oximetry in clinical practice (literature review). / Z.M. Seagal, V.V. Bryndin, S.Yu. Meshchanov et al. //Health, demography, ecology of the Finno-Ugric peoples. 2017;(4):81-85. doi:10.15829/1560-4071-2019-6-78-84.

12. Glanz S. Medical and biological statistics. / S. Glanz. – M: Praktika, 1999. – 459 p.

13. Grachev V.I. The influence of hypoxia on the central nervous system, organs and tissues, taking into account age-related characteristics / V.I. Grachev, I.O. Marinkin, I.T. Sevryukov // Norwegian Journal of Development of the International Science. – 2018. – No. 6-2(19). – P. 3-20.

14. Grishin O.V. Clinical significance of pulse oximetry in adults / O.V. Grishin, V.G. Grishin //Medical alphabet. 2020. No. 25. pp. 13-21.

15. Dikun N.V. Suggestion in medical-didactic discourse: concepts tortoise, turtle and teacher (based on the communicative practices of a medical college) / N.V. Dikun, I.G. Golubev, D.A. Demidenko //Modern science: current problems of theory and practice. Series: Humanities. 2021. No. 8. pp. 131-136.

16. Iron deficiency anemia in elderly and senile patients / A.N. Bogdanov, S.V. Voloshin, V.V. Tyrenko, A.S. Polyakov // Advances in gerontology. 2020. V. 33. No. 6. P. 1150-1157.

17.Zhorova V.E. Frequency and prevalence of iron deficiency anemia / V.E. Zhorova, E.G. Khilkevich //Medical Council. 2018. No. 13. pp. 78-81.

18.Zhuravlev Yu.I. Modern problems of measuring polymorbidity / Yu.I. Zhuravlev, V.N. Tkhorikova // Scientific bulletins of Belgorod State University. Series: Medicine. Pharmacy. 2013. No. 11 (154). pp. 214-219.

19.Zadorozhnyuk E.G. Are the concepts of "suggestion" and "counter-suggestion" in demand by modern social science? / E.G. Zadorozhnyuk, I.E. Zadorozhnyuk //Dialogue with time. 2021. No. 77. pp. 28-44.

20.Using the pulse oximetry method to determine the risk group for the purpose of preventing respiratory diseases: a prospective study / O.P., Karazhelaskov A.G. Lastovetsky, A.D. Fesyun, A.N. Arkhangelskaya, K.G. Gurevich // Kuban Scientific Medical Bulletin. 2016. V. 156, No. 1. pp. 62-66.

21.Kakov S.V. Pulse oximetry. / S.V. Kakov, V.P. Muler // Bulletin of new medical technologies 2006; XIII (1): 171-172.

22.Kapitonov D.D. Development of an algorithm for prioritizing information based on the mechanisms of the brain and spinal cord / D.D. Kapitonov, K.E. Ushakov, T.A. Malkina // The future of mechanical engineering in Russia. 2022. collection of reports. XV All-Russian Conference of Young Scientists and Specialists (with international participation). Moscow, September 21–24, 2022. pp. 380-386.

23.Kvitchasty A.V. Altered states of consciousness in sports psychology: hypnosis, suggestion and autosuggestion / A.V. Kvitchasty //Modern foreign psychology. 2021. V. 10. No. 3. P. 92-102.

24.Klimov A.V. Pulse oximetry / A.V. Klimov, M.A. Gumerova // Alley of Science. – 2021. V.63. No. 12. pp. 125-128.

25.Kozlov V.V. Theory and practice of clinical hypnosis / V.V. Kozlov, N.A. Vlasov // Human factor: Social psychologist. 2019. No. 2 (38). pp. 3-18.

26.Kotova Yu.O. The effect of using gel polish of different shades on the tissue saturation value measured using a pulse oximeter / Yu.O. Kotova, M.N. Starodubtseva, E.S. Petrova // Chemistry and physics - XXI century. Theory, practice, education. Collection of materials of the V All-Russian scientific and practical conference with international participation. Edited by N.A. Titova. Bryansk, 2022. pp. 104-105.

27.Kochkina M.S. Measuring arterial stiffness and its clinical significance / M.S. Kochkina, D.A. Zateyshchikov, B.A. Sidorenko // Cardiology. 2005. No. 1. pp. 63-71.

28.Kochneva E.V. Iron deficiency conditions and their express diagnostics in everyday clinical practice / E.V. Kochneva, M.V. Kralevska // Issues of dietology. 2017. V. 7. No. 2. P. 58-63.

29.Kushelevsky B.P. Angina pectoris and their differentiated therapy / B.P. Kushelevsky, A.N. Coconuts. M.: Medicine, 2018. 316 p.

30.Lazebnik L.B. Aging and polymorbidity / L.B. Labeznik // Consil. med. 2005. No. 12. pp. 993-996.

31.Lambich I.S. Angina pectoris / I.S. Lambich, S.P. Stozhinich. M.: Medicine, 2022. 432 p.

32.Maksimova E.D. Unconventional methods of treatment. hypnosis in medicine / Maksimova E.D., Kolobova D.A. // Problems of scientific and extra-scientific knowledge. Collection of scientific articles from the Department of Philosophy and Methodology of Science. Cheboksary, 2017. pp. 108-117

33.Medical and physiological effects of placebo based on the doctrine of dominance by Academician A.A. Ukhtomsky / V.N. Ananyev, N.Ya. Prokopyev, O.V. Ananyeva, E.S. Gurtova. //Science, society, technology: problems of modern development: monograph. Chapter 12. - Petrozavodsk: ICNP "NEW SCIENCE", 2023. 399 p. pp.219-269. ISBN 978-5-00215-128-8 DOI 10.46916/08112023-1-978-5-00215-128-8

34.Pulse oximetry methods: possibilities and limitations / A.A. Garanin, V.A. Dyachkov, A.O. Rubanenko, O.A. Reprintseva, D.V. Duplyakov //Russian Journal of Cardiology. 2023. T. 28. No. S3. pp. 59-67.

35.Nasyrova Z.A. Features of the course of coronary heart disease in patients with comorbid pathologies / Z.A. Nasyrova, Yu.Yu.K. Kurbonova, D.A. Nasirova // Bulletin of science and education. 2020. No. 1 (79). pp. 97-100.

36.Nechaev O.I. Improving care for comorbid pathology (experience of the Russian Federation) / O.I. Nechaev // X annual international scientific and practical conference "Current issues in medicine" and "IV Satellite Forum on public health and health policy." Baku, April 27–28, 2023. pp. 28-29.

37.Nurgazizova A.K. Origin, development and modern interpretation of the concepts of "comorbidity" and "multimorbidity" / A.K. Nurgazizova // Kazan Medical Journal. 2014. V. 95. No. 2. P. 292-296.

38.About hypnosis in medicine / K.I. Gorodnichev, M.A. Pakhomov, K.I. Horak, A.M. Morozov //Forcipe. 2019. V. 2. No. S1. pp. 1040-1041.

39.Olkhovaya E.D. Assessment of blood oxygen saturation in individuals of different age groups / E.D. Alder // Youth Innovation Bulletin. 2023. V. 12. No. S2. pp. 592-595.

40.Determination of blood saturation by photoplethysmographic and electrochemical methods: comparison of results in adult patients with respiratory diseases / E.A. Shergina, M.I. Chushkin, A.I. Nagaev, N.L. Karpina //Medical Alliance. 2023. V. 11. No. 2. P. 6-12.

41.Features of iron transport in patients with anemia of varying severity arising from chronic heart failure / P.G. Kravchun, O.A. Efremova, N.G. Ryndina, A.Yu. Titova // Scientific bulletins of Belgorod State University. Series: Medicine. Pharmacy. 2013. No. 4 (147). pp. 99-102.

42.Pavlov I.P. On the mechanism of the hypnotic state of a person / I.P. Pavlov // Questions of psychology. 1969. No. 5. P. 158-159.

43.Panev N.I. Comparative assessment of the frequency of risk factors for the development of coronary heart disease and arterial hypertension in miners with anthracosilicosis / N.I. Panev, N.A. Evseeva //Medicine in Kuzbass. 2022. V. 21. No. 4. P. 30-34.

44.Perezhogin S.A. Relevance of anemia of chronic diseases / S.A. Perezhogin //News of the Russian Military Medical Academy. 2021. V. 40. No. S1-1. pp. 114-116.

45.Polidanov M.A. Pulse oximetry: the essence of technology and modern technical means. / M.A. Polidanov //Modern Science. 2019;12(4):137-140.

46.Porovsky Ya.V. Comorbidity in medical practice / Ya.V. Porovsky, F.F Tetenev. //Siberian Medical Review. 2015. No. 4 (94). pp. 5-10.

47.Ratova L.G. Arterial hypertension and broncho-obstructive pathology, features of the clinical picture / L.G. Ratova, K.A. Zykov, Yu.A. Dolgusheva et al. // System. hypertension. 2012. No. 1. pp. 54-58.

48.Regional features of polymobidity in the modern clinic of internal diseases / I.M. Mitrofanov, Yu.A. Nikolaevna. Dolgova et al. // Clinical medicine. 2013. No. 6. pp. 26-29.

49.WHO guidelines on pulse oximetry. Geneva, 2009. 1-23.

50.Sarsenbaeva G.I. Comorbid diseases - an urgent problem of modern medicine / G.I. Sarsenbaeva // Pediatrics and pediatric surgery. 2021. No. 1 (103). pp. 73-78.

51.Silkis I.G. Mechanisms of functioning of the connectome, including the neocortex, hippocampus, basal ganglia, cerebellum and thalamus. / I.G. Silkis // Journal of Higher Nervous Activity named after. I.P. Pavlova, 2022. V. 72. No. 1. P. 36-54.

52.A modern view of a therapist on the problem of iron deficiency anemia in patients with cardiovascular pathology. / G.N. Gorokhovskaya, A.I. Martynov, V.L. Yoon, M.M. Petina //Medical Council. 2020;(14):70-78. doi: 10.21518/2079-701X-2020-14-70-78

53.Sternin I.A. Introduction to speech influence. /I.A. Sternin. Voronezh: Istoki, 2001. 252 p.

54.Tukaev R.D. Great Russian medical scientists, academicians I.P. Pavlov and V.M. Bekhterev and their contribution to the development of research and practice of domestic hypnosis, hypnotherapy, psychotherapy / R.D. Tukaev // Bulletin of psychotherapy. 2023. No. 85. pp. 15-27.

55.Resistance to hypoxia according to the Stange and Gench tests in women of the second mature age in Tyumen with a combination of coronary heart disease and iron deficiency anemia from the standpoint of the physiological doctrine of

the dominant of Academician A.A. Ukhtomsky / Olga Aleksandrovna Kamshilova, Nikolay Yakovlevich Prokopyev, Vladimir Nikolaevich Ananyev, Svetlana Vladimirovna Romanova, Elisey Sergeevich Gurtovoy..// Science and innovation - modern concepts: a collection of scientific articles based on the results of the International Scientific Forum (Moscow, November 30, 2023 .). Volume 2 / Rep. ed. D.R. Khismatullin. Moscow: Infinity Publishing House, 2023. 191 p. pp. 125-144. ISBN 978-5-905695-78-0. DOI 10.34660/INF.2023.20.24.094

56. Ukhtomsky A.A. Dominant. Articles from different years. 1887-1939. /A.A. Ukhtomsky. St. Petersburg: Peter, 2002. 448 p.

57. Functional state of the cardiovascular system in patients with chronic heart failure of coronary origin with concomitant iron deficiency anemia / E.N. Amosova, L.L. Sidorova, V.N. Tsaralunga, N.N. Sidorova //Heart and blood vessels. 2011. No. 3 (35). pp. 071-080.

58. Khryapinskaya E.V. Pharmacotherapy of patients with coronary heart disease in conditions of comorbid pathology / E.V. Khryapinskaya, G.S. Mal, I.A. Gribovskaya // Biotechnology and biomedical engineering. Collection of scientific papers based on the materials of the X All-Russian scientific and practical conference with international participation, dedicated to the 25th anniversary of the Faculty of Biotechnology and the 20th anniversary of the Department of Biological and Chemical Technology. 2017. pp. 208-209.

59. Frequency and structure of complications in patients with coronary heart disease and acute myocardial infarction / A.I. Tabarov, M.E. Rajabzoda, Sh.M. Safaraliev, I.Kh. Emomzoda //Science and innovation. 2021. No. 4. P. 197-203.

60. Frequency of coronary heart disease against the background of resistant arterial hypertension in young and middle-aged patients. / H.Yo. Sharipova, D.D. Rakhimov, R.G. Sokhibov, R.M. Gulova, D.U. Kosimova //Bulletin of Avicenna. 2022;24(3):317-323. Available from: https://doi. org/10.25005/2074-0581-2022-24-3-317-323

61. Shelestyuk E.V. Speech influence: ontology and research methodology. /E.V. Shelestyuk M.: FLINTA, 2020. 344 p.

62. Shurygin I.A. Pulse oximetry. Respiratory monitoring: pulse oximetry, capnography, oximetry. / I.A. Shurygin. St. Petersburg: Nevsky dialect; M.: BINOM, 2000: 11-98.

63. Yangurchina Yu.G. Differential diagnosis of iron deficiency anemia and anemia of chronic diseases / Yu.G. Yangurchina, A.G. Yangurchin //My professional career. 2020. V. 2. No. 19. P. 38-41.

64. Accuracy of a new pulse oximetry in detection of arterial oxygen saturation and heart rate measurements: the Sombrero study / S. Marinari, P. Volpe, M. Simoni, M. Aventaggiato, F. Benedetto, S. Nardini, S.M . Sanguinetti, R. Palange // Sensors. 2022. V.5031, N22. P. 1-18.

65.Assessment of Oxygen Saturation Using Pulse Oximetry in Patients with Steady State HbSS. / A.I. Ladu, A.M. Abba, A.A. Bukar, F.A. Abulfathi, Y. Kundili et al. // Ann Clin Lab Res. 2018 Vol.6 No.2: 237. DOI: 10.21767/2386-5180.100237

66.Brown D.P., Fromm E. Hypnotherapy and hypnoanalysis. New York; London: Routledge Publ., 2013. 367 p

67.Dynamics of age values of vital capacity of the lung in women of the second mature age in Tyumen with a combination of coronary heart disease and iron deficiency anemia from the position of physiological teaching about the dominant academician A.A. Ukhtomsky /Kamshilova Olga Aleksandrovna, Prokopyev Nikolai Yakovlevich, Ananiev Vladimir Nikolaevich, Romanova Svetlana Vladimirovna, Gurtovoy Elisey Sergeevich. // Proceedings of the International University Scientific Forum "Practice Oriented Science: UAE – RUSSIA – INDIA". (November 25, 2023. UAE) P. 146-160. DOI 10.34660/INF.2023.49.33.025 ISBN 978-5-905695-87-2

68.ESC Scientific Document Group. Fourth universal definition of myocardial infarction (2018). / K. Thygesen, J.S. Alpert, A.S. Jaffe, B.R. Chaitman, J.J. Bax, D.A. Morrow et al. //Eur Heart J. 2019;40(3):237-269.

69.Home measurement of blood pressure and cardiovascular disease: Systematic review and meta-analysis of prospective studies. / A.M. Ward, O. Takahashi, R. Stevens, C. Heneghan //J Hypertens. 2012; 30(3): 449-456.

70.Oemrawsingh A. Patient-Reported Morbidity Instruments: A Systematic Review / A. Oemrawsingh, N. Swami, J.M. Valderas, J.A. Hazelzet, A.L. Pusic, R.E. Gliklich, R. W. Bergmark // Value Health. 2020. T. 23, № 6. C. 791-811.

71.Respiratory rate in women of the second mature age in Tyumen with a combination of coronary heart disease and iron deficiency anemia from the position of the physiological teaching about the dominant of academician A.A. Ukhtomsky /Kamshilova Olga Aleksandrovna, Prokopyev Nikolai Yakovlevich, Ananiev Vladimir Nikolaevich, Romanova Svetlana Vladimirovna, Gurtovoy Elisey Sergeevich. // Proceedings of the International University Scientific Forum "Practice Oriented Science: UAE – RUSSIA – INDIA". (November 25, 2023. UAE) P. 136-145. DOI 10.34660/INF.2023.59.89.024 ISBN 978-5-905695-87-2

72.Rojas-Camayo J. Reference Values for Oxygen Saturation From Sea Level to the Highest Human Habitation in the Andes in Acclimatised Persons / J. Rojas-Camayo, C.R. Mejia, D. Callacondo // Thorax. 2018 Aug. 73(8). P. 776-778. DOI: 10.1179/146532806X107421

73.Self-monitoring of blood pressure in hypertension: A systematic review and individual patient data meta-analysis. / K.L. Tucker, J.P. Sheppard, R. Stevens, H.B. Bosworth, A. Bove, E.P. Bray et al. //PLoS Med. 2017;14(9):e1002389. Available from: https://doi.org/10.1371/journal.pmed.1002389

74.Soh C.H. Morbidity Measures Predicting Mortality in Inpatients: A Systematic Review / C.H. Soh, S.W. Ul Hassan, J. Sacre, A.B. Maier //j. Am. Med. Dir. Assoc. 2020. T. 21, № 4. C. 462-468.

75.The Lancet. Adoption of COVID-19 triage strategies for low-income settings (Correspondent) www.thelancet.com/respiratory Vol. 8 April 2020

76.Unestahl L.E. Alert, eyes-open sport hypnosis //American Journal of Clinical Hypnosis. 2018. Vol. 61. № 2. P. 159-172. DOI:10.1080/00029157.2018.1491387

77.Uneståhl L-E (1973) Hypnosis and Posthypnotic suggestions (PhD thesis Uppsala University). Örebro, Sweden: VEJE International.

78.Uneståhl L-E (1996) Integrerad Mental Training Forlag, Stockholm. SISU ISBN 91 87660 11 3.

DOI 10.34660/INF.2023.42.42.051

包機服務發展趨勢及挑戰
DEVELOPMENT TRENDS AND CHALLENGES OF AIR CHARTER SERVICES

Visnyakova Alena Aleksandrovna
Candidate of Sociological Sciences, Associate Professor
Irkutsk branch of Moscow State Technical University of Civil Aviation

抽象的。 研究此問題的相關性和可行性在於包機航班的快速發展及其對航空業的重大影響。

本文的目的是詳細概述包機服務發展的主要趨勢以及它們面臨的問題。 作者的研究結果包括包機服務需求的描述、競爭環境和限制的分析。

研究包機航空運輸發展趨勢和問題的科學和理論基礎包括俄羅斯理論家和科學家的著作以及界定組織和實施包機航空運輸的概念、內容和主要問題的法律規定。

關鍵字：包機運輸、需求、旅遊、競爭、機場、航空公司、安全。

Abstract. *The relevance and feasibility of studying the problem is due to the rapid development of charter flights and their significant impact on the air industry.*

The purpose of the article is to provide a detailed overview of the main trends in the development of charter services and an overview of the problems they face. The author's results include a description of the demand for charter services, an analysis of the competitive environment and restrictions.

The scientific and theoretical basis for studying development trends and problems of charter air transportation consists of the works of Russian theorists and scientists, legal provisions that define the concept, content and main problematic issues of organizing and implementing charter air transportation.

Keywords: *charter air transportation, demand, tourism, competition, airport, airline, safety.*

Introduction

Currently, charter air transportation is becoming increasingly popular and in demand among passengers and cargo clients.

Unlike a regular flight, a charter flight is one ordered by an organization or individual. As a rule, the customer is a tour operator.

The main characteristics of an air charter include the following:

– the flight is ordered and operated outside the established schedule;
– the date, time of departure and direction of the air charter are established by the customer, while the conditions are agreed upon with the aircraft traffic services of the specified airports of departure and destination;
– only the customer has the right to sell tickets;
– the pricing mechanism also remains under the control of the customer;
– seasonality factor.

Thus, an air charter is organized by a tour operator, the airline acts only as a carrier, this suggests that regular transportation remains a priority for the airline.

Nevertheless, the advantages of air charters for the customer and the carrier are obvious (Table 1).

Table 1

Benefits of a charter flight [1]

ADVANTAGES OF A CHARTER FLIGHT	
Customer	**Carrier**
the right to the conditions (change of conditions) of the flight, simplified destination, financial benefit.	diversification of the service portfolio, a clear improvement in financial performance, increase in market share, stable, competitive positions in the market.

The airline sector is one of the most strategic and vital economically, so it is imperative that the transport industry be competitive in domestic and global markets. However, despite its important economic and social impact, air charter remains an underexplored area.

The development of charter air transportation is fraught with problematic issues that require more in-depth research.

Main part.

As practice shows, the tourism market is the main customer of charter air transportation [5]. Charter tourism as a concept refers to package trips consisting of pre-arranged services, including transport, accommodation and often meals, and accompanying activity options. Most often, charter agencies hire aircraft from different airlines on a temporary basis, but may also use other modes of transport for transportation. By offering package tours at competitive prices, ensuring customer safety and reducing the need for individuals to book holidays, charter agencies are opening up an increasing number of destinations to tourists.

The leading positions in the Russian air charter market are occupied by airlines that are part of tourism holdings. Thus, the tour operator Pegas-Touristik got its own carrier in 2008 - the North Wind airline. Later, the tour operator creates another airline, “Ikar” Airlines LLC, which also shows good performance results [3].

Another example is the creation of the air carrier "AZURAir" as part of the tour operator "Tez-tour" [4]. Later, the "ROYAL FLIGHT" airline, the tour operator Coral Travel, acquired its "wings" [2]. The listed airlines are among the TOP 15 Russian airlines in terms of volumetric activity indicators (Table 2).

Table 2

Performance indicators of Russian charter airlines (2021 results)

Tour operator	Airline	Performance indicators		
		Passengers transported, persons	**Passenger turnover, thousand passenger km.**	**Passenger seat occupancy percentage,%**
PEGAS Touristik	«Northern Wind» LLC	5 926 317	19 269 878,32	81,9
	''Ikar'' Airlines LLC	1 718 588	4 414 422,10	83
TEZ TOUR	«AZURair» LLC	3 726 198	13 855 572,99	92,1
Coral Travel	''ROYAL FLIGHT'' Airlines JSC	1 493 490	5 511 472,95	90,1

In recent years, there has been a strong growth in the number of tourist trips, which leads to increased demand for charter flights. Charter airlines take on operational responsibility by selling all the seats on the plane (full charter) or a certain number of seats (split charter) to travel companies or travel agencies; they have no direct contact with passengers. Charter airlines operate on a seasonal basis.

The growing popularity of charter flights is also due to a decrease in aircraft rental costs. In recent years, the number of companies leasing aircraft has increased, which in turn has led to increased competition among them. Such a highly competitive environment has led to a decrease in the rental cost of the vessels themselves. Previously, such a service was available only to very wealthy companies and people.

The airline sector is growing rapidly, it is very important to understand the dynamics of this sector. The growing popularity of charter flights has led to increased competition among companies in this segment. Such conditions of high competition lead to the development of innovative technologies in this area and improvement of the quality of services offered. Charter companies that best meet customer needs and improve the level of service are more competitive in this market.

On the other hand, geopolitical changes occurring around the world, as well as events related to the COVID-19 pandemic, have significantly impacted logistics in general, and air travel and charter services in particular. Border closures in many countries in 2020-21. led to a reduction in the number of international flights. In 2022, the situation began to improve and stabilize, and the number of charter flights began to resume.

The ongoing changes at the state and international level in this market segment have led to regulatory changes in the field of charter air transportation. Such measures are applied to improve the quality of safety of charter flights. Therefore, it is important for charter companies to monitor regulatory and legislative changes in order to comply with their rules, requirements and regulations.

So, the increase in the number of charter air transportation is associated with an increase in demand for this type of service and increased competition in this segment. It is expected that the demand and number of charter air services will continue to grow in the future. High competition will lead to an improvement in the quality of services provided and the development of innovative technologies in this area.

The air charter segment, like any segment of the aviation market, has some difficulties and problems.

One of the most glaring of these problems is airport capacity. This feature makes it difficult for charter companies to operate. In addition, the tariff policy pursued by airports matters.

Another, no less important problem is regulatory. At the state level, restrictions are adopted in terms of aircraft certification, insurance, personnel requirements, sanitary and other standards, which in turn creates an additional burden for charter companies.

And finally, the most important, determining factor in any transportation is safety. In this area, charter companies must also ensure the safety of air transportation, simplify inspection procedures, and use the latest technologies to ensure safe transportation.

Conclusion.

The conducted research is related to charter air transportation, and highlights issues related to problematic aspects associated with charter air transportation (demand, regulatory support, safety).

The question of how transport companies cope with domestic and international competition, how they determine their competitive strategies is little studied in the scientific context. This aspect of the problem is a continuation of the scientific work of the author of the presented article.

References

1. A. A. Vishnyakova, T.A. Karpacheva. Relevance of charter transportation [electronic resource] // Access mode: https://cyberleninka.ru/article/n/aktualnost-charternyh-perevozok.

2. Official website of the tour operator "Coral Travel" [electronic resource] // Access mode https://www.coral.ru.

3. Official website of the tour operator "PEGAS Touristik" [electronic resource] // Access mode https://pegast.ru.

4. Official website of the tour operator "TEZ TOUR" [electronic resource] // Access mode – https://www.tez-tour.com.

5. Development trends and problems of the Russian charter transportation market [Electronic resource] – Access mode: https://cyberleninka.ru/article/n/tendentsii-razvitiya-i-problemy-rynka-charternyh-perevozok.

DOI 10.34660/INF.2023.73.97.052

自行車軌跡的幾何性質
ON THE GEOMETRIC PROPERTIES OF THE TRAJECTORY OF A BICYCLE

Shagapov Ildar Akhnyafovich
Candidate of Physical and Mathematical Sciences, Associate Professor
Ufa University of Science and Technology

註解。 該論文給出了給定後輪軌蹟的自行車前輪軌蹟的數學描述，並揭示了它們的一些幾何特性。 最簡單的兩輪自行車模型作為實用基礎。

以複雜功能的形式給予描述。 原始曲線和結果曲線以參數形式獲得。 此類曲線的特殊性在於其機械起源。

關鍵字：運動軌跡、自行車車輪、基曲線、切線、複函數。

Annotation. *The paper gives a mathematical description of the trajectory of the front wheel of a bicycle for a given trajectory of the rear wheel and reveals some of their geometric properties. The simplest model of a two-wheeled bicycle served as a practical basis.*

The description is given in terms of complex functions. The original and resulting curves are obtained in parametric form. The peculiarity of such curves is their mechanical origin.

Keywords: *motion trajectory, bicycle wheel, base curve, tangent, complex function.*

This paper considers the following problem: to construct a mathematical description of the curve (trajectory of the front wheel of a bicycle), given the base curve (trajectory of the rear wheel) and to identify the main geometric properties of the resulting curve.

Analogues of this problem are rarely found in the literature (see, for example, [1-2]).

For simplicity, we will assume that the movement occurs on a plane. By the trajectories of movement of the rear and front wheels we mean the curves that describe the centers of the projections of these wheels onto the plane; the projections of the wheels are tangent to the curves (trajectories) of their movement. The bicycle frame has a fixed length L and is a “continuation” of the projection of the

rear wheel. We will denote the trajectory of the rear wheel (base curve) by l, and the desired curve (trajectory of the front wheel) by S.

We will seek a mathematical description of the solution in terms of complex functions. In the process of solving, we will consider geometric properties, in particular questions about the length of the resulting curve and the area of the region bounded by the base and resulting curves (between the trajectories of the wheels).

Case 1. Let the trajectory of the rear wheel be the point l = (0, 0) - the origin of coordinates.

Obviously, in this case the front wheel either stands still or moves in a circle of radius L (Fig. 1)

$$S = \left\{ w \in C : w = L \cdot e^{i \cdot \varphi}, \varphi \in [0,2\pi] \right\}.$$

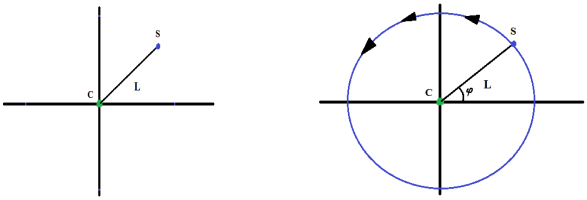


Figure 1. *Simple case*

To clarify the geometric properties, distracting from the bicycle, it is convenient to imagine a circle as a set of sectors.

Next, the following interpretation is proposed (see Figure 2 on the left). The interpretation is for illustrative purposes only. For a rigorous proof, first all curves must be replaced with polygons, all the indicated procedures must be performed for them, and then we must move to the limit when the maximum length of the sides of the polygon tends to zero.

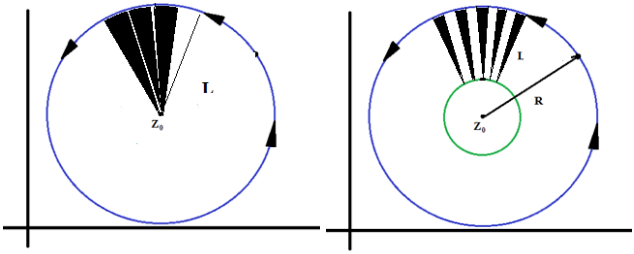


Figure 2. *Interpretation of the ring*

Let's replace the point z_0 with a circle of radius r. In this case, the original circle of radius L turns into a ring, which will consist of sectors of the circle and "rectangles" between them (see Fig. 2 on the right).

It is easy to see that the area of the ring is equal to the sum of the area of a circle of radius L (the sum of the areas of the black sectors) and the area of the rectangle (the sum of the areas of additional white rectangles), the sides of which are the length of the base curve and the length of the frame L.

Let's get back to the bike.

Case 2. Let the base curve be a circle with center at point z0 of radius r

$$l = \{z \in C : z = z_0 + r \cdot \exp(i \cdot t), t \in [0, 2\pi]\}.$$

Obviously, a tangent to a circle at any point is perpendicular to the radius. On the other hand, the same tangent can be obtained by rotating the "radius" of the circle by an angle. Therefore, it is enough to add to the point argument z. We obtain the following description of the desired curve (Fig. 3 on the left).$\frac{\pi}{2}\frac{\pi}{2}$

$$= \left\{ \quad \in \quad : \quad = \quad + \quad \cdot \exp(\cdot (+ \frac{\pi}{2}) \ , \ \in [0, 2\pi] \right\}.$$

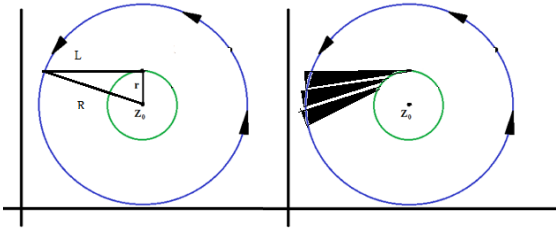


Figure 3. *Case of a circle*

Let's move on to the square. Note that although in this case we obtained a ring, its radius is different and it is arranged differently (see Fig. 3 on the right).

The proposed interpretation shows that in this case there will be no additional rectangles, and the resulting area is equal to the area of the original circle of radius L, this can be verified by direct simple calculation. The length of the resulting curve can be represented as follows (Pythagorean Theorem for radii):

$$2 * \pi * R = \sqrt{(2 * \pi * r)^2 + (2 * \pi * L)^2}.$$

Case 3.Let the curve l be a smooth closed convex curve, that is, it is the boundary of a convex figure (Fig. 4 on the left).

$$l = \{z \in C : z = x(t) + i \cdot y(t), t \in [-2\pi, 0]\}.$$

This case differs from the previous one in that the tangent to l will not be perpendicular to the radius vector of the curve l.

Using the connection between the derivative of a function and the tangent, we obtain the following description for the curve l (Fig. 4 on the right).

$$S = \left\{ w \in C : w = z + L \cdot e^{\arg(z')},\ z' = x'(t) + i \cdot y'(t),\ t \in [-2\pi, 0] \right\}.$$

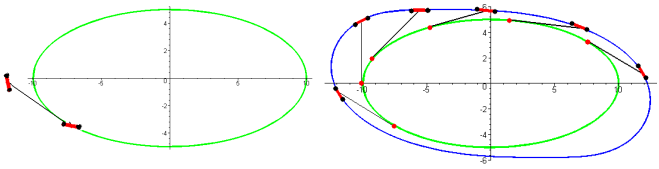


Figure 4. *Case of a closed smooth curve*

For a better understanding and application of the last formula obtained, it is convenient to have the following vector interpretation.

The term z answers the question "where to postpone the vector", the argument z' answers the question "where to postpone", the parameter L answers the question "how much to postpone". Then the desired curve is the trajectory of the end of the vector $\overrightarrow{\ }$ (Fig. 5)

$$\vec{w} = \vec{z} + \overrightarrow{L \cdot \exp(\arg(z'))}.$$

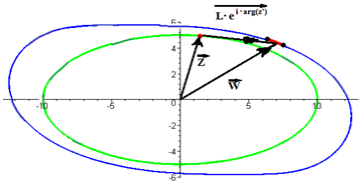


Figure 5. *Vector form of the solution*

Example 1. Let the initial curve l (trajectory of movement of the rear wheel of a bicycle) be an ellipse with semi-axes a=3 and b=1.

$$l = \left\{ z \in C,\ z = 3 \cdot \cos(t) + i \cdot 1 \cdot \sin(t),\ t \in [0,\ 2\delta] \right\}.$$

The start of movement of the rear wheel is at point (3, 0), the length of the frame is parameter L=2, the direction of movement corresponds to the increase in parameter t, that is, counterclockwise.

Then, using the formula obtained above, we obtain the following explicit mathematical description of the trajectory of the front wheel of a bicycle - curve S (see Fig. 6 on the left)

$$S = \left\{ w \in C,\ w = (3 \cdot \cos(t) + i \cdot 1 \cdot \sin(t)) + 2 \cdot \exp(\arg(-3 \cdot \sin(t) + i \cdot 1 \cdot \cos(t)),\ t \in [0,\ 2\pi] \right\}.$$

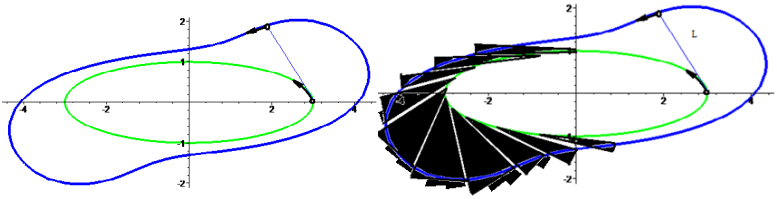


Figure 6. *Example 1*

The issues of area and length in this case are much more complicated. But the analysis shows that the previously proposed interpretation can be applied to this case (see Fig. 6 on the right). There will be no additional elements, and the sectors (highlighted in black) together form a circle if they are laid out from one point. Thus, the area of the resulting figure is equal to the area of the original (base) circle of radius L. The length of the curve requires further study.

Example 2. Let the base curve l be given as follows

$$l = \{z \in C,\ z = (-\sin(7t) + 10.1) * \cos(t) + i \cdot (-\sin(7t) + 10.1) * \sin(t),\ t \in [0,\ 2\pi]\}.$$

The start of movement of the rear wheel is at point (10.0), the length of the frame is parameter L=2, the direction of movement corresponds to the increase in parameter t, that is, counterclockwise (see Fig. 7).

The required curve will have the following form

$$S = \{w = (-\sin(7t) + 10.1) \cdot \cos(t) + i \cdot (-\sin(7t) + 10.1) \cdot \sin(t) + +2 \cdot \exp(\arg(z'),\ t \in [0,\ 2\pi]\}$$

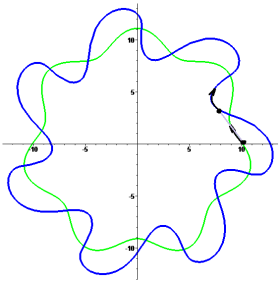


Figure 7. *Curves for example 2*

Let's consider a variant of the base curve (trajectory) of a general form. The simplest analysis of possible trajectories shows that, in principle, the trajectory of the rear wheel of a bicycle can also represent a piecewise smooth curve.

A piecewise smooth curve is a curve that can be divided into a finite number of parts, where each part represents a smooth curve.

From this definition it follows that in this case it is enough to describe the trajectory of the front wheel at those points when the trajectory of the rear wheel describes a certain angle (see Fig. 8 on the left).

In fact, for this angle we are only interested in the vertex, which represents the point. It turns out that at the apex of the corner the rear wheel, on the one hand, stands still, but on the other hand, it turns through a certain angle α.

It is easy to see that this case is similar to the case from point 1, the only difference is in the magnitude of the angle, that is, in this section the desired curve S will represent an arc of a circle of radius L turning α.

Let's look at this in more detail. Let us take as the base curve l a curve composed of two arcs of circles l1, l2 intersecting at point l0.

Obviously, for parts l1, l2 of the base curve l, the desired curve S will be represented by smooth curves.

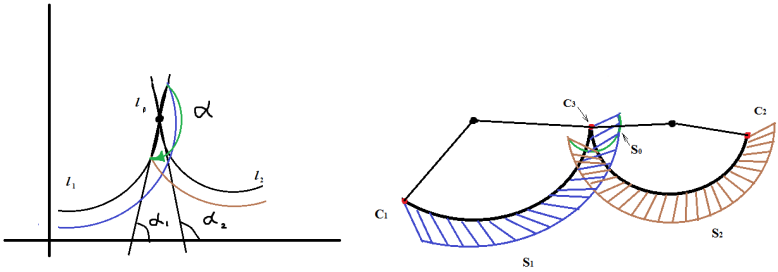


Figure 8. *Case of a non-smooth curve*

At the intersection point, the desired trajectory of the front wheel will be an arc of a circle with turning radius L α= α2 - α1. As a result, we obtain a piecewise smooth curve S consisting of curves S1, S0, S2 (see Fig. 8 on the right)

$$S=\left\{ w\in C,\ w=\begin{cases} z_1+L\cdot e^{i\cdot\arg(z_1')} \\ z_0+L\cdot e^{i\cdot t},\ t\in[\alpha_1,\alpha_2] \\ z_2+L\cdot e^{i\cdot\arg(z_2')} \end{cases} \right\}.$$

Example 3. Let the base curve l be a closed curve (cardioid) with one "special" point (see Fig. 9)

$$l=\{z\in C,\ z=(-\sin(t)+1.1)\cdot 2\cdot\cos(t)+(i\cdot(-\sin(t)+1.1)\cdot 2\cdot\sin(t),\ t\in[0,\ 2\pi]\}.$$

Then, according to the previously obtained formula, the desired curve S will have the following description

$$S = \left\{ w \in C,\ w = \begin{cases} (-\sin(t) + 1.1) \cdot 2 \cdot \cos(t) + (i \cdot (-\sin(t) + 1.1) \cdot 2 \cdot \sin(t) + \\ +2 \cdot \exp(\arg(z')),\ t \in (\pi/2,\ 5\pi/2) \\ t = \pi/2 \\ 0.2 \cdot i + 2 \cdot \cos(tt) + i \cdot 2 \cdot \sin(tt),\ tt \in [3\pi/4,\ 5\pi/4] \end{cases} \right\}.$$

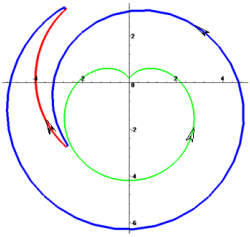


Figure 9. *Curve with one special point*

Note that in the last example, the start and end points could formally be connected by another circular arc. All figures were obtained in the Maple mathematical package.

References

1. *Gozbenko V.E., Lytkina E.M. Using equidistances to solve applied problems of controlling technical systems. – Irkutsk: IrGUPS, 2010. – 188 p.: ill.*
2. *Uteshev A.Yu. "Equidistant and not only..." [Electronic resource]. Electronic project. – 2010. 11.07. – Electronic data URL:http://www.pmpu.ru/vf4/dets/discrim/equidist*

科学出版物

上合组织国家的科学研究：协同和一体化

国际科学大会的材料

2023 年 12 月 9 日。中國北京

编辑A.A.Siliverstova
校正A.I.尼古拉耶夫

2023 年 12 月 9 日。中國北京
USL。沸点：98.7。 订单253.流通500份。

在编辑和出版中心印制
无限出版社