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Intelligent and Digital Technologies and their Application in Dental Practice

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ABSTRACT

The article considers the features of the application of intellectual and digital technologies in dentistry at the present stage. It was noted that dentistry 4.0 has changed approaches to providing everyday medical care with the help of intelligent technologies. This provides more opportunities to improve the dental education system. Dentistry 4.0 also uses intelligent manufacturing technologies that help to individualize dental care as much as possible. These technologies can also be used to improve the safety and quality of dental operations. In the future, these technologies will be useful for performing independent tasks. They can be used to predict the growth of healthcare and new developments for improvement. They create a flexible platform for new product development. Dentistry 4.0 is also useful in the analysis of fractures and craniofacial function, in addition, it allows you to introduce innovative materials into the practice of dentists and improve the quality of services provided.

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Introduction

At the present stage, there is a certain requirement for the intensive training of specialists in the field of healthcare. Dentistry 4.0 technologies play an important role in teaching, planning, healing, etc. The main technologies of Dentistry 4.0 are artificial intelligence (AI), the Internet of Dental Things (IoT), additive manufacturing (AM), cloud computing, 5G technologies, dental digital scanners, virtual reality, robotics, big data and others. This helps to improve the teaching of creative and innovative methods of the treatment process.[1]

The industries serving the healthcare sector are currently implementing advanced technical concepts to improve the treatment process. They use applications such as data mining, data analysis, and pattern recognition. IoT connects all parts of dentistry through an internet application and provides opportunities for the use of smart devices and sensors.

The skills of doctors and surgeons can be improved with the help of Dentistry 4.0 technologies. It provides a revolutionary transformation in the field of dentistry. Dentistry 4.0 is used to increase patient safety and comfort through better connectivity. They are used to record and track the data of various dental devices, which helps to improve the safety of such devices and their smooth operation.

These 4.0 technologies have great potential for solving the problems of individual customization, speed and complexity in the production of complex dental equipment. This provides an ideal opportunity for development and growth in healthcare, thereby ensuring much more intensive development of dentistry in the modern period.[2]

Robotics is an advanced innovative technology used for automation in the field of dentistry during the COVID-19 pandemic. All the main tasks that previously required contact between the patient and the doctor can be performed safely today.

Dentistry 4.0 technologies provide a digital transformation in healthcare and contribute to better management of the entire service delivery chain. Virtual technologies create a virtual world that helps improve communication, teamwork and decision-making. They are used to analyze the dental treatment plan and perform complex dental procedures. Technologies of Dentistry 4.0 help the dentist to solve various problems in the current scenario of treatment of patients. This made it possible to provide better protection for the patient and the doctor during the COVID-19 pandemic.[3] Additive manufacturing

technologies are used for the manufacture of individual implants, teeth, dentures, braces and other necessary devices. This is useful for restoring broken teeth and performing other complex dental procedures. Dentistry 4.0 technologies provide more advanced tools and surgical devices to improve the quality of patient outcomes. Thus, Dentistry 4.0 technologies play an important role in creating achievements in the field of healthcare.

MATERIALS AND METHODS

In the process of preparing the work, articles and scientific papers were studied within the framework of the topic under study, comparative and analytical methods were used to process the data obtained.

RESULTS

The quality of medical care can be improved with the help of "Dentistry 4.0" technologies, which include dental devices, dental procedures or operations at a lower price. Artificial intelligence, virtual reality, voice search and blockchain are some of the new promising dental care technologies that can play a crucial role in the healthcare industry. They help patients take medications on time by creating an automatic reminder mechanism. They are also useful for identifying patients at increased risk and allow dental staff to perform surgical interventions on a priority basis.[4]

As a priority for high-risk patients, personalized care can play a huge role. Based on the patient's previous treatment history, upcoming dental procedures are developed and recommended for individual health care. Thus, Dentistry 4.0 technologies play an important role in the dental industry.[5] In craniofacial therapy, the main task is to treat complex bones of the skull and face, as well as other hard tissues. Thus, dentistry 4.0 technologies are available to solve this problem and help ensure the proper functioning of facet joints to solve various learning problems related to the craniofacial region. These technologies are developing various devices that can be used to meet different clinical needs during the COVID-19 pandemic.

Dentistry 4.0 technologies, such as additive manufacturing, offer personalization, which is an important requirement in healthcare. Surgical implants are designed to repair connective tissue and can contribute to rapid clinical trials and research. These technologies are used for individual craniofacial 3D implants with less time and money.[6] All craniofacial implants and prostheses are used to properly replace the facial joint and align the operation. Technologies such as artificial intelligence are being used to create human intelligence that helps predict diseases and defects. Dentistry 4.0 demonstrates promising applications for personalized patient management and promotes the practice of performing real dental surgery. They are used for clinical trials to facilitate the work of dentistry in the future.

Robotics is also changing the approach to treatment. It has excellent potential to help the surgeon during surgery. Robots are used for physical therapy and other important medical processes.

θThe built-in software allows you to exchange data and connect via an Internet service. The devices can be easily tracked using a remote-control system and connecting technologies and sensors. This makes it possible to exchange information to perform various important tasks in healthcare. High-quality dental implants are easily manufactured according to the desired shape and size from the necessary materials. Dentistry 4.0 technologies reduce treatment time and increase automation to prevent errors.

Patient support and care are two of the most important issues that need to be addressed when implementing any relevant concept in this area. Thus, Dentistry 4.0, along with all its intelligent and updated tools, offers many fruitful results in terms of intelligent care, better treatment of patients, remote patient care, in-process training, the use of intelligent processors and compatible materials in order to improve the quality of dental services.[8] Dentistry 4.0 technologies are making fundamental changes in the education and training of doctors in the context of the ongoing COVID-19 pandemic. Technologies help to perform a complex and invasive dental surgical process. This allows you to track the patient's medical record and medical history. This helps to get a complete picture of the dental patient's health status in real time.[9] Medical billing, clinical trials, and the delivery of essential medical supplies are performed more efficiently.

Dentistry 4.0 provides a digital revolution to connect all major medical devices for better care in hospitals and even beyond. The field of dentistry can now receive better implants, artificial instruments and devices. These technologies have great potential for the production of various dental instruments and devices. Significant advantages of technologies within Dentistry 4.0, such as sensors, are used to control current dental processes and even to produce all the necessary tools related to treatment. They are used for the manufacture of individual surgical templates, implants and other plastic models.[10]

Patient-centered treatment or personalized medications prove their role/importance compared to traditional healthcare methods. Dentistry 4.0 technologies are capable of delivering accurate and promised benefits with patient-centered treatment based on individual patient histories. Electronic medical records also play an important role in dental research to expand their knowledge base to develop treatment procedures for some common health problems. Significant improvement of dental education and dental care platforms during the COVID-19 pandemic using Dentistry 4.0 technologies: relevant proposals, dental routes, highly effective dental instruments and devices, tooth pain relief, understanding of patient behavior and anatomy of the patient's teeth, correct decision regarding hard tissues, treatment of dental fractures, dental research, real-time location, dental information management, analysis of toothache, medical implants with intelligent sensors, advanced dental practice, training and education, patient records management, bone fracture detection, surgery using robotics, development of real-time capabilities and a transparent information system.[11]

DISCUSSION

Dental industries will change and be updated with increasing technological advances in order to maintain their position in the education system. Dentistry 4.0 technologies are also a great example of this, as are all processes, starting with monitoring patient registration data and test reports.

Table 1: Improving the efficiency of dental care using Dentistry 4.0 technologies

Areas of improvement	*Planned results to be achieved*
Improving the training of dental students	• Opportunity to demonstrate treatment processes to dental students • Machines help to improve the quality of life of dental patients through appropriate suggestions and reminders using intelligent technologies.
Dental digital technologies for students	• Researchers use digital technologies to conduct various dental care trials with less time and money during the COVID-19 pandemic • They help in the development of new medicines to improve care
Highly effective dental instruments and devices	• New emerging technologies are used for the rapid production of high-performance tools and devices. • It helps design and develop customized devices
Study of dental diseases and the nature of pain in dentistry	• These technologies play an important role in improving the quality of life of patients and help in the study of pain/diseases associated with teeth. • The patient feels comfortable during the surgery, the treatment is painless
Understanding behavior of patients	• It has great opportunities to understand the behavior of dental patients • This provides adequate support and allows the detection of diseases at an earlier stage
Study of the anatomy of the patient's teeth	• By using 3D-printed dental parts, dentists can better understand the anatomy of a patient's teeth. • Practical for the production of protective equipment required for COVID-19
Treatment of fractures of teeth	• Technologies such as artificial intelligence and the Internet of Things, with the help of innovative procedures, are used to better treat a tooth fracture.
Dental researches	• It promotes the best research, development and commercialization in the field of oral care • Dental diseases are easily detected, and the best innovations in the field of dental transplantation are also created
Real-time locations for a better learning process for dental students	• Using IoT, hospitals will be able to manage multiple new devices and hospital assets for better understanding. • This is used to provide real-time location services to various important and specific devices during the COVID-19 pandemic. • Dentistry 4.0 uses powerful technology that provides more opportunities in the healthcare system.
Dental Information Management	• With the help of operational information, you can easily manage information in dental clinics.
Analysis of toothache.	• Toothache is a common cause of pain that can be easily analyzed using these technologies. • It provides the best surgical procedures during dental surgery
Dental implants with smart sensor	• Built-in sensors are used to create intelligent dental implants that provide real-time information. • Smart dental implants provide a better fit after implantation into the patient's body.
Best Dental Practice	• Telestomatology is an economical way to communicate remotely with a patient. • This is the best way to improve communication by discussing on an online platform. • These technologies are the best tool for virtual meetings and practices.
Teaching and education	• Holography is the best tool for teaching, learning and learning • It helps to improve the planning of the entire treatment process •Technologies such as virtual reality can provide doctors and patients with better information • Now doctors can visualize the patient's dental data in 3D format
Maintaining the patient's medical history for further training	• Digital technologies in Dentistry 4.0 are used to save patient records with their detailed profile • It helps to improve treatment outcomes in the future.
Identification of craniofacial fractures	• AI is used to detect fractures in the mouth and other hard tissues • It is better to use it to assess the risk and predict the results of the patient's treatment.
Surgery using robotics	• Robotic technology is being introduced in dentistry to perform surgical operations • It is superior to other traditional methods, reducing blood loss and time during surgery
Real-time capability development	• Technologies help to develop real-time work capabilities to improve the efficiency of the healthcare system. • It provides useful information that can quickly help in solving current hospital services.

The most noticeable advantage of Dentistry 4.0 technologies is that the human data stored on them is not available on any server belonging to any application; instead, it remains with the person. They are so functional and at the same time simple that they can update the entire digital marketing system with continuous data collection, as well as ensure the security and storage of digital assets.[12]

During the development of infectious diseases, patients can conduct counseling sessions at home in complete privacy, as smartphones and tablets replace traditional monitoring and recording devices. Innovations make household gadgets, such as smartphones or tablets, more accessible and user-friendly both from the point of view of the healthcare industry and from the point of view of patients. Thus, technological advances give people or patients the opportunity to choose according to their choice.

Remote areas, along with megacities, today have the opportunity to be provided with high-quality medical services

through telemedicine. The hospital infrastructure is well equipped for fast communication during any emergency situation using Dentistry 4.0 technologies.

Another advantage of Dentistry 4.0 is electronic documentation management. The transfer of electronic medical records will be useful for everyone and will help ensure smooth operation in the field of dentistry. Technologies provide an extensive network that allows data exchange between users.

Electronic medical records often allow access to big data and vice versa, respectively, this makes it possible for analytical purposes to collect and process a huge amount of specialized information. This reduces healthcare costs and improves dental technology while reducing the cost of finding the necessary techniques and treatment technologies. Accordingly, the technologies of Dentistry 4.0 allow to improve the quality and effectiveness of treatment and provide the opportunity to conduct advanced dental research. Technologies such as deep learning provide new solutions for solving various tasks. This helps to predict the results of dental treatment, for example, for a patient with COVID-19. Big data is used to collect a huge amount of data and information for personalized patient treatment. Data can be analyzed from various sources. Innovative drugs can be rapidly developed to improve the quality of medical care.[13] In the digital world, the dental industry is constantly being transformed using new innovative technologies. There have been various innovations in dentistry using various intelligent dental devices, such as electronic chips and electronic medical records. This helps to increase the overall satisfaction of doctors and patients during the COVID-19 pandemic.[14]

The COVID-19 pandemic has forced researchers, technologists, scientists, educators, dentists, industrialists, etc. around the world to think about conceivable and feasible solutions to make appropriate improvements to the existing structure of all services as soon as this happens. The time of COVID-19 is over. Thus, various technological improvements are emerging to make the current educational platform more innovative. This new educational platform will be equipped with intelligent educational devices such as tools, quick learning settings, simpler practical actions, etc. Methods such as virtual and augmented reality make this level of education even more innovative and more advanced.

In the future, dental education will become better thanks to video conferencing, video streaming and an online discussion platform. This will improve the working environment in the production of various custom-made dental parts, as well as provide a stable work platform and rapid response to provide timely information.[15] In the future, Dentistry 4.0 can provide limitless opportunities in healthcare. Using digital technologies, doctors can store past medical information in digital form.[16] Digital imaging systems quickly analyze patient images and reduce the cost of the treatment process. Some ethical issues such as privacy, accessibility, security and data protection can be quickly resolved in the future.

CONCLUSION

In modern conditions, innovative technologies are being intensively introduced into the practice of dentists, one of which is Dentistry 4.0. This is due to the widespread use of digital and advanced technologies, as well as the introduction of new processes in dentistry and its auxiliary areas. COVID-19 has set new challenges for dentists and patients with regard to their individual requirements, regular dental examinations, fast and safe procedures. During the development of the pandemic, many people were afraid to visit dentists, even in mild cases, because they feared infection with COVID-19. A certain set of technologies will help to improve health education, treatment process and materials and minimize infection.

Competent implementation of technologies "Dentistry 4.0" stimulates the development of innovations to improve the quality of medical services. It allows automation and data exchange to be implemented in order to create a specific dental intelligent system. All this makes it possible for specialists in the field of dentistry to move forward intensively, using modern advanced approaches in their practice aimed at improving the processes of providing medical care to the population.

AUTHOR CONTRIBUTIONS

All authors contributed in reviewing the final version of this paper.

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