Postoperative Robotic Telerounding

A Multicenter Randomized Assessment of Patient Outcomes and Satisfaction

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Hypothesis: Patient safety and satisfaction are adversely affected when robotic videoconferencing (telerounding) is used in the postoperative setting.

Design: Randomized controlled trial.

Setting: Three academic institutions.

Patients: A total of 270 adults undergoing a urologic procedure requiring a hospital stay of 24 to 72 hours were randomized to receive either traditional bedside rounds or robotic telerounds.

Main Outcome Measures: The primary outcome measure was postoperative patient morbidity. Secondary outcomes were patient-reported satisfaction and hospital length of stay. Other variables assessed included demographics, procedure, operative time, estimated blood loss, and mortality. Patients also completed a validated satisfaction instrument 2 weeks after hospital discharge.

Results: Patients were equally distributed based on the baseline demographic and operative measures. Morbidity rates were similar between the study arms (standard rounds vs telerounds: 16% vs 13%; $P = .64$). Length of stay was similar in both arms (standard rounds vs telerounds: 2.8 vs 2.8 days; $P = .94$). In addition, patient satisfaction was equivalently high in both arms of the study.

Conclusions: Robotic telerounds matched the performance of standard bedside rounds after urologic surgical procedures. Virtual visits did not result in missed or increased postoperative complications. Hospital length of stay and ratings of hospital satisfaction were on par with those for traditional rounding.

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THE DEFINING IMAGE OF INpatient care is that of the physician conducting bedside rounds. This bedside interaction has come to be a measure of physician compassion. The reality for elective surgical patients is that established critical pathways define postoperative care. To be sure, these require timely physician oversight, but the value of the bedside visit may be secondary to objective vital signs and laboratory data.

See Invited Critique at end of article

Critical pathways standardize care for patients undergoing common surgical procedures. At the core of the critical pathway is the expectation that patient recovery proceeds at an expected rate and follows a linear course. The evaluation of such patients depends on the subjective (eg, history and physical examination) and objective (eg, vital signs and laboratory values) clinical tools. The relative weight of any given clinical measure varies not only by patient but also greatly by the type of procedure performed. Expected daily events after coronary artery bypass grafting vary markedly from those after a radical prostatectomy. For laparoscopic procedures, in-hospital recovery is compressed. Abnormal laboratory values and vital signs or failure to meet anticipated daily goals (eg, tolerating diet advancement) may precede physical examination findings as indicators of possible occult morbidity.

There has been a slow but steady integration of telecommunication technology into outpatient care. The telephone, introduced nearly a century ago, was initially decried as the death knell of the physician-patient relationship.[1] More recently, the merits and potential dangers of e-mail have generated spirited debates.[2,3] For postoperative patients, hospital care has remained grounded with the physician at the bedside. Recently, it has been shown that remote videoconferencing (telerounding) as an adjunct to regular bedside rounds positively affects patient perceptions of their postoperative hospital care.[4]

The central concern of the remote presence in the postoperative period is whether outcomes would be effected and complications could be identified in a timely manner.[5-8] In addition, the introduction of this technology must not lead to decrements in patient satisfaction with their care. To assess the safety and satisfaction of robotic telerounding in patients undergoing elective laparoscopic or endoscopic urologic surgical procedures, a randomized controlled trial was conducted at 3 academic institutions.

METHODS

DESIGN

Two hundred seventy patients were recruited from 3 sites: the University of California Davis Medical Center, Johns Hopkins Hospital, and Sentara Health. Institutional review board approval was granted at each institution independently. The study population consisted of patients scheduled for urologic surgery who were older than 18 years and could read and understand English. Patients undergoing the following laparoscopic procedures were offered participation: nephrectomy, partial nephrectomy, nephroureterectomy, retroperitoneal lymph node dissection, partial ureterectomy, and radical prostatectomy. Patients had an expected hospital stay of 24 to 72 hours. Eligible patients who were unable to provide consent or who did not want to participate in the study received the standard of care provided at each institution. A total of 270 patients consented to participate.

RANDOMIZATION AND OUTCOME MEASURES

A stratified block scheme was used for randomization. Participating patients were randomized to receive either standard daily bedside rounding by the attending surgeon (control arm) or daily telerounding only by the attending surgeon (intervention arm). The primary outcome measure was differences in rates of attending surgeon–identified complications between standard rounds and telerounds. The secondary outcome measures included differences in hospital length of stay and patient-reported satisfaction with hospitalization.

PROTOCOL

Consenting patients had their scheduled surgery and received the standard perioperative and immediate postoperative care. All the patients were managed with a rapid recovery protocol, which included a liquid diet beginning 12 hours after surgery with immediate advancement as tolerated; complete blood cell counts and measurement of serum electrolyte, blood urea nitrogen, and creatinine levels in the recovery room and each morning until hospital discharge; and usual nursing data recorded during each shift (including oral temperature, blood pressure, pulse, respiratory rate, fluid intake, fluid output, and pain scale score).

Once transferred to the patient floor, all the patients communicated with their attending physician on a daily basis. The visit, either at the bedside or via telerounds, followed a set script. The visit was conducted between the patient and the attending physician without other staff present. The focus of the visit was review of objective data (vital signs, fluid balances, and laboratory values) and subjective data (cursory abdominal examination if at the bedside and evaluation of drain effluent) and a discussion of the anticipated goals for the day. Visit duration was timed. Intervention patients could remove themselves from the study at any time by requesting a bedside visit by the attending physician. Telerounding concluded with either hospital discharge or identification of a major postoperative complication. A major complication was defined as an event that required transfer to a monitored setting. Minor complications included events that delayed discharge more than 24 hours beyond the expected length of stay; for example (but not limited to), postoperative ileus, decrease in hematocrit value, prolonged drain output, or fever.

EVENT MONITORING

Identification of complications was recorded prospectively. Usual resident-level bedside rounds were maintained throughout the study. The resident team and the attending surgeon recorded identified events independently, thus allowing for evaluation of concordance. This dual-rounding design served as a minimally acceptable standard as stipulated by the various institutional review boards. As a precondition of institutional review board approval, identification of an event required notification of the attending surgeon in a timely manner.

INSTRUMENT

We used a validated 21-item questionnaire to evaluate patient ratings of their hospital care. Items regarding postoperative care were designed using an extensively tested and validated response scale from 1 (poor) to 5 (excellent). Item stems were modified from Meterko and Rubin[9] to make them more salient to the postoperative experience. Five items asked patients to rate their baseline health status and their health status during the hospitalization. Seven items asked patients to evaluate aspects of the care they received while an inpatient. Nine items asked those randomized to the telerounding arm to evaluate the telecommunications system and to indicate their level of interest in having this system incorporated into usual postoperative care.

DEVICE

The telerounding robot is a 60-inch-tall wheel-driven device. The robot consists of the motor base unit, a central processing unit (Pentium III; Intel, Santa Clara, California), a high-definition digital camera, a flat-screen monitor, and a microphone. Data to and from the robot is transferred over a high-speed wireless network and is integrated with proprietary software. The physician connects remotely to the robot via a base station. The base station consists of a Pentium III desktop computer, a high-definition digital camera, a flat-screen monitor, a microphone, and a joystick controller. Each institution used identical technology. Previous testing of the system demonstrated imperceptible video and audio delay.

ANALYTIC PLAN

The primary end point of the study was patient morbidity. The expected rate of complications (major and minor) after a laparoscopic urologic procedure was 16.0%. On the basis of the power calculation, 270 patients (135 in each arm) were required in order to detect a 1% difference in complications at the $\alpha = .05$ level and the $\beta = .80$ level. Continuous variables were compared using paired *t* tests. Proportions were compared using

Table 1. Baseline Characteristics of the 270 Study Patients

	Telerounds (n=134)	Standard Rounds (n=136)	*P* Value
Patient factors			
Age, mean, y	53.6	54.3	.71
Male sex, %	62.0	60.0	.90
No previous hospitalization, %	76.0	69.0	.25
Self-rated health score[a] (scale, 1-5)	3.8	3.4	.05
Surgical distribution, %			
Upper urinary tract resection	63.9	59.3	.12
Upper urinary tract reconstruction	6.5	15.0	
Radical prostatectomy	29.6	25.7	
Hospital factors[a]			
Pain control score (scale, 1-5)	3.2	3.3	.92
Assistance score (scale, 1-5)	2.7	2.7	.84
Length of stay, mean, d	2.8	2.8	.94
Appropriateness of length of stay score (scale, 1-5)	3.6	3.8	.12

[a]The response scales ranged from 1, poor, to 5, excellent.

χ^2 analysis. Logistic regression was reserved for adjustments based on observed statistical differences in baseline demographic data.

RESULTS

A total of 270 patients were enrolled, 136 to standard rounds and 134 to robotic telerounds. Ten eligible patients declined to participate. No discernible differences in these patients based on baseline demographic measures were found compared with the study cohort. All 270 patients completed the posthospitalization patient satisfaction survey. **Table 1** outlines the baseline patient factors, disease distribution, and hospitalization factors. There were no statistically significant differences in mean age, sex distribution, disease distribution, rate of previous hospitalization, and self-reported health. In addition, there were no differences in self-reported postoperative pain, need for assistance, or the appropriateness of length of stay. There was no difference in length of stay between the 2 study arms. Although not displayed, no differences were noted in baseline demographic measures among institutions.

The complication rate for the study was 16.3%. There were no differences in the observed rates of overall, major, or minor morbidities between the 2 study arms (**Table 2**). In the telerounding group, there were no episodes of failed or delayed identification of complications.

Most patients gave high ratings for their hospitalization. The **Figure** demonstrates the percentage of patients reporting excellent care by item. Comparing standard rounds with telerounds, there was no difference in patient-reported satisfaction. Although not reaching statistical significance, there were trends toward a difference in favor of telerounding for the items regarding physician availability and delivery of medical information.

Among patients in the telerounding arm, ratings of very good or excellent were given for audio quality and video quality (94.4% and 90.7%, respectively) (**Table 3**). Two-thirds of these patients agreed or strongly agreed that telerounding should be a part of regular hospital care and that they would prefer to be seen by their own physician remotely rather than by a partner at the bedside. Three-quarters of the patients gave similar ratings for their comfort level with the system, and 86.0% believed that they could communicate easily via the telerounding system.

Table 2. Complication Rates by Study Arm

	Telerounds	Standard Rounds	*P* Value
Morbidity, No. (%)			
Overall	18 (16.7)	18 (15.9)	.88
Major	4 (3.7)	2 (1.8)	.82
Minor	14 (13.0)	16 (14.3)	.39
Mortality, No. (%)	0	0	NA

Abbreviation: NA, not applicable.

COMMENT

Postoperative decisions require evaluation of subjective and objective data. For elective surgery, the inpatient recuperative course usually proceeds in a predictable manner. Economic realities have mandated compression of hospitalizations. One technique to accomplish this goal is the judicious use of clinical pathways. Such pathways require vigilant physician oversight to ensure safe patient progression.

This study assessed the impact of telerounding on postoperative patient evaluation and management. For the cohort patients studied, we found no difference in outcomes comparing those managed with standard bedside rounds with those managed with telerounds. There were no instances of failed identification of morbidities by telerounding that were subsequently identified by resident staff (false-negatives), nor were there inappropriately identified morbidities when in fact none existed (false-positives).

The Institute of Medicine report *To Err Is Human: Building a Safer Health System* outlined a set of ambitious goals for the future of patient care.[10] Central to the recommendations was the challenge to find new ways to incorporate advanced electronic informatics and telecommunications into patient care to improve access and reduce medical errors. Telerounding has the potential to translate these goals directly to inpatient ward care.

Economic realities and staff shortages have placed increasing burdens on physicians' time. With increasing expenses (eg, malpractice, regulatory, and personnel) and decreasing reimbursement, physicians need to see more patients in various locations. Moreover, hospitals require volume and rapid turnover to maintain profitability. These factors increase time pressures on physicians. Telerounding with hospitalized patients has the ability to ease time constraints through elimination of travel time. Videoconferencing systems give physicians the potential to directly assess their own patient's situation. This

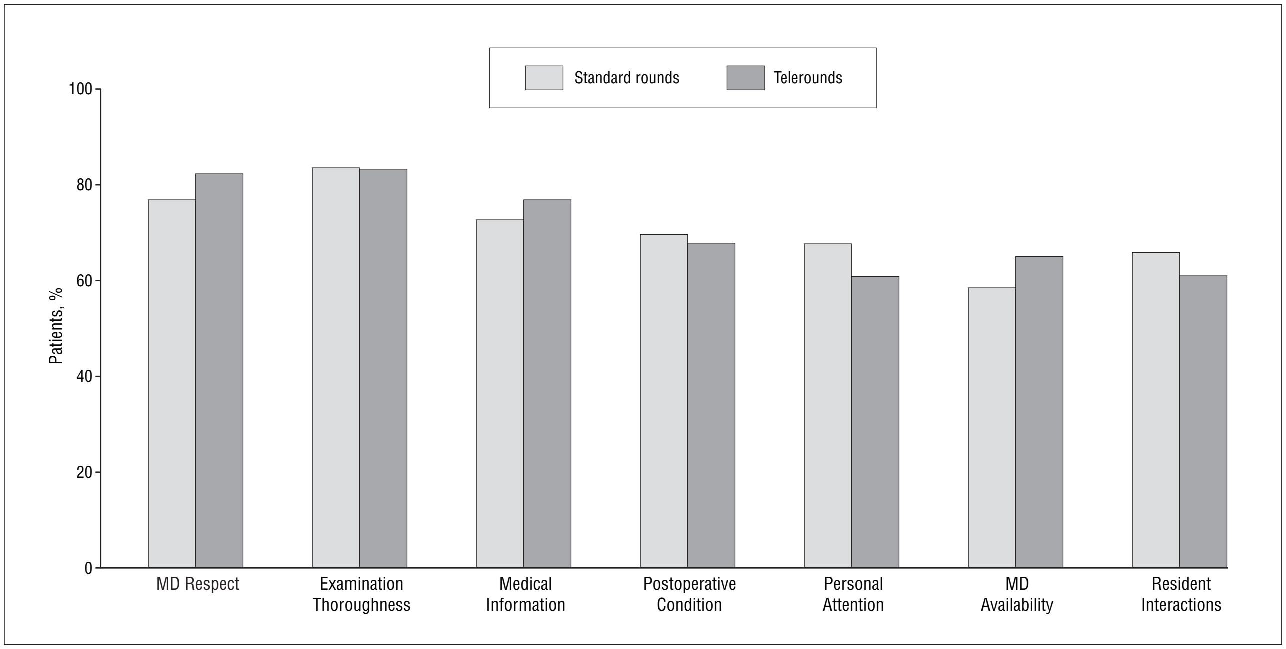

Figure. Percentage of patients reporting "excellent" rankings for each hospital satisfaction measure. MD indicates physician.

Table 3. Evaluation of the Telerounding System[a]

	Poor	Fair	Good	Very Good	Excellent
Audio quality	0	0	5.6	17.8	76.6
Video quality	1.8	0	7.5	24.3	66.4
	Strongly Disagree	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
My care was better because of robotic telerounding.	4.7	5.7	44.8	25.2	19.6
I feel that robotic telerounding should be a regular part of patient care in the hospital.	3.1	6.5	23.4	40.2	26.8
I could easily communicate with my MD using the telerounding system.	0.9	5.6	7.5	37.4	48.6
If I were hospitalized again, I would feel comfortable with robotic telerounding on an everyday basis.	2.8	10.3	11.2	34.6	41.1
If my MD was out of town, I would rather teleround with my MD than be seen by a partner.	2.7	11.2	18.8	28.0	39.3

Abbreviation: MD, physician.
[a] Data are presented as percentage of patients.

is optimal compared with current practices where partners or other health care professionals with little previous patient knowledge are called on to make assessments based purely on pathways rather than firsthand operative events.

Remote presence has been demonstrated to be an effective and safe method for patient management.[11-14] The use of remote critical care physicians for intensive care units otherwise managed by internists demonstrates a significant improvement in measurable patient variables. Intensive care unit stays and ventilation weaning periods were shorter and medical mistakes and adverse outcomes were fewer using tele-intervention systems.

A theoretical concern of introducing telemedical systems has been the erosion of physician-patient relationships. In a previous study,[4] the addition of a telerounding visit was found to have a significant positive impact on patient-reported satisfaction with their hospitalization. As an adjunct to standard bedside rounds, telerounding was found to improve patient perceptions of their surgeon's availability, the quality of the medical information delivered, examination thoroughness, and postoperative care coordination. In the present study, the attending physician was completely removed from the bedside during the postoperative period. Patients in the telerounding arm expressed similar high rates of satisfaction with their hospital stay to patients managed with standard bedside rounds.

It is important to temper the observed results with several caveats. The patient population selected had anticipated recovery times of 24 to 72 hours. The robust performance of this system may not necessarily be replicated for patients with evolving or slowly resolving medical conditions. For these patients, physical examination findings may play a more central role in evaluation. Second, telerounding is not an absolute replacement for bedside rounds. Physicians must be prepared to abandon the system when patients require direct physical assessment. It is difficult to compile a comprehensive list of absolute indications that require a bedside visit. However, it must be underscored that the observed performance of the telerounding system in this study was a function of the high index of suspicion demonstrated by the participating physicians. Decrements in the level of suspicion could lead to measurable decrements in telerounding safety. These patients were also seen by resident house staff, so the results may not directly translate to the general community setting.

In conclusion, telecommunication technology has been an important part of medical practice for more than 100 years, and it remains an important vehicle to improve patient care. Telerounding introduces the remote presence to the bedside for the management of elective surgical patients. From a patient safety and patient satisfaction perspective, there were no decrements in the quality of care when comparing bedside rounds with telerounds.

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INVITED CRITIQUE

We hold these truths to be self-evident: the attending surgeon must see the patients every day after surgery; he or she must look at the wound, handle the vitals board, look in the patients' eyes, and touch them on the shoulder; the attending surgeon must administer the healing touch.

Turns out it may all be wrong.

What a startling and delightful study! This follow-up study to one performed several years ago on a smaller group of patients again resulted in the surprising finding that patients do not mind being seen by robots instead of by their attending physician. In fact, they prefer to be seen by a robot when the other option is a physician who is not their own.

What happened to the healing touch? It has to be administered by someone who knows you. Patients do not want strangers, even well-informed strangers with a thorough sign-out on their personal data assistants, to be their physicians. Two-thirds of the patients in this study agreed that if their attending surgeon was out of town, they would rather teleround with their own physician than be seen in person by a partner.

The importance of human touch turns out not to be in the touch at all; it can be administered by a robot as long as there is a familiar face and mind on the other side.

We should not be surprised. People have a desire to be known. The robot, acting as an intermediary between the patient and the attending surgeon, maintains that important personal link. The sign-out, no matter how cautious and detailed, cannot convey that personal touch.

What is old is new again. Patients want their own physicians. What is surprising and delightful is that the use of new technology can actually keep that connection vital.

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