Srce i krvni sudovi 2021; 40(4): 264-267

Special article - Innovations

Telemedicine development in Serbian interventional cardiology

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Abstract Telemedicine includes the use of modern technology, especially two-way interactive audio video communication, computers and telemetry to provide health services to remote patients or to facilitate data exchange between primary care physicians and physically distant specialists. The rough division of systems used for telemedicine purposes (not entering e-health systems as a broader term) is done into systems of the so-called dedicated character, "proprietary" systems, as well as non-dedicated systems.

The first ZASINK was realized in November of 2015, using the dedicated Polycom system (HDX 7000), we realized that the system is able to manage through a very simple and slightly demanding Internet technology (so-called SIP protocol, with a very small request in terms of Internet flow of only 4/4 Mbit / s) this time in the local network, what was enough for us at that moment. By installing a remote controlled camera system (Eagle Eye camera), with the ability to control from a simple remote control and the ability to enter multiple preset camera positions, we eliminated the need for complex, bulky TV equipment, as well as the need for paramedic staff in the cath lab. A video of percutaneous procedures was transmitted in real time from the cath lab from a physical distance of about 500 meters. At the reception end, another Polycom videoconferencing system was used. ZASINK 2017 was held in the "Jezero" hotel on Bor Lake, and then this equipment was successfully used for the first time for transmission outside the local network. The same equipment was used to realize BASICS and "Meet the future od Serbian cardiology" in 2018 and SYNERGY in 2019.

Further improvement of the real-time transmission system has experienced a different format due to COVID19 pandemic outbreak and the need for transmission to be realized in an online format. We developed our non-dedicated system by independently purchasing video, audio, computer equipment and used it for the first time in the realization of ZASINK 2020 in a completely online format with multiple participants from different countries at the same time streaming on the Zoom platform.

By presenting the experience and development of the telemedicine system for the needs of ZASINK Congress, we have shown the possibilities of upgrading and adaptability of the telemedicine system in accordance with the needs and requirements.

Key words telemedicine, videoconferencing; Polycom, dedicated, non-dedicated, ZASINK

Introduction

Historically, the provision of health services necessarily involved physical presence, either the service provider traveled to visit the patient or, more often, the patient traveled to contact the health care provider, which also referred to professional communication between doctors / educators. Travel requires costs, either direct or indirect, delayed treatment, reduced productivity and is time consuming. In fact, travel has significantly participated in the overall cost of the health care system[1]. This has imposed the need to develop a system that would overcome the physical distance between health subjects in order to reduce costs and increase efficiency, especially in countries with a large territory and a scattered population, so that the physically health system is difficult to access. It should start with the broadest terms,

- **e-Health**, as defined by the World Health Organization (WHO) in 2005, is: "an efficient and secure way to use information technologies in support of health and other related fields, including health surveillance, services, literature, and education, knowledge and research."[2]
- **Telemedicine** is a part of e-medicine and e-health and according to the WHO definition: "Providing health services in a way that the patient and the service provider are physically separated, and using information technology to exchange information related to diagnosis and treatment of diseases, injuries, research and

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development, as well as continuous education of medical professionals "[3]

It includes the use of modern technology, especially two-way interactive audio / video communication, computers and telemetry to provide health services to remote patients or to facilitate data exchange between primary care physicians and physically distant specialists[4].

- **TeleHealth** is a broader term than telemedicine, which includes only the use of information technology in remote clinical work. TeleHealth, on the other hand, includes the non-clinical aspect of the remote health care system functioning, such as training and continuous medical education of health professionals, administrative meetings, public health and research purposes[5].

This includes health information systems that serve to collect, process, analyze and receive data needed for the organization and implementation of health care, but also for research and organization in health care [6]. The relationship between telemedicine, teleHealth and eHealth is presented in Figure 1.

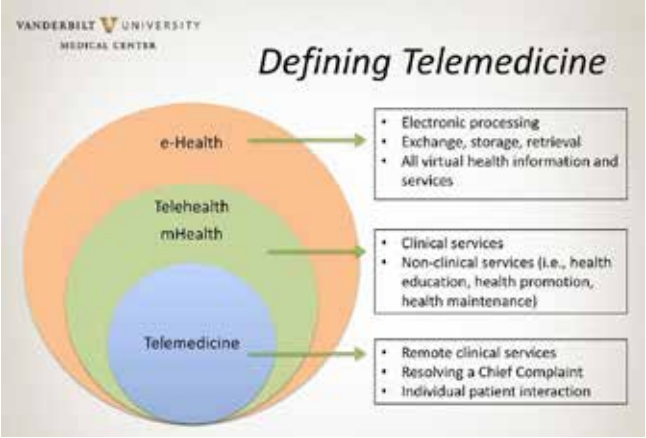

Figure 1. T Relationship between eMedicine, telemedicine and TeleHeath

In accordance with the widespread use of mobile devices in everyday life, another type of application of information technologies for medical purposes is defined by the so-called mobile health (mobileHealth, mHealth). **mHealth** is the use of mobile devices for the purpose of health services, exchange and collection of clinical data[7]. Since 2015, over 165,000 mobile applications related to health and health behavior have been available in online stores[8].

On the other hand, the percentage of households owning a computer in Serbia rose from 50.4% in 2010 to 74.3% in 2020, in the same year 80% of households owned broadband internet and 94.1% owned a mobile phone[9].

E-learning is used in 84% of countries around the world, 47% of WHO members use some form of electronic records, 80% of countries report the use of social networks in health promotion[3].

The rough division of systems used for telemedicine purposes (not entering e-health systems as a broader term) is done into systems of the so-called **dedicated** character, "proprietary" systems, as well as **non-dedicated** systems. Perhaps the difference between these two groups of systems should be described as "plug over play" in the former, and "plug and stay to play" in the latter. By installing a remote controlled camera system (Eagle Eye camera), with the ability to control from a simple remote control and the ability to enter multiple preset camera positions, we eliminated the need for complex, bulky TV equipment, as well as the need for paramedic staff in the cath lab. At the reception end, another Polycom videoconferencing system was used.

ZASINK telemedicine development

In March 2014, the Department of Invasive Cardiology of the Health Center Zajecar was opened as a section for providing coronary angiography, elective and primary percutaneous coronary angioplasty services for the area of eastern Serbia with a gravitational population of about 245,000. As the clinical experience accumulated, there was a need to connect with experts in the field of invasive cardiology from tertiary health care institutions, as well as with local cardiologists and health centers, all in order to improve clinical work and exchange experiences in the treatment of complex cardiac patients.

Everything was based on experiences in the application of IT technologies, using the electronic records system of the Ministry of Health of the Republic of Serbia - "ZIS-Health Information System", which has been in active use since 2012 in our health center. Dedicated equipment used nowadays ZC Zajecar received in 2011 as part of a telemedicine project implemented under the auspices of NALED, the Ministry of Health, and a donation from the "Merck" company, when the equipment from the "Polycom" company was obtained. KC Nis received the same set of equipment, as well as DZ Boljevac, for the purpose of achieving professional communication related to diagnostics and therapy.

On this basis, the first ZAjecar Symposium of Interventional Cardiology (ZASINK) was realized in November 2015 with the participation of eminent lecturers in the field of interventional cardiology from university clinical centers. In the preparation of this event, there was a need for direct transfer of intervention procedures from the cath lab to the venue of the event, which was then the amphitheater of the Health center of Zajecar. Simultaneously with live transmission the lectures were held. Initially, the idea was based on the use of TV systems, which in turn required the presence of complete equipment for the so-called "live" image transmission, as well as the presence of bulky equipment in the cath lab and staff who are not educated to work in sterile medical procedure environment. Insight into the features of the Polycom system (HDX 7000), we realized that the system is able to manage through a very simple and slightly demanding Internet technology (so-called SIP protocol, with a very small request in terms of Internet flow of only 4/4 Mbit / s) this time in the local network, what was enough for us at that moment. By installing a remote controlled camera system (Eagle Eye camera), with the ability to control from a simple remote control and the ability to enter multiple preset camera posi-

Figure 2. The first real time cath lab transmission using local network

Figure 3. The first real time cath lab transmission outside the local network (using internet)

tions, we eliminated the need for complex, bulky TV equipment, as well as the need for paramedic staff in the cath lab (Figure 2).

On the other hand, courtesy of the Siemens Serbia service technicians, we got a so-called "parasitic" output from the screen (note, which is a very simple technology that every desktop PC has), i.e. the so-called "imager", which simply connected to the PC input of the Polycom system, was visible at the reception end. Until then, the broadcasts from the cath lab took place by recording the screen of the imager in the cath lab with a professional TV camera! These first steps were characterized by the transmission of sound through a conference, i.e. "desktop" microphone, which provided satisfactory sound quality for the time.

A video of percutaneous procedures was transmitted in real time from the cath lab from a physical distance of about 500 meters. At the reception end, another Polycom videoconferencing system was used (courtesy of the staff of the health center in Boljevac).

The application of this system was used again in 2016, also for the transfer to the amphitheater of DZ Zajecar. ZASINK 2017 was held in the "Jezero" hotel on Bor Lake, and then this equipment was successfully used for the first time for transmission outside the local network (Figure 3).

The use of this equipment did not go unnoticed by the cardiology community in Serbia, and the same equipment is used for transmission from 3 different points, cath labs in KC of Serbia, IKVB Vojvodina to the main room at BASICS in 2018, as a leading professional meeting from the field of interventional cardiology in Serbia. In the same year, both systems from eastern Serbia (Zajecar and Boljevac) were used in the realization of the meeting "Meet the future of Serbian cardiology" organized by the Institute for Cardiovascular Diseases, Sremska Kamenca. The equipment was used to assist in the realization of the "SYNERGY" meeting in 2019.

Further improvement of the real-time transmission system has experienced a different format due to COVID19 pandemic outbreak and the need for transmission to be realized in an online format. We developed our non-dedicated system by independently purchasing video, audio, computer equipment and used it for the first time in the realization of ZASINK 2020 in a completely online format with multiple participants from different countries at the same time streaming on the zoom platform (Figures 4 and 5).

Conclusion

By presenting the experience and development of the telemedicine system for the needs of ZASINK Congress, we have shown the possibilities of upgrading and adaptability of the telemedicine system in accordance with the needs and requirements.

Figures 4 and 5. Online zoom platform streaming

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Sažetak

Razvoj telemedicine u Srpskoj interventnoj kardiologiji

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*Telemedicina (telemedicine) uključuje upotrebu savremene tehnologije, naročito dvosmerne interaktivne audio/video komunikacije, računara i telemetrije radi pružanja zdravstvenih usluga udaljenim pacijentima ili radi olakšanja razmene podataka između lekara primarnog nivoa zdravstvene zaštite i specijalista koji su fizički udaljeni. Gruba podela sistema koji se koriste u telemedinske svrhe (ne ulazeći u sisteme za e-zdravlje kao **širi** pojam), vrši se na sisteme tzv namenskog karakatera , ili anglosaksonski „proprietary" sisteme, kao i nenamenske sisteme.*

Prvi ZASINK realizovan je novembra 2015. Godine korišćenjem Polycom sistema (HDX 7000) uvideli smo da je sistem u mogućnosti da preko vrlo jednostavne i malo zahtevne internet tehnologije (tzv SIP protkolom, uz vrlo mali zahtev po pitanju internet protoka od samo 4/4 Mbit/s) ovog puta u lokalnoj mreži izvrši ono što nam je u tom trenutnu bilo dovoljno. Postavljanjem daljinski kontolisane kamere sistema (Eagle Eye kamera), sa mogućnostu kontrole sa prostog daljinskog upravljača i mogućnošću unosa više prememorisanih položaja kamere, u samu salu, eliminisali smo potrebu za složenom, glomaznom TV opremom, kao i potrebu za prisustvom paramedinskog osoblja u samoj angio sali. Svim ovim prenošen je video zapis perkutanih procedura u realnom vremenu iz angio sale sa fizičke udaljenosti od oko 500 metara. Pri tome je na prijemnom kraju koriščen drugi Polycom videokonferencijski sistem. ZASINK 2017.održan je u hotelu „Jezero" na Borskom jezeru, te je tada ova oprema prvi put uspešno korišćena za prenos van lokalne mreže. Istom opremom realizovani su i kongresi BASICS i "Meet the future od Serbian cardiology" 2018. i SYNERGY 2019. godine.

Dalje unapređivanje sistema prenosa u realnom vremenu je doživeo drugačiji format pojavom COVID pandemije i potrebom da se prenos realizuje u on line formatu. Razvili smo svoj nenamenski sistem samostalnom nabavkom video, audio, kompjuterske opreme i prvi put ga koristili u realizaciji ZASINK 2020. u potpuno onlajn formatu sa više učesnika iz različitim država u isto vreme streaming-om na Zoom platfromu.

Prikazom iskustva i razvoja telemedicinskog sistema za potrebe ZASINK kongresa pokazali smo mogućnosti nadogradnje i adaptibilnost telemedicinskog sistema u skladu sa potrebama i zahtevima.

Ključne reči: *telemedicina, videkonferencija, Polycom namenski, nenamenski, ZASINK*