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Tele-Surgery: A New Virtual Tool for Medical Education

Thais RUSSOMANO [a,1], Ricardo B. CARDOSO [a], Jefferson FERNANDES [b], Paulizan G. CARDOSO [c], Jarcedy M. ALVES [c], Christina D. PIANTA [c], Hamilton P. SOUZA [c], Maria Helena I. LOPES [b]

[a] *Microgravity Centre, School of Engineering, PUCRS University, Porto Alegre, Brazil*
[b] *School of Medicine, PUCRS University, Porto Alegre, Brazil*
[c] *Hospital São Lucas, PUCRS University, Porto Alegre, Brazil*

Abstract. The rapid evolution of telecommunication technology has enabled advances to be made in low cost video-conferencing through the improvement of high speed computer communication networks and the enhancement of Internet security protocols. As a result of this progress, eHealth education programs are becoming a reality in universities, providing the opportunity for students to have greater interaction at live surgery classes by means of virtual participation. Undergraduate students can be introduced to new concepts of medical care, remote second opinion and to telecommunication systems, whilst virtually experiencing surgical procedures and lectures. The better access this provides to the operating theater environment, the patient and the surgeon can improve the learning process for students. An analogical system was used for this experimental pilot project due to the benefits of it being low cost with a comparatively easy setup. The tele-surgery lectures were also transmitted to other universities by means of a Pentium 4 computer using open source software and connected to a portable image acquisition device located in the São Lucas University Hospital. Telemedicine technology has proven to be an important instrument for the improvement of medical education and health care. This study allowed health professionals, professors and students to have greater interaction during surgical procedures, thus enabling a greater opportunity for knowledge exchange.

Keywords. telemedicine, eHealth, virtual lectures, tele-surgery, educational tools, tele-education

1. Introduction

The rapid evolution of scientific knowledge and technical expertise in surgery explains the increasing demand of surgeons for easy and full access to high-quality information [1]. In addition to this, in recent years there has been a growth in medical specialization. Many medical centers however, may have either no qualified teachers or experts in certain subspecialties, or may have a lack of enough specialists to provide the required support to a growing demand from undergraduate students [2]. The fast development of telecommunication technology, such as greater Internet availability, capability and tools has brought new solutions to these issues [3].

[1] Corresponding Author: Thais Russomano, Av. Ipiranga 6681, Prédio 30, Bloco F, Sala 216, Porto Alegre/RS, Brazil 90619-900; E-mail: trussomano@hotmail.com.

Telemedicine and eHealth involves the use of telecommunication technology and computer power for the acquisition, storage and transmission of health data, allowing for the exchange of medical expertise and for case discussion. Virtual meetings, a critical evolution in telecommunication, have enabled health professionals located in different parts of a region, country or even the world, to discuss and give expert opinion concerning procedures, techniques and patient care, such as during live surgeries when the acting surgeon has the opportunity to improve skills and deliver a better health care to patients [4–6].

The wider access to low cost telecommunication technology and to computer systems by students, professors and health professionals has been responsible for the development of new educational tools, among them e-Health education programs. This progress has been possible due to the advances made in low cost video-conferencing, the increased capability of graphic computing softwares, the improvements in high speed computer communication networks and the enhancement of Internet security protocols [7, 8].

In response to this technological progress, eHealth education programs are becoming a reality in universities, providing the opportunity for students to have greater interaction at live surgery classes through virtual participation. This allows for better visual access for students through the use of imaging equipment, and an improvement in lesson delivery by the surgeon who has more control over what the students can see, whilst interacting directly with them with minimum distraction from the procedure.

Another clear advantage is the decrease in the possibility of contamination during the surgical procedure, due to the reduction in the number of people in the operating theater. This in turn, decreases the incidence of infection in the post-operative patient.

This new method of virtual education enables universities all over the world to remotely participate in such activities as lectures involving experts in different fields, continuous education programs, national and international workshops, scientific meetings, seminars, symposiums and congresses [9].

2. Objectives

The objectives of this tele-surgery project were:

1. to allow undergraduate students from the school of medicine and other health related areas to virtually experience surgical procedures and lectures;
2. to facilitate the learning process by enabling undergraduate students to have better access to the operating theater and surgeon, an improved view of the patient and more importantly of the surgical procedure itself;
3. to lower the risk of infection in the post-operative patient by reducing the number of people in theater during the surgical procedure;
4. to introduce undergraduate students to new concepts of medical care, remote second opinion and telecommunication systems;
5. to demonstrate new virtual education methodologies and tools to both professors and students.

3. Methods

The tele-surgery project was conducted at the Pontifical Catholic University of Rio Grande do Sul (PUCRS), involving the School of Medicine, the Sao Lucas Hospital, the Telemedicine Laboratory of the Microgravity Centre and the eHealth Student League.

This experimental pilot project carried out with the support of the biomedical engineering department of PUCRS university hospital, used an analogical system due to the benefits of it being less expensive and easier to setup (Figure 1).

The virtual lectures between the operating theater and the lecture hall were accomplished using a set of coaxial cables with 75 Ω of characteristic impedance and a total length of 150 meters, these being installed between the two venues with a concentration point in the lecture hall. From this point it was possible to extend connections to other rooms in the university hospital, allowing for greater flexibility to meet the demands of the schedules of surgery lectures.

A video camera with 520 lines of resolution and manual focus (adjusted by a technician via remote control) was positioned 80 centimeters away from the field of surgery during procedures. The acquired images were transmitted point-to-point via signal modulation systems with a frequency range of 60 MHz to 66 MHz. The received images were displayed in the lecture hall using a Sony data show projector onto a flat screen, enabling all students to have a total view of the procedure.

The professor in the lecture hall was able to choose from three sets of images by using either a direct current control device connected via the coaxial wire to the operating theater-based image acquisition equipment or by asking the theater technician to alter the view. The audience was able to communicate with the surgeon using a wireless microphone connected to the audio system in the lecture hall.

Tele-surgery lectures were also transmitted from PUCRS to undergraduate students of other partner university with whom there exist signed international cooperation agreements. This was possible by the use of a Pentium 4 computer (3.2 GHz clock speed and 1 Giga byte of RAM memory) connected via USB 2.0 port to a portable image acquisition device (resolution of 720x480 pixels at 30 frames per second for NTSC video system. Compression algorithm: MPEG-1), which was positioned at the concentration point.

A non high definition open source video-conferencing system, Skype software (www.skype.com), was used to give easy access to the lecture via Internet connection. This point-to-point system gave autonomy to students who could then observe the proceedings from any place with broadband Internet capability.

The equipment setup allowed all three places to communicate with each other, but the video image was not transmitted to the operating theater to minimize any disturbance to the theater environment. A webcam image of the invited participants was displayed in the lecture hall with the use of an auxiliary data show projector and screen (Figure 2).

Figure 1. Operating theater: Setup for surgery transmission

4. Results

A total of four tele-surgery lectures were accomplished between January and June 2008. The surgeries transmitted had themes directed at undergraduate students and were 1h and 30min each in duration. Two of the four lectures were also transmitted to undergraduate students of the Kaunas Medical University in Lithuania.

In all four tele-transmitted operations the surgeon was able to demonstrate to students via a large screen the anatomical structures and the surgical procedures, and was also able to answer any questions from the remote students whilst remaining focused on the patient.

It was possible for many students to participate with a good view for all of the surgical procedure, whilst reducing the risk of exposing the patient to additional contamination that could lead to post-operative infection. They also had the opportunity to consult with either the professor in the lecture hall or the remote surgeon regarding patient information and the techniques being applied during surgery.

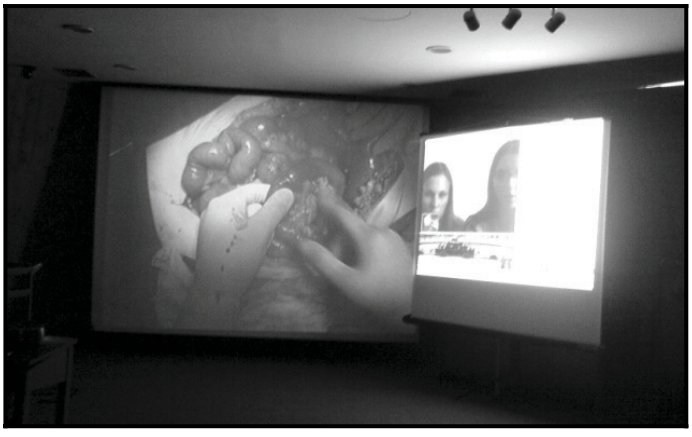

Figure 2. Virtual surgery lecture: Participation of health students from Kaunas Medical University, Lithuania

5. Conclusion

Telemedicine technology has proven to be an important tool in improving medical education and health care. In this study, health professionals, professors and students had the opportunity for greater interaction during surgical procedures enabling an excellent knowledge exchange.

Our experience demonstrates the feasibility and acceptability of presenting virtual surgeries and lectures to medical students. The low cost of an analogical system combined with the benefits of reducing the risk of patient contamination and the decrease of surgeon distraction in the operating theater were decisive in the positive evaluations given by participants.

The involvement of an international partner in the tele-surgery lectures was possible due to the addition of digital equipment to the system. It promoted the integration of Lithuanian undergraduate students to the virtual surgery procedures and discussions.

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