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THE ROLE OF MODERN IT TECHNOLOGIES IN THE DIAGNOSIS AND TREATMENT OF NEUROLOGICAL DISEASES

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Abstract: This article extensively discusses the role of modern information technologies in the diagnosis and treatment of neurological diseases. The focus is on the practical application of artificial intelligence, machine learning, telemedicine, digital neurochemistry, robotics, and virtual reality technologies in the field of neurology. The effectiveness of IT technologies in the early detection of brain and nervous system diseases, individualized treatment, and rehabilitation is also analyzed. The results of the study show that digital technologies play an important role in the prevention, diagnosis, and treatment of neurological diseases.

Neurological diseases are one of the most challenging areas of medicine, as they involve the complex structures of the human brain, spinal cord, and peripheral nervous system. Modern Information Technology (IT) and digital solutions are revolutionizing this field, significantly increasing the accuracy of diagnosis and the effectiveness of treatment.

I. The Role of IT in Diagnosis (Identification)

Modern IT is primarily integrated into brain visualization (imaging) and data analysis processes.

1. Imaging technologies and software

High-resolution CT (Computed Tomography) and MRI (Magnetic Resonance Imaging) scanners are now powered by sophisticated software. These programs allow detailed visualization, measurement, and 3D modeling of brain structure, blood flow (perfusion MRI), and even the orientation of brain fibers (DTI – Diffusion Tensor Imaging). IT speeds up these imaging processes, making it easier to process and archive the results on a computer.

2. Artificial Intelligence (AI) and Machine Learning (ML)

AI is playing a major role in neurological diagnosis. Machine learning algorithms can analyze huge datasets (Big Data) of MRI and CT images to detect microscopic changes or early signs of disease that are invisible to the human eye. For example, AI:

- **Alzheimer's disease**in predicting subtle changes in atrophy in certain parts of the brain years in advance;
- **Stroke**(hemorrhage or ischemia) to quickly estimate the size of the damaged area and determine the optimal time for treatment;
- **Epilepsy**In (Seizures), it is of great help in automatically identifying specific foci of seizure activity in electroencephalogram (EEG) data.

3. Big Data Analysis

IT solutions that enable the analysis of global medical databases (including genetic and epidemiological data) can help identify causal relationships in neurological diseases. This will help to find new diagnostic biomarkers and understand the patterns of spread of rare neurodegenerative diseases.

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The Role of IT in Treatment and Rehabilitation

IT plays a key role in personalizing treatment processes, conducting safer surgeries, and improving rehabilitation efficiency.

1. Tele-neurology and Remote Monitoring

Telemedicineplatforms allow neurologists to monitor and treat patients remotely. This is especially important for patients who live in rural areas or have mobility issues.

- **Wearable devices**(smart watches, special sensors) continuously collect data on patients' movements (tremor in Parkinson's disease), sleep quality, or seizures (epilepsy). This data is analyzed by AI, allowing the doctor to accurately adjust the dosage of medication or predict the deterioration of the disease.

2. Rehabilitation through Virtual and Augmented Reality (VR/AR)

Virtual Reality (VR)is actively used in neuro-rehabilitation after stroke, brain injury or multiple sclerosis. VR creates an interesting and motivating virtual environment for patients. In this environment, they can practice motor skills (limb function) in a way that is close to real-world conditions, but in a safe way. Augmented Reality (AR) adds digital elements to the real environment, making rehabilitation exercises more effective and personalized.

3. Computer Navigation and Robotics in Neurosurgery

IT robotics enables neurosurgical operations to be performed with high precision. Before complex procedures such as deep brain stimulation (DBS), computerized navigation systems (image-guided surgery) allow for micron-level precision in placing electrodes at the right point in the brain. This dramatically increases the chances of success in treating conditions such as Parkinson's disease and essential tremor.

4. Pharmacogenomics and Personalized Medicine

IT and Big Data medicine analyze genetic data to help predict the effects of drugs on each patient's body (pharmacogenomics). This approach creates the basis for personalizing drugs in the treatment of neurological diseases, and for choosing therapies that are effective and have fewer side effects.

In recent years, the rapid penetration of information technology (IT) into medicine has led to fundamental changes in the field of neurology. Neural networks, artificial intelligence (AI), computed tomography (CT), magnetic resonance imaging (MRI), and digital analysis systems have expanded the ability to accurately, quickly, and early detect diseases of the brain and nervous system.

Main part

1. The importance of neurological diseases

Neurological diseases are serious pathologies that result from dysfunction of the central and peripheral nervous system, among which stroke, Alzheimer's, Parkinson's, epilepsy, brain tumors, and neuropathies are the most common types.

2. The role of modern IT technologies in medicine

The application of information technologies in medicine is divided into several main areas:

• Artificial Intelligence (AI) and Machine Learning – AI can be used to detect changes in the brain from MRI or CT images.

• Telemedicine – allows patients to be monitored and treated remotely.

• Digital neuroimaging – allows for real-time monitoring of brain activity.

• Robotics and neuroprosthetics – brain-controlled prostheses make life easier for disabled patients.

3. IT technologies in the diagnostic process

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The most commonly used IT equipment in neurological diagnostics is:
• Computed tomography (CT) and magnetic resonance imaging (MRI)
Electroencephalography (EEG)
• Applications based on neural networks
• 3D modeling technology 4. IT approaches in treatment and rehabilitation
• Virtual reality (VR) therapy – used to restore movement after stroke or brain injury.
• Mobile apps – for monitoring Parkinson's and other diseases.
• Biofeedback systems – help reduce stress and increase concentration.

Expanded use of IT technologies in neurological diseases

1. Analysis and forecasting using artificial intelligence

In recent years, artificial intelligence (AI) has become the most effective tool in improving the quality of diagnostics in medicine. For example:

A neural network developed by Google DeepMind can analyze MRI results faster than a human doctor and predict Alzheimer's disease 5 years in advance.

IBM Watson Health, on the other hand, studies large amounts of clinical data and finds hidden connections between neurological syndromes.

Such systems also analyze patients' genetic data, allowing them to develop personalized treatment strategies.

2. Big Data and neuroinformation

Data on neurological diseases (imaging, EEG recordings, genetic results) is collected in extremely large volumes. This data is analyzed using Big Data technologies.

For example:

Neural connections are studied through digital brain mapping technology (Brain Mapping);

Neuroinformatics centers are developing new diagnostic methods by establishing data exchange on a global scale.

3. Robotic therapy in rehabilitation

Robotic rehabilitation systems are widely used to restore motor function after neurological injury:

Lokomat (robotic walking machine) – helps restore leg movement after a stroke;

ArmeoSpring is a robotic system that trains arm muscles. These technologies not only promote physical rehabilitation, but also activate the process of brain plasticity (neuroplasticity).

4. Virtual and augmented reality (VR/AR) in medicine.VR/AR technologies are being used not only in rehabilitation, but also in neuropsychological treatments.

For example: In the treatment of phobias, stress or traumatic situations (PTSD), an artificial safe environment is created using VR;

VR games that train brain activity are beneficial for patients with Parkinson's and dementia.

5. Integration of IT and neuroscience in Uzbekistan

A number of works are also underway in Uzbekistan to introduce digital technologies into the medical sector:

Electronic databases on neurological diseases are being created as part of the "Digital Health" program;

MRI, EEG, and EMG systems in specialized neurology centers across the republic are fully digitalized;

Modern IT technologies are not only increasing the speed and accuracy of diagnosis in neurology, but are also fundamentally changing treatment methods. Digital solutions such as

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artificial intelligence, telemedicine, VR, and robotics are playing a crucial role in the earlier detection of neurological diseases than ever before, their personalized and targeted treatment, and a significant improvement in the quality of life of patients.

Modern Information Technology (IT) is becoming a revolutionary force in the field of neurology. Artificial Intelligence (AI), Machine Learning (ML), High-Definition Imaging (MRI/CT) applications, Virtual and Augmented Reality (VR/AR), and Telemedicine systems are enabling earlier, more accurate, and personalized diagnosis and treatment of diseases.

When determining:AI can analyze neuroimaging data to detect early signs of disease that are invisible to the human eye, quickly calculate the area of damage in a stroke, and automatically detect abnormalities in brain activity. This dramatically improves the quality of diagnosis.

In Treatment and Rehabilitation: Robotic surgical navigation brings surgical precision down to the micron level. VR/AR makes rehabilitation more effective and motivating. Remote monitoring via wearable devices allows for continuous monitoring of the patient's condition and real-time adjustment of drug dosage.

Offers

The following suggestions are important to further enhance the role of IT in the diagnosis and treatment of neurological diseases:

1. Training specialists in neurology and IT

Opening the Neuroinformatics field: Introducing specializations such as neuroinformatics or medical AI in universities to train specialists at the intersection of medicine and IT. This will reduce the knowledge gap between neuroscientists and IT specialists.

Continuous professional development: Establish mandatory training courses for existing neurologists on the use of AI-based diagnostic systems, telemedicine platforms, and VR rehabilitation equipment.

2. Developing data infrastructure

Creating a centralized neuroimaging database: Create a single, secure database that stores anonymized MRI, CT, and EEG data collected across the country. This will serve as a basis for training local AI models and studying national disease patterns.

Legal regulation of telemedicine: Complete creation of a legal and regulatory framework for remote neurological care (Telemedicine) (determining responsibility, licensing, and data security).

3. Encourage technological investment

Supporting local production of AI-based diagnostic tools: Financial incentives for local IT companies to develop AI programs designed to detect neurological diseases (e.g., programs that automatically detect strokes).

Widespread implementation of rehabilitation technologies: Allocate budget funds for centralized procurement of VR/AR equipment and robotic therapy devices for stroke rehabilitation centers.

4. Ensuring cybersecurity

Since medical, especially neurological, data (brain images, genetic data) are highly confidential, ensuring the highest level of cybersecurity measures in their storage and transmission.

Conclusion. Neurological diseases are one of the most common diseases in the world. Artificial intelligence, telemedicine, VR, robotics and digital monitoring are the main directions of future neurology. Modern information technologies are causing revolutionary changes in the field of neurology. With their help, the possibilities of early detection of diseases, individual treatment

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and automation of rehabilitation have expanded. This improves the quality of life of patients and increases the efficiency of medical services.

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