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Feasibility and perceived usefulness of using head-mounted cameras for resident video portfolios

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Abstract

Background—There is limited guidance on how to longitudinally administer simulation materials or to incorporate video recordings into assessment portfolios of simulated surgical skills.

Materials and Methods—We launched a longitudinal weekly simulation curriculum for PGY1-PGY3 surgical residents based on the ACS/APDS Curriculum. Residents underwent monthly Objective Structured Assessment of Technical Skills (OSATS) while wearing head-mounted cameras. Videos of OSATS performance accrued into individual online video portfolios. Residents were surveyed about their attitudes toward video recording.

Results—Twenty-seven general surgical residents participated, completing 161 OSATS encompassing 11 distinct skills and generating 258 videos of simulated skills performance. The overall survey response rate was 88%. Residents viewed the curriculum favorably overall, and 36.4% of residents accessed their videos. Of those who did not watch their videos, 78.6% cited not having enough time, while 28.6% did not think the videos would be useful. Over 95% of surveyed residents expressed interest in having a video library of attending-performed procedures, 59.1% were interested in having their own operations recorded, and 45.5% were interested in video-based coaching.

Conclusion—Residents viewed longitudinal administration of the ACS/APDS Curriculum positively. While video recording in simulation is feasible, resident interest may be higher for intraoperative recordings than for simulated skills.

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Introduction

In the wake of work hour restrictions and an increasing number of surgical skills, simulation has emerged as a key component in the training and assessment of residents. Since 2008, all general surgery residency programs have been mandated by the Residency Review Committee (RRC) to have access to a simulation and skills laboratory for accreditation (1). Now, 10 years after this mandate, there is a persistent research need with regard to the design and implementation of simulation curricula as well as on effective simulation feedback (2, 3).

In 2007, the American College of Surgeons (ACS) and the Association of Program Directors in Surgery (APDS) released the National Skills Curriculum for Residents, a 3-phase program to increase the effectiveness and standardization of simulation-based surgical skill development (4). Phase 1 consists of 16 basic and essential surgical skills models; Phase 2 focuses on procedural and advanced skills models, and Phase 3 includes team-based skills modules. As of 2017, this curriculum has been adopted in some capacity by approximately 77% of residency programs participating in the ACS Accredited Education Institutes (AEI) program, nearly double the 30–40% adoption rate reported in 2013 across all general surgery residency programs (5, 6). However, a number of obstacles have prevented even broader adoption of the ACS/APDS curriculum outside of the ACS AEI program, including materials and space costs, personnel costs, lack of administrative support, limited faculty time/incentives, and resident patient care demands, among others (5, 7, 8).

At the same time that residency programs are working to overcome these obstacles and enhance their simulation programs to meet the RRC requirements, there is increasing interest in the role of video recording in surgical education. To date, a small number of groups have piloted the use of head-mounted cameras to improve feedback to surgical trainees in the operating room setting (9–12). In general, these studies demonstrate that incorporating video recording into surgical learning is feasible and viewed positively by trainees. However, there has been limited investigation into incorporating video recording into a longitudinal simulation curriculum. The ACS/APDS curriculum does not currently provide instruction to residency programs on how to incorporate video recording of simulated skills.

The purposes of this study were to determine the feasibility of using head-mounted cameras to create longitudinal resident video portfolios following the Phase 1 ACS/APDS Core Skills Curriculum for junior residents and to describe trainee attitudes toward the use of video recording in a simulation setting.

Methods

Setting

All simulation activities, including training sessions and OSATS, occurred in the Massachusetts General Hospital (MGH) Surgery Skills Lab. Surgical residents have unlimited access to the lab, which houses laparoscopic box simulators, a robotic simulator, an endoscopic simulator, and inanimate simulation models for the skills described below.

The lab is staffed part-time by simulation technologists who provide additional simulation materials and models to residents upon request.

Learners

During the 2017–2018 academic year, all MGH categorical general surgery residents in the PGY1-PGY3 years were required to participate in the weekly simulation curriculum described below as part of the overall general surgery curriculum. Exceptions were made for residents who were rotating off-campus, on vacation, or on night float rotations. Non-categorical surgery residents, such as non-designated preliminary residents and residents in surgical subspecialties rotating on general surgery, were welcome to join the simulation sessions and testing, but were not required to do so. Given that their instruction, practice, and testing were identical to categorical general surgery residents, only pooled data are presented in this study.

Curriculum

The 2017–2018 MGH longitudinal surgical skills curriculum was based on the ACS/APDS Phase 1 curriculum and followed a longitudinal, weekly schedule of structured instruction, practice, and testing on inanimate models (Table 1). The curriculum encompassed eleven of the sixteen Phase 1 skills, including suturing, knot-tying, surgical biopsy, surgical airway, chest tube, laparotomy, basic laparoscopic skills, advanced laparoscopy skills, hand-sewn bowel anastomosis, stapled bowel anastomosis, and vascular anastomosis. Once a week, residents had 90 minutes of protected simulation time. Residents were provided access to the ACS/APDS online modules to prepare for each session. The rationale for this curriculum structure was to incorporate principles of distributed and deliberate practice including spaced sessions and focused repeated practice with immediate feedback (13). The principle of maintenance training and testing was also incorporated through repetition of the skills across the academic year to minimize skill loss (14).

During the simulation sessions, residents were instructed on the skill of the week by senior residents or faculty for approximately 15–20 minutes before being given an opportunity to practice under supervision for the remainder of the session. Faculty were invited to teach particular skills based on their clinical expertise and practice. PGY 4 or higher senior residents participated as well to provide additional instructional support during the practice portion of the session. There was typically an instructor:learner ratio of 1:4 or less during the practice portion of the session to ensure opportunity for ample, immediate feedback to the learners on their technique. The eleven Phase 1 skills were repeated twice during the academic year. In Round 1, residents underwent an Objective Structured Assessment of Technical Skills (OSATS) in the final week of each month for the skills taught and practiced in the preceding 3–4 weeks. In Round 2, residents reviewed skills at an increased pace and underwent OSATS after 1 or 2 weeks of instruction and practice.

Residents in our program may rotate at affiliated hospitals and were excused from participating in OSATS during the month(s) they were off-site.

Video Equipment and Recording Procedures

GoPro Hero 5 cameras (GoPro, Inc., San Mateo, CA) were purchased as well as AmazonBasics Head Strap Mounts for GoPro (Amazon, Seattle, WA) and SanDisk 128Gb microSD memory cards (SanDisk Corporation, Milpitas, CA).

Videos were recorded in 1080p (1920×1080 pixels) resolution in the MPEG-4 file format. Filming for each skill was controlled by the faculty evaluator or simulation fellow. No editing or post-processing was performed for videos. At the end of each OSATS session, simulation fellows would download the video files from each camera onto an external hard drive. Videos were then sorted and labeled by participant number to ensure that the correct video would be uploaded to the correct portfolio. Simulation fellows would then upload the videos to their respective portfolios, which were hosted on a Dropbox Business (Dropbox, Inc, San Francisco, CA) account owned by the hospital.

Assessment

During each OSATS, residents wore head-mounted GoPro cameras to capture their simulated skills performance from a first-person perspective. Surgical education fellows placed the cameras on the participants' heads. Because each resident was of a different height, surgical education fellows would look through the viewing screen of the camera or use a tablet device synced with the camera to ensure appropriate views of the resident hands and the simulation model while performing the tasks (Figure 1). Faculty examiners observed performance of the simulated surgical skills and provided feedback immediately after skills performance. The feedback was also video recorded. Resident performance on the OSATS was evaluated on two scoring systems provided by the ACS/APDS curriculum. First, the ACS/APDS task-specific checklist for each skill was minimally adapted to reflect local surgical practice. Second, the examiner rated each resident's performance on the Global Rating Scale (GRS), a reliable and validated metric for the assessment of resident operative skills (15). Both sets of evaluation instruments were provided to the residents in advance of the OSATS in both written and electronic form, and they were posted in the simulation lab and available to the residents during all instruction and practice sessions.

Program evaluation

At the end of every OSATS session during the 2017–2018 academic year, residents were asked to complete an anonymous paper survey regarding the perceived value of the simulation practice and testing sessions (Appendix A). Participants were asked to select their level of agreement with 8 statements on a 5-point scale ranging from “strongly agree” to “strongly disagree”. Participants were also asked to indicate whether they had a chance to apply the simulated skill to patient care and if they had practiced independently outside of structured simulation sessions.

After Round 1 of the curriculum, all residents who had received links to a video portfolio of their simulated skills performance were asked to complete an additional survey regarding their attitudes towards video recording of the OSATS sessions (Appendix B). This survey was administered online via Qualtrics survey software, and residents received up to three reminders to participate. Participants were asked whether they had accessed their video

portfolio and, if so, the perceived utility of the videos. Questions regarding perceived benefits of the videos were adapted from a prior study of head-mounted cameras for intraoperative feedback (9). Participants who had not accessed the video were asked why they did not do so. All participants were asked about their opinions regarding the potential future utility of video recordings in surgery residency training.

The completion of surveys was voluntary, and residents were explicitly told that their compliance with survey completion would have no effect on their evaluation, promotion, or progression through the residency program.

Statistical Analyses

Descriptive statistics for program evaluation instruments were calculated. We used Intercooled Stata software, version 13.1 (StataCorp, College Station, TX) for all statistical analyses. Given the small sample size and pilot nature of the simulation curriculum, subgroup analysis between PGY levels was not performed.

All aspects of the study were reviewed and approved by the Partners Healthcare Institutional Review Board, Protocol #2018P000233.

Results

Twenty-seven (n=27) categorical general surgery residents participated in the simulation curriculum in the 2017–2018 academic year (9 residents per class year, PGY1-PGY3). Three non-categorical surgery residents participated in at least one OSATS. Residents completed 161 OSATS sessions encompassing the eleven Phase 1 skills, generating 258 videos of skills performance and 258 feedback videos. Of these totals, non-categorical surgery residents contributed 7 OSATS sessions and 21 skills videos, constituting 4% of OSATS sessions and 8% of videos.

The overall response rate for surveys administered after each OSATS was 90% (145 of 161 surveys completed). In general, residents viewed the new simulation curriculum favorably (Table 2). Across all post-OSATS surveys for all skills, an overwhelming majority of residents indicated that simulation improved their procedural skills (91%) and was a worthwhile use of protected time (85.4%). Across all OSATS sessions, nearly all participating residents reported planning to incorporate what was learned during simulation into future patient care (97.2%).

Of the 28 residents who had a video portfolio available for review after Round 1 of the curriculum, 22 completed the survey regarding use of video-recording during the OSATS (79% response rate). While 68.2% (n=15) of respondents indicated a prior use of video recordings to improve their personal performance in other domains, such as athletics or artistic performance, only 36.4% (n=8) of residents indicated having accessed their OSATS video portfolio. These residents generally indicated that video recordings were of high quality and moderate to very useful. Furthermore, these residents reported that the video portfolio was of moderate to extreme usefulness relative to monthly written evaluations from faculty or even intraoperative instruction from faculty (Table 2). Residents who did not

watch the video cited a lack of time as the number one obstacle to watching the video (79%, n=11). Other cited reasons included a perception that the video would not be useful (29%, n=4) and not knowing how to access the video portfolio (21%, n=3).

All participants on the video survey were asked if they were interested in other methods of incorporating video recording into surgical training. Nearly all residents (95%, n=21) indicated an interest in a video library of surgical procedures performed by attending surgeons. In addition, a majority of residents indicated an interest in intra-operative recordings of their own performances (59%, n=13), and about half indicated an interest in review of their OSATS performances with either a senior resident or faculty coach (45%, n=10).

A total of three cameras (\$399 each) were purchased along with three head-mounting straps (\$7.49 each) and three memory cards (\$66.81). The total cost of these supplies was \$1419.90. There was no cost to the surgical education team to use the Dropbox Business cloud-based storage account as the hospital had purchased and maintained the account with allowances for research teams and individuals. Each minute of video required approximately 180MB of storage space. The allotted time to complete tasks ranged from 6–15 minutes depending on complexity; thus, the size of each video ranged from approximately 1.1GB to 2.7GB.

Discussion

This work demonstrates the feasibility of creating longitudinal video portfolios of OSATS performance and feedback in the context of a yearlong simulation curriculum that follows the Phase 1 ACS/APDS Core Skills Curriculum. Aside from the video recording, characteristics of this curriculum included distributed practice with faculty and senior resident feedback and instruction, practice and testing phases with high instructor to learner ratios, repetition of skills across the academic year, and explicit and transparent evaluation criteria. Others have described administering simulation curricula spanning similar surgical skills across shorter periods of time, ranging from weeks to months, though we are unaware of any group routinely incorporating video recording into their simulation curriculum (7, 16).

Overall, learners perceived the new longitudinal curriculum very favorably, which is consistent with other studies of resident perceptions of the ACS/APDS curriculum (7, 16, 17). In particular, residents reported planning to incorporate simulation-based learning into clinical practice, believing their procedural skills improved as a result of the sessions, and found the sessions to be worthwhile, despite forgoing their usual patient care activities, which often include going to the operating room. Importantly, residents report practicing the skills over 50% of the time outside of the dedicated simulation time. While we do not have baseline data on the use of our simulation center, our perception is that after the introduction of the new curriculum, resident use of the skills lab to practice procedural skills increased dramatically.

However, only one-third or so of residents viewed their online video portfolio despite a majority of residents having a personal history of using video recordings to improve their performance in other domains, such as athletics or the arts. A lack of enthusiasm for the simulation video portfolios stands in stark contrast to the findings of other studies demonstrating high resident interest in intraoperative video recording and feedback (9, 11, 12). Part of this discrepancy may be due to the fact that the quality of faculty feedback during the OSATS sessions was already quite high relative to that in the actual operating room setting. During the OSATS, faculty were exclusively focused on the educational aims of the session rather than on patient care. Further, they had dedicated time and were provided with structured evaluation instruments to guide their feedback to residents. Therefore, the additional value of video review may be perceived to be less than in an operative setting where the attention of the faculty member is divided between patient care and education, and time is not routinely set aside for highly structured feedback on the resident's procedural skill.

Residents who did not access their video portfolios reported lack of time as the primary obstacle to engaging with their videos. In the era of increasing time pressures on all clinicians, mandating viewing of videos in residents' "free" time would likely not be a welcome intervention. However, we plan to enable mobile access to residents' video portfolio through the Dropbox Business application available for iPhone and Android devices. Furthermore, we are hoping to trial protected time during the senior-junior resident simulation sessions for juniors to review their videos with senior residents under the hypothesis that a set format for video review will increase access and utilization of the video portfolios.

This study has several important limitations. First, it is a single institution experience of a large academic residency program and thus may not be generalizable to other programs in non-academic settings, such as those with a smaller number of residents and/or fewer resources for surgical simulation. The resources available in the present setting include a pre-established surgical skills and simulation lab that has dedicated personnel, including simulation technologists and two lab residents pursuing surgical education and simulation research fellowships. Our program also has a pool of twenty PGY4 or higher lab residents who volunteer on a rotating basis to attend the weekly simulation sessions in order to optimize the instructor-to-learner ratio and to increase the quantity of teaching and feedback provided to junior residents without increasing the demands on the faculty. The curriculum described here may not be replicable in other settings with different resources. The use of surveys to assess resident perceptions and the wording of the surveys may have exposed the answers to response bias, particularly if residents may have felt a need to respond favorably to items due to the participation of their faculty and senior residents in teaching and evaluation sessions. Additionally, we did not include faculty rater training in the first year of the curriculum. This was an explicit decision in order to minimize any additional burden on the faculty that could potentially dampen their interest in teaching or affect their availability to participate in the simulation sessions. Resident performance on the OSATS is therefore not presented, as there may be high variability between faculty raters. Pre-testing was also not performed, and thus resident performance on simulation skills cannot necessarily be

attributed to the simulations sessions, although others have demonstrated the effectiveness of the ACS/APDS curriculum in improving the performance of simulated surgical skills (16).

Planned future improvements to the simulation curriculum include improved logistics for off-campus and night float residents such that they can also participate in simulation-based instruction and the OSATS. Furthermore, we plan to standardize faculty rater training on OSATS evaluation instruments. These changes will ensure that residents receive more uniform educational experiences regardless of their rotation schedule as well as consistent feedback from faculty during the testing portions of the curriculum. Additionally, rater training would allow for investigation of changes in resident performance based on OSATS scores and faculty feedback – either in simulation or in the live operating room. A recent review of simulation best practices emphasizes the need for simulation programs to offer faculty development and rater training to improve the quality of simulation instruction as well as to increase the rigor of simulation evaluation (18). We believe these are important improvements to make as rater-training should improve the quality of the video-based feedback that trainees receive and hypothesize that more consistent access to simulation-based instruction and OSATS feedback via video will improve utilization of video portfolios.

With regard to video review, our findings suggest that residents could find the videos useful if they accessed them. Future work could investigate the role of structured video review and coaching of simulated skills with faculty or senior residents to increase the benefit of video recording to a greater number of simulation participants. There is evidence that video-based coaching improves laparoscopic performance both on virtual reality trainers and porcine models of laparoscopic cholecystectomy (19). One study in the field of orthopedic surgery has demonstrated improved OSATS performance after residents reviewed head-mounted video recordings of simulated skills with a faculty member (20). Another potential area of focus for video review is intraoperative recording and feedback, though the operating room context provides its own unique set of challenges, including patient privacy, maintaining the sterile field, and heterogeneity of resident operative experiences. A long-term goal is to investigate whether incorporation of video feedback into surgical residency training, either in a simulated or live operating room setting, could lead to the more rapid development of operative skill and to improved patient outcomes.

Conclusions

This study demonstrates the feasibility of administering the Phase 1 ACS/APDS Core Skills Curriculum in a distributed, longitudinal fashion with associated video portfolios of simulated surgical skills and feedback. While residents view the longitudinal administration of the ACS/APDS curriculum favorably, only a minority of residents take the time to independently view their own video recordings. Residents who view the videos find them to be of moderate usefulness, suggesting that future work should focus on how to better incorporate structured video review into the simulation curriculum and thereby increase its utility to learners. Future work could also investigate how to optimize video recording for trainee feedback in other settings, such as the operating room, and to assess the benefits of video-based feedback on the acquisition of operative skill and on patient outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

OSATS	Objective Structured Assessment of Technical Skills
ACS	American College of Surgeons
AEI	Accredited Education Institutes
APDS	Association of Program Directors in Surgery
MGH	Massachusetts General Hospital

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Figure 1.

A) A faculty member providing feedback to a junior resident during an OSATS session while a surgical education fellow observes. The junior resident is wearing a head-mounted camera (circle) that is aimed at the simulated field (cone). B) Representative first person-perspective of head-mounted camera captured video still.

Table 1.

2017–2018 Weekly Simulation Curriculum. Participation by a given PGY level is indicated in the PGY1, PGY2, and PGY3 columns. Testing weeks are indicated by OSATS.

Week #	PGY1	PGY2	PGY3	SKILL	Week #	PGY1	PGY2	PGY3	SKILL
Round 1					Round 2				
1	X	X		knot-tying/suturing	31	X			knot-tying/suturing
2	X	X		knot-tying/suturing	32				OSATS (PGY1)
3	X	X		surgical biopsy	33	X	X		surgical biopsy
4	X	X		surgical biopsy	34				OSATS (PGY1 + PGY2)
5				OSATS (PGY1 + PGY2)	35	X	X		chest tubes/airway
6	X	X		chest tubes	36				OSATS (PGY1 + PGY2)
7	X	X		chest tubes	37		X	X	handsewn bowel anastomosis
8	X	X		airway	38				handsewn bowel anastomosis
9	X	X		airway	39				OSATS (PGY2+PGY3)
10				OSATS (PGY1 + PGY2)	40		X	X	stapled bowel anastomosis
11	X	X		basic laparoscopy/laparotomy	41		X	X	stapled bowel anastomosis
12	X	X		basic laparoscopy/laparotomy	42				OSATS (PGY2+PGY3)
13	X	X		basic laparoscopy/laparotomy	44		X	X	vascular anastomosis
14				OSATS (PGY1 + PGY2)	45		X	X	vascular anastomosis
15		X	X	handsewn bowel anastomosis	46				OSATS (PGY2+PGY3)
16		X	X	handsewn bowel anastomosis	47	X	X		basic laparoscopy/laparotomy
17		X	X	handsewn bowel anastomosis	48				OSATS (PGY1 + PGY2)
18				OSATS (PGY2+PGY3)	49		X	X	advanced laparoscopy
19		X	X	stapled bowel anastomosis	50				OSATS (PGY2+PGY3)
20		X	X	stapled bowel anastomosis					

Week #	PGY1	PGY2	PGY3	SKILL	Round 1				Week #	PGY1	PGY2	PGY3	SKILL	Round 2			
21		X	X	stapled bowel anastomosis													
22				OSATS (PGY2+PGY3)													
23		X	X	vascular anastomosis													
24		X	X	vascular anastomosis													
25		X	X	vascular anastomosis													
26				OSATS (PGY2+PGY3)													
27		X	X	advanced laparoscopy													
28		X	X	advanced laparoscopy													
29		X	X	advanced laparoscopy													
30				OSATS (PGY2+PGY3)													

Table 2.

Resident responses on post-OSATS surveys. Knot-tying, suturing, and surgical biopsy were included in a single OSATS session in Round 1 of the curriculum but split into two different OSATS sessions in Round 2. Results for other OSATS are pooled from both Round 1 and Round 2 surveys.

Statement	% of survey respondents who indicated “strongly agree” or “somewhat agree”									
	All skills pooled	Knot-tying, suturing, and surgical biopsy	Knot-tying	Surgical biopsy	Airway and chest tube	Laparotomy and basic lap	Hand sewn bowel	Stapled bowel	Vascular	Advanced lap
The simulation sessions helped me improve my procedural skills.	91.0	80	100	80	88.5	81.8	95.8	100	78	80
The simulation sessions were relevant to my current clinical responsibilities.	88.9	93.3	100	80	88.5	81.8	95.8	100	80	77.8
My confidence in performing these skills on a patient was improved by the simulation sessions.	86.8	80	85.7	70	88.5	68.2	100	93.8	100	88.9
My ability to perform these technical skills on a patient was improved by the simulation sessions.	86.0	73.3	85.7	70	84	77.3	100	93.8	93.3	88.9
I plan to incorporate what I learned during the simulation sessions into patient care in the future.	97.2	86.7	100	100	96.2	95.5	100	100	100	100
Simulation sessions are a worthwhile use of protected educational time even though I am unable to participate in my usual clinical activities.	85.4	80	85.7	80	76.9	77.3	95.8	93.8	86.7	100
I received sufficient instruction during the simulation sessions to do well on the formal assessment.	90.9	93.3	100	100	88.5	77.3	100	93.8	93.3	77.8
The formal assessment (OSATS) was an effective means of receiving feedback about my technical skills.	85.4	73.3	100	70	76.9	77.3	95.8	87.5	100	100
% of survey respondents who indicated “yes”										
Since the simulation sessions, I have had an opportunity to apply what I learned to patient care.	52.8	100	100	80	65.4	50	25	37.5	60	22.2
I independently practiced the technical skills between the simulation sessions and the formal assessment.	59.0	80	100	10	34.6	50	79.2	37.5	86.7	77.8

Table 3.

Residents who indicated having watched their video portfolio rated the usefulness and quality of the video recordings.

Question	Response	N (%)
Was watching the video useful for your surgical education?	Extremely useful Very Useful Moderately useful Minimally useful Not useful	1 (12.5%) 2 (25%) 4 (50%) 0 (0%) 1 (12.5%)
Was watching the video useful in identifying strengths that you have not perceived in the OR?	Extremely useful Very Useful Moderately useful Minimally useful Not useful	0 (0%) 1 (12.5%) 4 (50%) 2 (25%) 1 (12.5%)
Was watching the video useful in identifying weaknesses that you have not perceived in the OR?	Extremely useful Very Useful Moderately useful Minimally useful Not useful	0 (0%) 3 (37.5%) 3 (37.5%) 1 (12.5%) 1 (12.5%)
Was watching the video useful for identifying key technical aspects of the task?	Extremely useful Very Useful Moderately useful Minimally useful Not useful	1 (12.5%) 3 (37.5%) 3 (37.5%) 0 (0%) 1 (12.5%)
Compared to reading attending monthly evaluation forms or attending operative feedback, OSATS GoPro video review is...	Extremely useful Very Useful Moderately useful Minimally useful Not useful	2 (25%) 1 (12.5%) 4 (50%) 0 (0%) 1 (12.5%)
How would you rate the quality of the OSATS GoPro video?	Excellent Good Average Fair Poor	1 (12.5%) 7 (87.5%) 0 (0%) 0 (0%) 0 (0%)