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THE ROLE OF MODERN IT TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE IN MEDICINE PRODUCTION PROCESSES

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Abstract: This article examines the current significance of information technologies and artificial intelligence in the processes of drug production, as well as ways of their practical application. IT and II technologies are being introduced into the pharmaceutical industry, and the production of new medicines is being established. At the same time, artificial intelligence plays an important role in determining the molecular structure of new active substances through the analysis of biological and chemical data, optimizing clinical trials, and developing personalized medicines. Also, IoT, Big Data, and blockchain technologies are used to increase production efficiency and ensure the authenticity of medicines in the supply chain.

Thus, modern IT and artificial intelligence technologies are one of the key factors in the digitalization and innovative development of the pharmaceutical industry.

Keywords: modern technologies, IT technologies, artificial intelligence, digital economy.

Introduction

Currently, the pharmaceutical industry is one of the most dynamically developing sectors, embodying the most advanced achievements of science and technology. The processes of creating, testing, and producing medicines are considered complex, multi-stage, and highly precise. Therefore, the introduction of modern information technologies (IT) and artificial intelligence systems (AI) into these processes will allow increasing the efficiency of pharmaceutical enterprises, reducing the influence of the human factor, and improving the quality of products.

Thanks to artificial intelligence, work on the creation of a new medicinal product is being accelerated, clinical trials are being optimized, production stages are being automated, and the accuracy and reliability of quality control are increasing.

Main part

The pharmaceutical industry plays an important role in maintaining and improving human health. The processes of production and manufacture of medicines are very complex, requiring a lot of time, labor, and resources. Therefore, the introduction of modern information technologies (IT) and artificial intelligence systems (AI) is one of the most important tools for simplifying and

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increasing the efficiency of these processes. The main directions of application of these technologies are highlighted below.

1. Research and development of new medicinal substances

Artificial intelligence systems help determine the structure of new active substances by analyzing large volumes of biological data, the structure of proteins and chemical compounds.

- ***Molecular modeling and computer modeling*** allow predicting how drugs will interact with receptors in the body

- ***Thanks to the Deep Learning and Machine Learning algorithms, new combinations of substances are tested faster and yield effective results.***

2.Optimization of clinical trials

One of the longest stages of drug production is clinical trials. Artificial intelligence is finding solutions to these processes.

- Having analyzed the data, we selected the most suitable participants.
- Predicts side effects.
- Accelerates test results through fast and accurate analysis.

As a result, the duration of clinical trials is reduced, and the medicine enters the markets faster.

3. Digitization and Automation of Production Processes

Modern IT systems and IoT technologies allow for the complete automation of production lines.

- With the help of sensors, such important parameters as temperature, pressure, and humidity are constantly monitored.
- Such stages as packaging, measurement, and mixing of robotic systems are carried out without human intervention.
- With the help of II, production processes are constantly analyzed, and errors are identified at an early stage.

Quality and Safety Control Systems <1/2>

With the help of computer vision technology, it is possible to automatically check the form, color, volume, and quality of the medicine packaging.

Algorithms created on the basis of artificial intelligence allow us to detect malfunctions in the product in real time and correct them without stopping the production line.

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The role of artificial intelligence in the invention of medicines:

Artificial intelligence plays a crucial role in the process of discovering new medicines. It accelerates and cheapens these processes. He conducts this process in several stages.

- Data analysis: II analyzes millions of unauthorized data and determines which targeted diseases they can affect.
- Molecular modeling: Models II analyze the structure of molecules and predict what biological effects they will have on them.
- For example, the AlphaFold DeepMind system revolutionizes the definition of protein structure. This will accelerate the process of creating new medicines.

1. Design and optimization of medicines.

- With the help of artificial intelligence, new designs of medicines are being created - that is, "ideal" chemical structures are being created.
- Creates new types of medicines and new drug combinations (for example, ChatGPT).
- As a result, the number of tested molecules decreases, and the effective option is found faster.

2. Production and quality control

- In the process of drug production, quality control is automated using robotic systems.
- Analyzes the artificial intelligence process in real time based on data received from sensors and detects malfunctions in advance.
- As a result, the quality of products will be high, and the amount of waste will be low.

3. The role of II in clinical trials and data analysis.

Clinical trials are the most responsible and complex stage in the production of medicines. In this process, II performs the following steps.

- Automates the process of selecting and grouping donors.
- Analyzes clinical results in real time.
- Helps to identify and prevent side effects.

For example: analytical platforms based on II quickly assess the effectiveness and safety of medicines using clinical data. This approach increases the accuracy of the results and reduces the time of the tests.

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4. Advantages of IT and II integration.

The joint use of information technologies and artificial intelligence in the production of medicines yields the following positive results:

- It reduces the production time of new medicines to 5-10 years.
- Reduces production costs by 40-60%.
- Increases the accuracy of tests.
- Reducing human error and improving quality.

For example, the companies Pfizer, Roche, and Novatris are reducing the development time of new drugs by several years due to the use of Al and Big Data technologies.

5. Problems and Prospects

There are a number of problems in the implementation of IT and II technologies in the pharmaceutical industry:

- Data security and confidentiality issues.
- Algorithm opacity ("black box" problem).
- Insufficient development of international legal norms.

In the future, blockchain technology, artificial intelligence ethics, and standardized digital systems will be solutions to these problems.

6. Stage of research and development

- Data analysis and modeling: With the help of artificial intelligence (AI) and machine learning (MO), it is possible to detect new active substances, model their chemical structure, and predict their effectiveness.
- Bioinformatics: Development of targeted drugs by analyzing genetic and biomedical data
- Virtual tests: Computer tests reduce initial experiments on animals and humans.

7. Production process

- Automated control systems (SCADA, PLC): Are aimed at precise control of the production process and ensuring safety.
- IoT (Internet of Things): Devices and sensors track production parameters in real time.
- ERP-systems (Enterprise Resource Planning): allow optimal management of resources (raw materials, time, equipment).

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8. Quality control and certification

- LIMS (Laboratory Information Management System): Digital management of laboratory data, automatic registration of results.
- Data integrity: Ensuring data immutability and reliability is a requirement of GMP (Good Manufacturing Practice).
- Blockchain technology: combating falsification by tracking the source and quality of medicine batches.

9. Logistics and Supply Chain

- GPS and RFID technologies track medicines from production to pharmacies or hospitals.
- Smart contract and blockchain: Increase transparency and security of deliveries.

10. Marketing and consumer relations

- CRM systems: manage interaction with clients and medical workers.
- Analysis of Big Data: Identifies market demand and trends.
- Mobile applications: serve to receive information about the drug, remind about dosage, and register side effects.

11. Artificial Intelligence and Digital Innovations

- Optimizes clinical trials using II and allows patients to adapt.
- Digital twins are virtual copies of the production process.
- Cloud technologies allow you to safely store and analyze data.

Expanded role of IT technologies in the production of medicines

1. The Importance of IT Technologies in Scientific Research

In the pharmaceutical industry, the search for a new medicine is a very complex and lengthy process, and IT technologies are accelerating this stage.

- Artificial Intelligence (AI) and Machine Learning (ML): With AI, millions of chemical substances are analyzed, from which the most promising molecules are selected. For example, the AlphaFold company system DeepMind has achieved significant success in determining protein structure.
- Big Data: Various clinical trials, patient data, genetic analyses, and a large amount of information about drug effects are analyzed. Thanks to this, new effective and safe medicines are being developed.
- Simulation and modeling programs: With the help of computer models, the movement of

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medicinal substances in the human body is analyzed (pharmacokinetics and pharmacodynamics).

2. The role of IT in the production process

Modern pharmaceutical plants operate on the basis of fully automated systems.

- SCADA (Supervisory Control and Data Acquisition):

This system tracks and manages all processes on the production line (temperature, pressure, speed) in real time.

- IoT (Internet of Things):

The devices are connected to each other via the Internet, which allows remote control of each stage of production.

- Robotics:

The robots ensure accuracy and hygiene during packaging, dosing, and testing.

- 3D printing (3D printing):

Recently, the technology of producing medicinal tablets on 3D printers in accordance with the patient's individual dose has been developing.

3. Quality and Safety Control

Quality and safety in pharmaceutical products are the most important issue.

- LIMS (Laboratory Information Management System):

Stores laboratory data digitally, automatically registers analyses, reduces the number of human errors.

- QMS (Quality Management System):

Allows you to manage all quality control stages in a single system.

- Data integrity: Each measurement, result, and report in the production of medicines are stored in unchanged form. This is the main requirement of the GMP (Good Manufacturing Practice) standard.

4. Logistics and Delivery System

After the development of medicines, it is important to ensure their safe, fast, and high-quality delivery.

- RFID and QR Code Systems:

Each medicine packaging is assigned a special code that allows you to determine its authenticity, place, and date of manufacture.

- Blockchain: At each stage, from drug production to pharmacy, data is stored in the blockchain, which helps prevent falsification.

- GPS and intelligent transport systems:

The transportation of temperature-sensitive medicines will be monitored in real time (for

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example, the "cold chain" system for vaccines).

5. Marketing, Sales, and Patient Contact

- CRM (Customer Relationship Management):

Manages relationships with pharmacy chains and doctors.

- Mobile apps:

Patients will be able to receive complete information about the medication and monitor the time of administration using reminders.

- Analysis of advertisements using artificial intelligence:

Determines which medicines are in high demand in the market and strives for quick delivery of this product.

6. The role of IT in clinical trials

- Electronic Healthcare Systems (ESZ):

Allows quick and accurate analysis of patient data participating in clinical trials.

- Digital clinical trials (eClinical Trials):

Online observation, data collection through mobile applications, as well as remote monitoring.

7. Future Directions

- It produces personalized medicines using artificial intelligence.
- Digital twins (digital twin) - conduct experiments through a production line or digital patient copy.
- Cloud Computing: Pharmaceutical companies will be able to safely and globally manage their data.
- Cybersecurity:

Drug data protection is becoming increasingly important in the pharmaceutical industry.

Conclusion:

Modern IT technologies and artificial intelligence (AI) are fundamentally changing the processes of drug production, taking the pharmaceutical industry to a new level. With the help of digital twin technology, production lines are modeled in a virtual environment and predict process errors. Artificial algorithms, predicting the active substances of molecules and their interactions, significantly accelerate the process of creating new medicines.

Real-time control methods based on IoT systems allow for continuous analysis of the production process and automatic quality control. Also, thanks to the concept of "precision medicine," it becomes possible to create individual medicinal formulas that correspond to the patient's genetic and biological characteristics.

Thus, the integration of IT technologies and IT is an important factor in raising innovative

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approaches, scientific research, and production quality to a new level in the pharmaceutical industry.

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