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ARTIFICIAL INTELLIGENCE AND DIGITAL TECHNOLOGIES IN PHARMACEUTICALS

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Abstract

This article analyzes the areas of application of artificial intelligence and digital technologies in the pharmaceutical industry, their impact on research, production and practical pharmacy processes. In particular, the identification of drug molecules, optimization of clinical trials, improvement of the pharmacovigilance system, and the effectiveness of electronic prescription and digital management mechanisms are studied. Based on the analysis, the importance of artificial intelligence technologies in reducing time, cost and errors associated with the human factor is revealed. Also, scientifically based recommendations are given on existing problems in the industry, in particular, issues related to data security and personnel qualifications.

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Materials and Methods

21st century pharmaceuticals are gradually moving from traditional laboratory experiments and long-term clinical trials to digital modeling and algorithmic analysis systems. Previously, the process of creating a new drug took an average of 10–15 years, but now, thanks to data processing using artificial intelligence, this period can be significantly reduced.

Over the past decade, the development of genomics, bioinformatics and big data technologies has ushered in a new era in the pharmaceutical industry. In particular, the pandemic period has clearly demonstrated the need for rapid development of drugs and improvement of mechanisms for predicting their effectiveness. This has accelerated the process of widespread introduction of artificial intelligence algorithms into clinical and production processes.

At the same time, digital transformation plays an important role not only in scientific research, but also in pharmaceutical logistics, pharmacy management, pharmacovigilance systems and electronic prescribing. Therefore, it is advisable to systematically study the interrelationships of these processes and their impact on performance indicators.

Results and Discussion

While traditional drug discovery requires testing thousands of chemical compounds in the laboratory, artificial intelligence allows for molecular structure modeling and predictive biological activity prediction.

Table 1: Comparison of traditional and AI-based drug development processes

Indicator	Traditional method	AI-based method
Research period	10–15 years	5–7 years
Costs	Very high	Decreases by 30–40%
Number of test samples	Thousands	Reduced by algorithmic filtering
Error probability	High	Data-driven forecasting

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AI algorithms automatically analyze molecular docking, structural compatibility, and pharmacokinetic parameters. As a result, the number of promising molecules is significantly reduced, and only the most effective options proceed to the clinical trial stage. This process not only reduces time and costs, but also increases the scientific accuracy of the next stage - clinical trials. Because during the initial screening process, safety and biological activity indicators are pre-evaluated based on a database.

From this perspective, clinical trials are no longer a traditional experimental-testing model, but an integrated system supported by digital forecasting and real-time monitoring. Clinical trials are the most complex and costly stage of pharmaceutical research. It is at this stage that the effect of the drug on the human body, side effects, and therapeutic efficacy are determined.

Digital monitoring systems allow patients to monitor their health indicators in real time. For example, heart rate, blood pressure, glucose levels, or other biometric data are automatically transmitted to a central database through special devices. This reduces human error in clinical trials, allows for rapid analysis of results, and helps identify side effects early.

Based on AI, the processes of:

• correct division of patients into groups,
• early detection of side effects,
• statistical modeling of results

are carried out much faster and more accurately.

Table 2: Effectiveness of digital technologies in clinical processes

Criteria	Traditional control	Digital monitoring
Data collection speed	Slowly	Quick
Side effect detection	It may be late	Early stage
Statistical accuracy	Average	High

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This is of great importance in strengthening the pharmacovigilance system. Because the data collected at the clinical stage form an initial idea of the safety profile of the drug, the actual application process after its introduction into practice will further enrich this information. Thus, pharmacovigilance will not be limited to the framework of a scientific laboratory or clinical center, but will become a continuous monitoring system that continues through pharmacies and medical institutions.

In this regard, the introduction of digital management systems in pharmacy activities is an important factor in the effective organization of the practical stage of pharmacovigilance.

Electronic prescribing and automated accounting systems significantly reduce errors associated with the human factor. For example, cases such as entering the wrong dose, confusing the name of the drug, or selling an expired drug are automatically controlled by the digital system.

In addition, the possibility of warehouse control, monitoring the shelf life, and analyzing the drug circulation increases. Digital applications show the dynamics of the input and output of each drug, which helps to forecast demand, optimize the amount of reserves and ensure cost-effectiveness. Most importantly, the data collected at the pharmacy level can be integrated into the central pharmacovigilance system. As a result, side effects or changes in the effectiveness of drugs can be quickly identified and analyzed. Thus, digital management is not only a management tool, but also an important link in strengthening the safety mechanisms of the healthcare system.

In pharmacies where a digital system is implemented:

• calculation errors are reduced by 20–30%,

• time savings are 15–25%,

• service quality increases.

This ensures the social efficiency of pharmaceutical services.

Along with the introduction of artificial intelligence, the following problems are

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also emerging:

• Data security issues
• Transparency of algorithms
• Lack of qualified specialists
• Uneven development of digital infrastructure

If these problems are not systematically addressed, it will be difficult to fully utilize technological capabilities.

Conclusion

The above analysis shows that artificial intelligence and digital technologies have ushered in a qualitatively new stage in the pharmaceutical industry. The acceleration of the drug development process, the optimization of clinical trials, and the automation of the pharmaceutical management system are significantly increasing efficiency.

However, along with technological development, it is advisable to implement the following recommendations:

1. Introduce special AI training programs in the pharmaceutical sector.
2. Develop data security standards at the national level.
3. Implement a phased digital transformation in pharmacies and manufacturing enterprises.
4. Strengthen cooperation between research institutions and IT companies.

Thus, artificial intelligence is becoming one of the key factors in the future development strategy of pharmaceuticals. Its rational and scientifically based implementation will ensure not only economic efficiency, but also the sustainability of the public health system.

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