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Remote Presence Proctoring by Using a Wireless Remote-Control Videoconferencing System

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Remote presence in an operating room to allow an experienced surgeon to proctor a surgeon has been promised through robotics and telesurgery solutions. Although several such systems have been developed and commercialized, little progress has been made using telesurgery for anything more than live demonstrations of surgery. This pilot project explored the use of a new videoconferencing capability to determine if it offers advantages over existing systems. The video conferencing system used is a PC-based system with a flat screen monitor and an attached camera that is then mounted on a remotely controlled platform. This device is controlled from a remotely placed PC-based videoconferencing system computer outfitted with a joystick. Using the public Internet and a wireless router at the client site, a surgeon at the control station can manipulate the videoconferencing system. Controls include navigating the unit around the room and moving the flat screen/camera portion like a head looking up/down and right/left. This system (InTouch Medical, Santa Barbara, CA) was used to proctor medical students during an anatomy class cadaver dissection. The ability of the remote surgeon to effectively monitor the students' dissections and direct their activities was assessed subjectively by students and surgeon. This device was very effective at providing a controllable and interactive presence in the anatomy lab. Students felt they were interacting with a person rather than a video screen and quickly forgot that the surgeon was not in the room. The ability to move the device within the environment rather than just observe the environment from multiple fixed camera angles gave the surgeon a similar feel of true presence. A remote-controlled videoconferencing system provides a more real experience for both student and proctor. Future development of such a device could greatly facilitate progress in implementation of remote presence proctoring.

Key words: **telesurgery, remote-controlled videoconferencing, remote presence proctoring.**

The concept of telemedicine—a remote presence facilitating the diagnosis and treatment of disease from locations distant to the caregiver—started in the 1970s in support of space flight. Expansion of these capabilities into a human operating room has resulted in several telesurgery applications where a surgeon in a remote location actually performs an operation through a remote-controlled robot.[1-6] These uses of telesurgery have generally been proof-of-concept experiences and have been very expensive and labor intense.

Another more practical use of telemedicine technologies in surgery has been teleproctoring or teleconsultation, which is providing advice or supervision during a surgical procedure without the remote expert actually manipulating anything in the remote room. In these scenarios, the on-site surgeon is observed and advised by a remotely located expert surgeon who can provide expertise that would not otherwise be feasible in these remote locations. Again, most of these remote presence applications have been proof of concept.[7-9]

To achieve this remote presence for consultation within an operating room has required an operating room with multiple cameras mounted throughout the room to provide the multiple angles of view needed not only to view the operative field but also the entire operating room, including anesthesia and the operating team. A video router/switcher then controls the various images that are available to the remote site, and in most uses, a dedicated connection between the sites is necessary to handle the various video and audio signals. An objection to this type of remote presence has been the expense of outfitting a room with the video and audio capabilities and the disruption this manner of remote presence introduces to the operating room.

Although such capabilities provide a variety of images to follow, the interaction between the surgeon and the remote expert is largely by voice, and with more sophisticated systems, the remote surgeon's face on a screen somewhere in the operating room and an ability to draw on some views of anatomy or the operative field on a similar fixed viewing area in the room. To achieve this video-rich interactive environment in an operating room is expensive and often intrusive, as it requires a different manner of human communication than what is typical during surgery: a voice over a speaker and a visual presence either on your view of the operative field during laparoscopy or a

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monitor somewhere else instead of directly talking to the expert who is standing in the operating room with you.

In this study, we explored the use of a remote presence system that emulates a more human-type physical presence in an operating room rather than a remote presence by way of a fixed imaging and audio system. This system uses the public Internet to make the connection between the surgeon and the remote expert and doesn't require multiple cameras or video/audio switching during the procedure. The goal of the project was to assess whether this system provided a more "real" feeling of having a proctor in the room providing quality guidance and supervision.

Methods

This was a prospective study of teleproctoring and its impact on student and surgeon satisfaction with the teaching session. Student and surgeon satisfaction was measured by using a survey administered immediately after the teaching session.

Students and Surgeon Proctor

Medical students participating in an anatomy lab were asked to volunteer for the study. The anatomy lab teaching sessions were conducted at the dissection table of an anatomy lab where students were performing dissections of the abdominal contents. Two groups of 4 students were separately proctored during these dissections. The surgeon proctoring the teaching sessions was a senior member of the medical school surgical faulty. Both students and surgeon were asked to complete a survey at the end of the teaching session (Table 1).

Remote-Controlled Video Conferencing System

The remote-controlled video conferencing system is a personal computer (PC)-based system that uses commercially available computer components. The mobile unit uses a PC system integrated into a remotely controlled service robot (InTouch Health, Inc., Santa Barbara, CA). This unit provides a flat panel monitor, microphone, and camera mounted on top of the service platform. The unit on the top of the service platform can rotate left and right and tilt up and down, providing the movements similar to a human head (Figure 1).

This robotic unit is connected to the public Internet through an 802.11g wireless router. It is

Figure 1. The remotely controlled platform of the videoconferencing system carries the camera and the flat-panel monitor with the remote participant's image.

controlled remotely by another PC-based system with an attached joystick and connected to the public Internet. This allows the remotely located surgeon to navigate the service platform around the teaching area and control the top-mounted videoconferencing unit as if it is his or her head looking up and down, and left and right (Figure 2). Additionally, the remote surgeon can zoom the top mounted camera to provide close-up views of the remote teaching field. The remote proctor's face is projected onto the top-mounted video conferencing system to give an even greater personal presence in the remote environment.

Results

Two groups of 4 students participated in the two proctoring sessions. Each session lasted an average of 2 hours. The students typically are proctored by an anatomist from the Department of Cell Biology. Surgeons rarely can get away from clinical responsibilities to be in the anatomy lab during the session and are not a formal part of the course faculty for the anatomy class.

All students reported a positive experience with the robotic proctoring. Eighty percent of the students reported that after they became comfortable with the robot's presence, they at times forgot that the surgeon was not actually there with them during the session. All of the students reported that they thought the addition of the remote proctoring would significantly enhance their experience during anatomic dissections.

The surgeon reported a very positive experience with remote proctoring. When the control of the unit became more automated, the surgeon, at times, forgot that he was not physically present in the teaching session. The ability to directly navigate the videoconferencing system around the room and actually look face-to-face with students was a significant improvement over existing fixed systems.

Both students and surgeon thought the system would have similar benefits in bedside teaching and proctoring in an operating room. Both thought that the system felt "lifelike" and achieved a significant overall presence during the teaching session.

Figure 2. Remote control station.

Discussion

Remote presence through teleconferencing has been used in medicine, primarily for bedside or at home consultation, for more than 10 years. Despite some early technologic capability in this regard, widespread use of remote-presence teleconferencing in medicine has been hindered by the requirements of dedicated teleconferencing space and equipment, especially the equipment required at the client end. The expense of dedicated equipment and connectivity, as well as the need for the patient to come to the teleconferencing room, has made such applications impractical.

The system described here overcomes these barriers by being mobile, remotely controlled, and using the public Internet for connectivity. This system has been used for remote rounding in hospitals, thereby allowing surgeons to make more frequent visits to their patient's bedside and facilitate their recovery and eventual safe and timely hospital discharge. A recent prospective comparative study looked at patient acceptance of this technology for rounding.[10] This study found that patients who had "robotic" visits by their surgeon were extremely satisfied with their care and felt better informed regarding their progress and care plan than those patients who were not visited robotically. Although this system has been successfully used for remote rounding, this is the first description of its use for teaching and proctoring.

Proctoring surgeons, trainees, or students in performing procedures is critical to the safe teaching of new skills and the integration of new procedures into medical practice. To simply take a class, practice a few procedures on an animal, and then perform the procedure unsupervised on a patient leads to physicians progressing through their learning curves on human patients.

Although many suggest that simulation technology will allow physicians to perform hundreds of simulated procedures before ever performing one on a patient, thereby eliminating this learning curve, simulators are not ready to meet this demand, and physicians will likely always need some oversight the first few times a new procedure is performed in humans. Proctoring by an expert will always be of benefit to the new physician or experienced physician performing a new procedure.

Proctoring typically requires an expert to leave their practice and observe the physician in their home hospital, or the physician comes to the proctor's institution where they perform the procedure under the proctor's guidance. Both scenarios are problematic. It is very costly and disruptive for a proctor to leave their practice and travel to another institution. Considering the number of physicians and procedures to be proctored, this is not practical. Having the physician to be proctored come to the proctor's institution avoids these problems, but it is a very artificial situation to be in the proctor's institution where the equipment and support staff may be quit different from what the physician will have at their home setting. Also, it can be difficult to get privileges for outside physicians to perform procedures at the proctor's institution.

The promise of teleproctoring has been around for several years and many have held this to be the answer to the problems with proctoring early uses of new procedures. Most of the teleconnectivity

Table 1. Survey Administered After Proctoring Session

Place an "x" in the box that best supports the following statements.

1 - Strongly Agree

5 - Strongly Disagree

	1	2	3	4	5
The quality of the overall experience was good.					
The remote presence proctor enhance the learning experience					
I at times forgot that the proctor was not physically present during the session					
After I became comfortable with the robot, the presence of the proctor at times felt lifelike					
Remote presence proctoring would have other using in teaching and training					
Compared to standard teaching/proctoring, the remote presence proctor was an improvement					
I would accept having this type of teaching as a part of my regular curriculum					

available to telesurgery proctoring has required installation of expensive operating rooms with multiple fixed-position cameras, video routing/switching capabilities, dedicated video/audio connections, and an on-site expert to maintain and manage the video/audio systems and connectivity/routing. All of this has lead to elaborate and expensive systems. Also, the need for dedicated connectivity has limited the proctoring capabilities to only hospitals with similar connectivity and operating room configurations.

Even when the connectivity is present for both proctor and student, the interaction between the two is limited to primarily voice direction based on the view that the proctor can achieve through the fixed cameras. Joystick control on these fixed-position cameras gives the proctor some control over view, but there are limits to what can be viewed. Direct interaction between surgeon and proctor is also limited. Put simply, the face-to-face interaction that comes with actually being present in the operating room is largely lost through these systems. The surgeon and proctor are acutely aware of the remote presence throughout the interaction.

The system studied here overcomes many of these problems. The system can move anywhere in the operating room and view anything that the proctor would like to see. The control of view, locations, and magnification is entirely under the proctor's control. The system uses the public Internet and a readily available off-the-shelf wireless router, making it available to any operating room with nearby Internet connectivity.

Perhaps the most compelling aspect of this system is its "presence" in the operating room. The physical presence of something that moves and interacts like a human gives the proctored physician and accompanying staff the sense of the proctor actually being in the room. This study substantiated this concept by demonstrating that students being proctored during a dissection in an anatomy lab found the proctoring experience valuable and, at times, forgot that the proctor was not physically present.

The value of such a capability for not only proctoring but also for teaching, as was done in this study, is immense. As the demands on surgeons' time increases and the ability to travel (either across the street to the lab or across the country to another hospital) decreases, remote presence systems that give a quality and lifelike presence in the remote location should lead to greater collaboration and access to expertise where it would otherwise not be readily available.

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