

Agata Sobecka-Wajdzik, DMD

Department of Health Promotion, Institute of Public Health, Faculty of Health Sciences,
Jagiellonian University Medical College, Poland
agata.sobecka-wajdzik@uj.edu.pl

Dr Mariusz Duplaga

Department of Health Promotion, Institute of Public Health, Faculty of Health Sciences,
Jagiellonian University Medical College, Poland
mariusz.duplaga@uj.edu.pl

APPLICATION OF TELEMEDICINE IN STOMATOLOGY

Introduction

Among the biggest challenges facing present-day healthcare systems is the increase in chronic diseases, an increasing number of patient with many diseases and the demographic change resulting in an ageing population. Oral health is a serious global health problem. It is well known that the access to dental services is extremely varied in different areas and communities. A limited access occurs most frequently among the inhabitants of rural areas and people in difficult financial situation. Dental care is an important element of healthcare that requires a closer contact with the patient. This causes a significant risk of infection both for the patient and the service provider during the pandemic. The progress in ICT technologies is of crucial significance to medical services. Unexpectedly, telemedical and e-service systems became important tools to reduce epidemic threat during the COVID-19 pandemic. Telemedicine offers, also to stomatology, innovative solutions that influence the model of service provision and facilitate specialist consultations. A skillful use of telemedical and e-health systems may decrease the inequalities in access to dental services and to reduce the cost of measures aiming at the enhancement of oral health in the population.

1. The origin of telemedicine

For the first time the term *telemedicine* can be traced back in the scientific literature in the early 1970s. However, already in more remote times one can find descriptions of contacts that enabled help from people who offered distant health service in a particular community¹. Nevertheless, the development of telemedicine is most frequently associated with the progress

¹ N. Giraudeau, *e-Health Care in Dentistry and Oral Medicine*, Springer 2018, pp. 3-4.

in telecommunication, i.e. the area dealing with the transmission of information over long distances by means of electromagnetic signals².

Thus, the origin of modern telemedicine is perceived in the context of such inventions as telegraph, radio or telephone. Soon after the invention of telephone, expectations appeared to use it in the contacts with a doctor. The fast widespread of telephone communication made it a long-lasting basis for telemedical contacts. There are also cases of the use of telegraph for medical services that date back to the 19th century, e.g. during the American Civil War. At that time, the telegraph was used to order medical supplies and to improve care over the wounded.³ The invention of radio communication resulted in the forms of remote assistance to the crews and passengers on the sea. For example, in 1935 in Italy the International Radio Medical Centre was founded with the purpose of giving radio medical advice.⁴ Radio communication began to be used to provide medical advice to communities living in geographically isolated areas, and the first transmission of an electrocardiogram signal from a hospital to a laboratory using a telephone cable was made by Willem Einthoven in 1905⁵.

In the 1920s, innovative ideas for distant medical care appeared. For example, the Radio News magazine presented a concept of a “telemedical” station that made it possible to consult a doctor in a distant location while *Science and Invention* magazine informed about a device referred to as Teledactyl that was intended to facilitate distant physical examination with the application of booms resembling present-day booms of robots⁶.

In the 1940s, research was conducted on the application of the accessible telecommunication lines to transmit radiological images. The first, quite advanced telemedical projects were started in the 1950s. For these purposes, TV transmission was first used. In the 1960s and 70s initiatives appeared to apply satellite links for medical purposes. Within the *Mercury* space program NASA conducted tests of distant monitoring of the astronauts’ biomedical data. Satellite links were also used to provide medical assistance in crisis situations, e.g. during the earthquakes in Mexico in 1984 and Armenia in 1988⁷.

² A. Vladzimirskyy, M. Jordanova, F. Lievens, *A century of telemedicine: Curatio Sine Distantia et Tempora*, Malina Jordanova, Sofia, Bulgaria 2017, pp. 9-16.

³ K. M. Zundel, *Telemedicine: history, applications and impact on librarianship*, „Bulletin of the Medical Library Association” 1996, No. 84(1), pp. 71-79.

⁴ R. L. Bashshur, G. W. Shannon, *The Genesis of Telemedicine: 1870 to 1955* [in]: R. L. Bashshur, G. W. Shannon (ed.), *History of Telemedicine: Evolution, context, and transformation*, Mary Ann Liebert, Inc., New Rochelle, NY 2009, pp. 131-153.

⁵ T. Moukabary, *Willem Einthoven(1860-1927): Father of electrocardiography*, „Cardiology Journal” 2007, No. 14(3), pp. 316-317.

⁶ M. Novak, *Telemedicine Predicted in 1925*, „Smithsonian magazine”, <https://www.smithsonianmag.com/>

⁷ T. Patrinos, *NASA and Telemedicine 2020*, <https://www.nasa.gov/feature/nasa-and-telemedicine>

The expansion of the Internet was a significant stimulus to the development of distant forms of healthcare service and to a broader perception of the use of technology for medical purposes. It should also be added that the advance in robotic surgery made it possible to conduct an operation in 2001, during which the surgeon was located on the other continent the Lindbergh operation)⁸.

2. Teledentistry – definition and evolution

In 1997, teledentistry was defined as “ ... the practice of using video-conferencing technologies to diagnose and to provide advice about the treatment over a distance”⁹. At present, teledentistry is defined as a form of provision of dental services, particularly for communities living in rural or geographically isolated areas, with the use of electronic health records, ICT technologies, the Internet and digital images^{10,11}. Teledentistry supports decisions made by doctors who work in local communities and makes it possible to select patients for specialist treatment. The application of teledentistry may reduce the need to transport patients for consultations in distant medical centers. The development of teledentistry was an element of the progress that took place in telemedicine. The first examples of the use of telegraph or telephone to provide help to isolated communities were also related to dental care¹². The first attempts to enhance the image of treatment areas by electronic systems were conducted in 1950. In the 1960s training programs for stomatologists were broadcast on TV. In 1969, the American Dental Association developed a disease coding system for the purposes of dentistry, which facilitated the automation of cost accounting of dental treatments. In 1991, dental teleconsultations were launched for rural communities in California¹³. A further development of teledentistry is associated with the Total Dental Access Project that started in 1994 and was implemented by the US Department of Defense. The project proved that teledentistry may

⁸ S. E. Butner, M. Ghodoussi, *Transforming a Surgical Robot for Human Telesurgery*, „IEEE Transactions on Robotics and Automation” 2003, No. 19(5), pp. 818-824.

⁹ G. Chandra, J. Rao, K. Singh, K. Gupta, *Teledentistry in India: Time to deliver*, „Journal of Education and Ethics in Dentistry” 2012, No. 2, pp. 61-64.

¹⁰ S. A. Khan, H. Omar, *Teledentistry in practice: literature review*, „Telemedicine journal and e-health” 2013, No. 19(7), pp. 565-567.

¹¹ *Facts About Teledentistry*, <https://www.americanteledentistry.org/facts-about-teledentistry/>

¹² G. T. Clark, *Teledentistry: What is it now, and what will it be tomorrow?* „Journal of the California Dental Association” 2000, No. 28(2), p. 121-127.

¹³ S. Chang, D. R. Plotkin, R. Mulligan, J. Polido, J. K. Mah, J. G. Meara, *Teledentistry in rural California: a USC initiative*, „Journal of the California Dental Association” 2003, No. 31(8), pp. 601-608.

significantly lower the cost of treatment, facilitate the transmission of data and extend dental services onto rural and remote areas.

Since then, the number of projects aiming at the application of telemedicine in dentistry has risen not only in the USA but also in Europe, Australia and Brazil. An example of further, more advanced programs that included teledentistry is the Alaska Native Tribal Health Consortium project. Within its framework a number of activities were performed (e.g. training of dental assistants) that aimed at the provision of basic help to Alaska's indigenous population¹⁴.

Teledentistry, similarly to telemedicine, uses two basic modes of interaction¹⁵. One is the synchronous mode which consists in real time contacts. The other one is the asynchronous mode which assumes some delay in the information exchange. It is frequently referred to as the *store-and-forward* mode. The synchronic mode most frequently consists in the application of a teleconferencing system to present the patient's problem to the teleconsultant. The *store-and-forward* mode involves storing patient's data in a textual form as well as the results of image examination and sending them to a consulting center. It should be added that when long-term distant monitoring is required (e.g. in the case of chronic diseases), telemonitoring system can be applied. In these systems, patient data is sent to the monitoring center either synchronously or asynchronously depending on the parameters being monitored and the monitoring devices used by the patient.

3. Teledentistry applications

It seems that teleconsultations are the most popular form of telemedicine that is used in dentistry. They are held when a patient or a healthcare worker using ICT tools apply for medical consultation¹⁶. During the teleconsultation, the consultation recipient can share the information on the course of the disease, the results of diagnostic examinations and describe the doubts. It

¹⁴ M. E. Williard, N. Fauteux, *Dentists provide effective supervision of Alaska's dental health aide therapists in a variety of settings*, „Journal of Public Health Dentistry” 2011, No. 71(2), pp.27-33.

¹⁵ K. V. Reddy, *Using Teledentistry for Providing the specialist access to rural Indians*, „Indian Journal of Dental Research” 2011, No. 22(2), p.189.

¹⁶ A. Tynan, L. Deeth, D. McKenzie, C. Bourke, S. Stenhouse, J. Pitt, H. Linneman, *Integrated approach to oral health in aged care facilities using oral health practitioners and teledentistry in rural Queensland*, „The Australian journal of rural health” 2018, No. 26(4), pp. 290-294.

was proved that teleconsultations may reduce the number of traditional referrals from primary healthcare entities to specialist centers even by 45%.¹⁷

Telediagnosis consists in sharing image data and the results of other diagnostic procedures in order to gain assistance in establishing the diagnosis of an oral disease. Telediagnosis was applied in the EstomatoNet program in Brazil¹⁸. Stomatologists and primary care physicians were invited to the program. As it can be difficult for primary care physicians to diagnose and treat oral lesions, the number of referrals to specialists is significant. This results in longer queues, delays in establishing diagnoses and the increase in mortality caused by oral cancer. The research within the EstomatoNet program I 2015-2016 showed that teledentistry may contribute to the improvement of the cooperation between primary care workers and specialists and to improve the diagnoses of oral diseases. After teledentistry consultations, in 42.9% cases the consultants recommended referrals to specialists, in 23.6% cases they recommended biopsies and 16.2% patients were advised a checkup. It turned out that the application of teledentistry within the EstomatoNet program leads to a decrease in the number of traditional referrals to specialist consultations even by 60%.

Another example of the use of telediagnosis in stomatology is the use of the smartphone in caries screening. The research conducted by Kohar et al. showed that the assessment of oral cavity images makes it possible to differentiate between a healthy tooth surface and extensive carious lesions¹⁹. The research applied the system for distant oral cavity hygiene assessment among school children. However, another study showed that overdiagnosis with the use of image transmission may occur in the telediagnosics of early and moderate caries. The lack of tactile sensations reduces the specificity of diagnoses²⁰. Smartphones may be a useful tool to telediagnose malignant lesions of the oral cavity²¹. A high potential of mobile applications to promote the health of oral cavity and to enhance patient care was also confirmed by Haron et

¹⁷ C. S. Bavaresco, L. Hauser, A. E. Haddad, E. Harzheim, *Impact of teleconsultations on the conduct of oral health teams in the Telehealth Brazil Networks Programme*, „Brazilian Oral Research” 2020, nr 34, e011.

¹⁸ V.C. Carrard, M. R. Gonçalves, J. R. Strey, C. Pilz, M. Martins, M. D. Martins, C. A. Schmitz, R. G. Dal Moro, O. P. D'Ávila, D. Rados, E. Harzheim, *Telediagnosis of oral lesions in primary care: The EstomatoNet Program*, „Oral Diseases” 2012, No. 24(6), pp. 1012-1019.

¹⁹ E. K. Kohara, C. G. Abdala, T. F. Novaes, M. M. Braga, A. E. Haddad, F. M. Mendes, *Is it feasible to use smartphone images to perform telediagnosis of different stages of occlusal caries lesions?*, „PLoS One” 2018, No. 13(9), e0202116.

²⁰ A. Giudice, S. Barone, D. Muraca, F. Averta, F. Diodati, A. Antonelli, L. Fortunato, *Can Teledentistry Improve the Monitoring of Patients during the covid-19 Dissemination?*, „International Journal of Environmental Research and Public Health” 2020, No. 17(10), p. 3399.

²¹ K. Vinayagamoorthy, S. Acharya, M. Kumar, K. C. Pentapati, *Efficacy of a remote screening model for oral potentially malignant disorders using a free messaging application: a diagnostic test for accuracy study*, „The Australian journal of rural health” 2019, No. 27(2), pp. 170-176.

al.²² Telecytology may also be an element of distant diagnostics in dentistry. The first experiences with the use of the cellScope capsules, which are a mobile version of a microscope, seem to be encouraging²³.

The health care of patients with chronic diseases may be facilitated by telemonitoring. Currently, various mobile devices are available that enable recording biological signals or performing measurements by patients (e.g. the glycemia levels). The data from measuring devices can be sent to monitoring centers where the staff can react adequately. Giudice et al.²⁴ described an interesting solution that was applied during the COVID-19 pandemic. They used telemonitoring to monitor the condition of dental patients with the aim to reduce healthcare costs and the waiting time for a traditional visit at the dentist.

4. Specialist applications of dentistry

Dental and maxillofacial surgery

The application of telemedicine in the diagnostics of impacted and partially impacted molars results in similar effectiveness as in the case of diagnostics at the dentist's office.²⁵ Telemedicine may also shorten the waiting time and reduce the number of dental implant consultations at the specialists. The invasiveness of the treatment is decreased by applying a 3-D navigation system²⁶. The effectiveness of dental surgery may also be improved by mobile videoconferencing for teleconsultations and treatment planning²⁷.

Orthodonty

²² N. Haron, R. B. Zain, A. Ramanathan, M. T. Abraham, C. S. Liew, K. G. Ng, L. Choo Cheng, R. B. Husin, S. M. Yee Chong, L. A. Thangavalu, A. Mat, H. B. Ismail, S.A. Mahalingam, S. C. Cheong, *m-Health for Early Detection of Oral Cancer in Low- and Middle-Income Countries*, „Telemedicine Journal and e-health” 2020, nNo.26(3), pp. 278-285.

²³ S. Sunny, A. Baby, B. Lee James, D. Balaji, N. V. Aparna, M. H. Rana, P. Gurpur, A. Skandarajah, M. D'Ambrosio, R. D. Ramanjinappa, S. P. Mohan, N. Raghavan, U. Kandasarma, M. A. Kuriakose, *A smart tele-cytology point-of-care platform for oral cancer screening*, „PLoS One” 2019, No. 14(11), e0224885.

²⁴ A. Giudice, S. Barone, D. Muraca, F. Averta, F. Diodati, A. Antonelli, L. Fortunato, *Can Teledentistry Improve the Monitoring of Patients during the covid-19 Dissemination?*, „Internacional Journal of Environmental Research and Public Health” 2020, No. 17(10), p. 3399.

²⁵ J. Herce, R. Lozano, C. Salazar, A. Rollon, F. Mayorga, S. Gallana, *Management of impacted third molars based on telemedicine: a pilot study*, „Journal of oral maxillofacial surgery” 2011, No. 69(2), pp. 471-475.

²⁶ M. Truppe, K. Schicho, H. Kawana, R. Ewers, *Perspectives of teleconsultation in craniomaxillofacial surgery*, „Journal of oral maxillofacial surgery” 2011, No. 69(3), p. 808-812.

²⁷ S. R. Aziz, V. C. Ziccardi, *Telemedicine using smartphones for oral and maxillofacial surgery consultation, communication and treatment planning*, „Journal of oral and maxillofacial surgery” 2009, No. 67(11), pp. 2505-2509.

The application of teledentistry in orthodontics makes it possible to offer orthodontic treatment to children from underprivileged groups. The results of orthodontic treatment that is conducted by a general practitioner and remotely supervised by an orthodontist seem to be satisfactory²⁸. According to Cool et al., the orthodontist's advice that is provided online results in the decrease in the frequency of unnecessary referrals and makes it possible for primary care physicians to deal with a wider range of cases²⁹. Mobile communication may also reduce the number of visits of patients with braces as assistance can be offered to them in the event of everyday problems. For example, an orthodontist can offer adequate support when rubber bands fall out, the patient feels a discomfort or in the event of mucosa irritation.

Endodontics

Errors in diagnostics and prognoses of periapical changes are the source of numerous complications and unnecessary costs. They may lead to the removal of permanent prosthetic restorations. Periapical changes account for a significant percentage of tooth lesions whose treatment is most frequently carried out by doctors who do not specialize in endodontics. Zivkovic et al. proved that the use of telemedicine may contribute to more precise diagnostics of front teeth periapical lesions and to the development of an endodontic treatment plan to reduce complications³⁰. Beckers et al. showed that there are no significant differences between the diagnoses made in vivo in the course of the dental examination and the ones obtained through checking a series of images on a screen.³¹ Another example of the use of teledentistry in endodontics is the determination by a specialist of the root canal location on the basis of pictures taken by an intraoral camera. In 87% cases, a specialist was able to correctly identify all canals and to help the general practitioner to perform safely the procedure³².

Conclusions

²⁸ J. Berndt, P. Leone, G. King, *Using teledentistry to provide interceptive orthodontic services to disadvantaged children*, „American journal orthodontics and dentofacial orthopedics” 2008, No. 134(5), pp. 700-706.

²⁹ J. Cook, J. Edwards, C. Mullings, C. Stephens, *Dentists' opinions of an online orthodontic advice service* „Journal of telemedicine and telecare” 2001, No. 7(6), pp. 334-337.

³⁰ D. Živković, G. Tošić, B. Mihailović, M. Miladinović, B. Vujičić, *Diagnosis of periapical lesions of the front teeth using the Internet*, „PONS Medical Journal” 2010, No. 7, pp. 138-143.

³¹ W. P. Baker 3rd, R. Loushine, L. A. West, L. V. Kudryk, J. R. Zadinsky, *Interpretation of artificial and in vivo periapical bone lesions comparing conventional viewing versus a video conferencing system*, „Journal of endodontic” 2000, No. 26(1), pp. 39-41.

³² D. Brüllmann, I. Schmidtman, K. Warzecha, B. d'Hoedt, *Recognition of root canal orifices at a distance - a preliminary study of teledentistry*, „Journal of telemedicine and telecare” 2011, No. 17(3), pp. 154-157.

The application of telemedicine in stomatology has several advantages, including a better access to services, faster diagnosis of oral lesions and the improvement of patient treatment and monitoring. Thanks to distant contacts, the communication between the patient and the doctor is more convenient and, consequently, it is easier to conduct educational and promotional oral health activities. Teledentistry may have particularly great significance to the inhabitants of remote areas and people in difficult financial situation as it helps reduce the need to travel long distances. It may also be beneficial in the care of the handicapped people and seniors staying in nursing homes.

Despite numerous advantages, either the potential or the proven ones, there is still a lack of solid evidence for the feasibility of teledentistry. This may depend on the financing model of dental service in particular countries. Another issue is who should cover the costs of investing in the telemedicine equipment.

Other barriers for the development in this area is the concern about patient safety and the limited IT skills in the groups of patients that may potentially benefit most from telemedicine, e.g. seniors and people with disabilities. Moreover, one can sometimes see the reluctance of some physicians to use new technologies in everyday practice. The reasons for this include, for example, bureaucratic obstacles, the lack of refunding mechanisms, unclear situation regarding the liability for errors, the complexity of the technology or even the incompatibility of the hardware and software from different suppliers.

In conclusion one must say that despite a growing number of dental doctors, there are still significant inequalities in the accessibility to dental care services. This concerns mainly the specialist care. A wider application of telemedicine would, at least to some extent, alleviate the existing shortcomings of dental care. In addition, teledentistry facilitates the implementation of care services which are based on the cooperation between physicians on different levels in the reference ladder. Finally, the telemedicine interactions can be an alternative or supplement to face-two-face visits, particularly in the cases where patients need long-term monitoring.

Bibliography

- [1] Amável R., Cruz-Correia R., Frias-Bulhosa J., *Remote diagnosis of children dental problems based on non-invasive photographs - a valid proceeding?*, „Studies in health technology and informatics” 2009, No. 150, pp. 458-462.
- [2] Aziz S. R., Ziccardi V. C., *Telemedicine using smartphones for oral and maxillofacial surgery consultation, communication and treatment planning*, „Journal of oral and maxillofacial surgery” 2009, No. 67(11), pp. 2505-2509.

- [3] Baker 3rd W. P., Loushine R., West L. A., Kudryk L. V., Zadinsky J. R., *Interpretation of artificial and in vivo periapical bone lesions comparing conventional viewing versus a video conferencing system*, „Journal of endodontic” 2000, No. 26(1), pp. 39–41.
- [4] Bashshur R. L., Shannon G. W., *The Genesis of Telemedicine: 1870 to 1955* [w]: R. L. Bashshur, G. W. Shannon (red.), *History of Telemedicine: Evolution, context, and transformation*, Mary Ann Liebert, Inc., New Rochelle, NY 2009, pp. 131-153.
- [5] Bavaresco C. S., Hauser L., Haddad A. E., Harzheim E., *Impact of teleconsultations on the conduct of oral health teams in the Telehealth Brazil Networks Programme*, „Brazilian Oral Research” 2020, No. 34, e011.
- [6] Berndt J., Leone P., King G., *Using teledentistry to provide interceptive orthodontic services to disadvantaged children*, „American journal orthodontics and dentofacial orthopedics” 2008, No. 134(5), pp. 700-706.
- [7] Brüllmann D., Schmidtmann I., Warzecha K., d’Hoedt B., *Recognition of root canal orifices at a distance - a preliminary study of teledentistry*, „Journal of telemedicine and telecare” 2011, No. 17(3), pp. 154-157.
- [8] Butner S. E., Ghodoussi M., *Transforming a Surgical Robot for Human Telesurgery*, „IEEE Transactions on Robotics and Automation” 2003, No. 19(5), pp. 818-824.
- [9] Carrard V.C., Gonçalves M. R., Strey J. R., Pilz C., Martins M., Martins M. D., Schmitz C. A., Dal Moro R. G., D’Ávila O. P., Rados D., Harzheim E., *Telediagnosis of oral lesions in primary care: The EstomatoNet Program*, „Oral Diseases” 2012, No. 24(6), pp. 1012-1019.
- [10] Chandra G., Raov J., Singh K., Gupta K., *Teledentistry in India: Time to deliver*, „Journal of Education and Ethics in Dentistry” 2012, No. 2, pp. 61-64.
- [11] Chang S., Plotkin D. R., Mulligan R., Polido J., Mah J. K., Meara J. G., *Teledentistry in rural California: a USC initiative*, „Journal of the California Dental Association” 2003, No. 31(8), pp. 601-608.
- [12] Clark G. T., *Teledentistry: What is it now, and what will it be tomorrow?* „Journal of the California Dental Association” 2000, No. 28(2), pp. 121-127.
- [13] Cook J., Edwards J., Mullings C., Stephens C., *Dentists' opinions of an online orthodontic advice service* „Journal of telemedicine and telecare” 2001, No. 7(6), pp. 334–337.
- [14] *Facts About Teledentistry*, <https://www.americanteledentistry.org/facts-about-teledentistry/>
- [15] Giraudeau N., *e-Health Care in Dentistry and Oral Medicine*, Springer 2018, pp. 3-4.
- [16] Giudice A., Barone S., Muraca D., Averta F., Diodati F., Antonelli A., Fortunato L., *Can Teledentistry Improve the Monitoring of Patients during the covid-19 Dissemination?*, „International Journal of Environmental Research and Public Health” 2020, No. 17(10), pp. 3399.
- [17] Haron N., Zain R. B., Ramanathan A., Abraham M. T., Liew C. S., Ng K. G., L. Choo Cheng, Husin R. B., Yee Chong S. M., Thangavalu L. A., Mat A., Ismail H. B., Mahalingam S. A., Cheong S. C., *m-Health for Early Detection of Oral Cancer in Low- and Middle-Income Countries*, „Telemedicine Journal and e-health” 2020, No. 26(3), pp. 278-285.
- [18] Herce J., Lozano R., Salazar C., Rollon A., Mayorga F., Gallana S., *Management of impacted third molars based on telemedicine: a pilot study*, „Journal of oral maxillofacial surgery” 2011, No. 69(2), pp. 471-475.

- [19] Khan S. A., Omar H., *Teledentistry in practice: literature review*, „Telemedicine journal and e-health” 2013, No. 19(7), pp. 565-567.
- [20] Kohara E. K., Abdala C. G., Novaes T. F., Braga M. M., Haddad A. E., Mendes F. M., *Is it feasible to use smartphone images to perform telediagnosis of different stages of occlusal caries lesions?*, „PLoS One” 2018, No. 13(9), e0202116.
- [21] Moukabary T., *Willem Einthoven(1860-1927): Father of electrocardiography*, „Cardiology Journal” 2007, No. 14(3), pp. 316-317.
- [22] Novak M., *Telemedicine Predicted in 1925*, „Smithsonian magazine”, <https://www.smithsonianmag.com/>
- [23] Patrinos T., *NASA and Telemedicine 2020*, <https://www.nasa.gov/feature/nasa-and-telemedicine>
- [24] Reddy K. V., *Using Teledentistry for Providing the specialist access to rural Indians*, „Indian Journal of Dental Research” 2011, No. 22(2), p. 189.
- [25] Sunny S., Baby A., Lee James B., Balaji D., Aparna N. V., Rana M. H., Gурpur P., Skandarajah A., D’Ambrosio M., Ramanjinappa R. D., Mohan S. P., Raghavan N., Kandasarma U., Kuriakose M. A., *A smart tele-cytology point-of-care platform for oral cancer screening*, „PLoS One” 2019, No. 14(11), e0224885.
- [26] Truppe M., Schicho K., Kawana H., Ewers R., *Perspectives of teleconsultation in craniomaxillofacial surgery*, „Journal of oral maxillofacial surgery” 2011, No. 69(3), pp. 808-812.
- [27] Tynan A., Deeth L., McKenzie D., Bourke C., Stenhouse S., Pitt J., Linneman H., *Integrated approach to oral health in aged care facilities using oral health practitioners and teledentistry in rural Queensland*, „The Australian journal of rural health” 2018, No. 26(4), pp. 290-294.
- [28] Vinayagamoorthy K., Acharya S., Kumar M., Pentapati K. C., *Efficacy of a remote screening model for oral potentially malignant disorders using a free messaging application: a diagnostic test for accuracy study*, „The Australian journal of rural health” 2019, No. 27(2), pp. 170-176.
- [29] Vladzimirskyy A., Jordanova M., Lievens F., *A century of telemedicine: Curatio Sine Distantia et Tempora*, Malina Jordanova, Sofia, Bulgaria 2017, pp. 9-16.
- [30] Williard M. E., Fauteux N., *Dentists provide effective supervision of Alaska's dental health aide therapists in a variety of settings*, „Journal of Public Health Dentistry” 2011, No. 71(2), pp. 27-33.
- [31] Živković D., Tošić G., Mihailović B., Miladinović M., Vujičić B., *Diagnosis of periapical lesions of the front teeth using the Internet*, „PONS Medical Journal” 2010, No. 7, pp. 138–143.
- [32] Zundel K. M., *Telemedicine: history, applications and impact on librarianship*, „Bulletin of the Medical Library Association” 1996, No. 84(1), pp. 71-79.

Abstract

Teledentistry is a form of providing dental services with the application of ICT technologies. Teledentistry is of special significance when a primary care physician or any other primary dental service provider need support from a specialist. It uses similar tools and interaction scenarios to the ones used in other areas of telemedicine and e-health such as the contact in synchronic or store-and-forward modes. The use of modern technologies in oral cavity healthcare can have a great significance for remote populations, groups isolated from



bigger urban centers or groups that are at risk of poverty or other deprivations. The results of the current research show that teledentistry can be used in various areas of dental medicine, including orthodonty, endodency or even for major dental surgery planning. However, the effectiveness of teledentistry solutions depends mainly on the care system that is available in a country or region.

Key words:

telemedicine, e-health, teledentistry, orthodonty, endodency