EXPERIENCE AND PERSPECTIVES OF REMOTE INTERACTIVE TRAINING IN MEDICINE

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Abstract

Over the past 20 years there has been growing interest in remote interactive training of doctors using videoconferencing that allows for the exchange of knowledge and experience, and facilitates the introduction of new technologies. Videoconferencing was initially constrained by digital communication limitations and costs, but modern videoconferencing tools have helped to resolve this. Access to the experience and knowledge of leading world specialists can achieve through interactive video lectures, master classes or participation in scientific conferences. A Telemedicine Centre for videoconferencing based on modern ITU standards and a simulation-training centre where physicians can improve their practical skills have been installed at the Medical Institute of the RUDN- University. This provides the necessary infrastructure and conditions for the provision of videoconference based continuing medical education (CME) programmes which allow physicians to study at their workplace Two professional educational programmes on telemedicine have been developed and have been included in the list of CME programmes approved by the Ministry of Health of Russia. Using videoconferencing for interactive distance learning in CME, allows. These consist of theoretical sections of telelectures with interactive remote master classes from leading Russian and foreign clinics, the provision of parallel work using medical simulators, as well as the introduction of 3D visualization technologies in organizing master classes will improve practical skills.

Keywords: telemedicine; videoconferencing; interactive education; distance learning; Russia

Introduction

As technology becomes more affordable and a physician shortage looms, telemedicine is gaining attention as a possible solution to healthcare delivery. Telemedicine also holds great promise with regard to medical education. Several studies integrating telemedicine in medical education have shown positive outcomes, demonstrating similar or greater efficacy compared with traditional education.[1]

Technology enabled distance learning provides the opportunity to acquire new knowledge while continuing to work. It is convenient and flexible, does not depend on location and reduces financial and time costs, all of which make it attractive for doctors working in rural and remote areas. Online education has a number of advantages, including the opportunity to communicate with the world's leading experts, and exchange experience with colleagues, both local and foreign. This gives an opportunity to constantly improve qualifications and stay abreast of the latest developments. International online education not only allows participants to gain professional knowledge from world-class specialists, but also provides an opportunity to understand the social and cultural traditions of different countries. This is especially relevant with the introduction of the system of continuing medical education (CME).

Over the past 20 years there has been growing interest in remote interactive training of doctors using videoconferencing for the exchange of knowledge and experience, and facilitates the introduction of new technologies. Videoconferencing was initially limited by the high infrastructure and telecommunication costs and limited connectivity and bandwidth, but modern videoconferencing tools have helped to resolve this. In the 1990's, budget-based Intel and V-CON videoconferencing systems used the office PictureTel system, and digital telephony ISDN lines to provide video at 24-30 frames per second. This required six to

eight digital telephone lines, which increased the cost of telemedicine sessions.

In 1997, the doctor-cosmonaut, Professor Oleg Atkov, conducted the first tele-lecture for echocardiography of the heart from Moscow for doctors of Yakutia using ISDN digital telephony channels and satellite communications. (Figure 1)

Figure 1. The first (1997) remote (6,000 km) interactive telelecture on ultrasound of the heart from Moscow to Yakutsk in the Telemedicine project "Moscow-regions of Russia".

The telecommunication cost was one tenth that of the total cost of a lecturer's trip to remote regions.[2,3] But of even greater economic benefit during the first remote interactive videoconferencing was the diagnosis and treatment of newborns with heart defects. The total cost for a trip with a sick child to Moscow for full-time consultation in the Bakulev Centre was one hundred times more than the videoconference costs. Launched in the late 1990s, the telemedicine project "Moscow - the regions of Russia" for remote training of doctors and remote teleconferences, and the emergence of modern videoconferencing facilities that provided interactive communication with studio quality audio and video, and the transfer of two video streams simultaneously, gave a new impetus to the development of interactive online learning. (Figure 2)

Russian Law on Education, prohibits educational programmes for medical specialties being provided exclusively by e-learning. Therefore, blended education in which online education is combined with full-time practice is used for health professionals. Blended learning is becoming popular and is expected to become a "new traditional model" or a "new normal" kind of education.[4]

The effectiveness of telelectures is dependent on high quality teaching and interactive broadcasts, which only became available with the use of modern multi-point videoconferencing systems. This requires appropriate information and telecommunications infrastructure, as well as computer training and methodological provision.

A simulation-training centre where physicians can improve their practical skills and a Telemedicine Centre for videoconferencing have been installed at the Medical Institute of the RUDN University. Videoconferencing is based on modern ITU standards using the Collaborate Pro 900 videoconferencing unit from Clear One In 2011, Amendments to the Federal Law "On the Fundamentals of Health Care of Citizens in the Russian Federation" (No. 323-FZ) were accepted. This means that from 2016, ongoing accreditation of medical specialists is based on their CME activity. This provides the necessary impetus for the implementation of CME programmes. The Telemedicine Centre had to identify the needs of practicing physicians in advanced training (in particular, surgical doctors) and to select appropriate training methods.

Figure 2. Modern medical scientific and practical conference with remote participation of 20 clinics - with presentations, videotransmission of surgery operations in real-time mode, and interactive discussions.

The aim of this paper is to describe two CME programmes and e-learning activities at the Telemedicine Centre.

Methods

A literature review was undertaken of the international experience of using telemedicine technologies in medical institutions. The PubMed database and the

Russian Scientific Electronic Library were searched and conferences materials on telemedicine analysed. Search terms were based on the following key words: telemedicine, e-learning, distance learning, medical curriculum, videoconferencing, interactive education. The inclusion criterion was access to the full text.

Also during five years (2011 – 2016) the participants of the Telemedicine school, which has been held on Telemedicine centre of Russian Railways, were orally asked with respect to the requirements, opinions and wishes of practicing doctors about topics which should be mastered first and what methods they considered most appropriate for mastering new technologies and sharing experiences.

Results

Two professional educational programmes for physicians have been developed and have been included in the list of educational programmes posted on the Portal of Continuing Medical and Pharmaceutical Education of the Ministry of Health of Russia. Each programme entails 36 hours, which includes 18 hours of distance learning, 12 hours of full-time learning in the telemedicine centre and 6 hours for self-study. Lectures are broadcast online mode, but the final examination for each section is conducted by in-person oral examination. Practical classes are held in blended form (remotely and internally).

Programmes

Distant programme "Telemedicine Technologies in Healthcare Practice"

This course covers basic definitions, concepts, goals and objectives of modern telemedicine and the history of telemedicine and its development in Russia and abroad is described. Telemedicine projects are discussed and reasons for their success or failure are analysed.

Topics covered include the different aspects of teleconsultation, lectures, seminars, master classes, scientific and practical conferences, monitoring, and supervising. The concept of the telemedicine portal (Internet platform), as an environment for organizing telemedicine events is addressed as are the technical issues related to mobile telemedicine. Since videoconferencing is the technological basis of synchronous telemedicine, the standards of encoding/decoding information as well as image and sound quality are considered in detail.

Distant programme "Telemedicine in the health care system"

This programme includes special topics on telemedicine such as tele-radiology and tele-cardiology, ethical aspects of telemedicine, as well as the protection of personal data during telemedicine activities, including remote access to the medical information system (MIS) for remote consultations. We also pay attention to special telemedicine hardware and software.

Standards of storage and transfer of graphic information about patients including the principles of PACS (Picture Archiving and Communication System) and the DICOM (Digital Imaging and Communications in Medicine) standard are covered. Since pathomorphological examination is carried out at a distance using a video monitor instead of light microscope image, the technological equipment for telepathology is described. Students receive basic knowledge of the legal and economic issues in telemedicine.

Competencies

The courses aims to develop universal and professional competencies, in solving professional activity tasks using information and communication technologies, taking into account the basic requirements of information security. These include:

- use of telemedicine (information and communication) technologies in organizational and management activities;
- collection and analysis of patient's complaints, history, examination results, and laboratory, pathological and anatomical and other studies required for diagnosis;
- analysis and public presentation of evidence based medical information use of information technology in emergency situations;
- ability to bear social and ethical responsibility for the decisions made when acting in non-standard situations.

Practical skills

Medical specialists master the following practical skills in telemedicine:

- operation of equipment and organization of a teleconsultation with the telemedical consulting centre
- planning the work of the telemedicine consulting centre and organizing a request for scheduled and emergency tele-consultation

- organising videoconferencing for physicians and medical personnel, including lecture cycles for advanced training
- organization of teleconsultations for individual specialties
- popularisation and promotion of telemedicine technologies among doctors and patients.

Technical equipment

The Telemedicine Centre of the medical institute of the RFUP and the existing telemedicine centres in Moscow are widely used for videoconferencing sessions with existing Russian and foreign telemedicine centres. At the Telemedicine Centre there is a videoconferencing venue designed for 50 participants. It is equipped with the Collaborate Pro 900 videoconferencing unit from "Clear One". The ClearOne UNITE® 200 USB PTZ camcorder provides Full HD video quality with a resolution of 1080p at 60 fps, and uses a wide angle, 73° camera, for capturing all participants in the audience, with 12x optical zoom and remote control of the camera's zoom, pan and tilt functions. The venue has a professional document camera with built-in illumination plate for displaying x-rays with 240x magnification (16x optical and 15x digital), and a professional Microtek ScanMaker 9800XL A3 flatbed scanner to scan X-rays.

Discussion

In the early days of e-learning there was great enthusiasm, but little evidence of its effectiveness. When evidence did start to emerge, it seemed to suggest that e-learning offered outcomes similar to traditional methods of medical education.[5]

Mobile technologies are useful for areas with low bandwidth. A prospective study was conducted in Kenya using instructional video tutorials demonstrating techniques of cardiovascular and abdominal clinical examinations pre-loaded onto a tablet computer. Two groups of third-year medical students were compared, students in both groups received their usual clinical teaching for the duration of the study, additionally, the experimental group (25 students) used tablets and the control group (26 students) did not. Access to tablets and the video materials improved clinical education and efficacy and held promise for international training for both medical and allied healthcare professionals in resource-limited settings.[6]

However in medical education communication with experienced colleagues for mastering new diagnostic methods or operations is important. O'Donovan et al assessed the feasibility and impact of using low-cost tablets to deliver video tutorials and remote online peer-tutoring for clinical skills between nine junior medical students in Malaysia paired with five senior medical students in the UK, who played the role of peer-tutors. The Malaysian students were given a tablet to access instructional video tutorials. At the end of each week, the peer-tutors would observe their peer-learners as they performed a clinical examination via Skype. Although peer-tutors and peer-learners reported increased confidence in clinical examination they were less satisfied with the sound and video quality.[7]

Bertsch et al. evaluated the effectiveness of the students attending remote lectures using interactive videoconferencing. In their study 52 medical students attended lectures both in person and via 2-way videoconferencing over a telemedicine network. Exam scores did not differ for the 2 lecture modes, they concluded that students learn content focused on clinical learning objectives as well, using videoconferencing, as they do in the traditional classroom setting.[8]

Technology used by health care providers and recipients has changed dramatically during the past few decades. Fatehi et al. attempted to summarize various types of technologies used for interactive videoconferencing between health care providers and patients, and identify the trend of their change from 2002. They showed that a high proportion of telemedicine papers lack sufficient technical details. Dedicated VC systems (CODECs), were the most commonly used hardware, followed by computer/laptop/notebook. The connection speed (bandwidth) was not reported in 46% of the papers. Details of image quality and frame rate were mentioned in 11% and 5% of the papers, respectively.[9]

Four CME seminars on laparoscopic training were conducted in China. Overseas telelectures and live case demonstrations were introduced in each seminar via telemedicine based on a digital video transport system. Four telelectures and five live case demonstrations were successfully conducted. High-quality videos of 720 × 480 pixels at the rate of 30 frames per second were shown to the entire group of attendees. The time delay (latency) was only 0.3 s, with no packet loss.

The majority of the attendees were satisfied with the

quality of transmitted images and voices.[10]

As shown modern videoconferencing tools help to solve the problem of access to the experience and knowledge of leading world specialists. In our centre of telemedicine it can be done through interactive video lectures, master classes or participation in scientific conferences.

Tele-education

With the development of digital telecommunications providing high-definition images, tele-training has moved to a new level and includes:

- series of telelectures for remote continuing medical education;
- interactive master classes with on-line presentation of operations and diagnostic procedures from the best Russian and foreign clinics (Figure 3)
- remote supervision of young doctors by experienced specialists
- remote interactive participation in international scientific and practical conferences on a wide range of medical problems.

Distant telelectures

For remote telelectures a multi-point videoconferencing with studio quality of sound and video is used for a full interactive dialogue between the lecturer and the remote auditoriums. In addition, it is possible to organise clinical discussions and analysis of clinical cases, demonstrate any educational materials (presentations, video films, electro- and roentgenograms, etc.), including demonstration of the process of examination of patients using relevant diagnostic equipment, and inviting leading scientists from different cities and countries for individual television lectures

Interactive master classes

The essence of interactive videoconferenced master classes is the ability to interact with the remote operating surgeon and see the operation using a number of video cameras in the operating room, including a camera mounted on the surgeon's head. This allows the audience the invaluable experience of the "master", seeing the operation as "by the eyes of the surgeon" (as in many types of operations the surgeon obscures the operating field and even his assistants do not see all the manipulations and details). An important point is the ability of the remote audience to remotely control video cameras in the operating room (excluding the camera on the surgeon's head), which allows study of the

Figure 3. Interactive distant master-classes of leading cardiac surgeons in international training programmes.

operation of the surgical team as a whole and the actions of its members. (Figure 4)

For a number of operations, such as endoscopic surgery, and for diagnostic procedures is important to view video streams simultaneously. This allows observation of the surgeon's hands and x-ray image of the stent installation or position of the ultrasound probe and the picture on the monitor and possible interactive communication. With on-line demonstration of a number of manipulations, it is important to observe a three-dimensional picture of what is happening in order to understand the nuances and details of the "master's" work. It is impossible to obtain this using a conventional video camera. Russian scientists have developed a patented stereoscopic unit that includes a surgical helmet with two digital miniature HD cameras with the identical optical characteristics and adjustment means. (Figure 4) This unit was tested for two years in neurosurgery, oncology, maxillofacial surgery, laser surgery, etc., showing its effectiveness in improving the surgeon’s skills during interactive master classes.[11]

Figure 4. The operation of the stereoscopic unit in the operating room.

Figure 5. Real-time transmission of the endoscopic procedure and ophthalmic operation for tele-mentoring.

Tele-mentoring

The essence of tele-mentoring is to organize an interactive remote master class from the operating or diagnostic room, where a young doctor works, with a remote room, from where an experienced colleague can give advice. This allows a young doctor to effectively use the advice and experience of his teacher in difficult situations, and also clearly demonstrate the acquired skills.

Participation in international conferences

Participation in international scientific and practical conferences is a part of modern medical education, which allows access to information about the latest medical research directly from the leaders in the field. Equally important is the opportunity to participate in scientific discussions and present local research results. For economic and organizational reasons, physically attending most conferences and symposiums is problematic for most practicing doctors and students. Remote interactive participation in international conferences on a wide range of medical problems is a solution. This allows participants to not only listen to and watch the broadcasts of master classes, but also participate fully in scientific discussions, asking questions and delivering their own reports or commenting on-line operations or diagnostic procedures from clinic.

Conclusion

The telemedicine centre provides videoconference based remote training, online transmissions from the operating rooms, as well as interactive master classes with full interactive communication between the remote audience and the operating surgeon and monitoring the progress of the operation using a number of video cameras in the operating room.

Using videoconferencing for personalised interactive distance learning in CME, allows physicians to study at their workplace. A combination of theoretical sections of telelectures with interactive remote master classes and providing parallel work at

medical simulators, as well as the introduction of 3D visualization technologies in organizing master classes from leading Russian and foreign clinics will improve practical skills.

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