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USE OF COMPUTER TECHNOLOGIES IN DIAGNOSTICS, TREATMENT, AND REHABILITATION IN PEDIATRIC TRAUMATOLOGY

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Abstract
This article discusses the role and capabilities of computer technologies in the field of pediatric traumatology. Today, the possibility of carrying out the stages of diagnosis, treatment, and rehabilitation more accurately and conveniently based on digital technologies is expanding. Furthermore, Artificial Intelligence (AI) and 3D technologies are increasingly being used in medical practice, contributing to an increase in the effectiveness of the treatment process in pediatric traumatology.

Keywords: pediatric traumatology, computer technologies, diagnostics, treatment, rehabilitation, artificial intelligence, 3D technologies.

Introduction

The use of computer technologies in modern medicine plays an important role in the process of preserving and restoring human health. In particular, the implementation of modern technologies in pediatric traumatology facilitates the stages of diagnosis, treatment, and rehabilitation. Information technologies provide great assistance in accurate diagnosis, correct planning of the treatment process, and creating opportunities for the quick recovery of every patient.

1. The Role of Computer Technologies in Pediatric Traumatology

1.1. The Significance of Computer Technologies in Medicine

Today, information technologies are widely applied in the field of medicine. With the help of computer systems, patient histories, examination results, and the

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treatment process are saved electronically. This gives doctors the opportunity to fully control the patient's condition and quickly access the necessary information.

1.2. The Role of Computer Technologies in the Diagnostic Process

Since children's bodies are more fragile than adults', simple methods do not always give accurate results when identifying injuries or bone damage. Therefore, new examination methods based on computer technologies are widely used in medicine. For example, with the help of modern equipment such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Ultrasound Examination (UZE), changes in bones and soft tissues can be seen better. As a result, the process of diagnosing injuries in children and their treatment becomes more convenient and effective.

1.3. Electronic Medical Records (EMR) System and Data Security

Concept: Following the introduction of computer technologies into medicine, the patient's medical history, examination results, and treatment process are now stored in electronic form in computer systems. The Electronic Medical Records (EMR) System is a special software platform created for the secure collection and systematization of this data in a centralized manner.

Aid to the Physician: The EMR system allows doctors to fully monitor the patient's condition and quickly access the necessary information. In pediatric traumatology, this is crucial because knowing the child's growth dynamics and previous treatment history is the basis for making the correct decision.

Information Exchange: Digital data is easily standardized and enables prompt exchange between various specialists (e.g., orthopedist, rehabilitologist, or therapist). This improves the cooperation of doctors from different departments, contributing to the increased effectiveness of treatment.

Security Aspect: Electronic systems ensure that patients' personal data and medical secrets are protected from unauthorized access. Information is stored using special encryption (coding) methods, which guarantees the confidentiality of medical information.

2. The Significance of Computer Technologies in Treatment and Rehabilitation Processes

2.1. The Role of Computer Technologies in the Treatment Process

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Computer technologies are of great importance today in the treatment process in pediatric traumatology. In modern medicine, monitoring the patient's condition, accurately determining drug dosages, and planning surgical procedures has become much easier with the help of digital programs and specialized equipment. For example, a precise image of the bones and joints can be created using 3D modeling. This method allows surgical staff to act more accurately during surgery, minimize errors, and correctly install implants. As a result, the effectiveness of treatment increases, and the patient's recovery process accelerates.

2.2. The Significance of Computer Technologies in Rehabilitation

Rehabilitation is the process of returning the patient to a healthy life and fully restoring their body. This stage is of particular importance in pediatric traumatology, as it is crucial to correctly choose the recovery process for young patients. Therefore, computer technologies provide great assistance in tracking and controlling the process during the rehabilitation period. Today, motor activity, muscle strength, and the speed of recovery are regularly assessed using various programs. Artificial Intelligence (AI) systems analyze this data and recommend physical exercises or physiotherapy procedures appropriate for the patient. Furthermore, virtual rehabilitation programs are becoming increasingly widespread.

With their help, patients have the opportunity to perform exercises at home even without constant supervision by a doctor. This not only accelerates the recovery process but also simplifies remote monitoring for doctors. Thus, computer technologies have become an integral and important part of the rehabilitation stage in pediatric traumatology.

2.3. Diagnostics using AI and 3D Technologies (Fast and Accurate)

Artificial Intelligence (AI) — "The Smart Assistant": AI compares X-ray, MRI, or CT images with thousands of other scans. This allows it to find injuries or, for example, minor hairline fractures that the unaided human eye might miss. This is particularly useful for fractures in children, which are often indistinct.

3D Modeling — "Surgical Rehearsal": The injured area of the child (e.g., the pelvic bone) is scanned, and a precise 3D copy is created on the computer.

For the Doctor: The doctor can test the operation multiple times on this virtual model before the actual intervention. They know in advance which screw to use, where to place it, and at what angle.

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Result: The surgery becomes faster, less traumatic, and the number of errors is reduced.

3. Innovative Approaches and Information Technologies in the Treatment Process

3.1. Digital Planning of Medical Practices

The role of computer technologies in the treatment process in pediatric traumatology is very important. In modern medicine, monitoring the patient's condition, determining the dosage of drugs, and planning surgical interventions has become much easier with the help of digital programs and specialized equipment. In addition, computer systems, by saving patient histories and all examination results in electronic form, significantly lighten the workload of doctors.

Determining Medication Dosage (Dose): Special digital programs calculate the precise quantity (dosage) of necessary medications based on the patient's age, weight, and general condition. This especially prevents errors when treating children.

Surgical Procedure Planning: CT or MRI results are entered into the computer and virtualized. Doctors conduct scheduled testing of each stage of the operation in advance on the computer, without touching the patient. This serves to minimize unforeseen situations.

3.2. The Effectiveness of Digital Technologies (Gamification) in Rehabilitation

The Core Problem: In pediatric traumatology, physiotherapy and long-term rehabilitation sessions often pose difficulties due to lack of motivation and the monotony of exercises. This can reduce the effectiveness of treatment.

Innovative Solution — Gamification: Digital technologies, specifically Virtual Reality (VR) and Augmented Reality (AR) systems, solve this problem by transforming the rehabilitation process into interactive games ("Gamification").

VR/AR Capabilities: The patient uses special sensors or glasses to perform exercises in an engaging virtual environment. For example, the movement of an arm or leg directly affects the character in the game. This motivates the child to voluntarily and regularly perform the exercises.

Data Analysis and Monitoring:

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Smart sensors (wearable devices) used during the rehabilitation process accurately and objectively record the patient's range of motion, speed, and the degree of correctness of the exercises.

The collected data is transmitted to the doctors in real-time (online). This allows for the continuous optimization of the treatment regimen, adapting it to the patient's condition.

Result: Gamification mechanisms significantly increase the children's desire for recovery, improve the quality and frequency of exercise performance, which ultimately shortens the rehabilitation period and ensures the patient's faster return to a healthy life.

3.3. 3D Modeling and Precision of Surgical Interventions

Artificial Intelligence (AI) and 3D technologies are gaining great importance in treatment. For example, using 3D modeling, an accurate and three-dimensional image of the injured bones and joints is created. This method allows surgical personnel to act precisely during surgery, minimize errors, and install implants in the most correct location. As a result of 3D planning, the effectiveness of surgical procedures increases, and the patient's recovery process accelerates.

4. Computer Technologies and Artificial Intelligence Assistance in Rehabilitation

4.1. Monitoring and Assessment of the Recovery Process

Rehabilitation is the process of returning the patient to a healthy life and fully restoring their body, and this stage is important in pediatric traumatology. During the rehabilitation period, computer technologies provide great assistance in tracking and controlling the process. Motor activity, muscle strength, and recovery speed are regularly assessed with the help of various programs.

4.2. Individual Programs Based on Artificial Intelligence (AI)

Artificial Intelligence systems analyze this data and recommend physical exercises or physiotherapy procedures appropriate for the patient. Furthermore, virtual rehabilitation programs are becoming increasingly widespread. With their help, patients have the opportunity to perform exercises at home even without a doctor's supervision. This not only accelerates the recovery process but also simplifies remote monitoring for doctors. Computer technologies have become an integral and important part of the rehabilitation stage in pediatric traumatology.

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5. Main Results and Prospects for Development

5.1. Main Results Achieved through the Application of Computer Technologies

The introduction of modern computer and digital technologies into pediatric traumatology has contributed to raising the quality of medical services to a higher level.

Diagnostic Accuracy Increased: With the help of modern equipment such as CT, MRI, and UZE, the possibilities for better viewing changes in bones and soft tissues, as well as identifying injuries, have expanded.

Surgical Risk Significantly Reduced: Thanks to 3D modeling, surgical procedures (e.g., implant placement) are planned more accurately. This contributes to minimizing errors and increasing treatment effectiveness.

Recovery Process Accelerated: The possibility of remotely monitoring the rehabilitation process and creating individual programs for young patients through Artificial Intelligence (AI) systems and virtual rehabilitation programs has been established, resulting in an accelerated pace of return to a healthy life.

5.2. Prospective Directions for the Development of the Field

The future prospects for the application of digital technologies in pediatric traumatology are very broad.

AI Integration: There is an opportunity to automate and optimize treatment protocols through the wider implementation of AI systems that deeply analyze patient history and examination results.

Expansion of Tele-Rehabilitation: By further developing virtual and remote rehabilitation programs, patient access to treatment can be increased, particularly creating new opportunities for patients in remote (distant) areas.

VR/3D in the Educational Process: Improving the system for preparing young traumatologists for complex surgical interventions with the effective use of 3D modeling and Virtual Reality (VR) technologies is an important.

6.1. Recommendations for Implementation in Medical Practice

Based on the results and scientific conclusions obtained, the following recommendations are provided for implementing the research results into medical practice and the scientific and educational process:

Improvement of Diagnostic Practice:

It is recommended to introduce the method of 3D modeling and assessment based on Artificial Intelligence (AI) into the practice of medical institutions for the early

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diagnosis and prognosis of the course of bone fractures and joint injuries in children.

Take measures to provide healthcare institutions with high-performance computer systems and specialized software necessary for processing data obtained from digital examination methods (CT, MRI).

Increasing the Effectiveness of Treatment and Rehabilitation:

Implement surgical interventions performed based on 3D planning into the standard treatment regimens in pediatric traumatology. This method improves the quality of treatment by minimizing errors.

Standardize the use of rehabilitation activity indicators analyzed by AI when evaluating treatment effectiveness.

Recommendations on Prevention and Screening:

Introduce targeted screening programs to identify the condition of bones and joints using computer visualization among groups of children in sports reserves or with high-risk of injury.

Organize permanent dispensary observation for patients with these risk factors by pediatric traumatologists.

Application in Scientific and Methodological Practice:

Develop a methodological guide on 3D visualization and working with AI based on the research results and introduce it into the curricula of the departments of Traumatology and Orthopedics or Biomedical Engineering of Higher Medical Educational Institutions (HMEIs).

Organize special training modules based on Virtual Reality (VR) in professional development courses for pediatric traumatologists and surgeons.

Making Changes to Regulatory and Legal Documents:

Submit a proposal to the Ministry of Health to include relevant additions to the current national clinical protocols and standards for the diagnosis and treatment of pediatric trauma taking into account the obtained results.

6.2. Recommendations for the Continuation of Scientific Research Work

In order to further expand the practical significance of the obtained scientific results and deepen the solution to the research problem, the following scientific prospects and proposals are provided:

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Studying the Integration of AI Systems: Conduct broad studies to evaluate the effectiveness of AI systems applied in pediatric traumatology in the automation and optimization of treatment protocols.

Studying the Effectiveness of Tele-Rehabilitation: Organize studies with long-term follow-up for patients (for at least 3-5 years) to evaluate the impact of virtual and remote rehabilitation programs on the recovery rate and degree of disability after bone fractures in children.

Comprehensive Assessment of Economic Effectiveness: Conduct a "cost-effectiveness" analysis of implementing new methods of 3D planning and Tele-rehabilitation into practice, calculate the economic benefit for the state budget and the population.

Conclusion

The results of this study showed that the introduction of modern computer technologies into pediatric traumatology has great practical significance.

Diagnostic Accuracy: With the help of modern equipment such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), the possibilities for accurate diagnosis are significantly expanded.

Treatment Effectiveness: 3D modeling technology creates an accurate image of the injured bones and joints. This method serves for more accurate planning of surgical interventions, minimization of errors, and correct installation of implants.

Individual Approach: Artificial Intelligence (AI) systems gain importance in the processes of treatment and rehabilitation, recommending physical exercises or physiotherapy procedures appropriate for the patient through data analysis.

Accelerated Recovery: Virtual rehabilitation programs are widespread. With their help, patients have the opportunity to perform exercises at home even without a doctor's supervision, which accelerates the recovery process and facilitates remote monitoring.

Data Management: Computer systems, by saving the patient's history, examination results, and treatment process in electronic form, significantly lighten the workload of doctors.

In conclusion, the wide application of these advanced technologies in pediatric traumatology contributes to a significant increase in diagnostic accuracy, treatment outcomes, and the pace of young patients' return to a healthy life.

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