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THE TRANSFORMATIVE ROLE OF ARTIFICIAL INTELLIGENCE IN MODERN DENTISTRY

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Abstract: Artificial Intelligence is playing an increasingly important role in the field of dentistry, offering new opportunities to improve diagnosis, optimize treatment planning, and enhance procedure execution. Artificial Intelligence also improves methods for manufacturing prosthetic devices, thereby enhancing the quality of patient care and treatment outcomes.

Keywords: artificial intelligence, neural networks, innovative materials and medications, machine learning technologies, personalized medicine.

Artificial intelligence transforms modern dentistry through accurate diagnosis, treatment planning and material development. AI's capabilities enhance precision, reduce errors, and personalize patient care, integrating seamlessly with current

medical practices for improved outcomes. Artificial Intelligence

Neural Networks innovative Materials and Medications Machine Learning Technologies Personalized Medicine.

Over the past few years artificial intelligence (AI) has rapidly entered our lives, symbolizing a new stage in the history of digital technologies. AI is a field of computer science aimed at creating machines that can imitate human thinking and interaction using software applications and robotic systems [1, 7]. It has become one of the key technological revolutions of the 21st century, influencing various aspects of life, including medicine [4]. The application of AI in medicine was first described in 1976. Dentistry is one of the main fields of medicine where AI instruments are used [3]. AI is a valuable tool whose algorithms help dentists and clinicians analyze data from multiple sources of information (multimodal data) [5]. Its application is considered a complex technological, organizational, and medical task that requires the efforts of different professionals: engineers, data analysts, administrators, medical workers of various levels and specializations [1].

AI has become an indispensable assistant to a dentist in diagnosis and treatment planning. The capabilities of artificial intelligence allow you to choose and implement optimal solutions based on previous experience and rational analysis of external actions and to generate new ideas and solutions that did not exist before. [4]. AI can analyze medical data, detect diseases, and establish accurate diagnoses, as well as predict the results of treatment. It also helps in developing new methods of treatment and medications [4]. In orthodontics, AI can identify anatomical and pathological structures of the human dental and skeletal system and make complex decisions when planning orthodontic treatment. [5]. In addition, AI can optimize diagnosis and treatment planning, mark cephalometric points, perform anatomical analysis, and evaluate the progress and results of orthodontic treatment. [3]. In restorative dentistry, neural networks can detect caries or tooth restoration, as well as simplify the choice of treatment method for caries. In endodontology, neural networks can be useful for detecting traumatic dental injuries. AI can be used to assess the anatomy of root canal systems, calculate working length measurements,

and predict the success of repeat treatments [3]. Furthermore, AI is spreading in periodontics and is used to evaluate the loss of bone tissue around an implant and predict the development of peri-implantitis [3]. All this becomes possible due to AI's high accuracy and efficiency [1].

AI and neural networks are actively used in dental radiology for simplifying diagnosis, treatment planning, and predicting treatment outcomes [3]. Modern technologies can provide a crucial element of data processing in medical institutions – image digitization. Today, we see massive digitization of everything from patient records and radiological data to portable computers and multi-axis systems [1]. Researchers have been able to automate this time-consuming and prone-to-error process using AI algorithms [5]. Thanks to cone-beam computed tomography, it is possible to obtain three-dimensional images of the entire dental-skeletal system of a patient. However, to apply these data for therapy and develop a detailed treatment plan, the results of this instrumental examination need to be interpreted. Even an experienced dentist may miss some detail when looking at the images. To avoid this, today we use AI-based software like Diagnose to decode the results of research. Although manual identification remains the most widely used method, transitioning to AI analysis allows us to avoid lengthy procedures and minimize systematic and subjective errors. This eliminates the human factor and increases the accuracy and overall quality of diagnosis. The modern aspiration of dental practitioners to improve treatment effectiveness has led to the development of numerous instruments for achieving this, such as Dental Monitoring (DM) software. The DM system provides automated processing using deep learning algorithms [5]. It is also used for analyzing facial skeletal structure and identifying anatomical landmarks, analyzing radiographs and 3D scans, determining bone age, and planning and predicting treatment outcomes [5]. These AI abilities significantly improve communication between patients and dentists, often eliminating the need for many clinical and laboratory procedures, and the results of such research are much more accurate than those analyzed by humans [5]. It is expected that diagnostic AI will surpass all, except possibly the best doctors, in the next 20 years [1].

Considering the current scientific dynamics in the field of AI, it is possible to predict that it will become an integral part of diagnosis and treatment planning in the near future. Modern AI excels at using structural pattern knowledge and gaining understanding from enormous datasets. However, it is not capable of creating associations like a human brain and is only partially able to accept complex decisions in clinical situations. The effectiveness of AI work is achieved only when unbiased training data and a well-refined and trained algorithm is used [5]. Therefore, if successful implementation of AI is achieved, it may reduce the workload on medical professionals and improve the quality of work by reducing the number of errors and increasing accuracy [3, 5]. However, this requires close cooperation between commercial AI products and the scientific community, leading to further research, including randomized clinical trials, with a view to testing and integrating this concept into dental practice [5].

AI can also be used for developing new materials, medications, and other products. This is beneficial for many fields of scientific research, including medicine [4]. The production of new medications based on AI developments is much less controversial than doctor-AI [1]. AI can learn data about each individual to personalize treatment or keep up with an enormous number of new medications, treatment methods, and research. To do this all qualitatively and quickly goes beyond human capabilities [1].

Therefore, today the integration of two components - medicine and information technologies – is understood as a guarantee of society's intellectual potential in the future [6]. To achieve the best results, it is necessary to combine the advantages of AI while taking into account possible threats and challenges and, accordingly, outline ways to prevent and eliminate them [2, 4]. For ensuring the work and use of AI, suitable hardware and software are required, together with significant investments in equipment and personnel training [1, 4]. Insufficient level of preparation can lead to ineffective technologies usage and shortcomings in their implementation [4]. Solving these problems is complex and offers significant benefits for the updated medical process and its improved results [1]. The use of AI's significant advantage – its ability

to constantly improve with increasingly large amounts of data – increases the possibilities of modern medicine [1].

Thus, in today's working conditions, the use and implementation of AI in dental practice is should be considered urgently. But what place will AI take in dentistry? There are different trends that will shape its future in medicine and particularly in dentistry.

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