

# Application of Selected Telemedical Solutions in Dentistry

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## Abstract

**Introduction.** Telemedical solutions in dentistry are the future of development of this branch of science. The use of the broadly understood eHealth has a direct influence on quality of medical services rendered. Dentistry connected with new information and communication technologies is the subject of lively debate on the international arena.

**The aim of the paper.** The main aim of the paper is to present selected applications of telemedical solutions in dentistry, with special regard for orthodontics.

**Short description of the state of knowledge.** The study has been based on the analysis of international literature. The solutions of eHealth and mHealth in dentistry and public health have been reviewed. Dentistry, and especially orthodontics, is a branch of medicine which uses new technological solutions to a large extent. The telemedical aspect of e-services comprises e.g.: teleconsultation, gathering and processing of medical data and education of future medical personnel with the use of e-learning. Access to new ICT solutions and to mobile services determines the development of teledentistry.

## Key words:

eHealth, mHealth,  
telemedicine

**Conclusions and summary.** The Polish health care services are yet to take up challenges connected with implementation of basic eHealth solutions, such as a uniform and interpretative system of medical data sharing. Nevertheless, many of the solutions mentioned in the paper are already used in Poland. Moreover, patients' expectations are also clearly directed at the development of medical services in the area of communication technologies. Thus, the contemporary Polish health care services, including dentistry, face challenges which are already a part of everyday life in many European countries.

## Introduction

Health is the most important value in the human life. According to a definition of health, this value is not limited to absence of disease, but encompasses also physical, mental and social well-being with all its elements. The correlation between well-being and health is very strong. How to increase a sense of well-being in the societies poses a challenge to the European Union states. A feeling of well-being is especially important in the context of the current demographic situation: low birth rate and constant lengthening of average life expectancy. In these circumstances, maintaining health and full well-being becomes the priority. The contemporary health care services currently face a challenge of implementation of eHealth strategy. The term eHealth means an area at the intersection of IT and public health, referring to health services, information provided or extended via internet and related mobile technologies. The research indicates that the demand for development of telemedical services in the area of health and telemedicine shall increase gradually in the coming years [1]. These solutions are also applied in dentistry.

## The aim of the paper

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## Material and methods

The study has been based on the analysis of international literature. The solutions of eHealth and mHealth in dentistry and public health have been reviewed.

## eHealth in dentistry

The use of the most advanced information technologies, distance education, electronic medical documentation and multidimensional imaging are the daily reality of dental clinics in many countries [2]. According to WHO forecasts, telemedicine will reduce the distance between doctors and patients, resulting from the space a patient needs to cover in order to consult a physician. The broadly understood eHealth becomes the subject of lively debate on the international arena, causing an increased interest in services provided remotely due to geographical barriers which often separate patients and doctors. On the basis of available telemedical solutions, the European Commission issued a document: "Green Paper on Mobile Health" which is a part of the strategy: "eHealth Action Plan 2012-2020: Innovative health-care for the 21st century", thus setting the directions of action in the area of telemedicine for the EU [1]. Modern information technologies are aimed at improvement in care for patients through introduction of direct actions, such as providing remote medical care (telemedicine), and indirect ones, such as

organization of the system of care and education of future medical personnel [3]. The aim of new information technology is not only to improve quality of dental patients' treatment, but also to enable management of patients' health by qualified dentists even at a distance of thousands kilometres from health care institutions. One of the tasks of these intelligent systems is to support the diagnostic process. However, these systems would not be effective without telecommunication supporting this process and almost immediate sending of information to interested parties, within institutions all over the world. Owing to telemedical solutions, patients are equipped with tools enabling active involvement in the process of diagnosis and treatment and thus take increased responsibility for their own health [2,1]. Medical networks, access to digital information, dental teleconsultations, processing and analysis of diagnostic data are the elements from the sphere of teledentistry not commonly known in Poland yet [4]. Technological innovations in dentistry (computerization, development of network and infrastructure, development of the civic society) have significantly contributed to the advancement of ICT directed at supporting diagnostics and monitoring of patients, owing to which a new branch of telemedicine, known as teledentistry, has emerged [5]. Teledentistry was first defined by Cook in 1997 as "the practice of using video conferences and technologies to diagnose and give advice on distance treatment"[6].

## E-learning in dentistry

Technological progress is constantly associated with development of telemedicine, which poses new challenges and provides new opportunities to the educational system. The new media, which comprise educational multimedia and modern ICT solutions, increasingly dominate the teaching process and determine the quality of education. Technology and telemedicine create endless opportunities and stimulate learning. The behavioural approach to the education process, used so far, has been replaced with a more constructive method, providing an opportunity for broader extension of knowledge on the basis

of practical use of technology [7]. Availability of the mass media, the range of internet and mobile access to ICT functionalities raise the potential of telemedical solutions which enable introduction and use of new methods of effective education [8]. An increasingly popular form of teledentistry consultation in the field of educating medical personnel is e-learning. This method has become the central part of the academic life at schools and universities in many developed countries. In academic education, e-learning combines the areas which complement and influence each other in a positive way. E-learning in dentistry comprises e.g. the content of educational curriculum, practical training, communication, academic community (e-learning participants), technology and behaviour. Students use materials on the basis of e-libraries, videos and lectures. Video conferences, chats, discussion groups and social networking sites become the spaces of interaction between a student and a teacher. Evaluation of this type of methods demonstrates their higher effectiveness in undergraduate and postgraduate education [9-12]. Dynamics of the processes of informatization and digitalization cause a constantly growing interest in education which uses the above-mentioned solutions. Popularity of new techniques of teaching creates new challenges and expectations as to the quality and effectiveness of study, promoting education based on information transfer technology, which in turn is reflected in the level of educational effects attained [13].

## Medical data and development of dentistry

E-services are widely used in public health and medical care. The scope of medical services based on eHealth solutions and the number of institutions using them are constantly growing. Increasing mobility of IT systems and emergence of the information society determine the development of a new field of life, that is e-services [14]. Widespread use of computers and IT in dental practice entails a need to process and analyse a great amount of digital data. Since these processes cannot be carried out in the place of data entry, methods of telemedical transfer must be used

in data collection. Digital data based on telemedical methods are convenient both for the purposes of their sharing among dental experts and for scientific analysis of diagnostic processes and health needs on a macro scale. This manner of data sharing and processing is reflected in improved care for patients in dentistry, as well as in development of science and management systems. The use of the electronic medical database in academic centres of the dental profile has resulted in more efficient action by reducing the time needed to manage patients' documentation [15]. Currently, it is possible to observe an international tendency for development and systematization of telemedical processes. These actions include: scientific achievements in dentistry, the concept of e-services in the context of their source and methodological basis, determinants of dental institutions' functioning on the e-services market, identification of service providers and beneficiaries on the market, as well as customers' preferences and approach to new telemedical solutions [14].

## Computer systems in dentistry

Computerization in dentistry begins from using software for clinic management and electronic circulation of medical documentation. Then, the following directions of development should be mentioned: planning of invasive and non-invasive treatments, use of software for design and prediction of complex treatment schemes taking into account therapeutic and aesthetic requirements and other more radical interventions, as well as use of intelligent software to support decision-making processes.

OralCDx – a system for imaging lesions within the oral cavity and computer-based analysis of histological material, e.g. brush biopsy, enabling teleconsultations to confirm a diagnosis.

Digital radiology – an equivalent of a traditional radiograph, but with a lower radiation level. An exceptional quality of 2D and 3D images, computerized reconstruction and a possibility to obtain anatomical measurements immediately enable teleconsultations, treatment planning and remote interventions.

CAD/CAM system – software for digital modeling used in dental prosthetics and orthodontics. Owing to data transmission it is possible to entrust some work to other institutions, as part of teleconsultations [2].

## Telemedicine in orthodontics

Orthodontics is one of these branches of dentistry in which digital techniques are increasingly applied. Such devices as: computer tomographs, digital pantomographs, dental intraoral scanners, modern CNC machines and specialized software for diagnostics, planning and simulation of orthodontic treatment effects in a given patient are already everyday reality in many clinics around the world. On the basis of literature analysis it is possible to identify the notion of teleorthodontics. This is a branch of telemedicine which explores the application of telecommunication and information technologies in orthodontics and which does not require presence of highly qualified experts, but at the same time enables such actions as: diagnosis, planning of specialist consultation, education and support for a patient [16].

In Poland there are already available scanners for 3D imaging of all teeth, e.g. the Polish CMO technology (Digital Orthodontic Models). An image obtained in the new technology is sent online to a laboratory. Such solutions guarantee precision, save time and eliminate the problem of transport and mistakes connected with making or casting of an impression. This technique is also applied in other branches of dentistry: dental prosthetics and dental surgery. Owing to the development of mobile technologies it is possible to apply telemetric solutions also in the interaction between an orthodontist and a patient. On the basis of photos taken by a patient, it is possible to consult minor orthodontic problems, such as e.g. small shifts of elastics in orthodontic braces, discomfort connected with wearing braces or irritation within the mouth [2].

It has also been proven that telemedical consultations can effectively be used in orthodontic screening. The system enables correct identification of new patients and their qualification for orthodontic

treatment. Thus, application of these solutions contributes to increased effectiveness of referring patients to further orthodontic treatment [17]. Experiments conducted by many institutions have demonstrated the potential of teleorthodontics [18-20]. The results of comparative research developed by Yakima Valley Farm Workers Clinic and Odessa Brown Children's Clinic (Washington) did not reveal any significant differences between patients personally seen in clinics and those consulted via telemedical solutions (teleconverter orthodontics) [21].

The current level of technologies facilitates development of teleorthodontics owing to low costs of their application. From the scientific perspective, limitations of these services include: legal factors and impact on doctor-patient relationship [22].

The analysis of functioning of the telemedicine system in orthodontics demonstrates that a vast majority of doctors who use this system notice its advantages and a positive impact on the treatment process [23,24]. Orthodontics is the branch where computer technology is the most routinely applied and the scope of its use in everyday practice cannot be compared to any other branch.

## Conclusions

The advantages of using computer technologies are the following: precise and easy diagnostics, simple online transmission of data at any distances (a possibility to share data between dental offices), remote consultation of cases, planning different variants of treatment, monitoring of treatment progress, simulation of treatment results, simulation of surgical treatments, easy and safe data archiving, an opportunity to carry out joint research projects by various scientific institutions, creation of databases with characteristic cases, fast statistical analyses, and supervision of postgraduate education of doctors outside academic centres. Telemedical solutions in dentistry are the future of development of this branch of science. The use of the widely understood eHealth has a direct influence on quality of medical services rendered. The Polish health care

services are yet to take up challenges connected with implementation of basic eHealth solutions, such as a system of medical data sharing which would be uniform in interpretation. Nevertheless, many of the solutions mentioned in the paper are already used in Poland. Moreover, patients' expectations are also clearly directed at the development of medical services in the area of communication technologies. Thus, the contemporary Polish health care services, including dentistry, face challenges which are already a part of everyday life in many European countries.

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