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Analyzing real-world implementation hurdles of artificial intelligence in healthcare diagnostic

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Abstract. The healthcare industry is undergoing global reforms, and the use of artificial intelligence is undoubtedly relevant and timely, with programs that completely change the processes of diagnosis, treatment, management, patient lifestyle, and the professional activities of healthcare professionals. This article discusses the implementation of artificial intelligence, as well as the analysis of obstacles in medical diagnostics. This study includes a detailed overview of the current global problem and an analysis of the application of artificial intelligence. The data obtained confirm the active use of the latest technologies to improve the knowledge and professional qualities of medical staff for patient diagnosis. Among the real obstacles to the introduction of artificial intelligence in medical diagnostics are the issues of material and technical base, equipment capacity, and compliance of artificial intelligence technologies with the requirements of laboratory centres. To successfully develop, test, and implement a certain diagnostic technology, it is necessary to have clearly defined and adopted medical and economic decisions. The quality of artificial intelligence plays an important role, namely, it is necessary to take into account all possible errors, inconsistencies, similarities, and questionable data. One of the main challenges that arises is determining who is responsible for the final result of the analysis. Who will be responsible for critical errors (the developer or the executor), how to foresee possible errors, and mechanisms for correcting them.

Key words: artificial intelligence in medicine, development successes, development obstacles, modern medical diagnostics, technological base.

Introduction

Scientists around the world are constantly improving and developing the technological capabilities of digital systems for various sectors of society. The healthcare industry is one of the most promising for the development and implementation of artificial intelligence (AI). The diagnostic component of medicine cannot develop without modern technological progress. AI in diagnostics will speed up and improve the accuracy of disease diagnosis for further adjustment of patient treatment. This can help improve the quality of medical care in different countries and reduce healthcare costs [1, 2].

Many leading companies are currently working on improving diagnostic equipment. They are implementing software for devices using computed tomography, namely, to improve the quality and analysis of computed tomography scans, various laboratory tests, especially in the study of DNA — molecular diagnostics, radiology and morphology, etc.

Also, the search for and formation of criteria for the development of various complications in pathological conditions, such as hypertension and metabolic syndrome [4], surgery [5], is being carried out. AI is used to automate laboratory processes and expand diagnostic capabilities (blood pressure measurement, electrocardiography, etc.) [2]. This allows to expand human workflows, save results, detect errors in a timely manner, predict and speed up the time of test results interpretation and image analysis [2, 6, 7].

Although AI is actively developing in the scientific field, its implementation in practical medicine, namely medical diagnostics, is very slow and limited, due to various types of obstacles. To create effective machine learning programs, it is necessary to set specific goals and plans and determine development strategies [7].

Therefore, this study focuses on the relevant topic of identifying obstacles to AI implementation in medical diagnostics and possible ways to overcome them.

Objective of the study: to explore and highlight the obstacles to the implementation of AI in modern medical diagnostics.

Object and methods of the study

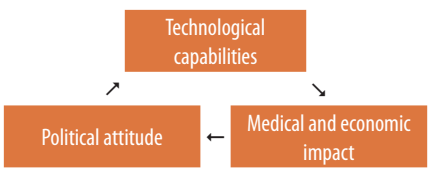
To achieve this goal, we analysed the current scientific literature available in Scopus, PubMed®, Google, and other databases. The search was aimed at determining the criteria for the development of AI, its implementation in the medical industry for diagnostics, and identifying factors that hinder its development. The publications were selected using the defined criteria: «artificial intelligence in medicine», «development successes», «development obstacles», «diagnostics», «technological development», «artificial intelligence and modern medical diagnostics», etc. The conducted literature search and its analysis allowed us to show the unresolved issues that become an obstacle to the introduction of AI in modern medical diagnostics.

Results

Medicine and AI

AI was first described in the middle of the last century, but some limitations in early models did not allow its implementation and application in medical diagnostics. A lot of research has been devoted to the study of the components and factors for the implementation of AI in the medical field (Figure) [1, 3, 8].

Figure Factors of AI implementation in modern medicine [1, 8]



The first obstacle is the limited access to patient medical data, no software interoperability, and primary care providers have software installed by a single healthcare provider that does not provide technical access for AI programs [1]. Some patient electronic databases cannot be used due to the lack of comparison with the data entered in accordance with the current requirements. For example, when analysing an image, noise and fuzzy edges can interfere with qualitative analysis.

Another important link for implementation is the political attitude of the authorities to medicine. It requires a clear understanding of who will regulate the implementation and control of AI in the country's healthcare sector. It is necessary to create common standards and develop recommendations for the implementation, reporting, and control of AI technologies in the healthcare sector. There is a risk of using black box algorithms. Therefore, it is necessary to establish clear guidelines for the implementation of AI in practical medicine [1, 3, 7].

The low level of implementation in medical practice is influenced by the economic and medical components. The problem lies in the low awareness of healthcare professionals, the lack of criteria for calculating the cost of services using AI and the reimbursement system, the creation of comparative AI programmes with services without it, and the determination of the effectiveness of technology implementation [1].

J. Wolff et al. (2021) point out: «This is especially true in a world of significant investment in artificial intelligence in healthcare, especially by large corporate entities, and the complexity of measuring economic impact has led to the use of industry-specific valuation methods. Therefore, accurate and internationally applicable measurements of health and economic impacts are needed» [1].

Another major obstacle was identified as a legal risk. The European Commission has proposed a mechanism in the Artificial Intelligence White Paper on database security, storage, and oversight [9]. This indicates the need to create structures to balance legal and ethical issues when implementing AI in medical diagnostics.

Based on the above, we can add the following:

AI will be implemented in certain blocks over time: first, there will be a narrow-profile implementation, then to general AI in medical institutions, and then to one autonomous system and a single solution to failures and problems [1]. To do this, it is necessary to either allow the use without permission (the technology is implemented, and problems are solved when they arise) or a precautionary approach (the technology is prohibited if it has any risks) [1].

The processes performed by AI are different from those performed by humans, AI reproduces answers very quickly, accurately, can perform multitasking tasks simultaneously, and therefore can achieve different results of the tasks. However, the results produced by AI may differ from the decision of a specialist. To overcome this obstacle, it is necessary to have clear guidelines for the expected result, the status quo regarding the time in which different options will be considered and the right decision will be made [1, 7].

S. O'Sullivan et al. (2019) point out that «In the real case of artificial intelligence-based robotic automated surgery, a distinction must be made between responsibility and fault. Tasks need to be clearly delineated so that responsibility can be clearly defined based on process steps (e.g., analysing an X-ray image), responsibility can be limited (e.g., manufacturer, operator, maintenance), and responsibility can be solely attributed (e.g., mandatory human rechecking of a decision made by an artificial intelligence programme)» [5].

AI in medical diagnostics

One of the components of successful medical care is high-quality diagnostics. To actively implement AI for diagnostics, first of all, an appropriate technical base with modern devices that will be reliably protected from external and internal influences is required (Table). It is necessary to ensure timely training of employees on technologies and their application, as well as continuous professional development [7, 10].

Table Problems arising from the use of AI in diagnostic areas of medicine [author's own development]

Factors of AI implementation	Problem
Privacy and cybersecurity	Reliable protection against external interference in the technological system of diagnostic centres is required to preserve all patient data. Avoid the possibility of errors by AI diagnostic systems (forgery, data alteration).
Reliability	Problems with the technology can affect the final result and diagnosis. High-quality formulation of AI processes and tasks, timely analysis, and control over the level of results directly affect the correct execution of tasks.
Technology and responsibility for it	Questions constantly arise about the technical, ethical, and managerial components of AI-based technologies. Who will be responsible for diagnostic errors?
Autonomy and support system	The public has access to modern applications used in medicine. When the need arises, a person can change the results, which will affect the final product.
Ethnic groups of the population	Not all countries and not all medical diagnostic institutions are able to have the appropriate material and technical base for AI technologies. Insufficient funding for healthcare.
Technological base	The development of AI technologies is mostly done by people without medical education, so there may be questions about medical errors. They cannot be corrected by medical staff, which will lead to a poor quality result.
Organisation, education, and management	Qualified AI healthcare providers and diagnostic laboratory staff have the data, and staff changes result in lost time for training and searching for qualified specialists.

If we consider various examples of AI application in various fields of healthcare medicine, namely medical diagnostics, including oncology, ophthalmology, gynaecology, dermatology, surgery, pathomorphology, etc., the prospects for AI implementation are to improve the quality and safety of medical care, as well as the possibility of transparency of expertise.

For example, a number of scientists presented a deep learning-based AI system for the assessment of esophageal squamous cell carcinoma but given that the assessment of cancer depth is subjective, differences in data interpretation were recorded, i.e., the assessment of cancer depth by different specialists may not have coincided [11].

A group of scientists led by Y. Horie used an AI program to detect cancers with a diameter of less than 10 mm but noted that additional training was needed to be more accurate and enable early diagnosis of oesophageal cancer [12]. A system has been developed that is capable of processing a large number of endoscopic images in a very short period of time, and diagnostics can be used in clinical diagnostics as an alternative and in support of endoscopic examinations.

Digital pathology is becoming a new standard of care in dermatology and other areas of medicine. To identify and verify skin cancer types, as well as malignant melanoma, A. Esteva and E. Topol (2019) developed convolutional neural networks, and also

emphasised that mobile devices with the application installed on them could be used for this diagnosis, which would provide inexpensive access to the diagnostic programme anywhere [13].

Z. Ahmad et al. (2021) used convolutional neural networks to identify treatable diabetic retinopathy, but the use of these networks will not replace doctors but will be implemented for routine examinations and tests that will help to quickly and efficiently identify patients with diabetic retinopathy or in the absence of it [3].

Inflammatory bowel disease, including ulcerative colitis and Crohn's disease, is a nonspecific inflammatory pathology affecting the gastrointestinal tract. Multicentre studies and meta-analyses have demonstrated the growing prevalence of inflammatory bowel disease worldwide. Although instrumental methods are commonly used to diagnose inflammatory bowel disease, they do not always provide a complete picture, and biopsy remains the gold standard for diagnosis. Y. Dong et al. (2019) used AI in their study to predict the course of Crohn's disease in Chinese patients, Crohn's disease is difficult to predict, an AI program can predict the risk of surgery, and the researchers emphasized that this program can be used for treatment tactics and personalized management of patients with Crohn's disease [14].

The use of AI in surgery faces a number of issues and challenges, and the most pressing question is whether AI will replace the work of surgeons. According to some reports, the introduction of AI can actively influence surgery by improving machine learning methods and automating procedures. However, there is evidence that serious errors are made when using these technologies, so the line between machine technology and leading surgeons and their experience will need to be balanced, and doctors' training and awareness will need to be improved to enhance their cognitive functions [5].

The introduction of digital surgery in medical diagnostics is actively underway, which will lead to a reduction in the cost of digital data, as well as the quality of digital images required for use.

To date, the following categories of digital pathology have been identified: static, dynamic, robotic, whole slide imaging, and hybrid methods.

Currently, automated microscopic pathology image factors are being used to predict non-small cell lung cancer and have been used to distinguish short-term survivors from long-term survivors in patients with stage I adenocarcinoma and squamous cell carcinoma and have shown that automatically derived image features can accurately predict the prognosis of lung cancer patients. Their results were statistically significant, and the researchers are confident that their methods are applicable to histopathological images of other organ cancers [15].

The studies described above show the active implementation and irreplaceable role of AI in many areas of medicine, namely diagnostic medicine. It is believed that the use of AI will lead to fast and accurate diagnostics, improve the quality of diagnosis, and improve the conditions of patient care. AI will not be able to completely replace doctors and medical staff, but it will definitely facilitate routine tasks, allow specialists to devote time to cognitive tasks, and be effective in making any diagnosis. All of these positive qualities of AI and its implementation will take time, as the methods need to be integrated into training programmes for specialists who will use digital images and data with computer algorithms in clinical practice. Direct cooperation between healthcare sectors and the involvement of the financial component, especially for developing countries, is essential to achieve positive and effective improvements in the use of AI in diagnostic medicine.

Discussion

Despite the development of technologies, the introduction of AI in medicine in different countries is very slow or even under consideration. R.A. Greenes et al. (2018) believe that this is due to problems that arise at the initial stage of implementation: «Many issues have been identified as partly responsible for the relatively slow adoption and lack of impact, including deficiencies in leadership, recognition of purpose, understanding of human interaction and the implications of computer-based clinical decision support workflow, cognitive models of the computer-based clinical decision support role, and proprietary implementations with limited interoperability and sharing» [8].

Machine learning is more actively used in medical diagnostics, which allows to speed up the diagnosis and determine an individual approach to treatment tactics [16]. Although AI helps to optimise the diagnostic system, it does not always process unstructured information (e.g., low-quality medical images, uncertain test results, etc.), which has a significant impact on the final result of the study and, therefore, the quality of medical services [7].

A number of authors point out that one of the obstacles to the active implementation of AI in diagnostics is the lack of standards, unified databases, and schemes for processing results, which can lead to different results in different hospitals, even in the same country [3, 5, 7].

It is also necessary to increase the trust and confidence of both medical staff and patients. J. Wolff et al. (2021) [1] recommend identifying ways to build trust in machine learning systems. This can be achieved through a full understanding of AI mechanisms by diagnostic department staff, their successful training, and education on the accessibility and safety of technologies for the public.

One of the main obstacles to implementation is the protection of the patient database. Laboratories should have different levels of protection of existing databases from external and internal interference. Each hospital should have a reliable and proven way to protect its database.

Another problem is the lack of consistency in diagnostic processes, the absence of approved guidelines for planning, programming, and testing each type of process, and the absence of a clear programme for eliminating detected errors. In addition, continuous reporting also facilitates the actual verification processes due to the continuous learning process of AI [1].

Criteria for different levels of AI risk in diagnostics need to be defined and differentiated (e.g., existing classes of medical products can be adapted to AI).

Establishing common requirements for the development and supply of IT products to the medical market, as well as a choice of different proven technologies, can help accelerate the development of AI in diagnostics and other areas of medicine.

Thus, modern scientific research is actively studying the potential and systems with possible AI involvement in the technological process. At the same time, practical medical diagnostics is slow to implement these technologies. To address this issue, a number of obstacles need to be overcome to adapt and improve to existing healthcare procedures. Changing political attitudes, improving the financial and economic state of healthcare, enhancing AI systems, training medical staff, and patient education will help overcome the existing obstacles and optimise medical diagnostics in the future.

Conclusions

Given that the healthcare industry is undergoing global reforms, the use of AI is undoubtedly relevant and timely, with its applications completely changing the processes of diagnosis, treatment, management, patient lifestyle, and the professional activities of healthcare professionals. In our study, we analysed the existing problems of AI implementation in diagnostic medicine of the healthcare system, as well as the most pressing obstacles in this direction.

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Аналіз перешкод впровадження штучного інтелекту в медичній діагностиці в реальному світі

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Анотація. Індустрія охорони здоров'я переживає глобальні реформи, і використання штучного інтелекту, безсумнівно, є актуальним і своєчасним, з програмами, які повністю змінюють процеси діагностики, лікування, менеджменту, спосіб життя пацієнтів і професійну діяльність медичних працівників. У статті розглянуто впровадження штучного інтелекту, а також аналіз перешкод у медичній діагностиці. Дослідження містить детальний огляд поточної глобальної проблеми та аналіз застосування штучного інтелекту. Отримані дані підтверджують активне використання новітніх технологій для вдосконалення знань та професійних якостей медичного персоналу для діагностики пацієнтів. Серед реальних перешкод для впровадження штучного інтелекту в медичну діагностику — питання матеріально-технічної бази, потужності обладнання та відповідності технологій штучного інтелекту вимогам лабораторних центрів. Для успішної розробки, апробації та впровадження певної діагностичної технології необхідно мати чітко визначені та ухвалені медико-економічні рішення. Важливу роль відіграє якість штучного інтелекту, тому необхідно враховувати всі можливі помилки, невідповідності, схожість та сумнівні дані. Однією з головних проблем, що виникає, є визначення того, хто несе відповідальність за кінцевий результат аналізу. Хто відповідатиме за критичні помилки (розробник чи виконавець), як передбачити можливі помилки та механізми їх виправлення.

Ключові слова: штучний інтелект у медицині, успіхи розвитку, перешкоди розвитку, сучасна медична діагностика, технологічна база.

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