Impact of remote monitoring and supervision on resident training using new ACGME milestone criteria

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Introduction: *The study objective was to determine the impact of remote monitoring and supervision (RMS) in integrated endourology suites (IES) on residents achieving endoscopic training milestones.*

Materials and methods: *Twenty-one urology residents evaluated RMS in IES using a 25-question survey. IES provided audio-visual communication for faculty to supervise residents remotely. Questionnaire used a linear visual scale of 1-10 to assess acceptability (8 questions), impact on training (10 questions), supervision level (1 question), and pre- and post-training milestone self-assessments (6 questions). Improvements in Patient Care Milestone #7 (upper/lower tract endoscopic procedures) and Patient Care Milestone #9 (office-based procedures) were analyzed.*

Results: *Twenty-one urology residents (out of potential 23) evaluated RMS in IES using a 25-question survey (91.3% response rate). Overall RMS acceptability and satisfaction was high (mean score = 9.1/10) with a majority (95.2%) feeling comfortable being alone with the patient. Residents reported positively on the following parameters: autonomy without compromising safety (8.7), supervision level (8.6), achieving independence (8.4), education quality (8.3), learning rate (8.1), clinical decision-making (8.0), and reducing case numbers to achieve proficiency (7.6). Residents perceived no issues with under- or over-supervision, and a majority (76.2%) expressed that RMS should be standard of training in residency programs. Residents reported mean level increases of 2.5 and 2.8 (out of 5) in Patient Care Milestones for endoscopic procedures and office-based procedures, respectively ($p < 0.0001$).*

Conclusions: *RMS in integrated endourology suites may enhance resident education and endoscopic training. The study demonstrated an increase in competency levels reported by residents trained using RMS.*

Key Words: resident training, remote supervision, remote monitoring, ACGME

Introduction

Graduate medical education training programs face challenges in delivering quality residency training without compromising patient safety and quality of care. These challenges stem from current healthcare economics that demand higher quality care to be delivered safer and more efficiently at lower cost. Additionally, recent regulations by the Accreditation Council for Graduate Medical Education (ACGME) mandate increased trainee supervision and a limited 80-hour work week interspersed with rest periods to promote resident well-being.[1] Furthermore, the ACGME recommended semi-annual assessments of training milestones for urology residents.[2] These milestones were developed to provide guidance to urology training programs in a form of standardized, objective assessment tools to ensure trainees acquire adequate surgical and clinical proficiency to practice independently.

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In our practice, we have implemented remote monitoring and supervision (RMS) in residency training, utilizing advanced telecommunication technology in integrated endourology suites (IES). Each IES is equipped with live two-way visual and audio communication, as well as telestration functionality, allowing faculty to monitor, instruct, and supervise urology residents remotely from a control room. We have recently reported patients' high level of acceptance and satisfaction with RMS during endoscopic procedures.[3] Based on the positive feedback, we hypothesized that RMS would have a positive impact on residency endoscopic training and education. The objective of this study is to determine the impact and value of RMS in IES on resident training and on achieving urology-training ACGME milestones from the residents' perspective.

Materials and methods

The study was approved by the Institutional Review Board at Emory University and by the Research and Development Committee at the Atlanta Veterans Administration Medical Center (AVAMC). This is a survey of first-year urology residents (UR-1) regarding their opinions, acceptance, and satisfaction levels with RMS in IES.

All residents surveyed in this study completed 4 months of training at the UR-1 level in state-of-the-art endourology suites as described in a previous report.[3] Briefly, each IES is equipped with live two-way audio-visual and telestration communication that allow for RMS of urology residents with a supervising faculty urologist from a control room located adjacent, within 5 meters, to the endourology suites. The close physical proximity between operating and supervising surgeons allows for immediate access to the attending when needed. The attending faculty monitored one endourology suite at a time to maximize resident training and patient safety. Visual signals were displayed in the IES on six monitors, the main two monitors being 24-inch high definition (1080p) ceiling-mounted monitors. Audio signals were communicated to the IES through ceiling-mounted microphone and speakers, which allowed personnel in the IES (residents, nurses, anesthesiologists, and patient) to listen to all communication. The majority of endourologic training during the first year of residency occurs at the AVAMC where RMS is utilized. Therefore, this survey may serve as a valuable evaluation tool of RMS during the initial endoscopic training period.

Inclusion criteria consisted of all UR-1s who had completed 4 months of training utilizing RMS at the AVAMC. Each UR-1 performed an average of 10 endourologic cases weekly either as the primary surgeon or first assistant corresponding to their level of training and familiarity with the procedure. As the primary surgeon, the UR-1 performed the majority of the procedure. This corresponded to approximately 70% of all endourologic cases as the primary surgeon during the 4 month RMS training period. The vast majority of endourologic cases performed included cystoscopy, ureteral stent placement, cystolitholapaxy, ureteroscopy with laser lithotripsy, transurethral resection of bladder tumor, and transurethral resection of prostate. Following completion of 4 months of RMS training, each resident was invited to participate in a 25-question survey on a voluntary, anonymous basis. The questionnaire included four sections: overall acceptability (8 questions), impact on training (10 questions), level of supervision (1 question), and pre- and post-training self-assessment of milestones (6 questions). For the first and second sections that evaluated overall acceptability and impact on resident training, a linear visual scale of 1-10 was utilized (1 = strongly disagree; 10 = strongly agree). For the third section, we used a modified linear scale with "ideal" level of supervision in the middle flanked by two side-scales of four intervals that assessed under-supervision (left side) and over-supervision (right side). We limited the survey to UR-1 residents to ensure consistency in baseline endoscopic trainee skill level prior to initiation of formal endoscopic training via RMS in IES.

For the forth section of residents' self-assessment, we used the ACGME Patient Care Milestone #7, which assesses a resident's ability to perform endoscopic procedures of the lower and upper urinary tracts, and ACGME Patient Care Milestone #9, which assesses a resident's ability to perform office-based procedures. Residents were invited to evaluate their milestone competency levels prior to and at the end of their 4-month endourology training utilizing RMS in IES. All residents were required to read the milestone criteria and guidelines detailed by the ACGME prior to completing the survey. The study investigators addressed all questions and potential ambiguities raised by the residents in order to ensure full understanding and consistency of the methodology of residents' self-reporting. All residents expressed full understanding of the reporting methodology prior to completing the survey. Surveys were administered in either paper or online formats (identical layout) per resident preference. A visual linear scale of 0-5 was utilized to evaluate milestone achievements. A score of 1 corresponded to an entry-level urology resident.

A score below 1 corresponded to a resident that has not achieved level 1 skills according to ACGME milestone definitions. For calculation purposes, we gave this skill level a score of zero. On the other end of the spectrum, the ACGME allocates a score of 5 to residents achieving highly proficient skill levels consistent with a urologist in practice for several years. According to the ACGME, only a few, exceptional residents achieve milestone scores of 5 by residency completion.[2]

The results of all surveys were analyzed and reported in the standard fashion. Additionally, a secondary analysis of the surveys was performed that excluded one extreme at each end of the spectrum (highest and lowest overall responders), reducing the sample size to 19 for the sub-analysis. Student's t-test was used for statistical analysis. A statistically significant result was defined by a probability value (p value) of < 0.05.

Results

The response rate was 91.3% (n = 21/23). The 21 responders included UR-1 residents over a period of 7 years (2008-2014). Overall, residents' acceptability and satisfaction with RMS was high with mean scores for all eight questions (section 1 of the survey) ranging between 9.1 and 9.3 out of 10, Table 1. The majority of residents (95.2%, n = 20/21, score range 7-10) felt comfortable being alone with the patient under RMS.

Residents reported that RMS positively impacted the quality of their training (section 2 of the survey) in all ten parameters surveyed as judged by mean scores of ≥ 7, Table 2. The parameters (mean scores) included the following: autonomy without compromising safety (8.7), availability of supervision and assistance (8.6), achieving proficiency and independence (8.4), quality of education (8.3), rate of learning (8.1), clinical evaluation (8.0), clinical decision-making (8.0), benefit of immediate feedback (7.7), and reducing the number of cases required to achieve proficiency (7.6), Table 2. The majority of residents (76.2%, n = 16/21, score range 7-10) expressed that RMS should be the standard of training in all American residency programs.

With regard to the level of supervision with RMS (section 3), a majority of residents (80.9%, n = 17/21) reported an "ideal" level. One resident reported minimal under-supervision (1 point below "ideal" on a scale of 4), one resident reported minimal over-supervision (1 point from "ideal" on a scale of 4), and two residents reported moderate over-supervision (2 points from "ideal" on a scale of 4).

After 4 months of training under RMS in IES, residents self-reported a 2.5 (out of 5) mean milestone level increase in lower tract endoscopy, a 2.5 mean level increase in upper tract endoscopy, and a 2.8 mean level increase in office-based procedures. All three milestone levels of improvement were highly statistically significant ($p < 0.0001$).

The inclusion and exclusion of responders with extreme scores (highest and lowest scores) did not impact the results of the statistical analysis or the conclusions. For survey sections 1, 2, and 3 there were no statistical differences in all parameters surveyed ($p = 0.609$-0.980) between the standard analysis and the sub-analysis excluding one extreme responder at each end of the spectrum, Tables 1 and 2. Similarly, the extremes did not impact the reported improvements in ACGME milestones (section 4); p values remained < 0.0001 for all three milestone self-assessments.

TABLE 1. **Survey results (section 1): overall acceptability (8 questions)**

Acceptance and satisfaction	**Mean score**	**Range**	**7-10 score**	**Mean score**	**Range**	**7-10 score**
	Standard analysis (n = 21)			**Excluding extremes (n = 19)**		
Overall acceptability	9.1	7-10	100%	9.2	7-10	100%
Overall communication	9.1	6-10	95.2%	9.2	6-10	94.7%
Being watched	9.1	5-10	95.2%	9.1	5-10	94.7%
Video-recording	9.2	7-10	100%	9.3	7-10	100%
Ensuring patient privacy	9.3	8-10	100%	9.3	8-10	100%
Being alone with patient	9.2	2-10	95.2%	9.2	2-10	94.7%
Assistance availability	9.3	6-10	95.2%	9.3	6-10	94/7%
Response rate	9.2	6-10	95.2%	9.2	6-10	94.7%

p = 0.827-0.980 – comparing individual parameters between the two analyses

TABLE 2. **Survey results (section 2): impact on training (10 questions)**

Impact on training	Mean score	Range	7-10 score	Mean score	Range	7-10 score
	Standard analysis (n = 21)			Excluding extremes (n = 19)		
Quality of training and education	8.3	3-10	90.5%	8.5	5-10	94.7%
Rate of learning	8.1	3-10	90.5%	8.3	5-10	94.7%
Proficiency and independence	8.4	3-10	90.5%	8.6	5-10	94.7%
Less cases to achieve proficiency	7.6	3-10	76.2%	7.7	4-10	78.9%
Autonomy and safety (balanced)	8.7	3-10	95.2%	8.9	7-10	100%
Supervision availability	8.6	3-10	90.5%	8.8	5-10	94.7%
Feedback optimization	7.7	3-10	81.0%	7.8	5-10	84.2%
Enhance patient care	8.0	3-10	85.7%	8.2	5-10	89.5%
Improve decision-making	8.0	3-10	90.5%	8.1	6-10	94.7%
RMS as a standard in training	7.3	1-10	76.2%	7.5	2-10	78.9%

RMS = remote monitoring and supervision
p = 0.609-0.837 – comparing individual parameters between the two analyses

Discussion

The majority of urology residency programs assess resident competency through case logs and individual evaluation reports by faculty members.[4] The methodology and tools used for such evaluations have the potential for variability depending on the individual evaluators and the type and environment of the residency rotation. In an attempt to standardize and better align resident evaluations to standard core competencies, the ACGME released semi-annual urologic milestones in 2013 to assess a trainee's knowledge, skills, and attitudes.[2] More streamlined and objective, these recently implemented milestones are organized in a developmental framework, from less to more advanced levels. The milestones used reflect and address the 6 ACGME core competencies of medical training: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice. Our study demonstrates that residents self-reported significant improvements in milestone competencies assessing lower and upper tract endoscopy skills (mean 2.5 point increases out of 5 for both endoscopy skills), as well as improvement in office-based procedures (mean 2.8 point increase out of 5) following a 4-month period of RMS training. According to the ACGME, a first year urology resident without prior endourologic training should typically attain a milestone level of 2 following initial endoscopic training, corresponding to a trainee who "is advancing and demonstrating additional milestones."[2] Such improvement constitutes an average increase of approximately 1.5 points compared to the 2.5-2.8 point increase experienced with RMS in this study.

The use of telecommunication technology in residency training has previously been tested using simulators, bench models, and teleconferencing.[5-11] The first report of remote monitoring utilizing teleconferencing within the operating room for training purposes utilized mannequin simulators.[12] None of these aforementioned studies, however, evaluated trainees' opinions, acceptance, or satisfaction regarding operating room remote surveillance. Additionally, RMS technology has not been trialed for resident training in open or robotic procedures. While RMS in IES remains a relatively new and expensive proposition in urology residency training, our institution has implemented and used this technology successfully for the past 9 years (since 2007). Our study demonstrates residents' acceptance and high level of satisfaction utilizing such telecommunication technology in urology residency training. The majority of residents reported an "ideal" level of supervision with RMS and expressed that this system should be the

standard of training in all American urology residency programs. Anderson et al, in a prior study on RMS and IES, demonstrated high patient-level satisfaction with RMS residency training technology.[3] Specifically, patients were satisfied having a urology resident perform the procedure, as well as having other residents and medical students observe the procedure remotely. Moreover, patients were comfortable being video-recorded and having two-way audio communication within the operating room. Additionally, no patient perceived compromised privacy or quality of care.

To evaluate operative resident performance, Benson et al developed a rating system for six fundamental urological procedures utilizing video and audio recordings; their rating system demonstrated internal consistency and reliability.[13] Similarly, Herati et al utilized audio- and video-based analysis to evaluate intraoperative cognitive and motor skills of urologic surgeons performing robotic and laparoscopic renal surgeries.[14] They found that intraoperative audio recordings provided an innovative way to assess the cognitive ability of the surgeon. Gearhart et al evaluated how pediatric urology and colorectal surgery programs taught and assessed their trainees' procedural skills.[15] They found that nearly 90% of trainees and program directors reported no formal assessment of procedural competency at the beginning of training. Additionally, dialogue with faculty was the most frequently utilized method for preparing operative cases. Textbooks, atlases, journals, web-based programs, and videos were used less frequently. Our current report on RMS in IES allows for similar real-time audio and visual monitoring of residents within the operating room in a controlled, safe environment while providing residents with appropriate autonomy and independence. The system utilizes telestration technology to enhance interactivity with attendings intraoperatively in real-time. Furthermore, resident performance can be recorded and re-evaluated at future time points.

Recent implementation of milestone training checkpoints by the ACGME, combined with revised duty hour regulations, warrants the utilization of effective telecommunication technology in urology residency training to expedite learning and operative independence in a safe, monitored manner.[1,2] The RMS training system has the potential to fulfill these needs. Additionally, it has a potential benefit in maintaining regulatory compliance of resident monitoring and supervision that is often labor intensive and potentially inefficient and costly. Zeidel et al calculated that $35,000 was spent annually to train each resident in internal medicine.[16] Additionally, Johnson et al determined that in order to support an internal residency training program, Rush University lost $163,949 in productivity during the 2004-2005 academic year.[17] Similarly, Gonzalez and McKenna evaluated the most pressing issues facing academic urology training centers amongst members of the Society of University Urologists and determined that lack of funding was the most common obstacle to adding new residency positions (65% of respondents).[18]

Our study suggests that RMS in IES may facilitate trainees achieving developmental milestones in an expedited manner, as well as potentially providing a satisfactory tool to evaluate core competencies in a standardized, controlled fashion. Limitations of our study include the lack of a non-RMS training control arm, as well as the potential for skewed responses by residents. Some residents may have responded favorably in fear of retribution, or unfavorably in reaction to recent negative evaluations or events. Counteracting such potential confounders was the optional and anonymous nature of the survey. Moreover, removal of the highest (5%) and lowest (5%) responders did not impact the statistical analyses or conclusions of the study. The potential of having a control arm in this study was logistically challenging and deemed unjustifiable due to the limited number of UR-1 residents in a single residency program and the multiple constraints in revising resident rotations to accommodate the study without negatively impacting the residency program. While larger, multicenter trials have the potential for increasing sample size, implementing such trials can be equally challenging given that RMS in IES technology is not widely available throughout most urology residency programs.

Conclusions

Remote monitoring and supervision (RMS) in integrated endourology suites (IES) has the potential to enhance resident education and training. Residents reported high levels of acceptance and satisfaction with RMS technology. Additionally, residents reported a positive impact of RMS in IES on endourology training. Using the new ACGME residency training milestones, this study demonstrated a significant increase in endoscopic skill competency levels reported by residents following a relatively short period of training under RMS. □

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