Surgical Telementoring in Pediatric Minimally Invasive Surgery

Dr. Steven Rothenberg in Colorado and his fellow Dr. Todd Ponskey in Ohio, recently performed the first ever telementored thoracoscopic lobectomy on a five-month-old female. Because this infant could not travel, telementoring was arranged to perform a right lower lobectomy of a congenital lung lesion. The surgery, performed in less than two hours, was one of the most complex procedures ever telementored. It not only saved a costly and difficult journey, but also ensured the infant the highest level of expertise available. Dr. Rothenberg helped with pre-operative set-up, positioning, trocar placement, and then guided Dr. Ponsky through the case without complication. According to Dr. Rothenberg, “The efficacy of this technique and technology in surgical education is huge.”

GLOBAL TELEMENTORING

Surgical Telementoring using a tablet - bridges two continents

In January 2014, Dr. Conor Delaney and Dr. Knut Magne Augusted at University Hospitals Case Medical Center assisted Dr. Rolv-Ole Lindsetmo at University Hospital North Norway, 6500 miles apart, in the first transatlantic telemented surgical sessions ever performed using a tablet PC. Two patients with colorectal cancer were operated on in Norway, and during the procedure, the Norwegian surgeon used the tablet to follow the surgical steps in real-time. The increased capability of wireless technology allows for two-way audio/video communication between a patient or surgeon located in a hospital's operating room and another surgeon that may be a mile or several thousand miles away. This promotes collaboration between fully trained surgeons that are seeking guidance from surgeons with special skills and equipment.

A WORD ON TELE-TERMINOLOGY

The increased capability of wireless technology today, allows for two-way audio/video communication between a patient or surgeon located in a hospital's operating room and another surgeon that may be a mile or several thousand miles away. This promotes collaboration between fully trained surgeons that are seeking guidance from surgeons with special skills and equipment.

SPECIALTY SOCIETIES JOIN TO IMPROVE SKILLS

For the first time in the United States, several surgical specialty societies will join together to implement a Grant to determine whether telementoring, otherwise known as “remote presence”, can help doctors learn new skills and improve old ones. If successful, this initiative could become the model for the training of mid-career surgeons and medical proceduralists who are not fully familiar with current techniques. They will be able to utilize equipment that allows more accomplished surgeons to watch and participate in their surgery from a remote site, to help less experienced surgeons with real-time advice and instructions.

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Using a wearable computer, known as “Google Glass”, physicians at the University of Arkansas for Medical Sciences (UAMS). Drs Barry Uretsky, Abdul Hakeem, and Christian Assad-Kottner (Fig.1) performed an interventional patent foramen ovale (PFO) closure procedure with the assistance of a congenital heart expert, Dr Eudice Fontenot, of the Arkansas Children’s Hospital. Dr. Fontenot, a recognized authority as the telementor.

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SPECIALTY SOCIETIES JOIN TO IMPROVE SKILLS

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required to be credentialed and actively performing sleeve gastrectomy procedures at their institution.

Since the necessity of travel is the major limiting step in the preceptorship or proctoring process, this telementoring program is expected to eliminate the drawbacks of travel and time away from work and family for both the surgeon trainee and the expert surgeon proctor.

One of the challenges to telementoring in the United States is the requirement that a physician be licensed in the state in which he is practicing and treating patients. While providing education to another physician through becoming involved in direct patient care, a proctor would, by necessity, need State licensing permission to change or alter a procedure. This would be true even for the purposes of teaching and ultimately improving patient safety.

How can this permission be achieved? A few states currently support telementoring by granting a license. However, these have different purposes and restrictions and, at this time, do not grant telementoring privileges. Many of the states currently have “consultation exceptions”, but most do not articulate what that entails except that a licensed in-state physician can request a consultation from a physician in another state. The majority of these consultation exceptions appear broad enough to possibly encompass telementoring, however in a few states they currently may be too narrow.

These permissions may be moving in a positive direction, however, as one state stands alone in clearly articulating the basis for the possibility. Delaware, in 1787 the first State into the Union, has become the first state to recognize the need for continuing surgical education and permits out of state consultation without need for licensure. Their law clearly states that “… Any consultation done for teaching and/or training purposes may include active participation in procedures, whether surgical or otherwise, provided a Delaware licensed physician remains responsible as the surgeon of record...” (1)

While this law does not specifically mention telementoring, Delaware State Division of Professional Regulation Executive Director, Gayle Lynn MacAfee believes “telementoring will provide a huge potential to the citizens of Delaware by offering patients the best medical expertise despite long distances; thus, allowing an opportunity for all physicians in Delaware to gain additional medical education through telementoring.”

Robert C. Knittle, Executive Director of the West Virginia Board of Medicine agrees: “the telementoring program offered by the Foundation is educational in its approach in order to enhance and update the specific skill sets and knowledge of a physician which can then be applied within the practice of medicine. I find your program innovative in its approach and a valuable training and educational component to our physicians in West Virginia. I do not find this program in conflict with the Medical Practice Act.” (2)
SPECIALTY SOCIETIES JOIN 
TO IMPROVE SKILLS

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Five of the fifteen scholarships have been awarded to surgeons in those two states. In other states, some of the scholarships have been awarded to former fellows of the proctors. That may offer a real solution to the complex problem of transition from residency to practice, which many surgeons find daunting and an impediment to patient safety.

The surgeons selected for this program will receive free of charge didactic on-line resources. Utilizing KARL STORZ VisiOR®, screens (3), these surgeons will then observe expegastric sleeve gastrectomy through a unique telementoring technology with two-way video and audio live communication. After the case observation, the expert surgeon will telementor the trainee for two or more cases.

In addition to this project, SAGES has developed a program called “Go Global!” As part of that program they will be providing telementoring to bariatric surgeons in South America. Surgical Telementoring News will be following these programs with a full report on its progress in our next issue.

1) The opportunity of telementoring is made possible through the Delaware Board of Medical Licensure and Discipline’s Rule 6.0 for Consulting Physicians, allowing consultations to be done telephonically, electronically or in person, provided a Delaware licensed physician remains responsible as the physician of record.

2) “The section of our Medical Practice Act, 30-3-13(d) is applicable to the actual practice of medicine which is defined as the “diagnosis or treatment of, or operation or prescription for, any human disease, pain, injury, deformity or other physical or mental condition. The practice of medicine is patient specific. Consultative practices are perceived as patient specific encounters which at times may even involve direct patient interaction.

3) “The Grant is being generously supported by KARL STORZ Endoscopy America, Inc., providing the remote presence devices VisiOR®.

SURGICAL TELEMENTORING IN PEDIATRIC MINIMALLY INVASIVE SURGERY

Continued from page 1

Reported results of telementoring are improving surgical practice, education, treatment and postoperative care. Telementoring is described as a “natural fit” in surgery as surgeons are often sparsely geographically distributed, and with a predicted shortage of surgeons, distance education is becoming increasingly important. Recent technological developments have led to a renewed interest in the potential of telemedicine to provide new cost-effective collaborative solutions in surgery.

The rapid evolution of emerging surgical technologies and procedures has necessitated that surgeons rapidly assimilate and train in a varying array of new procedures. Dr. Rothenberg noted that “this has been especially evident in the field of pediatrics and more specifically neonatal minimally invasive surgery. Cases such as thoracoscopic lobectomy, tracheo-esophageal fistula repair, or laparoscopic correction of congenital intestinal lesions are rare and require a high degree of skill and experience to complete.”

While there are large numbers of hands-on courses, teaching aids, video files, and mentoring programs developed to try and help surgeons learn and assimilate these techniques, there is a well-recognized distinction between a surgeon taking a training course and/or a mini-fellowship, and successfully applying these techniques in their practices. Having an onsite mentor is often not logistically or economically feasible, especially in a highly specialized field such as pediatric surgery where there are few expert mentors, or the frequency of a specific procedure is rare. When time is of the essence in a case that is emergent or semi-emergent, time restraints often do not allow for a mentor to be brought onsite. The wide use of the internet and the ability to transfer images and audio communication instantaneously is a logical and cost effective solution said Dr. Rothenberg. “We initially used the InTouch RP-7 mobile robot which had already proved itself in telemedicine endeavors where a physician for various reasons could not be onsite, to bring added surgical expertise into the OR.”

The RP-7 has been used extensively to allow physicians to monitor patients within the hospital from remote locations as close as the physician’s office across the street to other hospitals within the city or region, and has even been used transcontinentally.

“With this in mind, he added, it seemed a logical extension to bring the robot into the operating room environment to determine if similar consultation and mentoring could be achieved. A number of cases where the surgical mentor was offsite using a laptop and the RP-7 was in the OR were successfully mentored. This led to the development of another, more appropriate OR solution called VisiOR®.”

This technology is a collaboration between InTouch Health and KARL STORZ Endoscopy where the “brains” of the RP-7 were mounted on a boom mount clamp inside the OR and was directly connected to the video feeds generated in the integrated operative suite (OR1). The remote surgeon while on a laptop, or more recently from a portable tablet such as an iPad, can connect into the OR and directly communicate with the surgeon. The mentoring surgeon can access the room view as well as directly link to the endoscopic view, and can interact with the onsite surgeon via direct visual contact, voice and telestration.

Dr. Rothenberg started a pilot program at the Rocky Mountain Hospital for Children in Denver and a second VisiOR® was recently installed at Columbia University in the Morgan Stanley Children’s Hospital in NY. He has already established an onsite monthly mentoring program at Columbia for complex thoracoscopic and laparoscopic cases which were not emergent, but the placement of VisiOR® has greatly increased their bandwidth and ability to deal with more emergent cases over 2000 miles away. In his experience, the communication in all cases between the surgeon and mentor flowed well enough to facilitate the procedure. An additional benefit he said was the ability to have a second junior surgeon on a second control station that can monitor, comment on, and learn from the case. They have also accessed and controlled VisiOR® from New Zealand, Vietnam, and Taiwan; in the last case participating in resident’s hands-on animate lab, proving that this technology could be used globally. The greatest benefits to the operating surgeon seemed to be assistance in setting up the surgery (positioning, trocar placement, etc.), identifying the pathology, and discussing how best to approach the case. In general, the Telementor has considered the visualization of the operative field to be good to excellent, and felt that it allowed for mentoring on a level that was equivalent to having been in the room. The direct feed of the laparoscopic view allows the mentoring surgeon to see the same HD view that the onsite surgeons are viewing.

The greatest advantage in pediatric surgery is helping well-trained surgeons to overcome the hurdles of trying to implement the advanced techniques they have learned in cases that are relatively rare without compromising patient care and bringing added surgical expertise into the operating room. There is no question that surgical telementoring offers this opportunity. Sharing of medical expertise will improve outcomes and in the long run, greatly lower costs.
SURGICAL TELEMENTORING USING A TABLET - BRIDGES TWO CONTINENTS

A new low cost and innovative telementor solution

"Telementoring on tablet PCs is a fascinating and innovative solution," says Professor Conor Delaney, Chief of the Department of Colorectal Surgery, University Hospitals Case Medical Center in Cleveland. "The fact that we were able to perform transatlantic telestration (drawings over a live videostream) enhanced the mentors teaching capabilities and made it so much easier to reach a common agreement on the key surgical anatomical locations (Figure 1). The mobility of the technology is also of key importance, as mentors can connect to any Wi-fi or fast HSPA (High speed packet access) 3G-cellphone network, or the new or the new LTE (4G) mobile network. In a busy hospital workday, this is a huge advantage," says Dr. Delaney. In Norway, Dr. Lindsetmo, chief at the Department of Gastrointestinal Surgery, University Hospital North Norway, is in charge of a hospital telementoring network. "At present we aim to connect several local hospitals to a University Hospital. This will contribute to build surgeon-networks that have the potential of helping surgeons out of difficult situations in the operating theatre. As a University Hospital it is our responsibility to utilize available technology to the benefit of the patients. That is what telementoring is about; to improve the quality and safety of the surgery performed wherever the super-specialist must be located ".

Telemotorning as an educational tool

To meet the increasing demand for general surgeons, surgical telementoring for educational purposes should be further explored and evaluated," says Dr. Augestad, Research Manager, Department of Research and Innovation at Norwegian National Center of Telemedicine and Department of Gastrointestinal Surgery, University Hospital North Norway. Recently, a meta-analysis supported evidence that trainees can obtain similar clinical results to expert surgeons in laparoscopic colorectal surgery if supervised by an experienced trainer. Two surveys of laparoscopic telementoring, showed no significant difference in conversion, anastomotic leak or mortality compared to on site mentoring. "In the reviews we performed," says Dr. Augestad, "there was a 5 % complication rate and 5 % conversion rate, which is accordance with others.." In fact there have been reports of decreased operation time of telementoring compared to physical presence. 

"Present understanding of the effects of video-conference technology on surgical practice is limited," says Dr. Knut Magne Augestad. In a recent systematic review, 34 surveys were identified and summarized (1,2). Four hundred and thirty three surgeons were reported, with a complication frequency of 5 %. Laparoscopic cholecystectomy, colectomy and endovascular treatment of aortic aneurysm were most common procedures. All surveys focused on education, however only eight (23 %)

had a systematic evaluation of surgical performance and educational outcomes and reported improved surgical performance. Perceived usefulness of surgical telementoring was high among 83 % of surgical trainees. But, there was considerable room for improvement of research quality, as only 20 % of papers had defined a clear research question. Similarly, only 30 % of surveys performed an evaluation of user satisfaction of the technological telementor solution.

Telementoring as a tool to meet the surgical shortage

Unless the rate at which general surgeons are trained increases, the number of general surgeons per population will continue to decline. This means that the rate and volume of surgical education has to increase, and videoconference and surgical telementoring can be used to meet this demand. Telemotorning as a tool for education between different levels of healthcare has been described by different surgical specialties. Participant satisfaction was high and the opportunity to discuss case management significantly improved. However, bringing together multiple experts to focus on a single patient is a logistical challenge. With videoconferencing and telementoring, discussion of a series of patients among a broad range of experts is possible across vast distances.

Telestration, a core function in telementoring

From a clinical perspective, aspects such as video encoding and video resolution in telementoring solutions are important. Video encoding affects, for instance, how nuances in color of the intestines get represented in the video signal. Picture resolution affects what anatomical landmarks may be identified with a high degree of certainty. A video resolution of 768 x 492 and higher is perceived to give high perceived video quality, whereas 320 x 240 and lower is evaluated to provide medium perceived picture quality. The most common telementoring feature is telestration and it seems that this feature is mandatory for all telementoring solutions. The visual assisted mentoring utilizes telestration, which has been used mostly in weather forecasts and broadcasted sport events since the early sixties. Telestrators allow surgeons to draw a freehand sketch over the live video stream, and enables the
mentors to convey their teaching not only verbally but also visually leaving less place for wrong interpretation of the mentor instructions (3). “In my opinion, telestration is a core function of surgical telementoring, as it enhances the teaching capabilities significantly” says Dr. Lindsetmo at University Hospital North Norway. “I believe that the telestration is an obligatory functionality of telementoring systems due to the increased accuracy of pointing actions. However, no analysis of the impacts of telestration to educational aspects of telementoring has been performed and this needs further attention.” (3)

How is the patient security issue met?

All communications within the new telementoring tablet prototype – from the mobile App through telementoring center and to the streamer and back again – are secured over a patent-pending streaming technology using the IETF-standard Transport Layer Security (TLS) protocol, ensuring the confidentiality, integrity and availability of data. The telementoring prototype encrypts all data end-to-end using 256-bit Advanced Encryption Standard (AES). The prototype follows HIPAA guidelines for the privacy and security of remote access to healthcare information and can be used within a larger system to support HIPAA (Figure 2).

An international research initiative is needed

“During the last couple of years the technological solutions for surgical telementoring has made giant leaps forward,” says Dr. Knut Magne Augestad. As a research leader at The Norwegian Center of Telemedicine, he has worked with different technological solutions for surgical telementoring. “Two decades ago, we started up with solutions that were costly and extremely difficult for the surgeons to operate. Now we are at a stage where the technological solutions for telementoring are inexpensive and so easy to setup that the surgeons can do this independently. The necessary equipment is a PC, a PC tablet, any voice over IP (VOIP) headsets, telementoring software package, and a reasonably fast Wi-Fi or cell phone connection (Fast 3G/4G).”

“Tumor types have included pituitary adenoma, schwannoma, meningioma, sinonasal malignancy, chordoma, and esthesioneuroblastoma. The predominant reasons for failure are insufficient volume of cases and lack of mentoring” (3)

TELEMENTORING IN ENDOSCOPIC SKULL BASED SURGERY GOES GLOBAL

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Figure 2. Architecture of a PC tablet surgical telementoring system.

TELEMENTORING IN UROLOGY FROM CANADA TO CHINA, BRAZIL AND THE UNITED STATES

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From the Editor:

TELEMENTORING TO IMPROVE PATIENT SAFETY  Continued from page 1

Telementoring is a teaching tool that can bring 21st century medical breakthroughs into every operating room, clinic and surgical suite. The philosophy behind telementoring is simple and life-altering – provide the optimal tool for doctors to learn new skills and improve on old ones.

With a Grant by FAME, a division of the American Medical Foundation for Peer Review and Education, several surgical specialty societies have joined together for the first time to pioneer this initiative for the transfer of knowledge and skills from experienced surgical practitioners on complex techniques and procedures.

Telementoring establishes the new model for the most efficient and cost-effective transfer of knowledge and skills ever undertaken from the world’s top surgeons to other doctors around the globe, including recent graduates and surgeons who need new training. In this newsletter we described several surgical procedures where mentors have assisted their former fellows in improving skills. This “transference to practice”, is an exciting opportunity for future post graduate physician education. This model can create better-trained surgeons, improve medicine, increase patient care, and cut down on the cost and frequency of malpractice cases.

This first edition of Surgical Telementoring News explains telementoring as a surgical tool and introduces some of the people behind it. One contributor, Dr. Knut Augustdal, Director of the Department of Telemedicine from the Department of Gastrointestinal Surgery at the University Hospital North Norway, says that “together with the American Medical Foundation and others, we are seeking partners and funding for prospective trials in surgical telementoring. We are especially interested in collecting prospective data from smaller ongoing US and international telementoring trials, in one large quality database across surgical disciplines, where we aim to assess and develop the educational and cost-effectiveness of surgical telementoring.

Please write and tell us about your recent telementoring experience. Only by joining forces nationally and internationally can we truly demonstrate the potential of such advanced technology.

We need your support and would appreciate your comments.

Evelyn Baram-Clothier
Write to: editor@telesurgery.org

TELESURGERY: IS THERE A FUTURE?

Projects Agency (Darpa), NASA’s primary interest was in the development and utilization of robots for the U.S. Space Shuttle, International Space Station, and planetary exploration. Darpa was interested in developing tools for application in battlefield medicine, specifically trauma. These research efforts resulted in a wide variety of technologies with some commercialization.

Specifically, this funded research led to the establishment of two companies, Computer Motion and Intuitive Surgical. These companies then developed “telesurgery”-capable robotic “assist” systems, the Zeus and the da Vinci, respectively. The term “telesurgery” implied the systems could be used where surgeon and robotic system were separated by, in the da Vinci case, a 30 foot cable or in the Zeus case via communications network.

Early rationale for the da Vinci-like system was to be utilized on an airframe for wounded warfighters or in the actual theater of war, albeit at the rear echelon. The size of the system was too large and was not deployable, however, SRI was able to successfully license the technology to Intuitive Surgical and that company has been successful in developing a commercial line of surgical systems sold widely in the U.S. and around the world.

The concept of telesurgery was reflective of a desire to have surgeons in one place and surgical patients in another. This could be attributed to both a need and a potential shortage of surgical care capabilities in remote or extreme environments.

In the early 1990s, laparoscopic surgery began to become more widely used in surgical cases in the U.S. and worldwide. The Zeus and da Vinci systems integrated this minimally invasive surgical (MIS) approach, providing the surgeon a unique position, where they were removed from the actual patient by some relatively short distance.

As the 20th Century came to a close, Computer Motion and Intuitive Surgical were the two companies that had surgical robotic systems on the market. In the early part of the 21st Century, they were merged into one company, Intuitive Surgical.

World’s First Telerobotic Surgical Cases

In September 2002, Professor Jacques Marescaux utilized a Zeus robotic system to operate on a patient in Strasbourg, France, Marescaux was in New York City over 5,000 miles away. This surgery, a cholecystectomy, was the first true “telesurgery” and has been known as “Opéra Lindbergh”. Marescaux and his team were connected via significant virtual private network (VPN) to the surgical team and patient in France. Using the Zeus “surgeon” unit, he controlled the patient-sided (surgical arms) with end effectors inserted in the patient. This surgical procedure was successful.1,2

Shortly after this, Dr. Mehran Anvari, a Canadian surgeon began to conduct a series of surgical procedures between Hamilton and North Bay. This series of surgical events were also conducted using the Zeus system. Anvari conducted a number of clinical cases with a geographic separation of surgeon and patient.3,4

The outcome of both Marescaux and Anvari’s work has been well published and has served as the foundation for most of the research that has followed. Not only can these events lead to new and novel surgical capabilities but they also reinforce the concept of telementoring. Whereby and remote expert can provide guidance to someone who is located in some distance away.

In the mid to late 1990s, NASA funded the development of a commercial space center (CSC) at Yale University within, interestingly enough, the Department of Surgery, under the direction of Dr. Ronald Merrell. On his staff were two recognizable and notable surgeons, Dr. Richard Satava and Dr. James “Butch” Rosser. The purpose of the CSC, known as the Medical Informatics and Technology Applications (MITA) was to explore and develop testbeds in support of NASA’s interest in telemedicine both for human spaceflight and its international activities. Merrell and colleagues had become quite adept at providing surgical capability in mobile facilities in the jungles of Ecuador with low bandwidth connectivity to Yale surgeons for mentoring.5 This concept also proved valuable in mentoring physicians and other providers on Mt. Everest Base Camp.6

A Snippet About Research Efforts to Date

This serves as a testimony of what has been done, and how these possibilities can lead to new and more robust technologies, procedures and opportunities.

As commercial surgical robotic systems were becoming widely available in the early 2000s, one system was capable of long distant operation and the other required additional software modifications to permit such operations. The U.S. Army’s Telemedicine and Advanced Technology Research Center (TATRC) began to expand its research portfolio in telesurgery. In 2005, TATRC partnered with the University of Cincinnati’s Department of Surgery, Johns Hopkins University, Walter Reed Army Medical Center, and Intuitive Surgical to conduct a series of tests with the da Vinci ‘Classic’. The University of Cincinnati (UC) had two systems, one for research and one for clinical case load. The research system was modified to permit remote operations. On two occasions, once from Cincinnati and once from the American Telemedicine Association (ATA) Annual Scientific Meeting in Denver, CO (2005).

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experience in the use of a certain device or performing a particular procedure.

Using various types of equipment such as InTouch’s RP-Vantage and KARL STORZ’s VisiTOR1, hospitals and other organizations are able to facilitate remote procedure observation and a variety of supportive activities with the goal of improving knowledge and clinical outcomes as well as accelerating adoption of innovative medical devices and procedures.

In this first issue of Surgical Telementoring News, Greg Drutchas and Keith Wright, expert attorneys in telemedicine, address terminology for the different uses of remote presence in credentialing, peer review and practice settings. In the next issue, they will review the use of remote presence in enhanced credentialing and peer review.

According to this legal team, “As there is no “industry standard” with regard to terminology and without claiming these definitions represent authoritative nomenclature, we have developed the following terms for our legal work in the area, to describe and distinguish the level of observation and participation surgeons may have in the delivery of patient care by remote presence. In presenting the definitions, we use the term “surgeon” in its broadest sense to include any kind of proceduralist, including, by way of example, cardiologists and gastroenterologists.” (1) They present the following categories:

**Teleobserver:** A Teleobserver is a less experienced surgeon (but could also be a student or other trainee) seeking education by concurrently observing an experienced surgeon performing a procedure or demonstration of the use of a device. The less experienced observer will be able to remotely login and view the procedure, interact in the form of questions to the onsite surgeon. The onsite surgeon is able to teach. Without that interaction, the presentation would be easily substituted by a prerecorded event on videotape or electronic disk. The goal of this process is to expand knowledge and, in appropriate circumstances, spur innovation.

**Teleproctor:** A teleproctor is an experienced surgeon who, through virtual presence in an operating room, passively observes an onsite surgeon who is perceived to be fully qualified and trained to independently perform the proctored procedures or use of a device. Like a physically present proctor, the teleproctor’s interactivity will be limited to the ability to ask questions of the onsite surgeon for clarification. After observation, the teleproctor can then validate the skills of the surgeon or identify potential inadequacies. Examples may be observation on behalf of a hospital medical staff to evaluate a new surgeon who is provisionally appointed, or a current staff surgeon whose skills have been questioned. This approach is also ideal for evaluative use in a hospital lacking a cadre of other unbiased physicians with the same privileges, or for re-certification by a specialty organization. In this scenario, the teleproctor does not participate in the procedure, give guidance or otherwise function interactively; rather the teleproctor furnishes a retrospective review to the individual or organization for which the procedure is performed.

**Telementor:** A telementor is an experienced surgeon, highly skilled in a particular procedure or use of a device, who, on a remote basis, serves as a resource for an onsite surgeon, already fully trained in his field and in performing that procedure or device use. The telementor-advisor is available in the operating room via two-way video and audio to give guidance that adds depth of experience or knowledge for the surgeon performing the procedure. The telementor-advisor interacts but typically would not have the authority to intervene in the procedure. However, depending on the circumstances and with the appropriate type of authority, the telementor could start out as an “adviser” and based on observations and need, progress to being a “preceptor”.

**Telementor-Advisor:** A telementor-advisor is an experienced surgeon, highly skilled in a particular procedure or use of a device, who, on a remote basis, serves as a resource for an onsite surgeon, already fully trained in his field and in performing that procedure or device use. The telementor-advisor is available in the operating room via two-way video and audio to give guidance that adds depth of experience or knowledge for the surgeon performing the procedure. The telementor-advisor interacts but typically would not have the authority to intervene in the procedure. However, depending on the circumstances and with the appropriate type of authority, the telementor could start out as an “adviser” and based on observations and need, progress to being a “preceptor”.

**Telementor-Preceptor:** A telementor-preceptor, who might also be called a “telesupervisor,” observes and mentors but also has the right and responsibility to intervene and direct the individual that is performing the procedure. This potentially involves actual participation in patient care through remote direction. This allows for the teaching of new procedures and the use of new devices in a safe and secure environment. An additional purpose of the telementor-preceptor may be peer review and observation. It could make sense to use a telementor-preceptor where there are doubts about the sufficiency of judgment or knowledge of the onsite surgeon, who would benefit by the education, but it would not seem appropriate where technical procedural skills were in serious doubt after teleobservation.

**Telemedicine Practitioner:** Although some states have statutorily defined teledmedicine broadly to include consultation and education using interactive video or data communications (so as to cover telepreceptor or conceivably even a telementor), for purposes of this analysis the term telemedicine practitioner is used to describe a practitioner (proceduralist or otherwise) who actually performs patient care through virtual presence at a remote site. This requires authority to control a patient’s treatment and care and the legal ability to practice in the state where the patient is physically located. Current examples of telemedicine include remote operative neuro-monitoring, teleradiology or robotic surgery from a remote location.

Some of the difficulties in developing standardized industry-wide terminology is compounded by the fact legislators throughout the country are developing terminology specific to their own states and statutes as telemedicine issues (ranging from reimbursement to standard of care) continue to become more prevalent. Nevertheless, the healthcare and remote presence technology industries would benefit from consistent terminology.

(1) Contributed by Gregory Drutchas and Keith Wright, health lawyers in Detroit Michigan with the firm of Kitch Drutchas Wagner Valitutti Sherbrooke. They devote a very substantial part of their practice to medical staff, peer review and telemedicine issues.

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and conducted. In the NEEMO experiments, the Aquarius habitat was wired or tethered to the surface, where the signal was wirelessly transmitted from the water’s surface (buoy) to a terrestrial infrastructure. The next logical step was to evaluate how telesurgery could be done with a complete wireless network. Again UC partnered with TATRC and University of Washington to deploy a robotic system, Raven, an extreme environment. AeroEnvironment was contracted to provide an unmanned aerial vehicle (UAV) for communications support. In the high desert, north of Simi Valley, CA, a set of experiments were conducted with portable electrical power, a robotic system and a control system, which were separated by a little over 100 feet. The UAV provided the communications link between the two systems.10

After this work was completed several books and book chapters have been written, including Jacob Rosen, Blake Hannahford and Richard Satava’s book entitled ‘Surgical Robots’; Sajesh Kumar and Jacques Marescaux’s book entitled ‘Tele-surgery’; and Rifat Latifi’s book ‘Telemedicine for Trauma, Emergencies, and Disaster Management’. These are but a few reference tools that provide a foundation for moving telesurgery forward.

In the Rosen book, Dr. Gerry Moses and I presented a chapter on ‘Overcoming Barriers to Wider Adoption of Mobile Telerobotic Surgery: Engineering, Clinical and Business Challenges’. In this chapter, a number of challenges and barriers were discussed and these, discussed below, lay the foundation for how we might move forward, or at least begin a more fruitful discussion.

Where is it going?

A short summary of research activities in telesurgery has been presented. Much has been funded in the US by the military. In Strasbourg, France Dr. Marescaux runs the European Institute of Telesurgery at the Institut de Recherche contre les Cancers de l’Apparell Digestif and there is much more to do. It has been an interesting journey and with the growing challenges our healthcare system faces, perhaps our journey will get even more interesting.

None of these challenges have really been adequately addressed for telesurgery to be commonplace. Perhaps we are at a crossroads, where telementoring, while not prolific, is an acceptable tool and surgery at a distance is still in development. Telesurgery is not science fiction; it has been shown to work. Much has been done and there is much more to do. It has been an interesting journey and with the growing challenges our healthcare system faces, perhaps our journey will get even more interesting.

References

TELEMENTORING USING GOOGLE GLASS

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Google Glass is a wearable computer that is currently in a prototype phase ("Explorer" version). In essence, it is wireless extension of a mobile device ("smart" phone or tablet) with visual capability. Like a mobile device, the potential of Glass does not rely solely on its hardware but on the software/apps which are currently being developed. There are five components: 1) bone conduction transducer that is able to transmit audio through the temporal bone and mastoid process, 2) a microphone that captures voice and allows user to make phone calls and video conferences, 3) a camera that can record 5 megapixel photographs and 720p HD video that can be transferred live via the internet, 4) a computer with gyroscope, GPS, Wi-Fi, Bluetooth, and 12 GB of storage, and 5) a prism which provides the Glass display to the wearer.

Figure 1: Dr. Assad-Kottner using Glass to livestream the case to Dr. Fontenot

The foramen ovale is a connection between the right and left atria which is open (patent) in the fetus and closes in most infants spontaneously. About 10 percent remain open after birth and usually produce no symptoms. But there are some circumstances that may require closure. This can now be performed by a catheter, i.e. percutaneous.

According to Dr. Uretsky “Most interventional cardiologists who treat adults do not have extensive experience in closing a PFO. Although we felt comfortable doing the procedure, utilizing a mentor with expertise directly benefits the patient. After access was obtained, we spotted a mobile artifact on echocardiography at the end of the closure device highly suggestive of thrombus. These images were transmitted to the telementor who agreed with the diagnosis and suggested at this point to retrieve the device to avoid the possibility of a thromboembolic event (Figure 2, 3). When the device was retrieved, the suspicion was confirmed, with a thrombus noted at the device tip (Figure 4). The telementor further guided the operators to flush the sheath and adequately clean the thrombus from the device, with excellent results. The patient was discharged much improved.”

Figure 2: Monitor in which Dr. Fontenot was observing the procedure

Second, the quality of the videoconference is directly related to the bandwidth speed (both upload/download) of the network Glass is connected to. In order to have a good conference experience at 30 frames per second a connection of 2 megabits per second is required. Speeds can be lower but this will affect the quality of the video stream. In addition, if procedure is performed in a cath lab, leaded walls will likely degrade the network signal. Also, battery life does not last long if using it in videoconference. A fully charged battery can drain in less than 30 minutes. For this reason an external battery pack is usually required.

The concept of telementoring is becoming a feasible and accessible option for many professionals. As Dr. Christian Assad-Kottner explained, the reason for this is directly related to “Moore’s law” which states that every 18-24 months the number of transistors in an integrated circuit doubles. What this means is that technology is exponentially becoming cheaper, smaller, faster and more powerful and therefore more accessible. In 2014 the number of mobile-connected devices will exceed the number of people on earth and mobile data is expected to grow 11 times in the next 4 years reaching a whopping 18 exabytes (1 billion gigabytes) of transferred information. This is the reason why telemedicine, telehealth, and now telementoring are getting so much attention. We are entering an interconnected era in which wearable technology will empower individuals to communicate with each other seamlessly.

The UAMS team is now working to optimize transmission so as to view catheterization procedures in different locations within the institution with the ability of interventional colleagues to view and consult on the best approaches to manage the patient and improve patient outcomes....

About the author:

Professor Charles R. Doarn serves as a special assistant to Chief Health and Medical Officer at NASA and is an editor in chief of the Telemedicine and e-Health Journal. He has taken an interesting journey through academic medicine, spending nearly 15 years in surgery at Yale, Virginia Commonwealth University and the University of Cincinnati. He worked closely with colleagues in developing several telesurgery projects at UC funded in part by the US Army’s Telemedicine and Advanced Technology Research Center. In addition, he is an editor-in-chief of the Telemedicine and e-Health Journal, a job he shares with surgeon, Ronald Merrell. Mr. Doarn authored NASA’s strategic plan for Telemedicine and has published over 200 manuscripts, editorial, federal reports and book chapters.