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Deployment and early experience with remote-presence patient care in a community hospital

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Abstract
Background: The introduction of the RP6 (InTouch Health, Santa Barbara, CA, USA) remote-presence "robot" appears to offer a useful telemedicine device. The authors describe the deployment and early experience with the RP6 in a community hospital and provided a live demonstration of the system on April 16, 2005 during the Emerging Technologies Session of the 2005 SAGES Meeting in Fort Lauderdale, Florida.
Methods: The RP6 is a 5-ft 4-in. tall, 215-pound robot that can be remotely controlled from an appropriately configured computer located anywhere on the Internet (i.e., on this planet). The system is composed of a control station (a computer at the central station), a mechanical robot, a wireless network (at the remote facility: the hospital), and a high-speed Internet connection at both the remote (hospital) and central locations. The robot itself houses a rechargeable power supply. Its hardware and software allows communication over the Internet with the central station, interpretation of commands from the central station, and conversion of the commands into mechanical and nonmechanical actions at the remote location, which are communicated back to the central station over the Internet. The RP6 system allows the central party (e.g., physician) to control the movements of the robot itself, see and hear at the remote location (hospital), and be seen and heard at the remote location (hospital) while not physically there.
Results: Deployment of the RP6 system at the hospital was accomplished in less than a day. The wireless network at the institution was already in place. The control station setup time ranged from 1 to 4 h and was dependent primarily on the quality of the Internet connection (bandwidth) at the remote locations. Patients who visited with the RP6 on their discharge day could be discharged more than 4 h earlier than with conventional visits, thereby freeing up hospital beds on a busy med–surg floor. Patient visits during "off hours" (nights and weekends) were three times more efficient than conventional visits during these times (20 min per visit vs 40-min round trip travel + 20-min visit). Patients and nursing personnel both expressed tremendous satisfaction with the remote-presence interaction.
Conclusions: The authors' early experience suggests a significant benefit to patients, hospitals, and physicians with the use of RP6. The implications for future development are enormous.

Key words: Remote control — Remote-presence interaction — Robot — RP6 — Telemedicine — Telerounding — Remote presence

Telemedicine has been defined as the practice of medicine or the teaching of the medical art without direct physical physician–patient or physician–student interaction via an interactive audiovideo communication system using tele-electronic devices [11]. Telemedicine is not new. In fact, it has been practiced for more than four decades in the form of telephone consultations, auscultatory cardiac evaluation, electrocardiogram (ECG) transmission, and radiologic interpretation. Recent advances in communications and computer technology have provided considerable improvement in the remote interaction, providing not only telephone and "store-and-forward" capabilities, but also nearly real-time video and motion interaction.

A recent study comparing standard bedside rounding with telerounding using a Web-based video conferencing system with laptop computer camera and microphone and communicating via 802.11b wireless technology demonstrated "substantial improvements in ratings of examination thoroughness, quality of discussions about medical information, postoperative care coordination, and attending physician availability" in the telerounding arm of the study. In the robotic arm of the study, in which a mechanical robotic device, the RP6 (InTouch Health, Santa Barbara, CA, USA) was used as the communications interface instead of a laptop

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computer, patients expressed considerably higher satisfaction with regard to physician availability [1].

Because application of these technologies is in its infancy, very few such studies have appeared. Nevertheless, the apparent patient satisfaction and the recent availability of a usable device intrigued us to use such a system in a busy community hospital. This report describes the deployment of the RP6 and our early experience with it in a community hospital. As such, it is more descriptive than scientific.

Materials and methods

Description of the system

The RP6 is a 5-ft 4-in. tall, 215-pound robot that can be controlled remotely from an appropriately configured computer located anywhere on the Internet (i.e., on this planet, for now). The system is composed of a control station (a computer at the central location), a mechanical robot, a wireless network (at the remote facility: the hospital), and a high-speed Internet connection at both the remote (hospital) and central locations.

The robot itself houses a rechargeable power supply. Its hardware and software allow communication over the Internet with the central station, interpretation of commands from the central station, and conversion of the commands into mechanical and nonmechanical actions at the remote location, which are communicated back to the central station over the Internet.

The RP6 system allows the central party (e.g., physician) to control the movements of the robot itself, see and hear at the remote location (hospital), and be seen and heard at the remote location (hospital) while not physically there. The quality of the Internet connection needs to support data transfer speeds of at least 200 Kbps in each direction for both uploading and downloading. This usually is available with most digital subscriber lines (DSLs) and cable modem interfaces. The wireless network at the remote station must be of sufficient quality to maintain a connection with the RP6 throughout the facility, even in elevators, for the best performance.

The control station currently is a proprietary desktop workstation consisting of a Pentium-IV-grade central processing unit (CPU) or better, an off-the-shelf camera, a proprietary microphone, a dual-screen flat panel monitor, and an off-the-shelf specially configured joystick. The dual-screen monitor allows the RP6 control panel to be displayed on the left and the electronic medical record (EMR) or Picture Archive Communications System (PACS) information to be displayed on the right. The control panel displays information about the robot itself, such as battery power and signal strength of the connection as well as picture-in-picture (P-in-P) views of the remote and central locations. It displays a footprint of the robot and a graphic display of its proximity to surrounding objects at the remote facility. The graphic display is generated from information provided by infrared sensors located on the periphery of the robot and changes color as objects are approached. The system architecture is such that contact with objects while the robot is moving cannot occur.

A session is initiated from a central station that can be located anywhere a high-speed Internet connection exists. The physician (or client) logs on to the hospital's network via the Internet. Because of the Health Insurance Portability and Accountability Act (HIPAA) and other privacy concerns, this usually requires entry through the hospital's virtual private network (VPN) using passwords, instantaneously generated codes, or both.

After connection to the hospital's network is confirmed, the RP6 software program is opened. This brings up the control panel on the central station left-sided monitor. The software establishes a connection with the selected robot if it is available. There can be many robots in any facility, so a list of currently available robots is presented on the control panel. Once a connection to the robot is obtained, both the local and remote camera views are displayed in a P-in-P view on the left monitor. Using the joystick at the central station, the physician not only can unplug himself from the wall outlet, but also can drive the robot anywhere in the remote facility that has an adequate wireless signal.

The robot itself has three large spheres on its undersurface instead of wheels. This allows it to move forward, backward, and sideways. It also can rotate in place on its vertical axis because of its configuration. This is important when the physician needs to negotiate narrow doorways and patient rooms.

At the top of the RP6 sits a flat panel screen, a camera, a microphone, and wireless antennae. The flat panel can be moved independently of the robot's base using the joystick. This allows the physician to rotate or tilt the view at the remote location. The camera and software allow zooming, picture taking, and telestration on the local and remote monitors. Pictures obtained from the robot camera also may be stored.

Results

Setup of the system

The wireless system at the hospital was already in place. It provided excellent signal strength throughout the facility. The Internet connection at the facility also was already in place and easily satisfied the communication requirements.

Installation of the robot involved unpacking the unit from its crate, plugging it into a 110–120-volt standard electrical outlet and charging its batteries. Configuration of its hardware, firmware, and software to allow interaction with the wireless system was performed by expert technicians in less than 2 h.

Installation of each control station took 1 to 4 h depending on the quality of the Internet connection at that location and the VPN access program parameters. At each control station, the upload and download speeds were optimized to allow the best uninterrupted interaction between the central location and the remote location. This usually required only software manipulation.

Patient and personnel interaction

Our system has been in place for approximately 4 months, as of April, 2005. The patient and nursing personnel response has been very positive. Although a prospective study such as that of Ellison et al. [1] has not yet been conducted, the initial response throughout the hospital has been gratifying. Enamored by the technology, patients and their families have expressed excitement about the "cutting edge" technology. More importantly, they have enjoyed the increased access to physicians, especially at "odd" hours. Families have been very pleased with the ability to have a timely discharge visit instead of waiting hours for surgeons and other physicians to complete other activities before such visits.

In our experience, in which office visits are scheduled from 7:30 A.M. until 10:30 A.M., patients usually would have been discharged by 11:00 A.M. or later before the RP6 was installed. Now it is possible for them to be discharged as soon as their family arrives, usually 4 or more hours earlier than previously. To accomplish this, patient education and expectations are managed in a preemptive fashion on the previous day with a physical bedside visit by a physician member of the team (MIS Fellow) on the day of discharge but before the remote visit.

Regarding "off-hours" visits and consultations, the intensive care unit (ICU) has shown the greatest benefit. The intensivists have been able to wean patients from ventilators more efficiently, and to interact with nursing personnel and families when the intensivist him- or herself could not be physically present. Initial surgical consultation during off hours has been more efficient since the introduction of the RP6 at our institution. Notification that a consultation has been requested normally would require a physician to make a 20-min trip to the hospital, and then a 20-min trip back home. Those 40 min of travel time have been eliminated. Patients can be seen literally within 5 min after notification of a request for consultation. At that time, during, and after patient evaluation, orders can be given, and in most cases, a decision can be made as to whether immediate physical presence or operative intervention is needed. This has decreased delay in getting a needy patient to the operating room and has greatly facilitated time management when a nonemergent consultation is requested during off hours.

Nurses and other associated personnel have become surprisingly attached to the RP6. They appear to appreciate better physician access and more efficient patient management by the physician. They also appear to react to physician comments and orders better when they actually can see the face of the physician on the monitor and understand that he is giving them his full attention. Patients also have expressed similar sentiments, indicating that they feel more comfortable with a physician's comments and instructions when they actually can see his expression on the monitor.

As mentioned at the beginning of the article, this is all soft data, but encouraging soft data. More detailed study such as that provided by Ellison et al. [1] is both needed and planned.

Discussion

Computers have been used in medicine now for decades. Handheld computers have been used for nearly a decade, and robots have been used in surgery that long as well. Numerous reports have documented the benefits of computerized algorithms for the management of anti-infectives, ventilator protocols, complex intensive care cases, and interphysician communication [2, 9, 12]. Decision support is enhanced when computerized algorithms generate alerts, reminders, and other information driven by patient-specific data. These systems have reduced management error rates in a variety of settings.

Porting these computerized programs to handheld devices has been shown to improve weaning of patients from ventilators [8]. It also has provided more efficient access to medical databases, texts, and other patient management protocols [6]. As Gandsas et al. [4] have demonstrated, expanding the use of handhelds to accept streaming video with minimal real-time delay provides residents and students with better mobile access to minimally invasive procedures taking place when they were otherwise occupied with duties in a remote location of the hospital [4].

Whereas telephone communication is commonplace in medicine, the application of Web-based video conferencing in medicine still is relatively new and not all that widely used. Nevertheless, as Ellison et al. [1] have shown, it can have a significant impact on patient satisfaction. Remote patient monitoring in the ICU (the e-ICU) also has been shown by Rosenfeld et al. [10] to decrease ICU mortality, hospital mortality, ICU complications, and hospital costs.

One of the questions, however, involves reimbursement for the equipment and services provided in such settings. To that end, Congress reportedly enacted legislation on October 1, 2001 to expand Medicare coverage to include consultations, office visits, individual psychotherapy, and pharmacologic management when these activities involve interactive audio and video [3, 5].

The next step beyond video conferencing and e-ICU monitoring naturally is a robotic intervention in which the provider at a central station interactively communicates with patients and others at a remote location (hospital) incorporating two-way audio, video, and motion. Physician-directed robots are not new in surgery. Robots have proved to be useful in minimally invasive surgery for a number of years. They have extended the capabilities of experts by incorporating motion scaling and tremor reduction, and they have enabled surgeons with less expertise to perform operations, such as laparoscopic radical prostatectomy, that they would not otherwise be capable of performing [7]. It appears that systems such as the RP6 are poised to let us take the next step (or roll, as the RP6 does) to improvement of patient care through better access to physicians and other health care personnel at remote locations.

Conclusions

Remote-presence interaction between health care providers and patients still is in its infancy. Early experience with this technology is encouraging. Further study is warranted as these systems roll out into our environment.

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