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MECHANICAL ENGINEERING AND TECHNOLOGY

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Arkhyenko I.O.,
Savin O.B.National Aerospace University "KHAI", Kharkiv, Ukraine
<https://doi.org/10.5281/zenodo.17013675>

SOLUTION OF THE SPATIAL PROBLEM OF ELASTICITY THEORY FOR A HALF-SPACE SHELL

Abstract.

The article is devoted to the development of a method for solving the spatial problem of elasticity theory for a semi-infinite layer bounded by two horizontal and one vertical surfaces. Such problems are fundamental in the mechanics of deformable solids and are important for the analysis of engineering structures. The proposed approach is based on the generalized Fourier method. A key feature of the work is the application of the principle of load asymmetry to take into account the influence of the free vertical boundary. This allows the initial boundary problem for a semi-infinite layer to be reduced to a problem for an infinite layer, which greatly simplifies the mathematical apparatus. The numerical implementation of the solution of the obtained system of equations is carried out using the reduction method, which ensures high, predetermined accuracy of the final results. The proposed method allows obtaining a highly accurate calculation of the stress-strain state of a semi-infinite layer. The validation of the results is confirmed by comparison with known solutions and verification of the boundary conditions.

Keywords: elasticity theory, semi-infinite shell, generalized Fourier method, boundary value problem, stress-strain state, Lamé equations, reduction method.

Introduction. Ensuring the strength, reliability, and durability of structures is a priority in the aerospace industry and modern mechanical engineering. The desire to reduce weight and improve performance has led to the widespread use of modern materials, in particular polymer composites. However, structural elements such as wing panels, fuselage elements, hull parts, and shells often have complex geometries that include holes, cutouts, and joints, which are stress concentrators and potential sources of failure. Accurate calculation of the stress-strain state in such areas is critical for predicting the behavior of the structure under static and dynamic loads.

The study of stress-strain states, especially in composite materials, has been the subject of numerous scientific works. Modeling progressive damage in composites with notches, as shown in [1], allows predicting material failure. Understanding the relationships between the strength limits of polymer composites under different types of static loads (bending, compression, tension) is critical for design. Complications arise when analyzing multilayer composites subjected to impact loads [2, 3] and when calculating aircraft structures such as cockpit canopies. Particular attention is paid to stress concentrations around holes, as this is one of the main causes of failure [4]. Methods for minimizing thermal stresses in perforated composite plates are being investigated, and analytical solutions are being developed to determine stresses around holes in functionally graded materials.

There are two main approaches to solving such complex problems in elasticity theory: numerical and analytical. Numerical methods, among which the finite element method, described in detail in [5], plays a leading role, allow modeling objects of complex geometry

and taking into account the nonlinear behavior of materials. Modern software packages, such as ANSYS Discovery [6], provide powerful tools for performing static structural analysis. However, numerical methods require significant computational resources, and the accuracy of the result depends on the quality of the constructed mesh. Comparative analysis of analytical and numerical methods, conducted in [7], shows that each approach has its advantages and disadvantages, and combining them often gives the best results.

Analytical methods, although applicable to a narrower class of problems, allow us to obtain a solution in general form, which provides a deeper understanding of physical processes. The fundamental basis for analytical solutions to dynamic problems is laid down in classical works on the theory of diffraction and the propagation of harmonic oscillations and waves in elastic bodies [8–11]. One of the most powerful analytical tools for solving spatial problems in elasticity theory is the generalized Fourier method. The theoretical foundations of this method and its application to a wide range of problems are described in detail in the monograph by A. G. Nikolaev and V. S. Protsenko [12].

The application of the generalized Fourier method proved to be extremely effective for solving problems for bodies with cylindrical cavities and inclusions. This method was successfully used for mathematical modeling of the dynamics of an elastic half-space with a cylindrical cavity [13, 14], for studying the wave field of a layer with a cylindrical cavity [15], and for solving mixed problems for a half-space with a cylindrical cavity and several cavities with contact conditions [16–18].

In recent works, this method has been extended to even more complex problems. In particular, it has been applied to analyze the NDS of an infinite layer with a

cylindrical cavity under periodic loading [19], as well as to analyze a fibrous composite layer and the problem of rotating a layer with a cylindrical tube around a rigid cylinder [20].

However, despite significant progress in solving problems for infinite layers and half-spaces, problems for semi-infinite bodies, i.e., bodies bounded not only by horizontal but also by vertical surfaces, remain difficult to analyze. Classical approaches often do not allow the influence of lateral boundaries to be taken into account.

The aim of this work is to develop a concept for solving the elasticity theory problem for a semi-infinite layer bounded by two horizontal surfaces and one vertical surface. To achieve this goal, we propose an approach based on the generalized Fourier method combined with the principle of load asymmetry, which allows us to satisfy the boundary conditions on the vertical free surface and reduce the problem to one already studied for an infinite layer.

Problem statement. Consider an infinite elastic sphere located in the Cartesian coordinate system (x, y, z) . This sphere is bounded by two parallel planes: the upper boundary located at a distance $y = h$ and the lower boundary located at $y = -\tilde{h}$.

The main goal of this problem is to determine the displacement field $u(x,y,z)$ and the associated stress field $\sigma(x,y,z)$ inside this sphere. This is achieved by solving the Lamé equations, which are the fundamental equations of elasticity theory. They describe the equilibrium of an elastic body and have the form:

$$(\lambda + \mu)\nabla(\nabla \cdot u) + \mu\nabla^2 u + F = 0$$

$$\vec{U}_0 = \sum_{k=1}^3 \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} (H_k(\lambda, \mu) \cdot \vec{u}_k^{(+)}(x, y, z; \lambda, \mu) + \tilde{H}_k(\lambda, \mu) \cdot \vec{u}_k^{(-)}(x, y, z; \lambda, \mu)) d\mu d\lambda \quad (3)$$

where $H_k(\lambda, \mu)$ and $\tilde{H}_k(\lambda, \mu)$ are unknown functions that must be found from the boundary conditions $\vec{u}_k^{(+)}(x, y, z; \lambda, \mu)$ and $\vec{u}_k^{(-)}(x, y, z; \lambda, \mu)$ are the basis solutions, Lamé equations, chosen in the form [12]:

$$\begin{aligned} \vec{u}_k^{\pm}(x, y, z; \lambda, \mu) &= N_k^{(d)} e^{i(\lambda z + \mu x) \pm \gamma y}; \quad (4) \\ N_1^{(d)} &= \frac{1}{\lambda} \nabla; N_2^{(d)} = \frac{4}{\lambda} (\nu - 1) \vec{e}_2^{(1)} + \frac{1}{\lambda} \nabla(y \cdot) \\ &; N_3^{(d)} = \frac{i}{\lambda} \text{rot}(\vec{e}_3^{(1)} \cdot); \\ \gamma &= \sqrt{\lambda^2 + \mu^2}; \quad -\infty < \lambda, \mu < \infty. \end{aligned}$$

$$\vec{F}_h^0(x, z) = (\tau_{yx}^{(h)}(x, z) - \tau_{yx}^{(h)}(x, |z|)) \vec{e}_x + (\sigma_y^{(h)} \vec{e}_y(x, z) - \sigma_y^{(h)} \vec{e}_y(x, |z|)) + (\tau_{yz}^{(h)} \vec{e}_z(x, z) - \tau_{yz}^{(h)} \vec{e}_z(x, |z|)), \quad (5)$$

$$\vec{F}_{\tilde{h}}^0(x, z) = (\tau_{yx}^{(\tilde{h})} \vec{e}_x(x, z) - \tau_{yx}^{(\tilde{h})} \vec{e}_x(x, |z|)) + (\sigma_y^{(\tilde{h})} \vec{e}_y(x, z) - \sigma_y^{(\tilde{h})} \vec{e}_y(x, |z|)) + (\tau_{yz}^{(\tilde{h})} \vec{e}_z(x, z) - \tau_{yz}^{(\tilde{h})} \vec{e}_z(x, |z|)), \quad (6)$$

To find the unknown equations (3), we substitute the boundary conditions (5) and (6) into the left side of (3), after first expressing them in terms of a double Fourier integral. This gives us six equations when the boundary conditions are satisfied on the flat surfaces of the layer. By removing the integrals from the right and left sides of this equation, we obtain a system of linear algebraic equations of the second kind.

where u is the displacement vector; λ and μ are Lamé constants that characterize the elastic properties of the material; F is the vector of volume forces (e.g., gravitational forces).

The solution to this equation must satisfy the boundary conditions specified on the surfaces of the layer. In this problem, the stress values at the boundaries of the layer ($y = \pm h$) are known. These are the so-called Neumann conditions, which mean that a known external load acts on the surface. This allows us to determine a specific solution from the general family of possible solutions to the equations.

The stresses at the boundaries can be written as $F\vec{U}(x, z)|_{y=h} = \vec{F}_h^0(x, z)$, $F\vec{U}(x, z)|_{y=-\tilde{h}} = \vec{F}_{\tilde{h}}^0(x, z)$, where

$$\vec{F}_h^0(x, z) = \tau_{yx}^{(h)} \vec{e}_x + \sigma_y^{(h)} \vec{e}_y + \tau_{yz}^{(h)} \vec{e}_z, \quad (1)$$

$$\vec{F}_{\tilde{h}}^0(x, z) = \tau_{yx}^{(\tilde{h})} \vec{e}_x + \sigma_y^{(\tilde{h})} \vec{e}_y + \tau_{yz}^{(\tilde{h})} \vec{e}_z. \quad (2)$$

Thus, the complete formulation of the problem boils down to finding a displacement vector $u(x,y,z)$ that:

1. Satisfies Lamé's equation inside the layer.
2. Corresponds to the specified stresses at its upper and lower boundaries.

It is necessary to take into account the vertical boundary $z \leq 0$, with given zero stresses on the surface $z = 0$.

Research Methodology. We will present the solution to the problem in the form [15] for an infinite layer. In this equation, we will reduce the term corresponding to the cylindrical cavity, resulting in:

To account for the additional vertical boundary, we introduce an additional vertical symmetry boundary—the plane $z = 0$. This technique allows us to consider only half of the layer, which greatly simplifies the mathematical calculations, since we are moving from an infinite to a semi-infinite layer (at $z \leq 0$), while the load at $z > 0$ will be taken with the opposite sign.

Thus, the specified load is in the negative zone (at $z \leq 0$). To take into account the vertical boundary in an infinite layer (to obtain a semi-infinite layer), it is necessary to replace boundary conditions (1) and (2), taking into account the asymmetric load in the positive coordinate zone of the z -axis:

Having obtained a system of equations, we expressed them as $H_k(\lambda, \mu)$ and $\tilde{H}_k(\lambda, \mu)$. As a result, all unknowns of the problem were found.

Numerical studies of the stress state. Numerical studies were carried out for a homogeneous isotropic layer of aluminum alloy D16T (Poisson's ratio $\nu = 0.3$, modulus of elasticity $E = 7.1 \cdot 10^4$ MPa).

Geometric parameters of the model: $h = \tilde{h} = 15$ mm.

At the upper and lower boundaries of the layer, normal stresses are specified in the form of a unit wave with a negative sign, shifted from zero by an amount $-b$ along the z -axis, and an asymmetric positive unit wave (shifted from zero by an amount $+b$ along the z -axis):

$$\sigma_y^{(h)}(x, z) = \sigma_y^{(\tilde{h})}(x, z) - 10^8$$

$$= \frac{-10^8}{((z-b)^2 + 10^2)^2 \cdot (x^2 + 10^2)^2}$$

$$+ \frac{10^8}{((z+b)^2 + 10^2)^2 \cdot (x^2 + 10^2)^2}$$

and zero tangential stresses

$$\tau_{yx}^{(h)} = \tau_{yz}^{(h)} = \tau_{yx}^{(\tilde{h})} = \tau_{yz}^{(\tilde{h})} = 0.$$

The infinite system was truncated at $m=5$ (order of the system of equations).

The accuracy of the boundary conditions at the specified m and given geometric parameters is at least 10^{-8} for values from 0 to 1.

For verification, the obtained stress state results were compared with the work [15].

Conclusions. This paper presents a method for solving a spatial elasticity problem for a semi-infinite layer bounded by two horizontal and one vertical surfaces. This method is important for analyzing engineering structures in the aerospace industry and mechanical engineering, where elements often have complex geometries and are subjected to stresses that can lead to failure.

The main results and achievements obtained in the course of the research are as follows:

1. A new approach for analyzing a semi-infinite layer has been developed. The proposed method is based on a combination of the generalized Fourier method and the principle of load asymmetry. This made it possible to take into account the influence of the vertical free boundary, which is a significant advantage over classical approaches, which usually cannot take into account the side boundaries.

2. The mathematical apparatus has been simplified. The application of the asymmetry principle has made it possible to reduce the complex boundary value problem for a semi-infinite layer to the already studied problem for an infinite layer, which has greatly simplified the solution process.

3. High accuracy of calculations is ensured. The numerical implementation of the solution of the system of equations was performed using the reduction method. This made it possible to achieve a high, predetermined accuracy of at least

10⁻⁸ when performing boundary conditions.

4. The results were validated. The obtained results were compared with known solutions and checked for compliance with boundary conditions. This confirms the reliability and effectiveness of the proposed method.

In general, the proposed method is a powerful analytical tool for high-precision calculation of the stress-

strain state of semi-infinite layers. This approach can be used for further research, in particular for the analysis of dynamic loads and interactions with various types of inclusions and damage.

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PEDAGOGICAL SCIENCES

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Lopushniak Lesia,*Candidate of medical sciences, assistant***ORCID ID:** <https://orcid.org/0000-0001-8362-406X>**Bambuliak Andrii,***Doctor of medical sciences, professor***ORCID ID:** <https://orcid.org/0000-0002-6383-9327>**Honcharenko Valentina,****ORCID ID:** <https://orcid.org/0000-0001-7276-9052>*Candidate of medical sciences, associate professor***Dmytrenko Roman,***Candidate of medical sciences, associate professor***ORCID ID:** <https://orcid.org/0000-0002-1657-0927>*Bukovynian State Medical University**Chernivtsi, Ukraine*<https://doi.org/10.5281/zenodo.17013686>

USE OF PEDAGOGICAL TECHNOLOGIES IN THE PREPARATION OF FUTURE DENTISTS

Лопушняк Леся,*кандидат мед. наук, асистент***ORCID ID:** <https://orcid.org/0000-0001-8362-406X>**Бамбуляк Андрій,***доктор мед. наук, професор***ORCID ID:** <https://orcid.org/0000-0002-6383-9327>**Гончаренко Валентина,***кандидат мед. наук, доцент***ORCID ID:** <https://orcid.org/0000-0001-7276-9052>**Дмитренко Роман,***кандидат мед. наук, доцент***ORCID ID:** <https://orcid.org/0000-0002-1657-0927>*Буковинський державний медичний університет,**м. Чернівці, Україна*

ЗАСТОСУВАННЯ ПЕДАГОГІЧНИХ ТЕХНОЛОГІЙ ПРИ ПІДГОТОВЦІ МАЙБУТНІХ СТОМАТОЛОГІВ

Abstract.

At the current stage of health care development, more and more attention is paid to patient safety, ethical issues, increasing the responsibility of health professionals, a high level of professional skills and the rapid evolution of procedures and methods. The above requires the adaptation of a study program and the use of all available educational tools and technologies in the training of future medical professionals. The aim of the study was to conduct a theoretical analysis of scientific psychological and pedagogical, methodological and medical publications, methodological work of the department on the use of pedagogical technologies in the training of future dentists. The use of modern pedagogical technologies, in particular stimulation learning technologies and case technologies, in the process of professional training of future dentists performs several important functions: control, as it reveals the knowledge, skills and abilities of students; educational, because it requires students to achieve a certain level of education; educational, as is the formation of personal qualities of future doctors. By effectively organizing independent and classroom activities of the student, the teacher promotes development of clinical thinking, which inevitably becomes the basis for qualified and successful doctor's formation. Simulation training and case technologies contribute to the formation of professional competence of future professionals, skills and abilities of their mental activity, personality development, ability for self-studying, changing the paradigm of thinking, the ability to process large amounts of information, as well as the development of quality requirements for a specialist who must respond adequately and professionally in different situations, to be systematic and effective. Simulation learning technologies allow you to repeatedly and accurately reproduce important clinical scenarios and provide an opportunity to adapt the learning situation for each student.

Анотація.

На сучасному етапі розвитку сфери охорони здоров'я все більше уваги приділяється безпеці пацієнтів, етичним питанням, збільшенню відповідальності медичних працівників, високому рівню необхідної професійної кваліфікації та швидкій еволюції процедур та методів. Вищезазначене вимагає адаптування навчальних програм та використання усіх наявних освітніх інструментів і технологій при професійній

підготовці майбутніх медичних фахівців. Метою дослідження було провести теоретичний аналіз наукових психолого-педагогічних, методичних та медичних публікацій, методичної роботи кафедри щодо застосування педагогічних технологій в процесі професійної підготовки майбутніх стоматологів. Використання сучасних педагогічних технологій, зокрема технологій стимуляційного навчання та кейс-технології, в процесі професійної підготовки майбутніх стоматологів виконує кілька важливих функцій: контролюючу, оскільки виявляє знання, уміння та навички студентів; навчальну, тому що вимагає досягнення студентами певного рівня навчання; виховну, оскільки відбувається формування особистісних якостей майбутніх лікарів. Ефективно організовуючи самостійну й аудиторну діяльність студента, викладач сприяє розвитку клінічного мислення, що неодмінно стає основою формування кваліфікованих та успішних лікарів. Симуляційне навчання та кейс-технології сприяють формуванню професійної компетентності майбутніх фахівців, вмінь та навичок їхньої розумової діяльності, розвитку особистості, здатності до самонавчання, зміні парадигми мислення, вмінню переробляти значні об'єми інформації; а також розвитку вимог щодо якості фахівця, який повинен адекватно та професійно реагувати в різних ситуаціях, відрізнятися системністю та ефективністю дій. Технології симуляційного навчання дозволяють багаторазово та точно відтворити важливі клінічні сценарії та надають можливість адаптувати навчальну ситуацію для кожного студента.

Keywords: *pedagogical technologies, training, teacher, student, dentistry.*

Ключові слова: *педагогічні технології, навчання, викладач, студент, стоматологія.*

Introduction. At the current stage of health care development, more and more attention is paid to patient safety, ethical issues, increasing the responsibility of health professionals, a high level of professional skills and the rapid evolution of procedures and methods [1-3]. The above requires the adaptation of a study program and the use of all available educational tools and technologies in the training of future medical professionals. The aim of the study was to conduct a theoretical analysis of scientific psychological and pedagogical, methodological and medical publications, methodological work of the department on the use of pedagogical technologies in the training of future dentists [4].

Materials and methods of the study. Analysis of psychological and pedagogical, methodical literature, materials of educational and methodical conferences, methodical work of the department. Theoretical methods (analysis, synthesis, generalization, comparison, systematization, pedagogical modeling, theoretical forecasting) were used to achieve the goal and clarify the nature and features of the use of modern pedagogical technologies in the educational process.

Results obtained. The rapid decrease in the price of computing power and the elemental base of computers, the sharp growth of the market of mobile devices and applications contribute to the mass spread of virtual reality technologies and make it possible to sharply reduce the costs of educational materials. The use of virtual reality in the practice of professional training of future dentists radically transforms the principle of visual content of education, and fully corresponds to the global trend in teaching disciplines, which consists in supplementing traditional approaches with modern methods of information transmission: expanding the availability of electronic libraries, anatomical databases, the appearance of perfect simulators, which model the structures of the human body according to the system and topographic principle with the possibility of building planar projections and three-dimensional three-dimensional body models. The virtual identity of real objects, their universality and multifunctionality

can give the future doctor greater life experience in perception, in the implementation of actions. The high efficiency of implementation, the use of virtual reality as a full-fledged educational equipment that competes with traditional approaches, requires the presence of educational programs that have a script, a rigid algorithm of actions, which allows them to act as an educational technology. In their absence, only the teacher can transmit knowledge to the student. As a way of transferring and learning knowledge, the existing means of virtual reality make high demands on the teaching staff, whose active and competent position will allow the introduction of new technologies. The introduction of virtual reality tools expands the boundaries of the principles of visibility and accessibility. At the same time, the insufficient development of specialized content and the lack of established educational technologies can cause difficulties in the widespread implementation of these educational tools by teachers. Anticipatory work in this segment is combined with the creation of specialized educational programs for the professional training of teachers and should become an actual direction for the implementation of virtual reality technologies in the practice of teaching medical disciplines.

In order to form future doctors' clinical thinking in the educational process, case-study technologies are implemented in parallel with the improvement of traditional ones. The case method, or the method of situational exercises, is a teaching method that makes it possible to bring the learning process closer to the real practical activities of specialists. It promotes the development of ingenuity, the ability to solve problems, develops the ability to analyze and diagnose problems. This pedagogical tool helps to deepen the understanding of the topic, develop imagination, practically test the theory, explore ideas, identify patterns, relationships, formulate hypotheses, increase motivation, encourage thinking and discussion, get additional information, deepen knowledge, confirm views, apply analytical thinking, ability to solve problems and draw rational conclusions, develop communication skills, combine theoretical knowledge with practical problem

solving, turn abstract knowledge into skills and abilities. In the field of medical pedagogy, this technique allows developing clinical thinking based on the principles of evidence-based medicine, improving practical skills. This method is successfully used all over the world in teaching medical sciences. This pedagogical technology can be implemented in different ways. It can be a format of work in small groups, a business role-playing method, a discussion method, standardized patients, etc. [5]. However, one of the important ways of implementing the case study methodology is the use of information and educational web technologies, which makes the learning process interactive, effective and allows scaling educational materials to a large audience at the same time. With the help of information and educational web technologies, opportunities for a wider range of clinical cases, including rather rare ones, for qualitative visualization of additional research methods are revealed, which is impossible with the traditional training format. Access to interactive clinical cases is open and implemented using Internet access. An important advantage of the case method of learning is that this experience can be repeated if necessary and mastered according to an individual learning trajectory at a convenient pace with the help of Internet access. Interactive cases are widely presented on the websites of some medical educational institutions and in the Internet versions of medical journals, world societies of doctors of various specialties. Cases are illustrated materials that are shown to the user in a certain sequence. The user receives information about the patient using videos, graphic images, diagrams, etc., and after some time gets the opportunity to choose one or another action, assume a diagnosis, carry out a differential diagnosis, prescribe an examination, treatment. An interesting foreign project is the Open Labyrinth system, where the case method of learning is implemented using a special platform for creating and reviewing cases. In Ukraine, the study of the medical discipline using the case method began recently and needs to be developed and implemented in the practice of training modern specialists. Case technology is a complex and effective tool of innovative learning technology, which at the same time not only reflects a practical problem, but also actualizes a certain set of knowledge that must be mastered for its solution, and also successfully combines educational, analytical and educational activities, which increases effectiveness of modern educational tasks [6, 7]. The essence of case technology is that students are offered a real clinical situation, the description of which simultaneously reflects not only any practical problem, but also actualizes a certain set of knowledge that must be mastered in order to understand a specific task. Until now, there is no certain standard for presenting cases from medical disciplines [8]. Usually, cases are presented in printed form or on electronic media, multimedia presentations, photos, diagrams, tables are included in the text, which makes them more visual for students. Case technology is an active problem-situational analysis based on learning by solving specific problems – situations (cases) – by a group of students. With joint efforts, it is necessary to

analyze the symptoms, possible causes of its occurrence, find a practical solution, evaluate the proposed solutions and choose the most optimal one. Cases for independent work are more extensive and contain more information [9-10]. The use of case technology during the study of the academic discipline «Dentistry» helps students better remember complex topics, develop and train clinical thinking, master the skills of differential diagnosis of various pathologies, clearly and succinctly formulate their thoughts; develops the ability to listen, thereby stimulating interest in education. The organization of the educational process of professional training of future doctors with the use of cases makes it possible to prepare specialists as much as possible for taking the «KROK» exam.

Conclusions. The use of modern pedagogical technologies, in particular stimulation learning technologies and case technologies, in the process of professional training of future dentists performs several important functions: control, as it reveals the knowledge, skills and abilities of students; educational, because it requires students to achieve a certain level of education; educational, as is the formation of personal qualities of future doctors. By effectively organizing independent and classroom activities of the student, the teacher promotes development of clinical thinking, which inevitably becomes the basis for qualified and successful doctor's formation. Simulation training and case technologies contribute to the formation of professional competence of future professionals, skills and abilities of their mental activity, personality development, ability for self-studying, changing the paradigm of thinking, the ability to process large amounts of information, as well as the development of quality requirements for a specialist who must respond adequately and professionally in different situations, to be systematic and effective. Simulation learning technologies allow you to repeatedly and accurately reproduce important clinical scenarios and provide an opportunity to adapt the learning situation for each student.

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POLITICAL SCIENCES

Quliyeva Gulgun

Department of Diplomacy and Processes of Modern Integration

Baku State University

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THE PLACE AND GEOPOLITICAL SIGNIFICANCE OF WESTERN AZERBAIJAN IN THE REGIONAL SECURITY ARCHITECTURE

Abstract.

This article explores the place and geopolitical significance of the Western Azerbaijan issue within the framework of regional security architecture. The right of return for Azerbaijanis who were forcibly displaced from their ancestral lands due to historical deportations is not only a humanitarian concern, but also a key component for long-term peace and stability in the South Caucasus. The article analyzes the legal foundations of this issue, the risks posed by Armenia's monoethnic policies, the strategic value of the Zangezur corridor, and the positions of international actors. A lawful and peaceful resolution to the Western Azerbaijan issue can contribute to the establishment of a fair and stable regional security environment. The study also offers recommendations for strengthening diplomatic efforts, preparing for reintegration, and enhancing cooperation with international organizations. The article also recommends strengthening diplomatic efforts in this direction, preparing for the reintegration process, and expanding cooperation with international organizations. The place of the Western Azerbaijan issue in the regional security architecture, its geopolitical, legal, and diplomatic significance are analyzed. At the same time, the attitude of international actors toward this issue and its impact on the peace process in the region are examined. The goal is to show how the solution to this problem can contribute not only to the restoration of ethnic justice, but also to the establishment of a sustainable and inclusive security system in the South Caucasus.

Keywords: *Western Azerbaijan, regional security, geopolitical significance, deportation, peace and stability, Zangezur corridor, international law, South Caucasus, right of return*

INTRODUCTION

The regional security architecture is a system of structures and institutions that aligns the security interests of global and regional powers, states, organizations, and other actors. Within this framework, the issue of Western Azerbaijan has become a strategically important topic — not only in the context of restoring historical justice but also in shaping the future security dynamics of the South Caucasus. The issue of the rights of Western Azerbaijani Turks, who have been repeatedly deported from their native lands as a result of Armenia's monoethnic state policy, is not merely a humanitarian matter. It is also of vital importance from the perspectives of regional peace, ethnic balance, and geopolitical stability. In a complex geopolitical environment like the South Caucasus, ensuring security requires addressing historical and ethnic injustices and resolving frozen or unresolved issues through mechanisms based on international law. In this regard, the Western Azerbaijan issue is a fundamental humanitarian and political problem of strategic significance for the future of the region.

Throughout the 20th century, as a result of several stages of mass deportation (1905, 1918–1920, 1948–1953, 1987–1991), hundreds of thousands of Azerbaijani Turks were forcibly expelled from the territory of Armenia — historically known as Western Azerbaijan. Armenia's policy, aimed at establishing a monoethnic state, altered the regional demographic landscape and eliminated ethnic and cultural diversity. As a result, the rights of Western Azerbaijani Turks were violated for decades, and the issue remained largely ignored by international law.

However, in recent years, Azerbaijan's growing political influence, increased diplomatic activity, and the changing geopolitical realities in the region have laid the groundwork for reintroducing this issue into the international agenda. The Azerbaijani state seeks to ensure the peaceful return of Western Azerbaijani Turks to their ancestral lands, in accordance with international legal norms. This is not just a demand for justice by a displaced people, but also a necessary condition for long-term peace and security in the region.

Historical and Legal Roots of the Western Azerbaijan Issue

Western Azerbaijan — the territory of present-day Armenia, historically and ethnographically home to Azerbaijani Turks for centuries — has been subject to systematic and planned ethnic cleansing and deportations since the early 20th century. As a result of these processes, hundreds of thousands of Azerbaijani Turks were forcibly removed from their native lands, and their cultural, religious, and material heritage was either destroyed or appropriated. Each of these historical events represents a serious violation of human rights under international law and led to the artificial alteration of the ethno-demographic landscape of the region.

Waves of Deportation and Their Impact on the Regional Security Architecture

The geopolitical significance of the Western Azerbaijan region stems not only from its geographic location but also from the humanitarian and political problems created by historical injustices in this territory. In this context, the waves of deportation experienced by Western Azerbaijani Turks at different times during the

20th century lie at the heart of regional security concerns. These forced displacements were not carried out solely on ethnic and religious grounds but also aimed to alter the ethnic composition of the area and strengthen strategic control.

- **The Events of 1905:**

The Armenian-Muslim clashes of 1905–1907 led to the forced displacement of numerous Muslim families from their ancestral lands. These events occurred during a period of weakened central authority in the Russian Empire and marked the first major phase of ethnic conflict in the region. [21]

- **1918–1920:**

During and after World War I, and in the period of the first Armenian Republic's independence (1918–1920), the Dashnak government carried out large-scale ethnic cleansing against Azerbaijani Turks. During this time, tens of thousands of Azerbaijanis were expelled from regions such as Zangezour, Goycha, Daralayaz, and others; many villages were destroyed. [6]

- **1948–1953:**

Based on a decision by the Council of Ministers of the USSR, over 100,000 Azerbaijani Turks were relocated from the Armenian SSR to Azerbaijan's Kura-Araz lowlands starting in 1948. Although officially termed a “voluntary resettlement,” in reality, it was a forced deportation. This move, justified for political reasons, was actually part of the broader policy of monoethnicization in the region. [(USSR Council of Ministers Decision No. 4083, dated December 23, 1947)]

- **1987–1991:**

As the Soviet Union began to collapse, violence against Azerbaijani Turks living in Armenia intensified. Beginning in 1988, tens of thousands of Azerbaijanis were subjected to armed attacks and fled to the territory of the Azerbaijan SSR from regions such as Kapan, Spitak, Masis, Amasia, and others. This deportation ultimately resulted in the complete expulsion of Azerbaijani Turks from Armenia. [10]

The waves of deportation from Western Azerbaijan have had serious consequences for regional security. These events not only disrupted the ethnic balance but also became a long-term source of humanitarian and geopolitical tension in Armenian-Azerbaijani relations. A just resolution to the Western Azerbaijan issue is important not only from a humanitarian standpoint but also for the establishment of a stable and lasting security architecture in the South Caucasus.

Legal Documents

The right of return for the Western Azerbaijanis fully aligns with the fundamental principles of international law. This right is safeguarded by several key international documents, including:

- **The Universal Declaration of Human Rights (1948), Article 13:**

“Everyone has the right to leave any country, including his own, and to return to his country.”

- **The European Convention on Human Rights, Protocol No. 4, Article 2:** “No one shall be deprived of the right to enter his own country.”

- **The 1951 UN Convention Relating to the Status of Refugees and its 1967 Protocol:** These documents affirm the right of refugees to voluntarily return in safety and dignity.

- **Case law of the European Court of Human Rights:**

There is a solid legal basis in numerous rulings related to the right to property and return of displaced persons to their homes and lands.

The right of return is not limited to individual human rights but must also be recognized as a collective right of a people who were subjected to mass deportation.

Legal Documents and Rights: The Place of the Right of Return in International Law. The right of the Western Azerbaijanis to return to their ancestral lands is not only a historical and moral imperative but also a fundamental human right protected under international law. This right is enshrined in numerous international conventions, declarations, and rulings, with states being obligated to respect these rights.

- **The Universal Declaration of Human Rights (UDHR):**

Article 13 of this document explicitly recognizes the right to freedom of movement and the right to return:

“Everyone has the right to freedom of movement and residence within the borders of each state. Everyone has the right to return to his country.”

This clause forms the legal foundation for the right of return of persons who have been forcibly displaced or deported from their homeland.

- **The European Convention on Human Rights (1950):**

Adopted by the Council of Europe, Article 8 guarantees the right to respect for private and family life: “Everyone has the right to respect for his private and family life, his home and his correspondence.” This article is closely linked to the right to return to one's home and native land. The European Court of Human Rights has interpreted this article in several rulings as a safeguard for the right of return.

- **The 1951 Refugee Convention and its 1967 Protocol:**

These instruments focus on protecting individuals forcibly displaced from their homelands. Alongside the core principle of **non-refoulement** (prohibition of forced return), the documents recommend the creation of conditions for the safe and dignified return of refugees and displaced persons.

- **The UN Guiding Principles on Internal Displacement (1998):**

Drafted by the Special Representative of the UN Secretary-General on Internally Displaced Persons, these principles recognize the right of IDPs to return voluntarily, safely, and with dignity:

“Internally displaced persons have the right to return voluntarily, in safety and with dignity, to their homes or places of habitual residence.”

Legal Consequences and Calls to Action:

Based on these documents, the right of Western Azerbaijanis to return to their ancestral lands in present-day Armenia is a right recognized and protected

by international law. The Armenian state and the international community must facilitate the realization of this right and restore the rights violated through ethnic cleansing. Ensuring the right of return is not only a humanitarian necessity but also crucial for the establishment of long-term peace and security architecture in the South Caucasus.

The Activities of the Western Azerbaijan Community: Organization, Legal Struggle, and Internationalization.

The active efforts of the Western Azerbaijan Community play a vital role in systematizing and elevating the issue to legal and political platforms. This organization is the primary civil body advocating for the rights of our compatriots who were forcibly expelled from their historical homeland and working to ensure their return based on international law and political mechanisms.

• Organization and Objectives:

The Western Azerbaijan Community began operating in 1989, but in recent years—particularly since 2022—it has significantly expanded its scope with large-scale strategic initiatives. The community's main objective is to ensure the peaceful, lawful, and internationally recognized return of Western Azerbaijanis to their ancestral lands. The main directions of activity include:

- Collecting and archiving historical and legal documents;
- Building a legal basis for the right of return under international law;
- Expanding relations with Azerbaijani state bodies and international organizations;
- Promoting public awareness and conducting scientific-analytical work.

The "Concept of Return":

Prepared and presented to the public in December 2022 by the Western Azerbaijan Community, the "Concept of Return" serves as a strategic document outlining a unified approach and practical objectives. It details legal, security, economic, and social mechanisms necessary for the return process. The concept also proposes engaging international organizations, applying pressure mechanisms on Armenia, and establishing international guarantees and monitoring systems for return.

Activity within the Framework of International Legal Norms:

The community actively addresses the UN, the Council of Europe, the OSCE, and other international bodies to seek recognition of the right of return for our compatriots and to document Armenia's violations of international law. Reports and appeals prepared in 2023–2024 detail acts of ethnic cleansing, human rights violations, and cultural vandalism by Armenian governments.

Public and Academic Engagement:

The community is also actively involved in protecting cultural and historical heritage, promoting awareness of genocide and deportation events, and advancing public diplomacy and information strategies. Through conferences, academic publications, documentaries, and databases, it seeks to raise international awareness of the Western Azerbaijan issue.

Cooperation with the State

The President of the Republic of Azerbaijan, Ilham Aliyev, has repeatedly stated in his speeches that he supports the legitimate and peaceful return of Western Azerbaijanis and has clearly demonstrated political will in this regard. As the President stated in 2023:

"We must ensure the return of Western Azerbaijanis for the sake of restoring historical justice, based on international law." [8]

The activities of the Western Azerbaijan Community are significant both at the national level—preserving historical memory and strengthening organizational capacity—and at the international level—increasing legal and political influence. These efforts play a crucial role in restoring ethnic balance, legal norms, and security in the region, and highlight the importance of the Western Azerbaijan issue within the regional security architecture.

New Geopolitical Stage in the South Caucasus

The South Caucasus entered a new geopolitical phase following the Second Karabakh War in 2020. The restoration of Azerbaijan's territorial integrity and the emergence of new regional communication projects have begun to reshape the security balance in the region. However, Armenia's provocative policies, continued militarization, and its mono-ethnic state-building ideology remain serious threats to long-term regional stability.

The 2020 war brought fundamental changes not only to Armenia–Azerbaijan relations but also to the geopolitical and security architecture of the South Caucasus. The restoration of Azerbaijan's territorial integrity and Armenia's withdrawal from territories it occupied for nearly three decades shifted the regional balance of power, creating new geopolitical and military-political realities.

Azerbaijan's victory in the Second Karabakh War strengthened its military and diplomatic position in the South Caucasus. As a result of the conflict:

- Armenia emerged weakened and increasingly dependent on external powers—especially Russia and the Collective Security Treaty Organization (CSTO)—for its security.
- Azerbaijan enhanced its national security and regional influence, pursuing a balanced policy of cooperation with both Russia and Turkey [5].

The New Roles of Russia and Turkey

With the **November 10, 2020, trilateral statement**, Russia re-established a strategic role in the region by deploying peacekeeping forces. Meanwhile, Turkey's direct and open involvement introduced a new dual-polar balance.

The **Joint Monitoring Center in Aghdam** (Turkey–Russia) is a clear example of this cooperation [24]. This marked the first time in the post-Soviet era that Turkey was recognized as a stable actor in the South Caucasus.

New Security Architecture and Regional Formats

In the post-Karabakh era, regional security initiatives and cooperation platforms have gained momentum. The **"3+3 format"** (Azerbaijan, Armenia, Georgia

+ Turkey, Iran, Russia) aims to promote regional cooperation, but Georgia's refusal to participate and Armenia's ambiguous stance hinder the full realization of this platform [11].

The **Zangezur Corridor project**, which aims to establish direct connectivity between Azerbaijan and Nakhchivan, further enhances Azerbaijan's geostrategic position in land and energy transport [4].

The West's Increased Activity and Political Changes in Armenia

Following the Karabakh war, the **West—particularly the European Union—has adopted a more active role in South Caucasus peace initiatives**. The Brussels-format meetings facilitated by the EU are evidence of this engagement.

Simultaneously, the weakening of revanchist forces in Armenia and the Pashinyan government's gradual acceptance of post-war realities have allowed for some progress in the peace agenda [29].

A New Post-Conflict Security Order in the South Caucasus

The post-conflict stage in the South Caucasus is not just about redefining political borders but also about forming a new security system. In this phase:

- Azerbaijan has strengthened its position;
- Turkey has returned to the region;
- Russia seeks to maintain its influence while adapting to new realities.

Within this context, **the integration of the Western Azerbaijan issue into international law and regional security agendas is both strategically viable and legally necessary**.

After the Second Karabakh War, Azerbaijan emerged as a key military-political actor in the region. Through its **strategic alliance with Turkey**, it has bolstered its position within the regional security architecture. Post-war, Azerbaijan has demonstrated a constructive stance by focusing on **reconstruction, reintegration, and peace initiatives**. However, **Armenia's ambiguous approach to peace proposals has prolonged instability in the region**.

Despite international peace efforts, **Armenia's accelerated militarization since 2020 increases the risk of renewed conflict**. This policy, driven by revanchist domestic pressure and efforts to realign strategic partnerships, poses a serious threat to regional stability.

Between 2021–2024, Armenia's **military budget sharply increased, exceeding \$1.4 billion in 2024**, a nearly **50% rise** compared to previous years [(SIPRI, 2024); (Armenpress, 2023)].

The bulk of this funding was allocated to:

- air defense systems,
- unmanned aerial vehicles (UAVs),
- rocket launchers, and
- artillery systems.

Armenia has prioritized military-technical cooperation with **France, India, Greece, and Iran**. In recent years, Armenia has signed agreements with:

- **France** – air defense systems (Mistral) and radar technologies;
- **India** – “Pinaka” rocket systems and drones;
- **Iran** – military training and advisory cooperation [35].

While these efforts aim to enhance Armenia's defense capabilities, they also escalate the regional arms race and heighten military tensions.

The establishment of **new military positions in Zangezur and border areas**, as well as the deployment of troops by Armenia, has led to renewed tensions.

Incidents and ceasefire violations on the Azerbaijan–Armenia border in 2023–2024 underscore the real risk of escalation [24].

Domestically, **revanchist rhetoric and slogans like “There is no Armenia without Karabakh”** push public opinion in a militaristic direction. This pressure compels the government—particularly Prime Minister Nikol Pashinyan—to take actions that contradict the peace process and justify militarization, undermining trust and lasting peace in the region.

As noted by analyst Hakobyan, **Armenia's rapid militarization poses serious threats to the emerging security architecture in the South Caucasus**.

This policy not only risks confrontation with Azerbaijan but also with other regional stakeholders like **Turkey, Russia, and Iran**.

The Zangezur Corridor and New Transport Routes: A Platform for Regional Integration

The **Zangezur Corridor**, proposed in the November 10, 2020, trilateral statement, is not only intended to restore transport links between Azerbaijan and Nakhchivan. It also has the potential to initiate a new phase of **economic integration and interdependence** in the South Caucasus and the broader Eurasian region.

The corridor:

- enhances intra-regional cooperation,
- and serves as a vital component of the **Middle**

Corridor strategy (Trans-Caspian transport route connecting Asia to Europe).

By passing through Armenia's Syunik (Zangezur) region, the corridor would create a direct land route between **Azerbaijan, Turkey, and Nakhchivan**.

This connection will:

- boost Azerbaijan's logistical and energy transit role,
- provide direct land access to Turkey and Europe,
- and could also offer **Russia an alternative southern route**.

While **Iran** remains cautious, it is concerned that a route through Zangezur might weaken its regional position [15].

Beyond infrastructure, the Zangezur Corridor can serve as a platform for **building trust, political normalization, and security cooperation**.

Increased interdependence through transport connectivity could strengthen regional integration in the following areas:

- Armenia's participation in regional projects (e.g., within the “3+3” format);
- Acceleration of trade along the **Turkey–Azerbaijan–Central Asia corridor**;
- Activation of the **China–Europe Middle Corridor**;

- Closer linkage of Kazakhstan, Uzbekistan, and other Turkic states through the **Trans-Caspian route** [21].

A Strategic Opportunity and Political Dilemma for Armenia

The realization of the **Zangezur Corridor** presents a strategic opportunity for Armenia in terms of both **economic revitalization** and **emergence from regional isolation**. Through this corridor, Armenia could become integrated into the regional transportation chain involving **Russia, Iran, Turkey, and Azerbaijan**.

However, **revanchist and nationalist forces within Armenia** oppose this initiative, framing it as a “**threat to sovereignty**” [15].

As a **structuring factor for regional stability**, transportation and logistics lines serve as critical mechanisms for implementing political peace agreements and fostering **regional economic interdependence**. In this regard, the Zangezur Corridor could become a key structural element not only for connectivity between Azerbaijan and Nakhchivan but also for the broader **political stability of the entire South Caucasus**.

Zangezur Corridor: A Historical Opportunity for Security and Cooperation

The Zangezur Corridor and other emerging transport routes represent a **rare historical opportunity** to establish new models of security and cooperation in the post-conflict South Caucasus.

If pursued with **mutual trust** and **pragmatic approaches** by the regional states, this project may also **facilitate the peaceful resolution of the Western Azerbaijan issue** and contribute to **regional stability**. Hence, these transport routes could become not only economic channels but also **levers of political integration**.

The Role of the Western Azerbaijan Issue in the New Regional Configuration

The Western Azerbaijan issue holds strategic importance for maintaining **regional stability** and upholding the principle of **legal equality**.

The **new geopolitical and security configuration** that has emerged in the South Caucasus following the **2020 Second Karabakh War** has reshaped the strategies and approaches of regional actors. In this context, keeping the Western Azerbaijan issue on the agenda and resolving it **within a legal framework** is strategically important **not only for Azerbaijan but for the long-term stability of the entire region**.

Post-War Regional Dynamics

In the post-war period:

- **Azerbaijan’s territorial integrity has been restored,**
- **Armenia’s geopolitical position has weakened,**
- **Russia and Turkey** have become de facto joint actors in the regional security system,
- **The EU and the United States** have taken on more mediating roles in peace initiatives.

This new configuration requires the establishment of a **new security balance** and **interdependence framework**, as well as **systematic resolution of ethnic and humanitarian issues** in the region [5].

The Western Azerbaijan Issue: Legal Equality and Humanitarian Justice

The **peaceful return** of hundreds of thousands of **Azerbaijani Turks** deported from Western Azerbaijan to their native lands is a **legitimate demand** based on international law and the principles of equality.

The following **legal principles** are particularly relevant:

- **Article 13** of the **1948 Universal Declaration of Human Rights** (UN): right to return to one’s country;
- **Article 8** of the **European Convention on Human Rights**: respect for private and family life;
- **UN Guiding Principles on Internal Displacement (1998)**: the right to safe and dignified return [28].

Failure to uphold these rights would contribute to continued **ethnic injustice** and the reinforcement of **double standards**, posing a threat to **regional stability**.

The Peace Process and Inclusivity

Peace negotiations between **Azerbaijan and Armenia** should not be limited to border delimitation and the opening of communications. They must also address **ethnic rights** and the **restoration of historical justice**. In this sense, integrating the Western Azerbaijan issue into the peace agenda is an essential element of an **inclusive peace approach** [23].

Building Mutual Trust in the Region

The return of Western Azerbaijanis to their native lands with **political, legal, and security guarantees** is a critical mechanism for achieving **ethnic reconciliation, multiculturalism, and rule-based stability** in the region.

Otherwise, the issue will remain a “**frozen conflict**”, potentially becoming a source of renewed tensions in the decades to come. The Western Azerbaijan issue is not a gap in the region’s new security system—it is a **central element**.

Its **fair, legal, and peaceful resolution** is a key condition for **long-term stability, mutual respect, and equality** in the South Caucasus. Azerbaijan approaches this issue through the **lens of law and peace**, based on international norms, setting an example for constructive regional approaches.

Strategic Location: Zangezur's Geopolitical Importance

The **Zangezur region** (Syunik Province of Armenia) holds significant **geostrategic importance** as a territory that connects the **Iran–Armenia** and **Armenia–Georgia** transit routes. As one of the most sensitive areas in the South Caucasus, Zangezur's location is crucial both for regional transport lines and as a **convergence point for the interests of major powers**.

It hosts land and energy routes between:

- **Iran and Armenia**, and
- **Armenia and Georgia**,

making it critical for regional stability, future transportation networks, and the geopolitical balance.

A Junction Between Iran–Armenia and Armenia–Georgia

Located in southern Armenia, the Zangezur region provides a **44 km land border with Iran**, representing

Armenia's **only direct connection** to Iran. This corridor is vital for Armenia in terms of **energy and trade**.

Simultaneously, Armenia's primary **transport and trade routes to Georgia** pass through this region in a northward direction [15]. These characteristics make Zangezur a **strategic node** for merging **north–south corridors** and facilitating an **Iran–Armenia–Georgia axis**.

A Center of Geopolitical Rivalries

The **geostrategic importance of Zangezur** is not limited to neighboring states. It also reflects the **interests of major powers** such as:

- **Russia**, which seeks stability here through its **102nd military base** and regional influence;
- **Iran**, which aims to expand trade with Eurasia via Armenia and sees **alternative corridors through Zangezur as a threat** to its interests [15];
- **Turkey and Azerbaijan**, which seek **direct connectivity** and access to **Central Asia** via the Zangezur Corridor;
- **The EU and the US**, which are interested in infrastructure projects that contribute to **diversification and energy security** in the region [6].

A Crossroads for Transport and Energy Corridors

Zangezur has the potential to become a **convergence point** for both the **North–South International Transport Corridor** and the **Middle Corridor** projects. This would transform Zangezur into a **transcontinental transit hub** of strategic significance.

Ongoing **diplomatic and technical discussions** regarding the implementation of the Zangezur Corridor are increasing the region's **geo-economic weight**. The strategic importance of Zangezur is not only about restoring Azerbaijan's connectivity with Nakhchivan but also about shaping the **new transport and energy architecture** of the South Caucasus.

A **secure and legal opening** of this region could enhance regional stability and interdependence while reducing tensions.

Additionally, raising the **Western Azerbaijan issue** in this context may contribute not only to restoring historical justice but also to establishing a **more equitable geopolitical order**.

Restoring Ethno-Demographic Balance: Countering Mono-Ethnic Policies

The **South Caucasus has historically been a multiethnic and multicultural region**. However, since the late 20th century, **armed conflicts, forced deportations, and ethnic cleansing policies**—particularly in Armenia—have led to increased **mono-ethnic tendencies**.

The systematic deportations of **Western Azerbaijanis** from their native lands in **1905, 1918–1920, 1948–1953, and 1987–1991** serve as **striking examples** of this policy [6].

The Dangers of a Mono-Ethnic State Model

Armenia is currently the only country in the South Caucasus pursuing a **mono-ethnic state model**. Since 1991, **non-Armenian ethnic groups have been virtually absent** from the country.

This represents a **violation of humanitarian values, human rights, and the principle of peaceful coexistence** in a multiethnic society.

In this context, monoethnic policy:

- Poses a threat to regional stability;
- Deepens ethnic tensions;
- Contradicts long-term peace and confidence-building efforts [5].

Restoration of ethnodemographic balance

The restoration of ethnodemographic balance is a fundamental condition for ensuring diversity and peaceful coexistence in the region. It includes the peaceful and gradual return of Western Azerbaijani Turks to their ancestral lands, based on international legal grounds. This return is supported by the following international legal documents:

- The UN Guiding Principles on Internal Displacement (1998) – the right to safe and voluntary return;
- The European Convention on Human Rights – the right to property and return to one's place of residence;
- The UN Convention on the Elimination of All Forms of Racial Discrimination – prohibition of discrimination on ethnic grounds [31].

Promotion of diversity

The return of Western Azerbaijani Turks is not only a humanitarian and legal issue but also a necessary step toward restoring ethnic diversity and fostering a reconciliation environment in the region. Promoting ethnic diversity:

- Enhances the inclusiveness of the political system;
- Lays the groundwork for trust-building;
- Strengthens the concept of “ethnic justice” in the region;
- Reduces the risks of future conflicts [34].

Preventing monoethnic policies and restoring ethnodemographic balance is essential for establishing peace, stability, and legal relations in the South Caucasus. In this regard, the issue of Western Azerbaijan is not only about correcting historical injustices but also about shaping a sustainable regional model for the future. The international community must support this process with legal and human-centered approaches.

Guarantee for peace and security

If the return process is carried out under international supervision, it can contribute to the establishment of stability in the region. The peaceful, phased, and legally grounded return of Western Azerbaijani Turks to their native lands is of critical importance for building sustainable peace and a security architecture in the South Caucasus. This process should not only be viewed as a humanitarian or legal matter but also as a geopolitical stability guarantee. The implementation of this return under international law and with the participation of international observers would strengthen trust between parties and prevent potential conflicts.

Necessity of international oversight

Experience shows that the return of internally displaced or deported populations is one of the most sensitive and risky stages. Therefore, international organizations such as the UN, Council of Europe, OSCE, and

the European Union should monitor and provide technical support, serving as neutral mediators. Within the framework of international oversight, mechanisms such as security guarantees, social adaptation programs, and the restoration of property rights can be implemented [35]. Similar models have been applied in the Balkans (Bosnia and Croatia), the Caucasus (Abkhazia, South Ossetia), and the Middle East (Kosovo).

Restoring trust and preventing tensions

When accompanied by international mechanisms, the return process can result in the following positive outcomes for both Azerbaijan and Armenia:

- For Armenia: A shift away from a monoethnic structure and improvement of its international image;
- For Azerbaijan: Restoration of historical justice and implementation of a humanitarian mission;
- For the region: Transition to sustainable peace and the establishment of an ethnic reconciliation model [6].

Legal basis and international precedents

In international law, the "right of return" is recognized as an inseparable part of human rights. The following documents demand the provision of this right:

- The 1948 UN Universal Declaration of Human Rights – Article 13: Everyone has the right to return to their country;
- The 1998 UNHCR Guiding Principles on Internal Displacement – the right to safe, voluntary, and dignified return;
- The European Convention on Human Rights – Articles 1, 8 and Protocol 1, Article 1: the right to private life and property [28].

Interdependence between return and peace

The return of Western Azerbaijanis carries strategic importance not only in correcting past injustices but also in laying the foundation for future stability and regional cooperation. If conducted according to internationally recognized and guaranteed norms:

- The likelihood of renewed ethnic clashes in the region diminishes;
- A foundation is laid for positive transformation in Armenia-Azerbaijan relations;
- A development-oriented security architecture takes shape in the South Caucasus.

Zangezur Corridor and regional integration opportunities

The idea of opening the Zangezur Corridor and other communication routes is not only an economic opportunity but also a chance to promote geopolitical integration in the region. For Azerbaijan, Turkey, and the Central Asian countries, this corridor could become a crucial link in the Middle Corridor. Such projects can contribute to regional stability by creating mutual interdependence. Armenia's opposition to these projects is seen as an obstacle to the region's development.

The role of the Western Azerbaijan issue in the new configuration

In the post-war phase, the Western Azerbaijan issue has become one of the prominent topics in the new security configuration. The continuation of Armenia's monoethnic structure and the denial of return rights to

Azerbaijani Turks contradict legal equality and sustainable peace in the region. The peaceful and legally based return of Western Azerbaijani Turks is not only a humanitarian but also a strategic issue. It is a necessary element for building a fair peace model and ensuring diversity in the region.

Geopolitical importance of Western Azerbaijan

Western Azerbaijan is of strategic importance not only historically and legally, but also geopolitically. Its geographic location, control over key communication routes, its balancing role among regional powers, and impact on ethnodemographic stability make it a crucial component of the South Caucasus' security architecture.

Strategic location and transportation hub

The territories of Western Azerbaijan, especially the Zangezur region, are located at the intersection of major transit routes between Iran and Armenia, and between Armenia and Georgia. This region is also a critical zone through which the Middle Corridor—connecting the South Caucasus with Turkey and Central Asia—passes. Therefore, Western Azerbaijan is a strategic platform where both the North-South and East-West transportation corridors intersect. This positioning is of utmost importance for regional states in terms of logistical advantages, geoeconomic control, and the security of energy and communication networks.

Restoration of ethnodemographic balance as an alternative to monoethnic policy

Due to Armenia's longstanding monoethnic policies, the country has effectively become a homogenous state—an exception compared to other countries in the region, and a blow to regional stability. The peaceful and legally-based return of Western Azerbaijani Turks under international guarantees can eliminate this imbalance and support the development of a multiethnic, multilateral model of security and citizenship in the region. This is not only a matter of social justice but also a prerequisite for sustainable regional stability.

Guarantee mechanism for peace and security

Resolving the Western Azerbaijan issue through international law, without the use of force and via diplomatic means, can contribute to regional peace and security. The international supervision of this process could provide reliable guarantees for both Armenia and Azerbaijan. Peaceful return would help prevent future ethnic conflicts, avoid new escalations, and create a stable humanitarian environment in the region.

Shared interests of Turkey and Azerbaijan

The Western Azerbaijan issue aligns with the shared historical and strategic interests of Turkey and Azerbaijan. Both countries are involved in promoting security, transportation, energy, and economic integration projects in the region. The opening of the Zangezur Corridor stands out as one of the key initiatives uniting these interests. The coordinated efforts of Turkey and Azerbaijan in this area not only shift the geopolitical balance but also strengthen the influence of the Organization of Turkic States in the region. The strategic location of Western Azerbaijan provides a solid basis for deepening and systematizing this cooperation.

Approach of international actors

The issue of Western Azerbaijan is a focal point for many international actors within the geopolitical context of the South Caucasus. The positions on this matter differ depending on the interests of various regional and global powers and influence the balance of power in the region.

Russia: While providing military support to Armenia, Russia attempts to maintain a balanced position, taking into account Azerbaijan's growing power. Russia is a major regional actor with traditionally strong influence in the South Caucasus and acts as a strategic partner in military-technical cooperation with Armenia. The Russian military base No. 102 in Armenia, as well as arms sales and military training, support Armenia's defense capabilities [18]. However, in recent years, as Azerbaijan has strengthened both its military potential and its position in regional politics, Moscow has tried to maintain balanced relations with Armenia. This is reflected in the following aspects:

- **Acknowledging Azerbaijan's growing power and ties with Turkey:** Russia avoids completely favoring one side in the region, considering Azerbaijan's increasing influence and its close relations with Turkey [14].

- **Mediation role in the peace process:** Russia supports peace negotiations that take into account the interests of both Azerbaijan and Armenia, presenting itself as a guarantor of stability in the region [24].

- **Limiting military aid:** Despite Azerbaijan's rising military power, Moscow acts cautiously in fully meeting Armenia's defense needs to avoid weakening Russia-Armenia relations [18].

United States and European Union: The U.S. and the EU approach the Western Azerbaijan issue with caution in the context of human rights, but the presentation of legal justifications could increase their engagement. The U.S. and EU are key international actors in maintaining stability and protecting human rights in the South Caucasus. However, their stance on the Western Azerbaijan issue is generally cautious and balanced. This is due to the complex political environment in the region and the need to balance the interests of various sides [26].

Reasons for the cautious approach:

- **Preservation of peace processes in the region:** The U.S. and EU support a peaceful resolution to the Armenia-Azerbaijan conflict and aim to prevent further escalation.

- **Pursuing balanced policies:** These actors have strategic and economic relations with both Azerbaijan and Armenia and are therefore careful in expressing clear positions on conflict-related matters.

- **Promotion of independent legal procedures:** In matters of human rights, they prioritize international law and rulings from international courts [29].

The role of legal justifications: Presenting the Western Azerbaijan issue within the framework of international law, human rights, and the right of return could stimulate more active engagement from the U.S. and EU. Key legal documents and principles in this regard include:

- The **Universal Declaration of Human Rights** and **Guiding Principles on Internal Displacement**;

- The **European Convention on Human Rights**;

- The **UN Convention on the Elimination of All Forms of Racial Discrimination** [30].

Through these legal foundations, it is possible to bring the issue to the attention of the international community and activate relevant pressure mechanisms. Strengthening legal arguments may increase the diplomatic support and initiatives of the U.S. and EU, help international organizations and NGOs working in the field of human rights to raise global awareness, and promote peace and inclusivity initiatives in the region. These perspectives could lead to broader discussions on the legal and humanitarian dimensions of the Western Azerbaijan issue [24].

While the U.S. and EU place strong emphasis on human rights and the protection of peace in the South Caucasus, they adopt a cautious stance on the Western Azerbaijan issue. Strengthening legal justifications and presenting the issue in accordance with international legal norms may draw greater attention and enable a more active role for these actors in the region. Within the framework of human rights and international law, the U.S. and EU approach the Western Azerbaijan issue carefully. They primarily focus on the Nagorno-Karabakh conflict and peace processes in the South Caucasus but pursue a balanced policy to prevent new conflicts between Azerbaijan and Armenia. Enhancing legal justifications and promoting the application of international law could encourage more active participation from the U.S. and EU. However, these actors tend to limit their involvement out of respect for the interests of larger powers in the region.

Expansion of Regional Cooperation Frameworks:

It is essential to keep the issue of Western Azerbaijan consistently on the international agenda and support it within the framework of international law through platforms such as the Organization of Turkic States, the Organization of Islamic Cooperation (OIC), and other international bodies. These organizations can play an active role in fostering solidarity and dialogue in the region.

Reintegration Plans and Social Security Mechanisms:

Systematic reintegration plans must be developed to ensure legal, economic, and social adaptation for the future return of Azerbaijani Turks to their native lands. These plans should include job creation, improvement of housing and living conditions, provision of education and healthcare services, as well as the restoration of cultural heritage.

Mutual Security Guarantees:

The return process must be built on mutual assurances that ensure the security of not only Azerbaijani Turks but also other ethnic groups residing in the region. This would help prevent the recurrence of ethnic conflicts and contribute to the formation of an inclusive society where all people, regardless of ethnic background, enjoy equal rights. The role and geopolitical

importance of Western Azerbaijan in the regional security architecture of the South Caucasus are of particular significance in the current political and security context. Historical waves of deportation and ethnodemographic changes have shaped the region's complex social structure, turning the recognition and protection of the right of return within international law into a critical issue.

The ongoing post-conflict phase in the region necessitates the establishment of new security balances. Armenia's militarization and the intensification of power dynamics in the region elevate the Western Azerbaijan issue to both a humanitarian and geopolitical priority. The region's strategic location, including the opening of transit and transport routes like the Zangezur Corridor, as well as growing cooperation between Turkey and Azerbaijan, highlight the Western Azerbaijan issue in the context of regional integration and stability. However, the differing interests and cautious approaches of international and regional actors such as Russia, the US, the European Union, and Iran further complicate the geopolitical landscape.

Diplomatic Approaches and Peaceful Solutions:

To defend the right of return, diplomacy based on international law and non-coercive methods should prevail. The active participation of regional cooperation platforms (such as the Organization of Turkic States, the OIC, etc.) and careful preparation of reintegration plans covering social, economic, and legal aspects will contribute to long-term peace and ethnic harmony in the region. The resolution of the Western Azerbaijan issue should be implemented through regional cooperation and multidimensional diplomacy, in accordance with international legal principles, and be accompanied by mutual security guarantees and inclusive social policies. This approach is a prerequisite for lasting peace and sustainable development in the South Caucasus.

Strategic Importance of Western Azerbaijan:

The Western Azerbaijan issue holds a significant place in the regional security architecture of the South Caucasus, and its peaceful resolution in accordance with international legal norms is vital for ensuring long-term stability. This issue, rooted in historical and legal foundations, carries strategic importance in preventing monoethnic policies and restoring ethnodemographic balance in the region. The new geopolitical realities that emerged after the war, strategic transport routes like the Zangezur Corridor, and the positions of international actors present both challenges and opportunities in resolving the issue.

Cooperation Between Azerbaijan and Turkey:

Coordinated efforts by Azerbaijan and Turkey, diplomatic approaches grounded in international law, activation of regional cooperation platforms, and the development of reintegration plans can contribute to a peaceful resolution of the issue. A constructive solution to the Western Azerbaijan issue will not only restore the rights of Azerbaijanis but also support the formation of an inclusive, just, and sustainable security system in the South Caucasus. The strategic partnership between Turkey and Azerbaijan—based on shared history, cul-

ture, and language, as well as common security and development interests—is a vital condition for expanding regional integration.

Turkey and Azerbaijan's shared interests play a crucial role in shaping regional dynamics in the South Caucasus. Especially after the Second Karabakh War in 2020, this cooperation has entered a new phase both geopolitically and geoeconomically.

Geo-economic Cooperation Opportunities:

- **Energy transportation and transit:** The export of Azerbaijani gas to Europe through Turkey (via the TANAP and TAP projects) is a key indicator of this cooperation.

- **Zangezur Corridor:** The restoration of land connectivity between Nakhchivan and Turkey through the Zangezur Corridor boosts logistics and trade opportunities in the region [(IEA, 2023); (BP Statistical Review, 2024)].

- **Transport infrastructure:** The Baku–Tbilisi–Kars railway and other transport projects strengthen the strategic transport network connecting Asia and Europe through Turkey and Azerbaijan.

- **Economic investments and trade:** Trade turnover between the two countries has significantly increased in recent years, with joint investment projects underway.

Geopolitical Cooperation and Security:

- **Defense and military cooperation:** Military exercises, defense industry collaboration, and strategic consultations between Turkey and Azerbaijan have intensified.

- **Regional security initiatives:** Both countries share common positions on ensuring peace in the South Caucasus, border delimitation, and the formation of a regional security architecture.

- **Support on international platforms:** Turkey actively supports Azerbaijan's positions based on international law—and vice versa.

Regional Integration and Shared Future Perspectives:

The growing cooperation between Turkey and Azerbaijan continues in support of the peaceful and legal resolution of sensitive issues like the Western Azerbaijan matter. This cooperation lays the foundation for a new geopolitical order based not on rivalry, but on collaboration and mutual interdependence. Shared interests between Turkey and Azerbaijan create strong potential for developing geoeconomic and geopolitical cooperation in the South Caucasus. This partnership is one of the key factors in ensuring both regional stability and a peaceful, lawful resolution to the Western Azerbaijan issue. Enhanced mutual cooperation contributes to a more resilient and inclusive regional security architecture.

Mutual Security Guarantees:

The return process must be accompanied by security guarantees for both Azerbaijanis and other ethnic groups living in the region. Such guarantees are essential for the peaceful resolution of the Western Azerbaijan issue and the successful implementation of the return process. These guarantees aim to ensure the safety

not only of returning Azerbaijanis but also of other ethnic communities in the region, thereby contributing to long-term regional stability.

Key Principles of Security Guarantees:

- **Fair and equal approach:** Protection of the rights of all ethnic groups and prevention of discrimination;
- **Cooperation and dialogue:** Strengthening collaboration among local communities, state institutions, and international organizations for security assurance;
- **Legal safeguards:** Protection of human rights and enforcement of international legal norms.

Security During the Return Process:

- **Physical security:** Implementation of protective measures for returnees and prevention of military provocations in the region;
- **Social security:** Implementation of measures to minimize social tension and conflict during integration;
- **Psychological support:** Application of psychosocial programs to alleviate the stress and trauma caused by the return process.

Regional and International Roles:

- Monitoring the implementation of security guarantees through international observation missions and monitoring mechanisms;
- Promoting peace and trust-building in the region: encouraging ethno-cultural dialogue and applying multiculturalism principles;
- Establishing transparent and accountable platforms for security mechanisms.

Conclusion

The return process accompanied by mutual security guarantees serves to protect the rights and safety of both returning Azerbaijani Turks and other ethnic groups residing in the region. This is essential for establishing long-term peace and a climate of social harmony in the South Caucasus. The return of Western Azerbaijani Turks under international supervision, within the context of peace and human rights, should not only be seen as a humanitarian duty but also as a strategic tool for ensuring regional stability.

Such an approach would foster an atmosphere of trust in the region, regulate monoethnic policies, and pave the way for a stable and multipolar future for the South Caucasus. The Western Azerbaijan issue holds significance not only in terms of restoring historical justice but also in guaranteeing long-term stability and regional security in the South Caucasus.

Azerbaijan's peaceful approach to this issue, grounded in international law, can contribute to the establishment of a constructive security architecture in the region. The realization of the right of return, the restoration of regional balance, and the preservation of humanitarian values require that this issue take its rightful place on both regional and international agendas.

In the post-conflict period, Armenia has increased militarization, signing new defense agreements particularly with France and India. The rise in defense expenditures, procurement of new weapon systems, and

provocative actions in border regions indicate that Armenia continues to pursue a course that generates threats rather than integrates into the regional security architecture. This trend heightens the risk of renewed military tensions in the South Caucasus.

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PHILOLOGICAL SCIENCES

Poladova Sabina Elkhan

Azerbaijan University of Languages
Associate Professor, Department of English Phonetics

Baku, Azerbaijan Republic

Orcid id: 0000-0003-4886-971X

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DIFFERENCES BETWEEN TYPES OF VARIANTS IN LANGUAGE

Abstract.

This paper examines the phenomenon of linguistic variation and delineates distinctions among different types of variants within a language system. The topic is increasingly relevant, as modern linguistics recognizes the dynamic and variable nature of language, where uniformity coexists with diversity. Understanding linguistic variants is essential for describing how language functions across varied social, regional, and communicative contexts.

The primary aim of this study is to classify major types of linguistic variants—phonetic, lexical-semantic, morphological, grammatical, stylistic, and dialectal—and to analyze their defining characteristics. The research further investigates the causes of variant emergence and their role in enhancing the flexibility and expressive potential of language in real communicative situations.

Findings indicate that phonetic and morphological variants predominantly arise in spoken language, often shaped by regional and informal usage. Lexical-semantic and stylistic variants perform specific communicative or expressive functions depending on context, tone, or register. Dialectal variants reflect socio-cultural and regional identities, demonstrating the complex interplay between language structure and social reality.

Keywords: *linguistic variation, phoneme, allophone, positional variant, combinatory variant, dialectal variant*

Introduction

Variation constitutes a fundamental property of human language, observable across all structural levels of linguistic analysis. It functions both as a form and as a mechanism of linguistic operation, most prominently at the phonological level, where the production of speech sounds allows for extensive flexibility. The articulatory apparatus inherently provides a wide range of possible sound realizations, resulting in significant variability in pronunciation.

Crucially, variation in structurally indivisible linguistic units is not merely a consequence of contextual adaptation. Rather, it reflects an intrinsic property of the language system itself. According to L.V. Shcherba's ternary model of system–norm–speech, variability at the level of linguistic norms enables a systematic exploration of the relationships between variants and invariants, allowing linguists to identify and categorize the full inventory of elements at each level of the language.

This perspective underscores the importance of examining both the abstract structure of the language system and the concrete realization of speech. Variability manifests not only in individual utterances but also as an inherent feature of the normative language system, highlighting the interplay between structural consistency and expressive flexibility. Such a dual approach facilitates a comprehensive understanding of how language operates in both social and communicative contexts.

Literature Review: Theoretical Perspectives on Phonemes

Phonemes, as fundamental units of linguistic structure, have been the subject of extensive theoretical

debate. Classical and contemporary linguists have offered diverse perspectives regarding their nature, identification, and functional significance within language.

D. Jones, for instance, presents a physically oriented approach to phoneme identification. He asserts that “the phonemic significance of sounds may not be established on the basis of linguistic analysis or intuition, but only with the help of technical equipment” [3, p. 48]. However, this view is controversial, as the phonemic status of a sound can only be determined through linguistic criteria. Instruments can analyze acoustic properties of individual sounds and larger speech segments, but they cannot replace the rigorous application of linguistic principles in identifying phonemes.

Jones illustrates his position with examples from English. Words such as *puts*, *drinks*, and *boxes* may be pronounced with either [s] or [z], with no phonemic distinction in these contexts. According to Jones, phonemic identification in such cases depends on instrumental observation: if [s] is recorded, the phoneme is /s/; if [z], then /z/ [3, p. 48]. This approach, however, reveals inconsistencies, as Jones sometimes relies on native speaker intuition while simultaneously privileging instrumental analysis. His model does not clearly separate semantic function from structural significance, nor does it adequately address the phoneme's paradigmatic and syntagmatic roles—since, in syntagmatic sequences, physical sounds, rather than phonemes, are realized.

The core concern in Jones's model is identifying the distinctive function of the phoneme. By defining a phoneme as “a family of sounds or the mechanical sum of its allophones,” he essentially equates phonemes with collections of phonetically similar sounds. Yet,

contemporary phonological data reveal significant articulatory variation. For example, the voiced plosive /d/ in English exhibits context-dependent modifications:

- Before plosives: pronounced without explosive release (bad pain, good dog).
- Before nasals: articulated without nasal release (could meet, admit, sudden).
- Before /l/: articulated without lateral release (badly, bad light, middle).
- Before /w/: labialized (dwindle, dwarf, dweller).

These variations demonstrate that phonemes cannot simply be regarded as mechanical sums of allophones. In contrast, L.V. Shcherba's materialist approach provides a more robust framework: a phoneme is the smallest sound unit capable of distinguishing words and word forms, realized in speech through variants (allophones), with its linguistic essence inherently tied to communicative function [6, p. 131].

K.L. Pike similarly emphasizes the dual nature of the phoneme as both a meaningful linguistic unit and a sound [5, p. 152]. Pike treats phonemes not as fixed entities but as analytical constructs necessary to determine the phonemic inventory of a language, highlighting the unconscious organization of sounds by native speakers [5, p. 157].

M.F. Twaddell conceptualizes the phoneme as an "abstract fictive unit" [8, p. 67], with microphonemes (allophones) representing articulatory realizations of the macrophoneme. M.F. Twaddell assumes a near-identical relationship between linguistic distinctions and articulatory correlates.

K.A. Jafarova, representing the American descriptive school, defines phonemes as classes of phonetically similar sounds with specific distributional patterns or, more simply, as "classes of allophones" [2, p. 44]. As independent structural units, phonemes exist alongside morphemes and words, realized in speech via multiple variants, each reflecting articulatory-acoustic features determined by phonetic context and combinatorial positioning within words. L.L. Bulanin asserts that recognizing the phoneme's reality as an independent unit is crucial to understanding its essence within the language system [1, p. 37].

Methods and Materials: Positional and Combinatory Variants of Phonemes

In contemporary phonology, the realization of a phoneme is influenced by its position within a word or by neighboring sounds. Phonemes occurring in specific positions within a word's structure are termed positional variants, while sounds influenced by adjacent phonemes are called combinatorial variants [10, p. 48].

The Moscow phonological school introduces the term allophoneme to emphasize that a phoneme belongs to the level of language norm. Unlike the term allophone, which suggests realization at the speech level, allophoneme reflects the normative status of the phoneme [4, p. 53].

Phonemes exhibit multiple realizations in speech, shaped by three main factors, according to L.R. Zinder [10, p. 47]:

1. Phonetic conditions of realization, including surrounding sounds and syllabic structure.
2. Individual characteristics of speakers of the same language.
3. The coexistence of two pronunciations in identical phonetic environments.

L.R. Zinder adopts a ternary model for phonological analysis:

- Phoneme → system level
- Allophones → norm level
- Phones → speech level

He defines the phoneme as "the smallest, indivisible linear (i.e., temporal) unit of the sound side of language, potentially connected to meaning indirectly through the morpheme" [10, p. 45]. An allophone, in turn, is a phoneme realized in a specific phonetic position, with characteristics determined by combinatorial factors. Combinatorial changes depend on adjacent phonemes, while positional features are influenced by word-internal location and stress.

Variants of a phoneme always occur in mutually exclusive phonetic positions—a principle known as complementary distribution. A phoneme remains identical to itself across all permissible realizations, whereas variants differentiate specific phonetic positions within the word structure. Following the Leningrad phonological school, phonemes are not assigned semantic function; their role is to distinguish material forms of words.

G.P. Torsuev identifies critical phonetic positions influencing qualitative and quantitative modification of phonemes: word-initial and word-final positions, ordinal syllable position, phonetic context, and position within the accentual-rhythmic structure [7, p. 21]. These positions shape the emergence of systematic distinctions within the language and govern the realization of linguistic units across multiple levels.

The phonetic organization of a word integrates several structural layers: phonemic structure, phoneme combinations, syllabic structure, and accentual-rhythmic structure. All these structures coexist in any phonetic segment of a word, providing a ready-made template for speech realization. In continuous speech, phonemes manifest as shades or allophones, which vary according to combinatorial and positional conditions.

According to L.R. Zinder, "in phonological terms, all allophones are equal; every allophone, every speech sound is a representative of some phoneme, since every sound occurring in speech is necessary to preserve the phonetic shape of a word" [10, p. 50]. Differences between sounds either distinguish meaning—indicating separate phonemes—or do not, in which case they are allophones of the same phoneme [10, p. 50].

Y.S. Maslov further distinguishes between mandatory and optional allophonemes. Mandatory allophones recur consistently in specific phonetic positions across speakers and form part of the language norm, while optional allophones represent competing or facultative forms, such as speaker-specific variations [4, p. 52]. Positional and combinatorial variants collectively

preserve the phonetic structure of words, ensuring communicative accuracy without altering meaning.

Classification of Phoneme Variants

F.Y. Veysally categorizes phoneme variants into mandatory and optional types. Mandatory variants are subdivided into basic and specific variants, while specific variants are further classified as combinatory and positional. Optional variants are divided into optional and individual variants [9, p. 248].

Combinatory variants exist in a complementary distribution, meaning that the realization of one variant precludes the occurrence of another in the same phonetic environment. This principle, often termed the positional exclusion principle, ensures that variants maintain systematic distinctions within the language.

Despite theoretical divergences among linguists, contemporary phonological frameworks converge on the recognition of mandatory and optional variants. Mandatory variants include:

- **Basic variants:** typically vowels pronounced in isolation or phonemes in positions of maximal differentiation, such as stressed vowels or intervocalic consonants.

- **Specific variants:** subdivided into positional and combinatory types. Positional variants are determined by the phoneme's location within a word or syllable, while combinatory variants are conditioned by co-occurrence with neighboring phonemes.

Examples from English:

- Combinatory variants of /b/ and /t/ appear in words such as *band* [bænd], *beach* [bi:tʃ], *bean* [bi:n], *tall* [tɔ:l], *take* [teɪk], *tea* [ti:], *team* [ti:m], *tea-pot* [ti:pɒt], *tell* [tel], and *ten* [ten].

Examples from Azerbaijani:

- Positional variants are influenced by suprasegmental characteristics. For instance, strong vowel reduction may result in vowel deletion in unstressed positions between voiceless consonants (*qələm*, *gələcək*, *dünya*).

These variants are positionally or combinatorily marked and are recognized by native speakers as normative realizations of the phoneme. Phonetic differences often relate to the degree of prominence of specific features, such as voicing or labialization in English plosives ([t], [p], [k] for voiceless; [b], [d], [g] for voiced). Variations may be quantitative or qualitative but do not disrupt the functional identity of the phoneme.

Optional variants include individual and facultative variants, which arise from speaker-specific characteristics or stylistic choices. Examples include lispings or whistling realizations of fricatives, or variations in the pronunciation of /R/ in German, where the uvular variant increasingly replaces the apical trill [9, p. 246].

Mandatory variants carry greater linguistic significance than optional ones. Substituting one mandatory variant for another may compromise comprehension, whereas facultative variants generally permit free variation without hindering understanding.

Individual variants, although minor in synchronic analysis, provide insights into speaker identity and may serve as potential sources for phoneme evolution over time. Additionally, variants contribute to the emotional and stylistic expressiveness of speech, illustrating the opposition between neutral and emotional realizations.

Allophonic Variation and Functional Significance

Allophonic variation represents the realization of phonemes in actual speech and is a fundamental aspect of phonological description. A phoneme is never realized in isolation; it always manifests as one or more allophones, which are determined by positional and combinatory factors.

Allophones are classified according to their conditioning factors:

1. **Positional allophones:** determined by the phoneme's location within a word or syllable (initial, medial, final).

2. **Combinatory allophones:** influenced by the phoneme's neighboring segments within the sound chain [7, p. 47].

Each allophone possesses distinct acoustic and articulatory properties, shaped by its phonetic position. Within a single position, a phoneme may only be represented by one variant, ensuring complementary distribution of allophones. Different allophones of the same phoneme never occupy the same phonetic position.

According to L.R. Zinder, all allophones are equally representative of their respective phonemes, as every speech sound contributes to preserving the phonetic form of a word [10, p. 50]. Differences between sounds either function to distinguish meaning, designating separate phonemes, or remain allophonic, without altering word identity.

Y.S. Maslov further distinguishes mandatory and optional allophones. Mandatory allophones consistently recur in specific phonetic positions across speakers and form part of the language norm. Optional allophones represent speaker-specific or stylistic variations and may coexist as alternative forms. Positional and combinatory variants collectively maintain the phonetic structure of words, supporting communication while preserving phonemic integrity [4, p. 52].

The phonetic organization of words integrates multiple layers—phonemic structure, phoneme combinations, syllabic structure, and accentual-rhythmic patterns—which are realized simultaneously in speech. The differentiation of allophones reflects systemic distinctions in the language and the operational principles of linguistic units at various levels.

Combinatory-positional factors ensure that allophonic modifications are predictable and systematic, even when minor individual variation occurs. These modifications, while sometimes idiosyncratic, do not compromise phonemic identity or the intelligibility of speech. Consequently, the study of allophonic variation provides a comprehensive understanding of phoneme function, revealing both its normative properties and its adaptive flexibility in real communication.

Stylistic, Emotional, and Diachronic Perspectives of Variants

In addition to positional and combinatory factors, phoneme variants can be analyzed from stylistic and emotional perspectives. Variants may reflect differences in neutral versus expressive speech, contributing to the emotional coloring of utterances. Such stylistic distinctions do not alter the phonemic identity but enrich communicative nuance, enabling speakers to convey subtle affective or pragmatic information.

From a diachronic perspective, individual variants may serve as potential sources for the emergence of new phonemes. While these variants are not crucial for synchronic functioning of the language, they offer valuable insight into language evolution and speaker-specific articulatory habits. For instance, a distinctive realization used consistently by a subset of speakers may, over time, become phonemically significant, demonstrating the dynamic nature of language systems.

A thorough phonetic description of phonemes must account for allophonic variation with careful attention to the extent and nature of modifications. The perceptual significance of phonetic changes—whether qualitative or quantitative—serves as a central criterion for distinguishing intraphonemic (within-phoneme) and interphonemic (between-phoneme) realizations in connected speech.

In English, allophonic series of consonant phonemes are conditioned by combinatory-positional factors and are largely invariant across speakers. However, minor individual deviations arise due to speaker-specific articulatory habits, reflecting subtle variability within the framework of systematic phonological rules. Such variations, while informative about individual speech characteristics, do not compromise the phonemic structure or communicative function.

In summary, the study of stylistic, emotional, and diachronic aspects of phoneme variants highlights the flexibility, adaptability, and expressive capacity of spoken language. Variants allow languages to maintain systematic integrity while accommodating individual and social factors, reinforcing the notion that phonemes are both normative units and dynamic entities in real communication.

Conclusion

This paper has explored the multifaceted nature of linguistic variation, with a particular focus on the classification and functional significance of phoneme variants. Phonemes, as fundamental units of sound, exhibit systematic allophonic variation that is governed by positional, combinatory, stylistic, and individual factors. These variants collectively ensure that speech remains intelligible while accommodating both normative patterns and individual differences.

Mandatory variants, encompassing basic and specific types, are essential for maintaining phonemic distinctions and ensuring clear communication. Optional and individual variants, by contrast, reflect speaker-specific characteristics, stylistic choices, and emotional nuances, contributing to the expressive richness of language. Combinatory-positional factors provide the structural basis for the distribution of variants, while diachronic perspectives highlight the potential for language change over time.

The comparative analysis of classical and contemporary phoneme theories—including the approaches of L.V. Shcherba, D. Jones, K.L. Pike, M.F. Twaddell, H. Gleason, L.R. Zinder, Y.S. Maslov, and others—demonstrates both the historical evolution of phonological thought and the enduring relevance of phonemic principles for understanding language functioning. Across these perspectives, phonemes are consistently revealed as dynamic, context-sensitive, and socially grounded units, realized through a spectrum of variants that reflect the complexity of human speech.

In conclusion, the study of phoneme variants not only elucidates the structural and functional organization of language but also underscores the interplay between system, norm, and speech. Recognizing the diversity of variants, their constraints, and their communicative roles enhances our understanding of language as a flexible, adaptive, and expressive human faculty.

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MEDICAL SCIENCES

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*Andrushchak M. O.,
Tarasiuk D.,
Varvrynets R.,
Tkachuk Ya.,
Honcharuk L.M.*

Bukovyna State Medical University

OVERVIEW OF THE COURSE OF CORONAVIRUS INFECTION

Abstract.

Coronavirus disease is one of the dramatic problems of modern medicine. Nature presented mankind with a threatening message that the evolution of life on Earth is not over and ecological disturbances have disastrous consequences. Scientists of the world are faced with a task that, if successfully resolved, will in some way depend on the continued survival of humanity. A new disease that is spreading rapidly is characterized by several peculiarities. This rapid fluidity of the virus, high prevalence rate, specific pathogenesis, and clinical manifestation, etc. Despite the obvious severity of the situation, the combined efforts of scientists in the fight against the pandemic of coronavirus infection will already lead to a significant success: Detailed characterization of the causative agent, determining the mechanism of infection spread, grounded and put into practice methods of laboratory diagnostics, created a base of production doses of commercial test systems, most importantly, over a remarkably short period created, tested vaccines, which made it possible to substantiate promising approaches to therapeutic tactics and prophylaxis. At the same time, variability of clinical manifestation requires the study of pathogenetic mechanisms of disease manifestation, especially at the initial stages. It is important to establish the adaptation-compensatory mechanisms and related cellular reactivity of the organism of patients, which not only need to be used to solve diagnostic problems, treatment, and determination of the prognosis of the disease course. Coronavirus disease is a severe respiratory viral infection with airborne transmission caused by a new coronavirus (SARS-CoV-2), which affects people of different ages and occurs in the form of asymptomatic, mild, and severe forms with the development of atypical pneumonia, severe acute respiratory syndrome, which can lead to death. Based on the examination of absolute and relative numbers of the main populations of immunocompetent cells of peripheral blood to determine the level of adaptation pressure and cell reactivity of the organism of the patients with coronavirus disease on admission to hospital treatment. It is important to establish the adaptation and compositional mechanisms and associated cellular reactivity of the body of patients, which not only need to be used to solve diagnostic problems, treatment, and determination of the prognosis of the disease course. Coronavirus disease is associated with an 86.96% increase in the level of adaptive tension in the relative number of immunocompetent cells and a 56.86% increase in the absolute number of immunocompetent cells.

Keywords: *coronavirus disease, adaptive process, cell reactivity.*

Introduction. The presence of coronavirus infection was verified by clinical manifestation, results of PCR, instrumental methods of examination, and other laboratory tests included in the protocol of diagnostics and treatment tactics accepted at the state level. Blood was taken from the finger of the sick and practically healthy people on an empty stomach (7-8 a.m) and carried out clinical and general blood analysis. Based on the results of the clinical blood analysis, we calculated immunohistological coefficients and indices, which determined the level of adaptive tension of the body and the type of individual tension of each patient. The level of cellular reactivity associated with the adaptive tension of the organism of patients with coronavirus disease was determined by the index of cellular reactivity and confirmed absolutely by immunohistological leukocyte indices of CalfCalif, Reiss, Chimich, Intoxication Index, modified leukocyte Intoxication Index, hematologic Intoxication Index by Vasilievich, and others. Statistical evaluation of the numerical results was carried out according to standard methods of variation statistics with the establishment of arithmetic average

values (M) and standard error ($\pm m$). Reliability of the results of the study for independent samples was calculated by Student's t-coefficient (by the distribution of arrays close to normal. The variability of differences was considered to be $P < 0.05$ Methods Clinical and laboratory tests were performed on 20 patients with coronavirus disease in the infectious disease department of Regional Clinical Hospital "Chernivtsi", all patients agreed to participate in clinical and laboratory tests. The results of clinical and laboratory examinations of 30 practically healthy persons of the same age (average age 63.17 ± 3.17 years, the average age of those who had coronavirus disease was 64.57 ± 4.27 years) were used for the study comparison. The majority of patients had a moderate course of the disease, and only 7% of patients had a severe course of the disease. Every patient admitted to the hospital was diagnosed with bronchial and lung lesions, which were confirmed by X-ray and computer tomography (CT). In the structure of diagnosed pneumonia, bilateral lung damage prevailed (98.3%). Symptoms of gastrointestinal tract involve-

ment were observed in 11 patients (16.9%). The diagnosis was confirmed by nasopharyngeal smears, which were taken by dacron swabs with subsequent placement in a transport medium for respiratory smears. Biological material was collected in the first 24 hours from the moment of hospitalization of patients with signs of ARVI and suspicion of COVID-19 and examined by PCR method. All patients obtained positive results. Results the blood system plays a leading role in ensuring the adaptive capacity of the organism. This role is determined, first of all, by its function of transport of vital nutrients and acid-carrying energy sources for cells and tissues of the body.

These methods can be used to assess the nature of non-specific action of various agents, pathogens, and others, as well as to determine the efficacy of targeted activation therapeutic practice and to predict the course of the disease. Adaptation reaction in patients with coronavirus infection was determined by the relative and an absolute number of leading populations of immunocompetent cells of peripheral blood. The prognostic value of the adaptation coefficient is determined, and the prevalence of some other non-specific adaptation reactions of the organism is detected. The following adaptive reactions of the organism were determined: stress, training, calm activation reaction, increased activation, and overactivation. Adaptation index is used as an integrated test, calculated by the ratio of the absolute and relative number of lymphocytes and segmented neutrophils. Adaptation index increases in the direction of "stress" → "training" → "calm anactivation reaction" → "elevated activation reaction" → "overactivation", thus high values of the adaptation index correspond to a more favorable prognosis of disease progression. The majority of Patients with Coronavirus disease (45%) showed increased activation and overactivation, which was confirmed by the following observation. All of the patients recovered and started a traditional way of life, and the patients who were found to be stressed were on artificial pulmonary ventilation, and the course of activation was normal. Adaptive reactions of the human organism is closely connected with the cellular reactivity of the organism, the level of which is determined by the indices of the absolute and relative number of the main populations of immunocompetent cells in the peripheral blood. Components that characterize cell reactivity are leukocyte indexes of intoxication, hematologic index of intoxication according to V.S. Vasilievich, nuclear index of the degree of endotoxemia, lymphocytic-granulocytic index, and the index of the ratio of the absolute number of leukocytes to the sed rate.

Conclusion. The level of adaptive tension in patients with coronavirus disease increased by 86.96% and by 56.86%, which characterizes the positive prognosis of the disease prevalence (all patients recovered). The majority (60%) formed an increased activity (30%), overactivation (15%), and calm activation (15%) of nonspecific adaptive reactions.

2. Associated with adaptive reactions, the cellular reactivity of the body of patients with coronavirus disease decreases by 82.98%, as evidenced by the increase. The latter has a significant (by 7.64%) advantage.

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Izyuk Yuliia Stanislavivna,

Delitsoi Olha Yuriivna,

*4th years students, 5 group
specialty 222 "Medicine"*

Bukovinian State Medical University

Kvasnytska Olga Borysivna

PhD in Medical Sciences, Associate Professor

Department of Internal Medicine

Bukovinian State Medical University

Chernivtsi, Ukraine

<https://doi.org/10.5281/zenodo.17013720>

RENAL FUNCTION IN NUTRITIONAL STATUS DISORDERS

Abstract.

The article, based on literature data, examines the main pathophysiological changes in kidney function in cases of nutritional status disorders (obesity and starvation), mechanisms of damage and adaptation, clinical consequences and possibilities of therapeutic correction.

Keywords: *kidneys, metabolism, obesity, fasting, chronic kidney disease, pathophysiological mechanisms, treatment strategy.*

Introduction. Kidney function is critical in maintaining homeostasis of the body, especially in conditions of metabolic disorders. Obesity and prolonged fasting represent two opposite metabolic states that have different effects on the morphology and function of the kidneys. With obesity, conditions for hyperfiltration, the development of chronic kidney disease (CKD), glomerulosclerosis, a decrease in the estimated glomerular filtration rate (eGFR) are formed, and an imbalance in the regulation of sodium, lipids and adipokines arises. In the state of starvation, on the contrary, autophagy, ketogenesis and mechanisms of preservation of the protein pool are activated. In both cases, the kidneys are both a target and an active regulator of systemic changes. The article considers pathophysiological changes of kidney function in metabolic disorders, mechanisms of damage and adaptation, clinical consequences and possibilities of therapeutic intervention [1,2].

The purpose of our study was to study the literary data to determine the changes in the functional state of the kidneys in metabolic disorders - in particular in obesity and starvation - and to determine the key pathophysiological mechanisms that lead to morphological and functional changes in renal tissue.

Presentation of the main material and discussion. Obesity is one of the main risk factors for the development of CKD. It is accompanied by a complex cascade of pathophysiological changes, including hyperfiltration, increased load on the glomeruli, the development of glomerulomegaly and segmental glomerulosclerosis [3].

The genetically enhanced body mass index (BMI) is associated with a decrease in eGFR, an increase in urea levels and the ratio of albumin to creatinine in the urine, which indicates microalbuminuria and early nephropathy. In this case, the renin-angiotensin-aldosterone system, oxidative stress and chronic inflammation are activated, leading to structural damage to the nephron [4].

In addition, obesity is associated with a violation of energy metabolism in the kidneys. It has been found that it leads to accumulation of lipids in the tubules, activation of endoplasmic reticulum, fibrosis and apoptosis. Disregulation of adipokines, in particular leptin and resistin, also contributes to the progression of kidney damage [5].

In patients with obesity and non-alcoholic fatty liver disease (NAFLD), the risk of CKD increases, even without concomitant hypertension or diabetes. One of the mechanisms is the hyperproduction of nitric oxide (NO), peroxynitrite and endothelin-1, which indicates nitrosive stress and endothelial dysfunction [6].

Obesity associated with NAFLD leads to the activation of endoplasmic stress in the kidneys, which causes glomerular hypertrophy, apoptosis and interstitial fibrosis. In mouse models, there was an increase in the expression of the gene of the leading marker of cell apoptosis of the enzyme caspase-3 (Casp3), the protein gene of the transforming growth factor TGF β 1, which is a key regulator of various cellular processes (growth, differentiation, apoptosis), as well as the marker of cellular stress BiP - the main heat shock protein in the endoplasmic reticulum, which indicates the initial changes, the same as for CKD [6,7].

Studies show that bariatric surgery and type 2 Na-glucose cotransporter (SGLT2) inhibitors are able to improve renal function in obese patients, regardless of the glycemic profile [7], which requires further research.

In addition to the classical structural changes, obesity has an increase in pressure in the renal veins, leading to venous stagnation, activation of endothelial cells and the launch of fibrosis. This is one explanation for why even in the absence of diabetes or hypertension, patients with high BMI show a gradual decrease in eGFR and development of CKD [8].

Interestingly, the new data suggests a two-way relationship between the kidneys and metabolic status: The kidneys themselves can regulate food behavior by secreting a growth factor of differentiation 15

(GDF15), which activates the saturation center in the brain. This mechanism is activated in response to cellular kidney damage observed in obesity, and can be a protective way to limit further weight gain [9].

In addition to the well-described changes, new studies indicate the role of intestinal dysbiosis and associated metabolic disorders in obesity, which affects vascular regulation in the kidneys. This causes the development of obesity-associated glomerulopathies (OAG), which manifests itself histologically pronounced.

In the state of starvation there is a deep metabolic restructuring. The main sources of energy are ketone bodies - β -hydroxybutyrate and acetoacetate, which are synthesized in the liver and kidneys. The kidneys are active participants in ketogenesis, especially in conditions of prolonged carbohydrate deficiency [10].

In addition to influencing energy metabolism, fasting triggers the expression of the HMGCS2 gene in the proximal tubules, which encodes the synthesis of the mitochondrial enzyme 3-hydroxy-3-methylglutaryl-CoA synthase 2 (HMGCS2) and controls ketogenesis in the kidneys. This process is especially important during a long-term calorie deficit, when the gluconeogenesis of proteins becomes limited and the body goes to alternative energy sources. HMGCS2 catalyzes the first, irreversible stage of ketogenesis, the process of formation of ketone bodies to obtain energy during fasting. Activation of this enzyme allows to maintain energy stability in kidney cells and reduces the risk of ischemic damage in conditions of reduced blood flow [11].

Autophagy is one of the most important processes that are activated in the renal tubules when hungry. It provides the disposal of lipid drops, the regeneration of amino acids and the preservation of cellular energy. Animal experiments confirm that autophagy disorder leads to decreased ATP, impaired mitochondria and cell death [12].

It is known that autophagy plays not only an energy, but also a protective role in damage. In the polycystic kidney, for example, active autophagy reduces the progression of the disease through the purification of defective organelles. In starvation models, autophagy activity correlates with the survival rate of nephrocytes, a decrease in apoptosis and the maintenance of the normal functioning of the channel apparatus [13].

Research data show that during prolonged fasting, autophagy in the kidneys is an important factor in the formation of lipid drops and subsequent ketogenesis. In experimental models of mice with autophagy deficiency in the liver and kidneys, blood ketone levels and physical activity were lower than in animals with functional autophagy. This confirms the importance of renal autophagy in maintaining the systemic energy balance in terms of energy deficit [13,14].

It is established that during fasting renal excretion of nitrogen changes: In the early stages, urea excretion prevails, and in chronic starvation – ammonium genesis. This is important for maintaining acid-base equilibrium, since ammonia provides the regeneration of bicarbonate [14].

In addition to the role in the mobilization of energy substrates, autophagy in the kidneys also affects the preservation of intracellular integrity. In mice with nitrospesific insufficiency of autophagy, accumulation of lipid drops, a decrease in ATP levels and an increase in apoptosis were observed, which indicates the impossibility of effective use of fatty acids as an energy source [14,15].

However, aggressive or uncontrolled weight loss, such as in athletes, can cause acute kidney damage. This is due to dehydration, electrolyte disorders and perfusion disorders [15].

Despite the opposite metabolic vectors, obesity and starvation have common pathogenetic nodes: Oxidative stress, autophagy, energy balance disorder and endothelial dysfunction [6,9,13].

In this context, a promising direction is the modulation of the AMPK–mTOR–SIRT1 signaling pathway, which represents the main signaling pathway that regulates cell energy metabolism and cellular response to stress. AMPK (AMP-activated protein kinase) and SIRT1 (Sirtuin 1) are enzymes that in response to stress, such as fasting, activate and inhibit mTOR (a target of rapamycin in mammals). The activation of these pathways during fasting has a nephroprotective effect, and obesity associated with their suppression with the progression of lesions [13].

Among pharmacological agents, SGLT2 inhibitors, glucagon-like peptide-1 receptor agonists (GLP-1), as well as antioxidants that affect lipotoxicity and microvascular regulation are most studied [7,14].

Conclusions. The function of the kidneys significantly changes in metabolic disorders. With obesity, there is a gradual structural damage to the renal tissue, leading to CKD, while fasting triggers adaptive mechanisms, which under certain conditions are protective. The identification of common pathogenetic mechanisms gives grounds for the development of new therapeutic strategies aimed at preventing and slowing the progression of renal lesions in patients with metabolic disorders.

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Marchuk Yuliya,*PhD in Medicine, Associate Professor, Department of Clinical Immunology, Allergology and Endocrinology, Bukovinian State Medical University***Andriychuk Denys,***PhD in Medicine, Associate Professor, Department of Pediatrics and Medical Genetics, Bukovinian State Medical University***Marchuk Oleg,***PhD in Medicine, Associate Professor, Department of Orthopedics and Traumatology, Bukovinian State Medical University***Marchuk Volodymyr,***PhD in Medicine, oncological surgeon, oncological gynecologist, Chernivtsi Regional Clinical Hospital***Kostiv S.I.***Intern, Lviv Regional Infectious Diseases Clinical Hospital*<https://doi.org/10.5281/zenodo.17013734>

PROFESSIONAL COMMUNICATION IN MEDICAL EDUCATION: STANDARDS AND MODERN APPROACHES

Abstract.

In modern medicine, effective professional communication is an integral part of the quality of medical services and professional activity of a doctor. Increased patient awareness, the development of information technology, and the strengthening of the patient's role in decision-making require improved approaches to communication. Today's standards of professional communication are aimed not only at conveying medical information, but also at building trust, ensuring the patient's psychological comfort, and promoting interdisciplinary interaction.

Keywords: *professional communication, medicine, standards, interpersonal interaction, medical ethics, patient-centered approach, interdisciplinary interaction.*

Objective: the purpose of the article is to analyze the basic standards of professional communication in medicine, to investigate modern approaches to the interaction of medical personnel with patients and colleagues, and to determine the importance of communication skills for improving the quality of medical services and treatment outcomes.

The concept and importance of professional communication in medicine

Professional communication in medicine is defined as the process of exchanging information between a doctor, medical staff, a patient and their family, as well as between specialists of different profiles for the purpose of diagnosing, treating and preventing diseases. It is a key component of a doctor's professional competence, as it contributes to:

- accurate collection of medical history;
- increasing patient trust and satisfaction;
- ensuring the safety and quality of medical services;
- forming a positive image of the medical institution.

Standards of professional communication

1. Respect for the patient's personality. A key aspect of the standards is recognition of the dignity, individual needs, and values of the patient.
2. Confidentiality. All information about health status and treatment is confidential.
3. Clarity and comprehensibility of information. Healthcare professionals must adapt information for patients, taking into account their level of knowledge and psychological state.

4. Partnership with the patient. The patient has the right to participate in decisions regarding their treatment.

5. Professional ethics and empathy. The doctor must demonstrate empathy, kindness, and respect, regardless of personal preferences or the patient's condition.

Modern approaches to professional communication

1. Patient-centered approach. It implies that the doctor treats the patient as an equal partner, taking into account their individual needs and expectations.

2. Interdisciplinary interaction. Collaboration between doctors of different specialties requires well-established communication to coordinate treatment processes.

3. Digital technologies in communication. The use of telemedicine, electronic patient records, and medical chatbots helps simplify the exchange of information and access to medical services.

4. International organization standards. Recommendations from the WHO, the European Medical Association, and national medical councils form the basic requirements for professional conduct and communication.

Challenges in medical communication

- Increased workload on medical staff, limiting the time available for communicating with patients.
- Cultural and linguistic differences between patients and doctors.
- The need for continuous improvement of doctors' communication skills.

Ways to improve professional communication

1. Introduction of training and simulation technologies. Practical training in communication skills at medical universities and during professional development.

2. Psychological support for medical workers. Ensuring adequate working conditions and the psychological and emotional well-being of staff.

3. Development of telemedicine services. These help to reduce workload and ensure more accessible communication with patients.

Conclusions

Professional communication in medicine is a key component of high-quality medical care and safe treatment. Its standards and modern approaches are based on partnership with the patient, interdisciplinary interaction, and the use of innovative technologies. The systematic development of communication skills among healthcare professionals helps to increase trust, reduce the risk of medical errors, and improve treatment outcomes.

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Marchuk Yuliya,
PhD in Medicine, Associate Professor, Department of Clinical Immunology, Allergology and Endocrinology, Bukovinian State Medical University

Andriychuk Denys,
PhD in Medicine, Associate Professor,
Department of Pediatrics and Medical Genetics, Bukovinian State Medical University

Marchuk Oleg,
PhD in Medicine, Associate Professor, D
epartment of Orthopedics and Traumatology, Bukovinian State Medical University

Marchuk Volodymyr,
PhD in Medicine, oncological surgeon, oncological gynecologist, Chernivtsi Regional Clinical Hospital
Kostiv S.I., Intern, Lviv Regional Infectious Diseases Clinical Hospital

<https://doi.org/10.5281/zenodo.17013748>

THE ROLE OF ARTIFICIAL INTELLIGENCE IN STUDENT LEARNING

Abstract.

In today's rapidly digitizing society, education requires constant updating of methods and technologies. Artificial intelligence (AI) plays a key role in this process, as it allows not only to automate routine tasks, but also to create individual learning trajectories for students, increase the efficiency of the educational process, and prepare young people for new challenges. education, students, digitization, personalized learning, innovative technologies, adaptive systems.

Keywords: *AI, education, students, digitization, personalized learning, innovative technologies, adaptive systems.*

Objective: the purpose of this article is to study the role and possibilities of introducing artificial intelligence technologies into the educational process of higher education institutions, analyze their impact on the quality of education and the development of students' competencies. The article also aims to summarize current scientific and methodological approaches to the integration of AI into pedagogical activities and to formulate recommendations for the effective use of such technologies in the education system.

Introduction

In the 21st century, education is undergoing a profound transformation driven by the development of digital technologies. Artificial intelligence (AI) is increasingly becoming a tool for supporting the learning process and improving the quality of education. Its application opens up new opportunities for individualizing learning, expands the pedagogical tools available to teachers, and develops new competencies in students. The purpose of this article is to analyze the role of AI in student learning, identify its advantages, challenges, and prospects for implementation in higher education.

The potential and advantages of AI in education

Personalization of learning paths

AI systems are capable of analyzing the individual needs of students and creating personalized learning paths. AI-based platforms can take into account the pace of learning, learning style, and level of knowledge of the student. This optimizes the learning process, making it more effective and convenient.

Automation of routine processes

AI tools reduce the workload on teachers by automating the checking of assignments, creating tests, preparing materials, and collecting statistical data. This allows teachers to devote more attention to individual consultations and a creative approach to learning.

Instant feedback

Thanks to AI algorithms, students can quickly receive comments and recommendations on completed assignments. This promotes the development of independence and self-regulation in learning.

Accessibility of knowledge

AI technologies promote the development of inclusive education by ensuring the accessibility of learning materials for students with different needs and abilities.

Intelligent learning environments

AI integration enables the creation of virtual laboratories, simulators, and adaptive courses. For example, the use of virtual or augmented reality in combination with AI makes it possible to simulate real-life situations, which is especially important for students in technical and medical fields.

Challenges and risks of AI implementation

Ethical and legal aspects

The implementation of AI in the educational process requires adherence to the principles of academic integrity, personal data protection, and avoidance of algorithmic bias.

Risk of reduced critical thinking

Students' dependence on ready-made answers provided by AI can negatively affect the development of information analysis and synthesis skills.

Unequal access to technology

The use of AI can exacerbate educational inequality due to some students' limited access to high-quality tools and platforms.

Need for teacher training

The effective implementation of AI in the educational process is only possible with systematic training of teachers and the development of their digital competence.

Potential danger of abuse

AI can become a tool for academic dishonesty if appropriate control mechanisms are not implemented. Clear policies and assessment systems need to be created to encourage students' own intellectual contributions.

Methodological aspects of AI integration into higher education

Selection and adaptation of technologies

When integrating AI, the specifics of the discipline and learning objectives should be taken into account. Tools should be accessible to students and easy to use. For the humanities, it is advisable to use chatbots and analytical platforms, while technical specialties require simulation systems and intelligent simulators.

Formation of an ethical culture

The use of AI should be accompanied by teaching students the ethics of technology use and the development of academic integrity. The development of codes of ethics and the inclusion of courses on digital ethics in educational programs is becoming a necessity.

Development of new forms of assessment

AI makes it possible to create flexible assessment systems that take into account the individual achievements and progress of students. Algorithms can track skill development throughout the learning process, forming detailed portfolios.

Using AI for research

AI can become a tool in students' research work, helping to collect, analyze, and visualize data. This allows them to develop scientific thinking and the ability to work with large amounts of information.

Interdisciplinary opportunities

The integration of AI into education promotes interdisciplinarity. Engineering students can collaborate with humanities students to develop educational applications, and economists can collaborate with programmers to model market processes.

Practical cases of AI application

1. Intelligent tutors: Coursera and Khan Academy platforms have implemented AI systems that adapt content to the individual needs of students.
2. Analysis of written works: Grammarly and Writefull services help improve the quality of texts by providing real-time recommendations.
3. Virtual laboratories: Medical universities use AI systems to simulate operations and research.

4. Predicting academic success: Algorithms make it possible to predict students' academic difficulties and provide support in advance.

Prospects for development and conclusions

AI opens up new horizons for the modernization of higher education. Its implementation will contribute to:

- the development of adaptive and personalized educational environments;
- improving the efficiency of teachers;
- expanding access to education for students with different needs;
- the formation of new competencies in the field of digital technologies.

However, it is important to remember the balance between technology and the human factor. Teachers remain key carriers of values, culture, and critical thinking. The use of AI should be a tool for developing creative potential, not replacing it.

The development of artificial intelligence in higher education is not only a technological challenge but also a humanitarian task. The formation of digital culture, critical thinking, and the ability to learn throughout life are key guidelines for a modern university that actively integrates innovation.

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Marchuk Yuliya,*PhD in Medicine, Associate Professor, Department of Clinical Immunology,
Allergology and Endocrinology, Bukovinian State Medical University***Andriychuk Denys,***PhD in Medicine, Associate Professor, Department of Pediatrics and Medical Genetics,
Bukovinian State Medical University***Marchuk Volodymyr,***PhD in Medicine, oncological surgeon, oncological gynecologist, Chernivtsi Regional Clinical Hospital
Kostiv S.I., Intern, Lviv Regional Infectious Diseases Clinical Hospital*<https://doi.org/10.5281/zenodo.17013759>

IMPACT OF THYROID DYSFUNCTION ON FERTILITY AND PREGNANCY: THE ROLE OF HYPERPROLACTINEMIA

Abstract

Thyroid disorders are the most common endocrine problems in women. In most of the cases, thyroid can lead to infertility or miscarriages. The etiology of infertility is multifactorial with thyroid disorders as the most common presenting factor, hypothyroidism in particular. Infertility in women can lead to emotional and psychological stress. The prevalence of hypothyroidism during pregnancy is estimated to be 0.3%–0.5%. Hypothyroidism and hyperthyroidism can result in menstrual irregularities and anovulatory cycles, thus affecting fertility. There is a significant high prolactin (PRL) level in infertile women with hypothyroidism when compared to euthyroid patients, indicating the relation between hypothyroidism and hyperprolactinemia. The amount of thyrotropin releasing hormone (TRH) from the hypothalamus is markedly increased by inhibition of pyroglutamyl peptidase II, the enzyme catalyzing TRH. The increased TRH in hypothyroidism causes increased thyroid-stimulating hormone and PRL secretion by pituitary, leading to infertility and galactorrhea. In recent years, a neuropeptide called kisspeptin, encoded by *Kiss1* gene, a potent stimulus for GnRH secretion, has been recognized, which suggests a future direction of treatment with kisspeptin and benefits the fertility induction among hyperprolactinemic infertile patients. Untreated hypothyroidism during pregnancy can lead to infertility, fetal deaths, premature deliveries, and abortions. Therefore, women planning for pregnancy and infertile women should be assessed for thyroid hormones and serum PRL.

Keywords: Hyperprolactinemia, Hypothyroidism, Infertility, Pregnancy, Thyroid.

Relevance

In recent years, the problem of neuroendocrine pathology has become particularly important. This is primarily due to the fact that obesity and type II diabetes are becoming widespread. Recent studies have shown the impact of metabolic disorders on the cardiovascular system in increasing the frequency of heart attacks and strokes in obesity, as well as the development of insulin resistance and diabetes mellitus against the background of sufficient insulin production by the pancreas (insulin-independent diabetes mellitus).

Objective: based on the literature review, consider the relationship between thyroid disorders and how it affects pregnancy.

Introduction

During pregnancy, there will be a great physiological stress on mother and fetus. Physiology of thyroid is modified during pregnancy, which helps prepare the maternal thyroid gland to cope with metabolic demands. The prevalence of hypothyroidism during pregnancy is estimated to be 0.3%–0.5%. During pregnancy, to meet increased physiological demands of growing fetus, thyroid hormone production is augmented, which leads to increased production of serum estrogen up to 500–1000 pg/mL during the first half of gestation. This results in 2–3-fold upregulation of hepatic thyroxine (T₄)-binding globulin (TBG) production. Increased TBG levels may alter equilibrium between bound and free T₄ (FT₄). The T₄ in free state is utilized by the body, so the reduced FT₄ can increase

the levels of thyroid-stimulating hormone (TSH) by feedback mechanism. This elevated TSH in turn leads to hypothyroidism

Pathogenesis.

Functional hyperprolactinemia occurs during pregnancy as a result of hypertrophy of the pituitary lactotrophs, which is a physiological process necessary for lactation. Predisposing factors are pregnancy complications: gestosis, threat of termination, prolonged lactation after preterm birth, as well as a history of other causes of functional hyperprolactinemia. Excessive synthesis of prolactin begins during pregnancy and suppresses the gonadotropic function of the pituitary gland. As a result, follicle and steroidogenesis does not occur in the ovary, which is manifested by the absence of menstruation after cessation of feeding during lactation. Rarely, this syndrome develops after late (in the second trimester) spontaneous or induced miscarriages. Approximately one third of women are overweight with a uniform (female type) distribution of adipose tissue. Trophic stretch marks on the skin of the abdomen and thighs are not typical, but may be whitish or pale pink in color.

The diagnosis is not difficult and is based on a typical clinic: the absence of menstruation against the background of ongoing, sometimes spontaneous, lactation.

Hormonal studies reveal an increased concentration of prolactin (about 2000 IU/l), decreased levels of

gonadotropins (LH and FSH) and estradiol, respectively, at the lower level of basal values.

Gestagen and tarragon tests were positive, excluding the uterine form of amenorrhea. Transvaginal echography shows multifollicular ovaries, normal size, reduced uterine size, thin endometrium. Computed tomography and magnetic resonance imaging are performed with high prolactin values to exclude pituitary tumors. The most common mistake made by doctors is to prescribe COCs to regulate the menstrual cycle without identifying the cause of amenorrhea, which increases hyperprolactinemia and can contribute to the development of micro- and macroadenomas of the pituitary gland. prescription of COCs to regulate the menstrual cycle without identifying the cause of amenorrhea, which increases hyperprolactinemia and can contribute to the development of micro- and macroadenomas of the pituitary gland.

Treatment consists of prescribing dopamine agonists - parlodel or its analogues (up to 7.5-10 mg/day) until the ovulatory menstrual cycle is restored and normal blood prolactin levels are restored. During treatment, the dose is gradually reduced until normal prolactin levels appear. Ovulation is tested by the level of basal temperature, ultrasound monitoring of the growing follicle, and the peak of gonadotropins.

Prevention.

When planning a pregnancy, timely detection and treatment of the causes of transient hyperprolactinemia is necessary, including long-term use of OCPs or other medications.

Conclusion.

Thyroid disease requires special care in pregnant women or those desiring pregnancy. Untreated hypothyroidism during pregnancy can lead to infertility/subfertility, fetal deaths, premature deliveries, and abortions. Assessment of serum thyroid profile and PRL

levels should be done in women desiring pregnancy and at early stage of infertility. Early intervention with appropriate therapy can avoid the fetal complications in pregnancy due to hypothyroidism and to improve fertility rate among infertile women. The tests for hyperprolactinemia and thyroid disorders should be made routine in pregnant and infertile women.

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Liashuk Ruslana
Ph.D., Associate Professor,
Bukovyna State Medical University,
Chernivtsi

<https://doi.org/10.5281/zenodo.17013763>

CHARACTERISTICS OF SOME NEW METHODOLOGIES AND TOOLS FOR TEACHING MEDICAL UNIVERSITY STUDENTS

Abstract.

This article discusses the importance of integrating interdisciplinary knowledge in modern medical education. Since clinical cases are often multifaceted, medical students must be able to effectively combine knowledge from various disciplines. Several methods are presented to achieve this goal, including: using the case method, conducting multidisciplinary discussions with specialists, organizing practical seminars and interdisciplinary trainings, as well as developing integrated curricula. The role of interactive online platforms as a tool for collaborative work and knowledge exchange is also mentioned. The proposed approaches are aimed at developing not only complex clinical thinking in students but also teamwork and effective communication skills.

Keywords: Medical education, interdisciplinary knowledge, integration, case method, multidisciplinary discussions, practical seminars, integrated curricula, online platforms, medical pedagogy, immunology, allergology.

Interdisciplinary Knowledge Integration: It's important to organize training in a way that allows students to integrate knowledge from various medical disciplines (immunology, allergology, therapy, dermatology, pediatrics, etc.), as clinical cases often have a multifaceted nature. This can be achieved through the case method, multidisciplinary discussions, and practical seminars involving specialists from different fields of medicine [1].

The integration of interdisciplinary knowledge is a key aspect of modern medical education, as clinical cases often require a comprehensive approach that covers various medical disciplines. To enable students to effectively integrate knowledge from immunology, allergology, therapy, dermatology, pediatrics, and other medical fields, it is necessary to create a learning environment that promotes the unification of these disciplines. Here are a few ways this can be achieved:

1. The case method is an effective tool for integrating interdisciplinary knowledge, as it allows students to analyze real or simulated clinical situations that require the application of knowledge from various medical fields. In the analysis of a specific case, students must consider all aspects of a patient's health: from clinical history to laboratory test results, determine a diagnosis, and develop a treatment plan, taking into account the specifics of each discipline. This allows students to understand how different areas of medicine interact in real-world practice.

2. Multidisciplinary discussions, with the participation of specialists from various medical fields, are an important element of education. Such discussions can take the form of seminars or meetings where students have the opportunity to listen to different points of view and suggestions from doctors of various specialties regarding a specific clinical case. For example, when treating a patient with a complex disease, an immunologist, allergist, therapist, and dermatologist can be involved in the discussion. Students not only gain integrated knowledge but also develop important skills in teamwork and effective communication.

3. Multidisciplinary discussions, with the participation of specialists from various medical fields, are an important element of education. Such discussions can take the form of seminars or meetings where students have the opportunity to listen to different points of view and suggestions from doctors of various specialties regarding a specific clinical case. For example, when treating a patient with a complex disease, an immunologist, allergist, therapist, and dermatologist can be involved in the discussion. Students not only gain integrated knowledge but also develop important skills in teamwork and effective communication [2].

4. Integrated curricula aim to create a single learning strategy that combines knowledge from different medical disciplines. For example, in a program that covers therapy, dermatology, and pediatrics, students can study the shared aspects of diseases such as allergies, which can have skin manifestations while also causing exacerbations in the immune system. This allows students to gain a deeper understanding of the processes occurring in the body and learn to apply a comprehensive approach to patient treatment.

5. Interdisciplinary trainings and simulations for modeling complex clinical situations are another effective method for integrating interdisciplinary knowledge. Students can work together in groups, interacting as doctors of different specialties, which allows them to develop a shared understanding of clinical cases and make decisions based on knowledge from several disciplines. [3].

6. Interactive online platforms allow students from different medical disciplines to work together and exchange experience and knowledge. Such platforms can include interactive case studies, discussion forums, and video lessons where specialists from various medical fields explain important aspects of knowledge integration in clinical practice. [4,5].

Online education and virtual platforms: Distance learning platforms, which include interactive tests, online lectures, and discussion forums, can significantly increase the accessibility of knowledge. They

also help students manage their time independently, and support feedback from teachers and specialists [6].

Conclusion

The integration of interdisciplinary knowledge is a necessary condition for training qualified doctors who are capable of working effectively in complex clinical situations. Students who are trained through case methods, multidisciplinary discussions, and practical seminars are better prepared for real clinical practice, where successful treatment often depends on understanding and interaction between different medical fields. This approach helps students develop not only knowledge but also the necessary skills for effective teamwork in a clinical environment.

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*Лупуляк Аліна Ярославівна,
здобувачка вищої освіти медичного факультету
Печеряга Світлана Володимирівна
к.мед.н., асистентка кафедри
акушерства, гінекології та перинатології
Буковинський державний медичний університет
м. Чернівці, Україна*

АКТУАЛЬНІ АСПЕКТИ ВЕДЕННЯ АКУШЕРСЬКИХ КРОВОТЕЧ

*Lupuliak Alina,
master's student at the Faculty of Medicine
Pecheriaha Svitlana
Candidate of Medical Sciences, Assistant
Department of Obstetrics, Gynecology and Perinatology
Bukovinian State Medical University
Chernivtsi, Ukraine*

CURRENT APPROACHES TO THE MANAGEMENT OF OBSTETRIC HEMORRHAGE

Анотація.

Акушерські кровотечі й надалі залишаються однією з провідних причин материнської смертності у світі, що зумовлює необхідність особливої уваги з боку акушерсько-гінекологічної служби. Частота післяпологових кровотеч сягає до 10% усіх пологів, причому у близько 1% випадків розвивається тяжка форма, що становить загрозу для життя жінки. Основними типами акушерських кровотеч є передпологові, пологові та післяпологові, а серед причин — патологія плаценти, розрив матки, порушення скоротливої здатності міометрія, коагулопатії. У статті розглянуто основні етіологічні чинники, сучасні методи діагностики, класифікації та протоколи ведення акушерських кровотеч відповідно до міжнародних клінічних рекомендацій. Наголошено на важливості індивідуалізованого підходу до кожного клінічного випадку з метою зниження материнської смертності та збереження репродуктивного здоров'я жінки.

Abstract.

Obstetric hemorrhage remains one of the leading causes of maternal mortality worldwide, necessitating increased attention from obstetric and gynecological services. Postpartum hemorrhage occurs in up to 10% of all deliveries, and in approximately 1% of cases, it takes a severe form that poses a life-threatening risk to the woman. The main types of obstetric bleeding include antepartum, intrapartum, and postpartum hemorrhage. The most common causes are placental pathology, uterine rupture, impaired contractility of the myometrium, and coagulopathies. This article discusses the key etiological factors, current diagnostic methods, classifications, and clinical management protocols for obstetric hemorrhage in accordance with international guidelines. Emphasis is placed on the importance of an individualized approach in each clinical case to reduce maternal mortality and preserve women's reproductive health.

Ключові слова: акушерські кровотечі, материнська смертність, атонія матки, діагностика, лікування, профілактика.

Keywords: obstetric hemorrhage, maternal mortality, uterine atony, diagnosis, treatment, prevention.

Вступ. Акушерські кровотечі посідають одне з провідних місць серед причин материнської захворюваності та смертності як у світі, так і в Україні. За даними Всесвітньої організації охорони здоров'я, щороку від тяжких кровотеч під час вагітності, пологів або у післяпологовому періоді помирають десятки тисяч жінок, при цьому значна частина цих випадків є потенційно попереджуваною [1]. Акушерські кровотечі можуть виникати в будь-якому триместрі вагітності та мають різноманітну етіологію — від порушень імплантації та патологій плацентації до розривів матки, травм родових шляхів, а також коагулопатій [2].

Сучасна клінічна практика передбачає не лише швидке розпізнавання симптомів і точне встановлення джерела кровотечі, але й впровадження ефе-

ктивних алгоритмів ведення таких станів, що базуються на принципах доказової медицини. Значна увага приділяється ранній оцінці ризиків у вагітних, стратифікації пацієнток за групами ризику, впровадженню сучасних методів візуалізації та лабораторного моніторингу, а також мультидисциплінарному підходу до надання допомоги [3].

Застосування таких інноваційних рішень, як цільова інфузійна терапія, препарати для стимуляції скоротливої здатності матки, методи інтервенційної радіології (зокрема, емболізація маткових артерій), а також розробка та впровадження локальних клінічних протоколів сприяють покращенню результатів лікування та зменшенню кількості ускладнень [4, 5]. Таким чином, акушерські кровотечі залишаються серйозним викликом для практичної охорони здоров'я, що потребує постійного

оновлення знань, удосконалення тактики ведення та обміну досвідом на міждисциплінарному рівні.

Мета. Метою цієї роботи є аналіз сучасних підходів до діагностики, профілактики та лікування акушерських кровотеч із урахуванням останніх клінічних настанов та світового досвіду з метою зниження материнської смертності та ускладнень у період вагітності та пологів.

Результати та обговорення. Акушерські кровотечі поділяються на передпологові (до початку пологів), пологові (під час пологів) та післяпологові (в перші 24 години або пізніше після народження дитини) [6]. До основних причин передпологових кровотеч відносяться передлежання та відшарування плаценти, а також розрив матки при наявності рубця після кесаревого розтину [7]. Під час пологів частими причинами є травматичні ушкодження родових шляхів, дисточія шийки матки та розриви промежини. Післяпологові кровотечі найчастіше пов'язані з аномаліями скорочення матки, затримкою частин плаценти, коагулопатіями або інфекціями [8]. Найбільшу небезпеку для життя матері становлять післяпологові кровотечі, що є найчастішою причиною материнської смертності у світі.

Згідно з класифікацією ВООЗ, виділяють чотири основні причини післяпологових кровотеч - «4Т»: тонус (атонія матки), тканина (затримка плаценти), травма (ушкодження), тромбін (порушення згортання) [9]. Найбільш частою є атонія матки, що виявляється в більш ніж 70% випадків [10].

У сучасній практиці велике значення має стратифікація ризику акушерських кровотеч ще на етапі антенатального спостереження. Розроблено шкали прогнозування тяжкої кровотечі, що включають такі чинники, як багатоплідна вагітність, передчасне відшарування плаценти, підвищений індекс маси тіла, багатоводдя, анемія, попередні операції на матці. Це дозволяє завчасно планувати місце та умови пологів, особливо у випадках, які вимагають наявності крові, оперативного втручання або доступу до відділення інтенсивної терапії [12].

Діагностика ґрунтується на клінічній оцінці об'єму крововтрати, гемодинамічного статусу пацієнтки та ультразвуковому обстеженні на наявність залишків плаценти або гематом [13]. Однак оцінка крововтрати «на око» часто є неточною, тому рекомендується використовувати стандартизовані інструменти, як-то об'ємні контейнери для збору крові, гемоглобінометрія та вимірювання об'єму втрати [14].

Згідно з останніми клінічними протоколами Міжнародної федерації гінекологів та акушерів (FIGO) та Американського коледжу акушерів і гінекологів (ACOG), ведення післяпологових кровотеч базується на чітко визначеному поетапному алгоритмі, що передбачає поступове посилення інтенсивності лікування залежно від тяжкості стану пацієнтки та ефективності попередніх заходів.

На першому етапі здійснюється медикаментозна терапія, яка включає застосування утеротонічних засобів: окситоцину, метилергометрину, простагландинів (карбопрост, мізопростол). У деяких

випадках може бути доцільним внутрішньоматкове введення препаратів, наприклад таблетованого мізопростолу, для локального посилення скоротливої активності матки [11].

При неефективності консервативної терапії, згідно з протоколами, переходять до другого етапу — механічного впливу на джерело кровотечі. Найбільш широко використовується тампонада матки балоном Бакрі, яка дозволяє тимчасово зупинити кровотечу шляхом створення внутрішньоматкового тиску. Цей метод є ефективним у випадках атонічних кровотеч та дозволяє виграти час для подальшого втручання.

Третій етап — хірургічне лікування, яке включає: компресійні шви на матку (найпоширеніший варіант — шви В-Lynch); лігування маткових або внутрішніх клубових артерій, що дозволяє зменшити кровотік до органа-мішені. У випадку неефективності всіх попередніх заходів, при загрозі життю пацієнтки, показане радикальне оперативне втручання — екстирпація матки (гістеректомія). Це крайній захід, до якого вдаються лише за умов тяжкої, неконтрольованої кровотечі, особливо в умовах коагулопатії або відсутності ефекту від менш інвазивних методів [11, 15].

Ефективність кожного з етапів залежить насамперед від етіологічного чинника кровотечі, об'єму крововтрати, супутніх ускладнень та — критично — від часу, що минув до початку адекватної терапії. Чим раніше розпочато втручання згідно з протоколом, тим вищі шанси зберегти матку, стабілізувати стан жінки та уникнути летальних наслідків [15].

Сучасні рекомендації щодо профілактики післяпологової кровотечі включають активне ведення третього періоду пологів: введення утеротоніків одразу після народження дитини, контроль за народженням плаценти та профілактичне масування матки [16]. Пренатальний скринінг на фактори ризику (багатоплідна вагітність, пологи в анамнезі з кровотечами, анемія) дозволяє своєчасно спрогнозувати перебіг пологів [17].

Ведення масивної кровотечі потребує мультидисциплінарного підходу із залученням акушерів, анестезіологів, гематологів та хірургів. Необхідною є готовність до проведення гемотрансфузійної терапії, застосування антагоністів фібринолізу (транексамова кислота) та застосування інноваційних методів - таких як балонна тампонада Бакрі або емболізація маткових артерій [18].

Важливою складовою профілактики ускладнень є навчання персоналу, симуляційні тренінги з моделювання екстрених ситуацій, а також забезпечення готовності установ до екстрених акушерських кровотеч [19]. У країнах із розвинутою системою акушерської допомоги створено протоколи швидкої реакції, що дозволяють зменшити час від початку кровотечі до стабілізації стану пацієнтки [20].

Новітнім напрямом у профілактиці та лікуванні масивних кровотеч є застосування точкової (РОС) коагуляційної діагностики за допомогою ме-

тодів тромбоеластографії (TEG) та ротаційної тромбоеластометрії (ROTEM). Ці методи дозволяють оцінити функціональний стан коагуляційного каскаду в реальному часі, що особливо важливо при рідкісних коагулопатіях або під час інтенсивної інфузійної терапії [21].

Окрему категорію становлять акушерські кровотечі при рідкісних патологіях, таких як інвазивне прирощення плаценти (placenta accreta spectrum), що потребують ретельної пренатальної діагностики за допомогою УЗД і МРТ, а також попереднього планування операції [22].

Додатково заслуговують уваги питання акушерських кровотеч у жінок із коагулопатіями (хвороба фон Віллебранда, тромбоцитопенія), для яких потребується індивідуальний протокол з профілактикою згортальних ускладнень і продуманою інфузійною терапією [23].

У контексті глобального здоров'я актуальним є підвищення доступу до якісної акушерської допомоги в умовах обмежених ресурсів. У країнах з низьким та середнім рівнем доходу впроваджуються недорогі та ефективні інтервенції, як термопакети, протоколи з активного ведення третього періоду пологів, доступ до базових утеротоніків та мобільні бригади швидкої акушерської допомоги. Створення логістичних ланцюгів для забезпечення засобами переливання крові також відіграє критичну роль у зменшенні смертності [24, 25].

Висновки. Акушерські кровотечі є серйозним викликом сучасному акушерству, що вимагає своєчасної діагностики, чіткої організації допомоги та застосування ефективних методів лікування. Розуміння патофізіологічних механізмів кровотеч, вчасне впровадження профілактичних заходів та мультидисциплінарний підхід є ключем до зниження рівня материнської смертності та збереження репродуктивного здоров'я жінки. Стандартизація надання допомоги, тренінги для персоналу та оновлення клінічних протоколів повинні бути невід'ємною частиною системи охорони здоров'я.

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**Lopatiuk Mariia Serhiivna,
Smetaniuk Anna Vasylivna,
Yarosh Viktoria Yuriivna,
Delitsoi Olha Yuriivna,**

*4th year students, 5 group
specialty 222 "Medicine"*

Bukovinian State Medical University

Kvasnytska Olga Borysivna

PhD in Medical Sciences, Associate Professor

Department of Internal Medicine

Bukovinian State Medical University

Chernivtsi, Ukraine

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THE ROLE OF GASTRO- AND HEPATOPROTECTORS IN THE TREATMENT OF GASTROINTESTINAL TRACT DISEASES: MODERN APPROACHES

Abstract.

The article reviews the current classifications, mechanisms of action, clinical efficacy, and prospects for the use of gastro- and hepatoprotectors in the treatment of gastrointestinal diseases. Particular attention is paid to the evidence base and the results of recent clinical trials confirming the effectiveness of these drugs in the complex therapy of gastroenterological and hepatological diseases

Keywords: *gastroprotectors, hepatoprotectors, gastrointestinal diseases, liver diseases, treatment, prevention, clinical effectiveness*

Introduction. Diseases of the gastrointestinal tract and liver are still an urgent problem of modern medicine, given their high prevalence and impact on the quality of life of patients. In this context, gastroprotectors and hepatoprotectors play an important role in the prevention and treatment of relevant pathologies [1]. Gastroprotectors are aimed at protecting the gastric and duodenal mucosa from damage caused by aggressive factors, such as gastric acid, non-steroidal anti-inflammatory drugs (NSAIDs) and others [2]. Hepatoprotectors, in turn, contribute to the restoration and protection of liver cells from toxic effects, including drug, alcohol and viral lesions [3].

The article considers modern classifications, mechanisms of action, clinical effectiveness and prospects of use of gastro- and hepatoprotectors in the treatment of diseases of the gastrointestinal tract. Particular attention is paid to the evidence base and results of recent clinical studies confirming the effectiveness of these drugs in the complex therapy of gastroenterological and hepatological diseases [4,5].

Presentation of the main material and discussion.

Gastroprotectors are a group of drugs that help protect the gastric mucosa and duodenum from damage caused by aggressive factors. The main mechanisms of action of gastroprotectors include increased secretion of mucus, stimulation of regeneration of epithelium, inhibition of gastric acid secretion and neutralization of free radicals [5].

The classification of gastroprotectors includes several main groups. Antacids neutralize gastric acid, reducing its aggressive effect on the mucous membrane. Proton pump inhibitors (PPIs), such as omeprazole and esomeprazole, block the secretion of gastric acid, contributing to the healing of ulcers. H₂-blockers

(ranitidine, famotidine) reduce acid secretion by blocking histamine receptors in the parietal cells of the stomach [6,7].

Among the gastroprotectors there are also drugs that strengthen the protective mechanisms of the mucous membrane. For example, sucralfate forms a protective pellicle on the surface of ulcers, and misoprostol, an analog of prostaglandin E₁, increases the secretion of mucus and bicarbonates, improving blood flow in the mucous membrane [8].

The researchers pay considerable attention to the study of the role of regulators of the gut microbiome in the prevention and treatment of gastrointestinal diseases, since the violation of the microbiota has a close connection with the occurrence of inflammatory processes, the violation of the mucous barrier and the development of hepatobiliary disorders [9]. In this context, the combined use of prebiotics, probiotics, and postbiotics is seen as a potential direction of gastro- and hepatoprotection, which can enhance the effect of traditional drugs and contribute to the restoration of epithelial homeostasis [10].

Cytoprotectors belong to the separate group with the effect of reducing oxidative stress, which is a key mechanism for damage to the mucous membrane and liver tissue. In particular, medications based on glycyrrhizic acid, silymarin, essential phospholipids have the ability to reduce free radical products, suppress inflammatory cytokines and improve microcirculation in the affected areas [11,12].

Molecules with properties of synthetic mimetics of anti-inflammatory peptides are also actively studied, which can selectively bind to receptors on the surface of mucous membrane and hepatocytes cells, inducing the production of endogenous protective factors, such as prostaglandins and epidermal growth factor [13].

The first clinical studies of such compounds show encouraging results in the treatment of both acute and chronic forms of gastritis and steatohepatitis [14].

In recent years, there has also been a growing interest in the transplantation of fecal microbiota as an auxiliary method of restoring intestinal homeostasis in patients with severe forms of enteropathy and hepatitis. In some cases, this approach allowed to improve metabolic rates, reduce the manifestations of integrin inflammation and increase sensitivity to traditional therapy [15].

Hepatoprotectors are drugs that contribute to the protection and restoration of liver cells with various liver lesions. The mechanisms of action of hepatoprotectors include antioxidant activity, stabilization of cell membranes, stimulation of regeneration of hepatocytes and inhibition of fibrogenesis [16].

The classification of hepatoprotectors covers several groups. Flavonoids, such as silymarin, have a powerful antioxidant and membrane-stabilizing effect. Essential phospholipids, such as essential, restore the structure of cell membranes of hepatocytes. Amino acid-based drugs, such as ademetionine, contribute to detoxification and regeneration of the liver [17].

Clinical studies confirm the effectiveness of gastro- and hepatoprotectors in the treatment of appropriate diseases. For example, the use of PPIs in patients with gastric ulcer leads to faster healing of ulcers and reduction of symptoms. The use of hepatoprotectors, such as silymarin, in patients with chronic hepatitis contributes to the improvement of liver function and reduction of the inflammatory process [18,19].

In addition to pharmacological innovations, an important component of modern therapy is a personalized approach that takes into account genetic polymorphisms of enzymatic systems, concomitant diseases and the patient's lifestyle. For example, in patients with mutations in the glutathione-S-transferase genes, the effectiveness of some hepatoprotectors is reduced, which requires individual selection of therapy based on pharmacogenetic testing [20,21].

Modern research also focuses on the use of natural drugs as gastro- and hepatoprotectors. For example, curcumin and artichoke-based phyto-pharmaceuticals show a positive effect on liver function and protect stomach mucosa [22,23].

An important aspect is the safety of the use of gastro- and hepatoprotectors. Although most of them have a good safety profile, side effects such as diarrhea, headache or allergic reactions are possible. Therefore, before prescription, it is necessary to take into account the individual characteristics of the patient and possible interactions with other drugs [24].

In the context of increasing resistance to traditional drugs and side effects, researchers are drawing attention to new approaches to the treatment of gastrointestinal and liver diseases. In particular, new molecules with combined action are being developed, combining gastro- and hepatoprotective properties, and the potential of probiotics and prebiotics in maintaining the health of the gastrointestinal tract is being studied. [25]

Conclusions. Gastro- and hepatoprotectors play a key role in the complex treatment of diseases of the gastrointestinal tract and liver. Their effectiveness is confirmed by numerous clinical studies, and modern approaches to therapy take into account the individual characteristics of patients and the possibility of combined use of drugs. Further research and development of new products will help improve the results of treatment and the quality of life of patients.

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