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**The Future of Medical Robotics:
Creating Synergy in the Interaction of
Patients, Caregivers, and Intelligent Machines**

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Robots are gaining acceptance in hospitals. Despite misgivings of skeptics who believe that “real” medical care will always be defined by the healing touch of hands-on caregivers, robots have started to prove their worth in one of the most labor-intensive sectors of the American economy. Machines that perform human tasks are now playing significant, even essential, roles in shaping the delivery of affordable and acceptable health care for the 21st century. Robots in clinical applications have moved from one-of-a-kind experimental devices to a variety of proven commercial products over the past decade.

In 2001, robotic applications in surgery were the focus of the first future-focused study conducted for Bon Secours’ Technology Early Warning System (TEWS). The resulting white paper evaluated technologies that are now well-established in the medical marketplace, such as Intuitive Surgical’s da Vinci® system.¹ In 2003, the sixth TEWS publication evaluated the prospects for service robots that are now being used as substitutes for many human activities (e.g., delivery of materials to specific locations, order fulfillment, automated specimen testing in medical laboratories).²

Now, in 2007, this TEWS white paper presents an in-depth inquiry into the next wave of robotic applications in health care—automated machines that allow caregivers to provide non-invasive care to distant patients. This newest commercial application does not yet have a universally accepted name. It is often described, however, with reference to its principal function: extending a clinician’s capabilities through **remote presence**. This depiction is conceptually appropriate, but it is not functionally specific. Surgical robots also provide remote presence, but they perform very different clinical tasks (e.g., removing tissue inside the body through minimal access techniques, implanting radioactive pellets in prostate tumors via brachytherapy).

¹ <http://www.bshsi.com/tews/docs/ROBOTIC%20SURGERY.pdf>

² <http://www.bshsi.com/tews/docs/TEWS%20Service%20Robots.pdf>

Defining Medical Robotics

This paper employs the rubric of **medical robotics**, reflecting common historical use of *medicine* to differentiate non-invasive diagnosis and therapy from *surgery* (e.g., medical oncology that counteracts tumor growth with chemotherapy vs. surgical oncology that removes tumors; medical cardiology that reverses atherosclerosis with drugs, diet, and exercise vs. surgical cardiology that uses angioplasty to remove coronary plaque). Therapeutic and rehabilitative applications of robots (e.g., physical therapy, prosthetic machines to emulate limb function) arguably merit a fourth classification—perhaps presaging a fourth TEWS white paper.

Indeed, current differences in specific applications support designation of four distinct categories of robots in health care delivery: surgical, medical, service, and rehabilitative. The distinctions are relevant because robots designed to perform tasks in any one of the four clinical areas would generally not be suitable for use in any one of the others. Vendors will be differentiated accordingly, that is, a market leader in one area will probably not offer products in the other three.

The expanding scope of robotic applications in health care is demonstrated by a sampling of keywords used to catalogue articles in a recent issue of the *Proceedings of the Institute of Electrical and Electronics Engineers* (Volume 94, Number 9, September 2006):

- Active constraint robotics
- Anatomical models
- Augmented reality
- Biomechanics
- Biomechatronics
- Computational models
- Computer-integrated surgery
- Haptic interfaces
- Human-machine cooperative systems
- Medical image analysis
- Navigation
- Neurorobotics
- Robotic assistive systems
- Surgical assistants
- Telerobotics
- Telesurgery
- Virtual reality

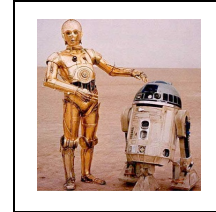
The diverse professional origins of these terms demonstrate how robotic applications in health care are the product of multidisciplinary collaboration. Bioscientists, statisticians, psychologists, and many types of engineers (e.g., computer, mechanical, electrical, optical) are contributing simultaneously to the creation of robotic applications in wide variety of domains. New applications in health care will evolve from today's robotic developments in aerospace, aviation, manufacturing, distribution, transportation, and other industrial sectors. Consequently, medical robotics has the potential to develop in some unexpected and promising directions.

Technical Components

The physical form of medical robots is currently defined by several distinct, integrated functional components assembled on a single physical platform that can be maneuvered in different vectors by a remote caregiver. The robot chassis will generally house networked computer components, telecommunications devices, video cameras and graphic interfaces (including monitors and printers) to convey visual information, and

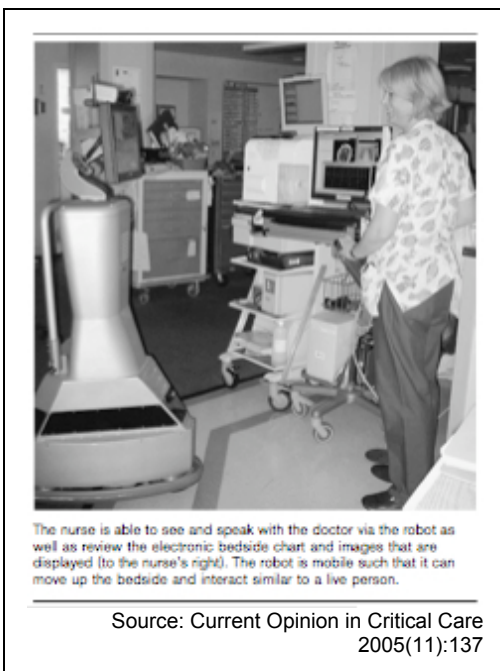
microphones and speakers to enable audible communications. At present, a fully functional medical robot includes components that emulate relevant human senses (with the exception of touch). The technologies should be interoperable over the public Internet, allowing the robot to be an active participant in the delivery of patient care.

Following basic principles of human factors engineering, a medical robot is designed and constructed to the maximum possible extent as an unobtrusive interface between a patient and a remote caregiver. Medical robots are generally human in scale, even though the same functions could be combined in a much smaller device. Medical robots purposefully resemble Star Wars' C3PO, not R2D2.



A medical robot should also emulate the physical presence of the remote health professional. The caregiver moves the medical robot around exam rooms and treatment areas, just like physicians and nurses who are in the same place as the patient. The robotic platform is completely mobile and can be moved to any open space on the floor. Robots contain sophisticated devices to sense the location of objects and humans in the immediate area and software to steer them clear of collisions. Robots are also battery-operated so that no cables restrict movement or cause hazards. Of course, the batteries must be periodically recharged, placing the robot out of commission or restricting use when it is plugged in to an electrical outlet.

The robot's visual interactions are accomplished through cameras and monitors typically mounted at the eye level of a patient sitting up in bed or on an examination table. This arrangement eliminates the problems associated with looking up to the ceiling-mounted cameras that are commonly found in video surveillance systems. The camera in this real-time videoconferencing system allows the remote clinician to see anything in the

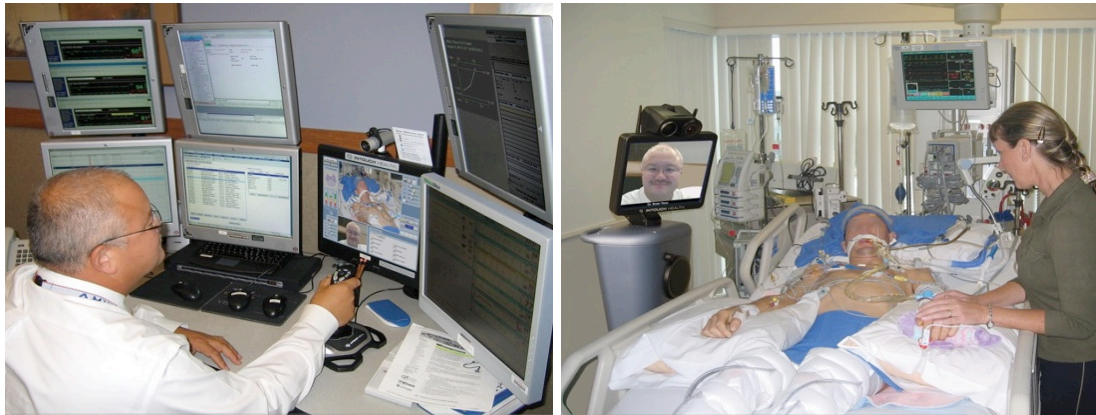


room—assuming, of course, an unobstructed view. When something is in the way, the robot can usually move to a different location without causing any disruption (e.g., forcing a surgeon to move). The operator can rotate the lens to look at a person or at an object in the room, such as the display from an imaging device shown in the adjacent photo. Today's high-resolution optics and displays are able to produce images of diagnostic quality in most circumstances. The system's screen can be used to display the face of the telepresent operator or other pertinent information, such as a diagram that shows the patient how to apply a bandage.

Today's medical robots effectively provide all the interactive capabilities that have been built into telemedicine networks since the 1990s. However, the medical robot represents a

significant advantage over traditional (i.e., fixed) telemedicine systems. It can take the necessary technology to the patient room, whereas the patient must be taken to the “telemedicine room” when the interactive technology is stationary (i.e., hardwired into ceilings and walls or embedded in stationary videoconferencing consoles). The economic superiority of robots will likely prove to be significant, either because one robot can cover the spatial equivalent of many telemedicine rooms or because no time or money is needed to move patients. By eliminating the need to transport patients, medical robots eliminate a major source of risk and medical errors in hospital care. In addition, the technology can be integrated directly into normal workflow patterns, an advantage not found in fixed telemedicine systems.

Typical configuration of a medical robot system: remote operator’s station (left) and patient room/ICU (at right); the actual robot platform is located to the left of the bed.



Photos courtesy of InTouch Health

Functional Capabilities

Although this paper argues that *medical robotics* is the most appropriate descriptor for the technology and applications being reviewed, the literature commonly uses two other terms for the same purpose—remote presence and robotic telepresence. These designations appropriately emphasize the technology’s remarkable capability to place human expertise anywhere that a robot can operate—effectively in any place (with Internet access, of course) that can be navigated by an upright human. A medical robot not only overcomes the barrier of place, a fundamental component of the definition of telemedicine.³ It also gives mobility to the remote operator, a powerful new capability for telemedicine.

³ “Telemedicine is the combined use of telecommunications and computer technologies to improve the efficiency and effectiveness of health care services by liberating caregivers and patients from traditional constraints of time and place.” Bauer JC and MA Ringel Telemedicine and the Reinvention of Health Care: The Seventh Revolution in Medicine (New York: McGraw-Hill, 1999), p. 85

The medical robot becomes the virtual eyes (seeing), ears (hearing), and mouth (speaking) of the person who controls it from afar, extending most of the remote clinician's senses into the room with the patient. As noted previously, the clinically significant exception is the sense of touch. At least one medically qualified human caregiver is generally present with the patient to convey tactile impressions to the colleague who is controlling the robot from a remote site. A virtual nose (smelling) is also missing in medical robots, but smell is not a major clinical concern in the types of care supported by medical robots. A review of technical journals suggests that some engineers are working to add tactile capabilities to medical robots. Efforts to develop virtual olfactory extensions are not mentioned.

A medical robot is particularly promising for its ability to bring a telepresent specialist into the examination room with a patient in the company of his or her primary care practitioner. (The significant clinical benefits of virtual specialty consults have been amply demonstrated by studies of fixed telemedicine systems in intensive care units and operating rooms.⁴) The medical robot allows the remote specialist to conduct visual and verbal examinations and to share knowledge and advice with the onsite generalist who manages the patient's ongoing care. Consequently, robotic telepresence opens multiple channels of communication; it is not limited to communications between the remote clinician the patient.

In addition to creating new opportunities for specialty consultations with other physicians' patients, medical robots are also being used to enhance specialists' capabilities to see their own hospitalized patients. The new concept is called **telerounding** because it allows a physician to make virtual bedside visits from home, office, or any other location that offers broadband access to the Internet. (See sidebar at right.) Initial experiences suggest that telerounding has excellent potential to become a common practice.

Making the Telerounds

"Surgeon Garth Ballantyne, MD, prefers to personally oversee his post-op patients. So when he had to travel to Europe last year, he turned on his laptop, hopped on the Internet, powered up a robot in Hackensack, NJ, and drove it into the recovery room. Soon, he was chatting with his patients, thousands of miles away.

JAMA: 12 January 2005, p. 150

Telerounding promises to reduce the number of times that a specialist must return to the hospital from the office during the day or from home at night. Telephone conversations with a nurse or resident at the bedside cannot always provide enough information to help the attending physician decide whether to make a special trip to see a patient with a potential problem. By using a medical robot to observe the patient's responses to questions, commands, stimuli, and other non-verbal cues, the remote specialist can

⁴ For a detailed comparison of the three applications based on common technologies—eICU®, surgical robots, and robotic telepresence—see Vespa, P "Robotic telepresence in the intensive care unit" *Critical Care* 9 2005, vol. 9. (The article is available online at <http://ccforum.com/inpress/cc3743>.)

determine whether the patient requires an immediate “hands on” visit. Physicians with telerounding experience report enthusiastically that medical robots have relieved them of many night-time trips to the hospital, resulting in more sleep and improved overall performance.⁵ (Recent research on the relationship between sleep and clinical performance strongly suggests that medical robots can reduce medical errors by helping physicians get more sleep. Well-rested doctors are much less likely to make mistakes, another way in which medical robots enhance quality of care in hospitals.)

Physicians who have used medical robots during the day report fewer disruptions to their office schedules, with resulting benefits for all concerned. They do not spend the unproductive (and tiring) time that would have been lost to travel between office or home and the hospital. Medical robots also promote continuity of patient care—another factor clearly associated with quality—by enabling virtual visits at times when a face-to-face visit at another site would be impossible or disruptive. For example, a physician could use a medical robot to make a hospital “call” between scheduled appointments at the office, avoiding the annoying delays caused when the doctor leaves the office with patients in the waiting room.

Published reports have also attributed significant savings to telerounding that allows a physician to see hospitalized patients a second time during the day, that is, at another time in addition to normal rounds. One study quantified the results of earlier discharges made possible when physicians used medical robots to evaluate patients in the afternoon or early evening. In a significant number of cases, patients could be discharged earlier as a result of telerounding. Without the visits made possible by the medical robot, these patients would have continued to occupy the bed until regular rounds the next morning. Length of stay was reduced 0.17 days, and total costs to the hospital were reduced \$750,000 year⁶

Finally, telerounding enables a patient to be seen by the same physician when distance would otherwise be a barrier. Based on his experience with medical robots, Louis Kavoussi, MD, professor of urology formerly at Johns Hopkins Medical Institutions in Baltimore, MD has observed that patients would rather be seen by the same physician, “even if it’s on a video screen.”⁷ Such statements might have seemed irrational ten years ago, before the Internet and Web introduced new ways to communicate. Patients’ willingness to accept a real-time video interface with a doctor is perfectly plausible in 2007 because virtual communications have become a part of everyday life for a large segment of the population. Not surprisingly, care delivered by medical robots is acceptable to a significant and growing number of patients. (See subsequent discussion of patient acceptance.)

⁵ Telephone interviews conducted by the author, January 2007.

⁶ Thacker, PD “Physician-Robot Makes the Rounds” *Journal of the American Medical Association* 293(2):150, 12 January 2005 Similar findings for cost reductions associated with early discharge made possible by telerounding will be presented in an article accepted for publication later this year in the *American Journal of Surgery*.

⁷ *Journal of the American Medical Association* 293(2):150, 12 January 2005.

Current Clinical Applications

Medical robots have been used successfully in several settings for many different types of care. A review of journal articles and news stories finds reports of deployment in intensive care units (ICU), medical and surgical bed units, cardiac catheterization laboratories, emergency departments (ED), operating rooms (OR), psychiatric services, and neurology clinics.

To date, the most widely publicized use of medical robots is probably the stroke network operated by 21 hospitals in Michigan. It has been the subject of numerous features in medical journals,⁸ television programs, and newspapers. (For example, the Associated Press article at right.) Widely circulated, favorable stories like this one surely help promote patients' acceptance of medical robots.

Recent articles in professional journals provide detailed descriptions of robotic telepresence in clinical practice. Applications range from proctoring medical students in an anatomy laboratory⁹ to providing post-operative

Michigan Hospitals to Have Robot on Call

21 Michigan hospitals to have robot on call to help stroke victims arriving at emergency rooms

PONTIAC, Mich., Oct. 19, 2006
By SARAH KARUSH Associated Press Writer



(AP)

(AP) When a patient arrives at an emergency room with symptoms of a stroke, doctors must act fast. But the crucial decisions that can prevent death or severe disability are harder to make without a neurologist, and not every hospital has one on call.

Starting next month, however, 21 Michigan hospitals will have what is being touted as the next best thing: a robot on call.

Spearheaded by St. Joseph Mercy Oakland Hospital, the project is one of several around the country in which stroke specialists from one hospital are using technology to share their expertise with smaller facilities. Experts say it's a trend that could greatly improve patients' chances of recovery.

St. Joseph Mercy Oakland is one of 13 certified primary stroke centers in the state and offers

some of the most advanced treatment for the disease, which occurs when a blood vessel in the brain becomes blocked or bursts.

The RP-7 robots, made by Santa Barbara, Calif.-based InTouch Health, are about 5 feet tall and have a screen for a head, on which the doctor operating it on the other end is seen. A camera is mounted on top, transmitting video and audio back the other way. The doctor uses a joystick to move the robot.

⁸ Vespa, PM "Multimodality monitoring and telemonitoring in neurocritical care: from microdialysis to robotic telepresence" *Current Opinion in Critical Care* 11:133-138, 2005. An expanded analysis of this program at UCLA is forthcoming: Vespa, PM *et al* "Intensive care unit robotic telepresence facilitates rapid physician response to unstable patients and decreased cost in neurointensive care" *Surgical Neurology* (2007).

⁹ Smith, DA and JE Skandalakis "Remote Presence Proctoring by Using a Wireless Remote-Control Videoconferencing System" *Surgical Innovation* 12(2):p T1-T5, June 2005.

coverage for patients in a urology service.¹⁰ These reports provide promising evidence that desired qualitative outcomes of both medical education and patient care can be enhanced by appropriate use of medical robots.

Future Clinical Applications

Applications of robotic telepresence in patient care will extend into many other clinical areas as more clinicians and managers become aware of the devices and their initial successes. The examples in the previous section illustrate only the initial uses of a technology with untapped capabilities to help combat labor shortages and access problems. In addition to deploying medical robots in service lines where they have not yet been tried, health care's creative leaders will undoubtedly develop applications that transcend any particular medical specialty.

This author's analysis of current challenges in health care delivery suggests some interesting examples of clinical circumstances where medical robots might flourish:

- Isolating caregivers from patients whose conditions would put a caregiver at risk, such as using a medical robot to examine a patient affected by a deadly contagious disease (e.g., avian flu) or contaminated by an environmental hazard (e.g., radioactivity, toxic chemical) that could harm health professionals who come in direct contact with the patient.
- Establishing an interface between a remote caregiver and a blind, deaf, or mute patient, with the robot's sound system, video, or keyboard interfaces used to compensate respectively for the patient's inability to see, hear, or speak with a health professional in the same room.
- Overcoming cultural or religious barriers to care when on-site caregivers and a patient are incompatible for non-clinical reasons, such as using a medical robot controlled by a remote female practitioner to examine a Moslem woman in a hospital where all onsite practitioners are male.
- Providing an unbiased clinician when the onsite caregiver would have a potential conflict of interest with the patient, such as substituting the remote physician for a doctor who is called upon to treat a family member or a patient with whom he or she has had a personal conflict.
- Expanding the use of advanced practice nurses (e.g., nurse practitioners, certified nurse midwives), clinical pharmacists, and other qualified non-physician practitioners who are delivering more services that were previously offered only by physicians, that is, developing robotic telepresence in the context of nursing and pharmacy practice patterns.

¹⁰ Ellison, L M *et al* "Telerounding and Patient Satisfaction after Surgery" *Journal of the American College of Surgery* 199(4):523-530, October 2004.

- Creating an international community of medical specialists who can provide superior treatment to patients with whom they share medically relevant bonds, such as a physician in India using the robot to treat a Hindu patient in an American hospital without any clinicians who can speak the patient's language or make medical decisions in consideration of the patient's culture. (With their ability to connect a non-English speaking patient to a remote clinical who speaks the patient's language, medical robots have already proven their value in overcoming language barriers.)

As new applications are developed, medical robotics will surely encounter the same problems that telemedicine had to address as it became an established platform for providing health care. Payment, licensure, liability, reliability, cost, and other issues will all arise because robotic telepresence is something new and different. Fortunately, medical robotics can learn important lessons by studying the history of telemedicine and accelerate the learning curve, if not avoid the problems. Telemedicine has moved from the periphery of common practice to widespread acceptance in approximately a decade. Given the technological similarities between robotic telepresence and telemedicine, the adoption of medical robotics certainly has potential to occur in considerably less than ten years.

Patient Acceptance

Many patients and practitioners can be expected to resist virtual health care when they first learn about it. They will not easily accept the possibility that a machine could perform as an acceptable extension of a “real doctor” and that benefits of virtual proxy might outweigh any disadvantages. However, published evaluation of applications in medical robotics suggests that patient acceptance will not be a significant or long-term barrier to acceptance of robotic telepresence for non-invasive health care.¹¹

Of course, opposition to the traditional “hands on” doctor-patient relationship will never completely disappear. Nothing in health care is ever going to satisfy all the people all the time. For example, many patients and practitioners oppose health maintenance organizations (HMO) as a delivery model. On the other hand, overall satisfaction is extremely high for those who choose to participate in an HMO, and many HMOs are very successful in retaining their members. The existence of vocal opposition to a new model for delivering health care is not an impediment to its success if the model is acceptable to an audience large enough to ensure its economic viability. Robotic telepresence does not need to overcome detractors as much as it needs to develop supporters—an outcome which seems likely in consideration of initial analysis of consumer acceptance.

¹¹ The author reviewed manuscripts of two papers that have been accepted for publication later in 2007. The papers' findings are under embargo until they appear in print, but they will include strong evidence of patient acceptance. Interviews with users and observation of medical robots also demonstrated positive patient attitudes toward medical robots.

A study of patients who had urological surgery at Johns Hopkins in 2002 and 2003 found the highest levels of satisfaction among patients who received the standard (morning), once-a-day bedside round by attending physician plus a second telerounding visit in the afternoon via a medical robot controlled by the same physician. The patients in the comparison groups received only the morning visit or the morning visit and an afternoon telemedicine visit that did not use a robot. In particular, patients in the “morning round plus medical robot group” expressed a belief that they had the highest level of access to the attending physician.¹²

As the phone company used to say, reach out and touch someone...

Communications is central to the practice of medicine. Patients must be able to relay information about symptoms so that physicians can process the data and make treatment decisions. Although palpable physical findings are an important component of gathered information, many decisions about established patients are made based on in-depth conversations.

Just as the introduction of the telephone 100 years ago was heralded as the death knell for the doctor-patient relationship, so too, modern critics have decried the use of email and video conferencing as the development of increasing barriers to “appropriate medical care. Some have suggested the separation from the bedside will necessarily lead to medical errors and potentially avoidable morbidity and mortality. The literature, limited though it may be, would suggest otherwise.

Lars M. Ellison *et al* J Am.Coll.Surg, October 2004

Issues Shaping the Future of Medical Robots

This analysis has identified many reasons to expect a promising future for medical robots. The clinical and commercial successes of surgical robots over the past decade provide general proof for the concept of physicians working with intelligent machines. The parallel success of virtual coverage in ICUs demonstrates the value in of telepresence in non-surgical settings. All things considered, the use of robots for medical (i.e., non-invasive) care is a logical and feasible next step in the evolution of technology to enhance health care.

In addition, nothing in the published literature and interviews conducted for this paper suggests insurmountable roadblocks to adoption of medical robots in medical practice. Medical robots are “ready for prime time,” and they are among the few viable solutions to significant problems facing health care organizations today. If for no other reason than addressing bottlenecks created by personnel shortages, medical robots can be expected to proliferate because they increase the efficiency of increasingly scarce health professionals. Robotic telepresence does not threaten to replace physicians with machines, but rather to improve the productivity of the ones we have. The concept of a completely autonomous medical robot, one that could treat patients without any real-time

¹² Ellison, L M *et al* “Telerounding and Patient Satisfaction after Surgery” *Journal of the American College of Surgery* 199(4):523-530, October 2004

control by a qualified health professional, is still very much in the realm of science fiction.

Researchers are exploring very practical improvements in the functionality of medical robots. Referenced articles mention active projects to improve human compatibility, safety, reliability, and control mechanisms. Ongoing advances in battery technology will also accelerate the adoption of medical robots by extending the time of a robot's use and supporting the addition of more powerful onboard capabilities. Although published literature emphasizes advances being made in the United States, it also indicates that significant research and development activity in medical robotics is occurring in France, Great Britain, and Japan.

One major factor that will influence the speed and scale of market development—the relative cost of medical robotics—is not included in this analysis. Although two previously referenced articles identify impressive cost savings associated with telerounding, the published literature does not include any formal analyses of cost-benefit or return on investment (ROI). Given the realities of health care today, such financial studies are not necessary to support the adoption of medical robots. The relevant economic issue is **cost-effectiveness**, finding the least expensive way to do something that must be done.¹³ For example, if discharge-eligible patients must be seen by their attending in the afternoon or evening to make way for patients backed up in the corridors of the emergency department, telerounding should be adopted if it costs less than any other viable solutions.

“The value proposition for medical robotics is as varied as the various value propositions for technical innovations in the field of health care. Some robots improve the dexterity of a surgeon, some extend the reach of a clinician to a remote location, some improve hospital efficiency by moving material or drugs about autonomously, some improve the quality of treatment for a patient, and many more are yet to be invented and will provide a value proposition that has not been thought of yet. The exciting thought is that robotics technology has now reached a state of maturity where it can quantifiably improve our health care system and the society in which we live.

Wang, Butner, & Darzi

“The Developing Market for Medical Robotics”
Proceeding of the IEEE 4(9): September 2006

Implications and Challenges for BSHSI

Bon Secours is already a pioneer in medical robotics at its Baltimore Health System hospital. (See final item on next page.) In addition to drawing upon its existing experience with telepresence, BSHSI should consider several other related opportunities to enhance performance throughout the system:

- Prepare appropriate, concise information materials to inform clinical leaders and service line managers about the use of medical robots to improve productivity of

¹³ Bauer, JC “Return on Investment: Going Beyond Traditional Analysis” *Journal of Healthcare Information Management* 17(4):4-5.

overextended health professionals and to enhance performance in areas where robots have already demonstrated their value in health care. These materials should be disseminated to local and system-wide task forces that are revising care delivery processes. A focused, one-hour continuing education program on medical robots could be prepared to launch the awareness campaign throughout the system.

- Begin active pursuit of partnerships with research organizations and vendors to develop creative applications of medical robots in selected Bon Secours facilities. A group of senior managers could be organized to identify research and development opportunities and to enlist clinicians in the process of forming partnerships.
- Provide implementation support to physicians and other clinicians who decide to use a medical robot to enhance their services' efficiency and effectiveness. The supportive services should include readiness assessments and implementation assistance to prepare participating clinicians for successful adoption of the technology and related changes in patterns of care.

Interview with Neal Reynolds, M.D., Bon Secours Baltimore Health System

Q. Why did your intensive care unit decide to use a medical robot?

A. Like hospitals everywhere, ours is facing a serious shortage of critical care physicians. Hospitals cannot meet Leapfrog criteria if they have to rely on recruitment, so we had to find an alternative. The medical robot from InTouch was just what we needed to improve coverage without trying to hire more intensivists.

Q. Did you have previous experience with medical robots when you made the decision to acquire one for your ICU?

A. No, but I had been extensively involved in development and use of the VISICU™ system in Norfolk. I knew that telemedicine and telepresence could be used to overcome doctor shortages and to provide excellent care. Using a robot was a logical next step.

Q. What is your personal experience with the medical robot in your hospital's ICU?

A. It has made several positive contributions to the quality of care for all concerned. The robot allows me to teleround in the early evening and to get to know the nurses on the evening shift. We prepare care plans during my virtual visit, so the nurses seldom need to call me at night now. And I get more sleep!

Q. Based on your experience, what is your vision for the future for medical robotics?

A. I think that the robots offer a technology platform to network community physicians here in Maryland. This is the state that created the national model for emergency medical services systems back in the 1970s and the virtual intensive care model in the 1990s. We now have a phenomenal opportunity to develop the national network for medical robotics, starting right here in Baltimore.