REVIEW ARTICLE

CONTENTS

Artificial intelligence in the training system of future doctors

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ABSTRACT

Aim: To analyze the potential of artificial intelligence in the process of solving innovative ideas in the system of training future doctors, improving the educational process in medical universities, and analyzing the concept of quot; health and quot; as a key term in professional activity. In order to achieve the stated goal, we plan to examine the importance of this concept for regulatory documents and propose an original (authorial) solution to these issues.

Materials and Methods: A systematic literature search was carried out in the following databases: PubMed, Scopus, Web of Science, Google Scholar. Additional grey literature was identified through institutional repositories, conference proceedings, and relevant policy documents of the Ukrainian government and the European Union. Such keywords and their combinations as "artificial intelligence", "medical education", "empathy", "anamnesis", "academic integrity", "iatrogenesis", "digital transformation", "higher medical school", "information culture", "AI in healthcare", "Poland", "Ukraine" were used. Inclusion criteria encompassed peer-reviewed articles published between 2018 and 2025 in English, Ukrainian, or Polish that focused on the use of AI in medical education, clinical training, and healthcare organization, as well as studies analyzing its advantages, limitations, ethical considerations, and offering comparative or practical recommendations. Exclusion criteria included non-scientific sources, articles unrelated to medical education or healthcare, and studies lacking clear methodology or outcome measures.

Conclusions: Artificial intelligence in organizing the administrative work of medical institutions has the significant potential. This refers to information about staff and patients, organizing communication schedules with specialists of the relevant profile, and optimizing schedules.

KEY WORDS: education, medicine, university, personality, creativity, artificial intelligence, communication

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INTRODUCTION

Artificial intelligence is becoming an everyday reality. We should note the rapid pace at which new technological advancements are being implemented. At the same time, a review of the literature indicates that the number of publications on the threats and benefits of artificial intelligence significantly exceeds the number of specific recommendations for its effective practical use. In training future doctors, attention is drawn to potential violations of academic integrity. At the same time, there is a need for a series of studies on the use of AI in the educational process, particularly in preparing for high-quality history taking: the culture of questioning, empathy, the ability to speak and listen to the interlocutor, and avoiding iatrogenesis.

AIM

To analyze the potential of artificial intelligence in the process of solving innovative ideas in the system of training future doctors, improving the educational process in medical universities, and analyzing the concept of quot; health and quot; as a key term in professional activity. In order to achieve the stated goal, we plan to examine the importance of this concept for regulatory documents and propose an original (authorial) solution to these issues.

MATERIALS AND METHODS

The study was conducted over the past five years (2020-2025) at I. Horbachevsky Ternopil National Medical University. On the basis of comparative studies, the experience of Polish colleagues was taken into account. Methods of comparison, analytical generalization, expert assessments, creative essays were used. To achieve the goal of the study, the capabilities of artificial intelligence were used, data from computer systems were compared with the conclusions of teachers and young people, and their own experience in solving complex social issues was summarized. Special attention was paid to correctness, creative use of the capabilities of

artificial intelligence, and consideration of the requirements of academic integrity. A systematic literature search was carried out in the following databases: PubMed, Scopus, Web of Science, Google Scholar, and the Polski Mercury Lekarski and Wiadomości Lekarskie journal archives. Additional grey literature was identified through institutional repositories, conference proceedings, and relevant policy documents of the Ukrainian government and the European Union. Such keywords and their combinations as "artificial intelligence", "medical education", "empathy", "anamnesis", "academic integrity", "iatrogenesis", "digital transformation", "higher medical school", "information culture", "AI in healthcare", "Poland", "Ukraine" were used. Inclusion criteria encompassed peer-reviewed articles published between 2018 and 2025 in English, Ukrainian, or Polish that focused on the use of AI in medical education, clinical training, and healthcare organization, as well as studies analyzing its advantages, limitations, ethical considerations, and offering comparative or practical recommendations. Exclusion criteria included non-scientific sources, articles unrelated to medical education or healthcare, and studies lacking clear methodology or outcome measures.

REVIEW AND DISCUSSION

For In modern medicine, it is important to respond promptly to new challenges, changes in public life, to assess the benefits and threats posed by new information technologies. One of the current tasks is to understand the opportunities and threats of artificial intelligence, which has become an everyday reality in a few years. The authors of the article «The impact of the introduction of artificial intelligence technologies on the current human rights and freedom as a concept» (Vitalii M. Pashko , Andrii O. Harkusha, Oleksii S. Soloviov), which was published in the journal "Polski Mercury Lekarski" rightly emphasized the significant advantages of artificial intelligence in healthcare, but also made valid comments regarding possible threats, the need to protect patients' rights, and compliance with the requirements of confidentiality of medical information [1].

The authors of the articles constantly emphasize the possibilities of artificial intelligence in management, rationalization of document flow, interaction with patients. Changes in the work of pharmacy employees, doctors' search for drugs available for a given region have been repeatedly noted. At the same time, doctors and teachers of medical universities note a growing trend towards self-medication, self-diagnosis of diseases, and patients' attempts to influence the choice of treatment strategy and tactics. Some students are excessively fond of using information technologies, which reduces the level of creativity, finding a way out of complex, ambiguous situations, and increases communication deficiencies, which is the basis of the anamnesis, and the problem of iatrogenesis becomes relevant. We also recorded a gradual decrease in the level of empathy when solving specific situations of suicidal tendencies. Suicide attempts are recorded among students. These issues require additional study. The war in Ukraine and mass emigration have only exacerbated these problems.

It is time to modernize higher medical education. As rightly noted in the article "Artificial Intelligence in Medical Education: Promise, Pitfalls, and Practical Pathways" (Sarup Saroha) educational institutions should use clear criteria for evaluating the effectiveness of integrating artificial intelligence into curricula, use modeling, portfolios, adhere to the principles of ethics, correctly use the capabilities of computer systems during clinical practice, diagnostics, and the development of critical thinking. Medical education institutions, preparing students for thoughtful and collaborative work with artificial intelligence "By preparing students this engage thoughtfully and collaboratively with AI, medical schools have an unparalleled opportunity this shape the future of healthcare, one that is smarter, fairer, and more effective for both patients and practitioners. This includes equipping graduates with the skills this navigate ethical and clinical complexities and encouraging awareness of broader issues such as algorithmic bias and global disparities in access to AI tools. With thoughtful integration into medical curricula, AI can enhance care, reduce inefficiencies, and serve as a force for innovation without compromising the human connection at the heart of medicine. By embedding thoughtful AI education today , medical schools can ensure that the doctors of tomorrow lead a healthcare system that is both technologically advanced and deeply human" [2].

Other researches [3, 4] deserve attention as well. Based on a review of a significant number of sources, the authors of the article came to an important conclusion: "In summary, the integration of AI into healthcare education has been widely embraced due this its capacity this enhance diagnostic precision and simplify intricate medical procedures. Nevertheless, it is important to note the existing gaps in the literature that can guide future research endeavors. Firstly, it is critical to develop long-term training protocols that not only evaluate the lasting impacts of AI on healthcare training but also ensure continuous updates in the curriculum this reflect fast technological changes.

Secondly, integrating the patient's perspective into AI applications is essential for preserving a patient-centered approach in healthcare. Future investigations should focus on measuring patient satisfaction and the direct impacts of AI- trained professionals on patient outcomes. Thirdly, the advancement in explainable AI (XAI) models is also crucial. Improving the transparency of AI decision-making processes will help build trust and acceptance among healthcare providers, ensuring AI is used ethically in clinical settings. Finally, the question of accountability in medical decisions involving AI cannot be overlooked. Establishing clear legal and ethical guidelines is imperative this navigate the complexities and maintain trust in AI-enhanced healthcare settings. Moving forward, addressing these challenges with thoroughly research and strategic policy making will be pivotal in maximizing the benefits of AI for training healthcare providers and enhancing patient care outcomes" [5] .

The editorial staff of the magazine "Wiadomości Liekarskie" it will be interesting to know how the GPT-4 artificial intelligence was evaluated by specialists who read articles from this popular journal on the topic of AI. Upon our request, we received information that these are mainly: «Medical specialists and doctors who are interested in applying new technologies to improve clinical decisions and medical practice. Scientists and researchers in the field of medicine, healthcare and medical technologies who follow new trends and research in artificial intelligence. Lawyers and ethicists who analyze the legal and ethical aspects of introducing AI into the medical field. Medical teachers and educators in higher medical educational institutions who introduce innovations into educational programs. Administrative and managerial employees of medical institutions who plan to use AI to manage and optimize processes.»

In 2025, we decided to propose twenty paragraphs for the textbook «Medical Pedagogy». The study of European experience allowed us to conclude that this is one of the promising areas for improving the quality of education for students of medical universities. Summarizing many years of teaching experience, we were able to substantiate the structure of the textbook, comparing the results later with the proposals of artificial intelligence. The results are presented in Table 1. For comparison, exploring the possibilities of artificial (computer) intelligence, we asked the GPT chat to prepare twenty paragraphs for the textbook. In a second, the computer system proposed its option. The results are presented in Comparative Table 1.

Draw your own conclusions about the competition between a human and a computer system. Pay attention to similar topics and differences. These topics cover key aspects of medical pedagogy according to modern standards and the structure of leading textbooks.

We will not search winner of the competition human and artificial intelligence. Faster language it's about interaction and rational using information. It should be noted another feature. We spent our native testing capabilities of artificial intelligence [6, 7]. The results will be of interest to specialists. Artificial intelligence coped well with the definition of concepts, review of literary sources, and originally reviewed the author's articles. Difficulties were evident in solving creative, non-standard tasks, giving advice when suicidal thoughts arise, and responding to text with elements of humor and irony. Among students and teachers of medical universities, the expert assessment of the advantages and disadvantages of loneliness [8] attracted particular attention. These areas require further study.

To understand the capabilities of artificial intelligence, it is worth paying attention to how the computer system searches for information about the popularity of topics when studying AI in Ukraine. The only requirement is the accuracy of the formulation of questions and an assessment of the objectivity of the results. We received the following answer, which will be interesting for a wide range of specialists: "A review of educational programs, courses and research in recent years shows that the greatest interest among Ukrainians is in the following areas and topics in the field of artificial intelligence: 1. *Machine learning (ML) and working with data*. The greatest emphasis in schools, universities and private educational centers is on data analysis, designing machine learning models and products based on them. More than 60% of AI/ML specialists in Ukraine work in this area. 2. *Generative AI*, working with modern large-scale language models (Chat GPT, Gemini, Claude), creating texts, images, code - one of the most demanded educational competencies. 3. *Using computer models* for object recognition in images, application in medical diagnostics, agribusiness, protection. 4. *Ethical and legal aspects of AI*.

A significant part of educational courses, especially government and partnership courses with Google and Diia, contain modules on ethics, privacy, security and regulation in the field of AI. 5. *AI in business, education and management*.

The emphasis is on the practical use of AI technologies for automating business processes, analyzing markets, implementing in public administration, education, medicine, and the agricultural sector. 6. *Automation of routine tasks and digital transformation*. 7. *Courses from Google, Diia and other platforms* focus on skills that can significantly increase efficiency by automating work processes. 8. *Using AI in cybersecurity and defense*.

Table 1. Comparative characteristics of topics for the textbook «Medical Pedagogy»

Teacher's suggestions (A. Vykhrushch)	Artificial intelligence suggestions
1. System of basic concepts. Lexicography.	1. Introduction to medical pedagogy: modern teaching and role in the training of medical personnel.
2. Regularities of development of educational systems.	2. History of the development of medical pedagogy and medical education.
3. The formation and development of medical pedagogy. Periodization.	3. Subject, tasks and methods of medical pedagogy.
4. Medical rhetoric: past and future.	4. Basic categories and concepts of medical pedagogy.
5. Pedagogical culture of medical university teachers.	5. Pedagogical process in higher medical school: structure and features.
6. Student personal development.	6. Features of educational and cognitive activities of medical students.
7. Medical pedagogy in the context of comparative studies.	7. Principles and patterns of learning in medical education.
8. Content, forms, and methods of teaching.	8. Didactics of medical disciplines: content, forms and methods.
9. Psychological characteristics of patients.	9. Innovative technologies of education in medicine.
10. Praxeology in the educational process.	10. Monitoring and evaluation of academic achievements of medical students.
11. Fundamentals of acmeology.	11. Theory of education in medical education: main directions and tasks.
12. Pedagogical personology.	12. Formation of professional communicative competence of a doctor.
13. Communication in medicine.	13. Medical ethics and deontology in the pedagogical process.
14. Integral thinking of the individual.	14. Interdisciplinary integration in medical pedagogy.
15. Information culture of a professional.	15. Organization and implementation of preventive work using medical pedagogy.
16. Development of creative abilities of the individual.	16. Corrective and practical medical pedagogy.
17. Anamnesis: theory and practice.	17. Inclusive education in medical pedagogy.
18. Iatrogenicity: causes and consequences.	18. Socio-psychological aspects of teaching and educating student youth.
19. Psychological and pedagogical culture of a professional.	19. Pedagogical competencies of a higher medical education teacher.
20. Prospects for the development of medical pedagogy.	20. Prospects for the development of medical pedagogy in the context of educational reform.

Source: compiled by the authors of this study

Ukraine is actively integrating AI into digital security and the defense sector, which is reflected in thematic courses and projects. It should be noted that AI not only offered generalized information from researchers, but also named scientific conferences whose materials were used and published in 2025 [9, 10].

It is worth noting that one general tendency inherent in book authors. A sufficiently professional theoretical base has been created in monographs and manuals on the possibilities of AI [11 - 18]. Now necessary move to system examples with the transition from medicine to specific subareas i.e. pediatrics, surgery, therapy etc. Let us emphasize importance exactly systemic assessments, not individual ones examples. It is no coincidence experts The Club of Rome in the anniversary reports "Come on" in December 2017 set the development of integral thinking as a priority task.

In our opinion, a promising task is to compare state documents on the use of artificial intelligence in different countries. For example, in December 2020, the Ukrainian government approved the "Concept for the Development of Artificial Intelligence in Ukraine". This document emphasizes that Ukraine is "a member of the Special Committee on Artificial Intelligence at the Council of Europe, in October 2019 it joined the "Organization for Economic Cooperation and Development, Recommendation of the Council on Artificial Intelligence, OECD/LEGAL/0449", and artificial intelligence is considered as "an organized set of information technologies, with the use of which it is possible to perform complex complex tasks by using a system of scientific research methods and algorithms for processing information obtained or independently created during work, as well as create and use their own knowledge bases, decision-making models, algorithms for working with information and determine ways to achieve the set tasks"[19]. As a positive fact, we note the objective recognition of existing problems. According to the

Table 2. Definition of the concept of «health» by medical university scientists

Structure / scientists	1	2	3	4	5	6	7	8	9	10	11	12
Human greatest treasure		+										
The state of organs and systems in which they perform their functions well		+					+					
The state of organs and systems in which the full functioning of the body is ensured		+	+			+						
A state of complete emotional, mental, physical well-being, balance	+			+	+		+	+	+	+	+	
Social integration of the individual						+						
Multidimensional dynamic state that develops in the process of realization of genetic potential in the conditions of a specific social and ecological environment									+			
A condition that allows a person to perform their biological and social functions to varying degrees									+			
The process of preserving and developing physiological properties and potentials									+			
The process of maximizing life expectancy with optimal work capacity and social activity									+			
Absence of diseases and defects												+

Source: compiled by the authors of this study

authors of the order, there are as many as 17 of them: from the low level of digital literacy, awareness of the population regarding the general aspects, opportunities, risks and safety of using artificial intelligence to the lack of modern advanced training programs for teachers of higher education institutions.

The experience of Polish colleagues deserves special attention. We mean a special portal dedicated to AI [20], the results of a unique sociological survey of Poles' opinions on artificial intelligence [21, 22], analytical books of the level [23], good examples of medical care for the elderly using AI [24].

In scientific research, insufficient attention is paid to keywords. In our works (A. Vykhrushch and O. Khrystenko) we studied the opinion of future doctors regarding keywords in medicine and received eloquent data. According to students, these are primarily "mutual understanding, responsibility, faith, diagnosis, trust, help, experience, life, health, knowledge, doctor, treatment, humanity, medicine, peace, skills, organism, professionalism, prevention, mind, sterility, resilience, stress resistance, accuracy, care, help, "do no harm", empathy, improvement" [25]. With a similar task for artificial intelligence, we received the following list: doctor, patient, diagnosis, disease, symptom, therapy, treatment, prevention, research, organism. This is an interesting topic for further research, discussion in student classrooms, and modeling a successful doctor.

In addition, we asked first-year students to choose one word that characterizes a medical university graduate. The answers are quite interesting: "adaptation, endurance, courage, responsibility, discipline, enthusiasm, motivation, learning, perseverance, memory, cognition, hard work, confusion, diligence, curiosity, purposefulness" [25]. To a similar question about artificial intelligence, we received no fewer interesting answers: 1. *High level of emotional intelligence* - the ability to recognize and manage one's own emotions and show empathy to the point of satisfaction. 2. *Communication skills* - the ability to communicate effectively with patients, parents, and colleagues, which is important for medical practice. 3. *The desire for self-development and learning* is the motivation to constantly improve one's qualifications, master new knowledge and skills. 4. *Responsibility and professionalism* - a serious attitude towards training and clinical practice. 5. *Ability to adapt to change* - skills for working in the dynamic and stressful conditions of modern medicine. 6. *Practical orientation* - active use of simulation centers and stages to consolidate theoretical knowledge. 7. *Teamwork* is the ability to collaborate effectively within medical teams. 8. *Mobility and readiness for academic exchanges* - willingness to participate in mobility and exchange of experience. 9. *A holistic view of health* is an understanding of the biomedical, social, and cultural aspects of medicine. 10. *Psychological resilience* - the ability to manage stress and emotional burnout

Meanwhile, the keywords regarding the negative qualities of modern youth are interesting: apathy, irresponsibility, sedentary lifestyle, inflated self-esteem,

self-confidence, frivolity, laziness, arrogance, imperfection, inconstancy, oversaturation" [25]. How artificial intelligence reacted to a similar question: "Stress vulnerability - difficulties in managing emotions in stressful situations. Lack of practical experience at the initial stages of training - sometimes theoretical training prevails over practice. Overload - a large amount of educational material, which can lead to burnout. Sometimes insufficient motivation for independent learning - dependence on teachers and help. Problems with time organization and self-discipline - difficulties in balancing study and personal life. Tendency to perfectionism - which can lead to internal pressure and anxiety. Limited conflict management skills - difficulties in solving problems in a team. Insufficient development of leadership qualities at the beginning of training. Heterogeneity of the level of initial training among students - difference in knowledge of basic sciences. Some inertia in the use of modern digital technologies at the start of training - the need for additional training.

In our opinion, it is advisable to continue these studies in different countries for comparative characteristics and identification of priorities in the youth environment.

In the folk culture of many nations there is an interesting saying «I don't have a clue». In fact, this is a very important problem. The outstanding Polish educator Wincenty Okon argued that the level of lexicography determines the level of science [26]. In one of the articles, we highlighted the problem of defining the term «health» (Table 2). It would be advisable to conduct a comparative characterization of the essence of this concept among representatives of different cultures. This is important for several reasons: «First, teachers use the concept of health in the process of teaching students and thus «replicate» their position. Second, the correlation of theoretical generalizations, regulatory documents, recommendations of the World Health Organization and the position of practitioners is important, which, by the way, can become the topic of a separate study» [27].

CONCLUSIONS

To understand the patterns of development of new phenomena, it is necessary to study the periodization of their formation, identify stages and define prospects. When it comes to artificial intelligence, four main stages can be distinguished. First, these are the works of mathematicians and philosophers who prepared the theoretical basis of programming. It is obvious that this preparatory stage can be divided into separate parts. The second stage coincides with the emergence and spread of computers. The beginning of the third stage was the availability of the Internet. Currently, we are witnesses of the rapid development of artificial intelligence. Note that each subsequent stage required less time. The need to continue theoretical generalizations is obvious. At the same time, a dynamic process of assessing the possibilities of using artificial intelligence in various types of human activity is underway. Medicine is no exception.

Researchers underline the significant potential of artificial intelligence in organizing the administrative work of medical institutions. This refers to information about staff and patients, organizing communication schedules with specialists of the relevant profile, and optimizing schedules.

The next higher stage is information about the course of the disease, comparison with similar cases, recommendation of the computer system regarding the search, availability, and choice of medical drugs. It is worth emphasizing that this information can only be of a recommendatory nature, only the doctor in the process of anamnesis can take into account the individual characteristics of the patient, the dynamics of changes in health, and make a final decision on the treatment strategy.

Studying the features of the use of artificial intelligence, especially among young people, an alarming trend has been recorded regarding the spread of self-medication, and in the case of a positive result, the promotion of its advantages among peers. We note the possibility of manipulative influence. The authors of computer programs have worked so that in the process of communicating with artificial intelligence, the user not only receives answers to questions, but also receives information on an emotional level, with elements of empathy, support, and compassion.

The possibilities of using artificial intelligence in medical universities are promising. Teachers have the opportunity to access generalized information of world level, the preparation of illustrative materials is significantly facilitated, with the help of simulation training it is possible to show the course of the disease, the dynamics of changes in the body, the functioning of organs and the body as a whole. The work of postgraduate and doctoral students is significantly facilitated. It is through the intelligent use of artificial intelligence in the process of training future doctors that it is possible to achieve optimal use of its capabilities in the future.

When used correctly, artificial intelligence has many positive opportunities for self-improvement and professional development of students. Interesting examples are the comparison of the results of a brainstorming session, a student group, and solving a similar problem with artificial intelligence. The threat of violating the norms of academic integrity, substituting creative search, and one's own efforts for the help of artificial intelligence is also obvious.

The idea of testing the capabilities of artificial intelligence by practitioners of various levels and promptly summarizing the results and discussing them on the pages of periodicals is promising.

Nowadays, we are witnessing a transition to a qualitatively higher level of information culture. This is another civilizational challenge of the globalized world, which representatives of science and practice will have to take into account.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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