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ORIGINAL ARTICLE

Developing a formal curriculum on basic open and laparoscopic skills in a new community hospital general surgery residency program with limited simulation resources

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Abstract

Background: There is little information in the literature with regard to the development of simulation curricula within new general surgery residency programs, especially those based in community hospitals with limited simulation resources and experience in graduate medical education. As members of a new surgery residency program at such a community hospital, with limited resources, we aimed to implement a formal simulation curriculum on basic open and laparoscopic surgical skills, quantify the progress of trainees over the course of a single academic calendar year, and describe our experience. **Methods:** To implement a formal simulation curriculum, in collaboration with the surgeon faculty, a team of trainees developed a schedule of simulation topics to occur throughout the academic year. The team also devised a set of simulation exercises to evaluate trainee performance throughout the year using improvised materials. Junior residents participated in testing sessions where they completed these tasks and data were recorded. At the end of the academic year, data were analyzed to evaluate changes in trainee performance throughout the year. **Results:** A total of 16 junior trainees participated in the simulation testing sessions throughout the year. By the end of the academic year, time to completion decreased significantly in three of the four suturing tasks, while qualitative scores increased in all four tasks. There was significant improvement in time to completion for two of the five laparoscopic tasks. While there was a trend towards increasing scores, only one laparoscopic task had significant improvement in qualitative scoring by the end of the year. **Conclusions:** Even with limited resources, the implementation of a structured simulation program can result in objective improvements in surgical trainee performance.

Keywords: *surgical; simulation; development; residency; program; limited resources*

Introduction

Surgical training has changed drastically over the last several decades. Healthcare has undergone an industrial revolution and with this change has come ever growing financial and societal pressures for surgeons to achieve the best clinical outcomes possible. However benevolent these forces may be, an undeniable consequence has been the limiting effect it has had on the quality of training for tomorrow's surgeons. With growing bureaucratic and medicolegal pressures, modern faculty surgeons are more reluctant than ever to afford their trainees the autonomy and operative experience that was once common in years past.[1] The decline in authentic operative experience for surgical residents has not gone unrecognized within the surgical community nor has the implication that this decline may result in today's surgical trainees being less prepared than their predecessors upon entering into surgical practice. Recognizing the potential for gaps in experience, simulation has been touted as a potential call to arms.

The benefits of simulation in non-surgical fields requiring technical skills and tolerance for high stress scenarios such as the military and aerospace industries are well known. Similarly, within the last two decades, the benefits of surgical simulation have been demonstrated in multiple well-designed randomized controlled trials.[2–5] Perhaps the strongest evidence in support of surgical simulation is that involving laparoscopy. A 2009 Cochrane Review concluded that laparoscopic simulation decreased time to completion, increased accuracy, and decreased errors.[6] More importantly, data suggest that skills acquired in simulation can be translated to improved performance in surgery on real patients.[7] Supported by a plethora of literature, simulation is now recommended for all surgical trainees in the United States by the Residency Review Committee and the American College of Surgeons.[8] Moreover, in order to become board certified in general surgery, surgical residents in the United States must successfully complete simulation-based testing in the American Gastrointestinal and Endoscopic Surgeons Fundamentals of Laparoscopic Surgery (FLS) program.[9] Finally, perhaps most importantly, the majority of surgical residents believe that simulation is beneficial to their training.[10]

Although simulation has become a cornerstone in modern surgical training, the literature is lacking in regard to the development of simulation curricula within new general surgery residency programs, especially those based in community hospitals with limited simulation resources. This article will offer insights into the challenges faced when developing a fully functional simulation curriculum involving basic open and laparoscopic skills in a new community hospital general surgery residency program prior to having graduated its inaugural class. We offer our experiences in navigating through the entire process, from conception to implementation, as well as overcoming limited resources and navigating the schedules of busy faculty. In addition to subjective feedback from the simulation team and participants, the quality of the program will be evaluated by analyzing quantitative simulation data taken from surgical trainees throughout a single academic year from July 2021 to July 2022. In doing so, we hope this article may offer insight to other general surgery residency programs regarding the implementation of simulation curricula involving basic open and laparoscopic skills, especially those in community settings with limited resources.

Methods

The academic year of 2021–2022 marked the program's fourth academic year and the first year in which the program boasted a full complement of trainees [i.e. all five levels of post-graduate year (PGY) training positions filled]. With a full roster, the program aimed to develop a formalized simulation-based training curriculum. A team of three residents from different training levels (PGY-2, PGY-3, and PGY-4) were assigned to develop and implement a simulation curriculum. The simulation team sought out faculty surgeons who had particular interest in teaching technical skills and collaborated in regard to the program's particular needs. With insight from faculty surgeons, the simulation team determined that core principles of surgical technique were of the utmost importance, consisting of instrument handling (both open and laparoscopic), suturing, and knot tying. As such, a curriculum of training exercises was formulated and scheduled to occur every other week for approximately 1 h during the program's designated academic half-day throughout the year (Appendix 1). Each session attempted to focus on a particular technique or operative topic. The first few sessions focused on orientation and basic knowledge such as instrumentation and proper handling. During the year, sessions gradually focused on more complex topics and techniques, from basic suturing to vascular anastomoses. Senior and chief residents served as proctors during the more rudimentary simulation sessions. As the year progressed, the presence of at least one faculty surgeon was requested for more advanced sessions. Adopting from advocates of 'low-cost simulation,' we utilized equipment borrowed from the hospital's surgery department and laparoscopic trainers gifted to the program by industry representatives. Additional materials, such as suture pads and extra instruments, were purchased from general online retail sources, the total costs of which were inconsequential. By primarily using resources which had already been available, the total cost of implementing our simulation curriculum was inconsequential to the program's annual budget.

In an attempt to objectively evaluate the trainees' response to simulation, performance data were obtained at three different sessions throughout the academic year. Specifically, 'testing days' were scheduled during the Fall, Winter, and Spring seasons, each at approximately 3-month intervals to track the progress of participants. We aimed to focus these testing sessions on tasks and techniques felt to be most critical to having good surgical technique, that is, suturing and knot tying, as well as basic laparoscopic skills. Given that senior residents (PGY-4 and PGY-5) typically helped proctor simulation sessions and were expected to have already gained expertise in most simulation tasks, our testing was focused towards PGY-1, PGY-2, and PGY-3 residents. We tested trainees' performance in two different skills categories: conventional suturing and laparoscopy. Each category consisted of several different tasks developed to simulate techniques commonly used in surgical practice. For the suturing category, four different tasks were developed in collaboration with the simulation team and faculty. The laparoscopic tasks were based on the five standardized exercises required to pass the FLS exam.[11] Grading criteria were also similar to those of the actual FLS examination; however, additional criteria were added in an attempt to make the tasks more challenging for trainees. Detailed instructions and unique grading criteria were then written for each task and printed on laminated sheets for residents to review on testing days (Supplementary files 1 and 2). PGY-1 and PGY-2 residents participated in suturing assessments, while PGY-2 and PGY-3 residents participated in the laparoscopic skills testing. Participants were graded by senior residents and faculty based on their availability at the time of testing.

Data extracted were the examinee and their respective training level, examiner, date, specific exercise, time of completion, and the grading score (Supplementary files 3 and 4). Following completion of the academic year and final testing session, data were then analyzed. Evaluating how completion times and grading scores changed throughout the year was our primary focus. Data were stored throughout the year and later analyzed using Microsoft Excel (MSCorp LLC, WA). Analysis of variance (ANOVA) was used to detect significant differences among the average scores and times obtained during the three testing sessions throughout the year.

Formal written consent was obtained from each of the participating residents. This study was approved by the institutional review board of HCA West Florida Division of Graduate Medical Education and Research.

Results

While there were scattered absences throughout the year due to trainees being post-call or at outside rotations, a total of 12 residents (eight PGY-1 and four PGY-2) participated in the suturing skills testing throughout the year (Tables 1 and 2, Figs 1 and 2). During the initial Fall assessment, there were two disqualifying scores of 0 from different PGY-1 residents, both due to an inability to complete the tasks. Specifically, one resident was unable to complete a one-handed tie with their non-dominant hand, while the other never received instruction on how to throw mattress sutures. After the Fall assessment, there were no further disqualifications. The average time to completion of interrupted sutures using instrument tying was 145 s during the Fall assessment, reducing significantly to 85 s by the final assessment in the Spring ($P = 0.004$). Similarly, mean quality scores increased from 3.0 to 4.6 during the initial Fall and final Spring assessments, respectively ($P < 0.001$). Of the suturing tasks, mattress sutures using two-hand tying took the longest to complete with an average time of 258 s to completion during the Fall

Table 1. Time (seconds) to completion for suture skills simulation tasks among PGY1–2 residents.

	Interrupted sutures / instrument tying	Mattress sutures / two-hand tying	Ligation / one-hand tying	Drain stitch / any tying
Fall				
PGY1-a	NA[a]	NA	NA	NA
PGY1-b	114	150	203	186
PGY1-c	158	203	134	127
PGY1-d	149	330	149	148
PGY1-e	97	275	110	141
PGY1-f	121	309	117	99
PGY1-g	248	296	134	191
PGY1-h	205	260	180	109
PGY2-a	102	167	157	155
PGY2-b	105	263	128	96
PGY2-c	154	269	80	80
PGY2-d	NA	NA	NA	NA
Average	145	258	140	133
Winter				
PGY1-a	174	270	175	111
PGY1-b	114	180	217	123
PGY1-c	NA	NA	NA	NA
PGY1-d	60	313	108	191
PGY1-e	108	161	87	191
PGY1-f	97	173	133	164
PGY1-g	157	343	178	196
PGY1-h	115	203	107	147
PGY2-a	90	236	109	111
PGY2-b	116	205	103	117
PGY2-c	116	195	109	111
PGY2-d	NA	NA	NA	NA
Average	115	228	133	138
Spring				
PGY1-a	94	190	100	94
PGY1-b	92	200	111	128
PGY1-c	99	188	117	119
PGY1-d	NA	NA	NA	NA
PGY1-e	75	146	78	117
PGY1-f	101	225	100	95
PGY1-g	NA	NA	NA	NA
PGY1-h	52	150	108	107
PGY2-a	77	171	133	121
PGY2-b	91	187	74	100
PGY2-c	NA	NA	NA	NA
PGY2-d	82	145	45	142
Average	85	178	96	114
P-value	0.004	0.036	0.009	0.305

[a] NA: not available.

Table 2. Qualitative scores (0–5) for suture skills simulation tasks among PGY1–2 residents.

	Interrupted sutures / instrument tying	Mattress sutures / two-hand tying	Ligation / one-hand tying	Drain stitch / any tying
Fall				
PGY1-a	NA[a]	NA	NA	NA
PGY1-b	3	3	1	2
PGY1-c	1	0	1	2
PGY1-d	3	4	1	2
PGY1-e	3	3	2	3
PGY1-f	3	3	1	5
PGY1-g	2	3	0	2
PGY1-h	3	3	2	4
PGY2-a	4	4	2	2
PGY2-b	4	3	3	3
PGY2-c	4	4	2	4
PGY2-d	NA	NA	NA	NA
Average	3.0	3.0	1.5	2.9
Winter				
PGY1-a	3	5	3	3
PGY1-b	4	5	3	4
PGY1-c	NA	NA	NA	NA
PGY1-d	4	3	3	3
PGY1-e	4	4	3	4
PGY1-f	5	5	3	3
PGY1-g	4	4	3	2
PGY1-h	4	4	4	5
PGY2-a	4	5	4	5
PGY2-b	4	5	4	4
PGY2-c	4	5	4	4
PGY2-d	NA	NA	NA	NA
Average	4.0	4.5	3.4	3.7
Spring				
PGY1-a	4	5	4	4
PGY1-b	4	3	4	4
PGY1-c	4	5	3	5
PGY1-d	NA	NA	NA	NA
PGY1-e	5	5	4	5
PGY1-f	5	4	5	4
PGY1-g	NA	NA	NA	NA
PGY1-h	4	4	4	5
PGY2-a	5	5	4	5
PGY2-b	5	5	4	5
PGY2-c	NA	NA	NA	NA
PGY2-d	5	5	5	5
Average	4.6	4.6	4.1	4.7
P-value	<0.001	0.001	<0.001	0.001

[a] NA: not available due to absence.

assessment. Nonetheless, we observed a significant reduction in time to completion to 178 s by the final Spring assessment ($P = 0.036$). Quality scoring also increased from an average of 3.0 to 4.6 ($P = 0.001$). Both time to completion and quality scores pertaining to the ligation with the one-handed tying task significantly improved throughout the year, from 140 to 96 s and 1.5 to 4.1, respectively ($P = 0.009$, $P < 0.001$). While there was a trend towards decreasing completion time, placing a drain stitch using any method of tying was the only suturing task in which we did not observe a significant reduction in time to completion ($P = 0.305$). Despite this, we did observe a significant increase in mean quality scores for placing drain sutures from a score of 2.9 to 4.7 ($P = 0.001$).

A total of eight residents (four PGY-2 and four PGY-3) participated in the laparoscopic skills testing sessions (Tables 3 and 4, Figs 3 and 4). Laparoscopic skills testing proved more difficult for trainees as there were disqualifying scores within each of the five tasks during all three testing sessions throughout the year. Specifically, four residents during Fall and four residents during Winter received scores of 0 for dropping the peg out of view during the peg transfer task. Precision cutting was failed once during the Winter assessment due to exceeding the allowed time to complete the task. A single failing score in the ligating loop task was observed during the Fall assessment due to tearing of the appendage. There were several disqualifications in the extra-corporeal suturing task throughout the year, as well. There was one failure in Fall for going over the allowed time to complete the task. Additionally, there were two disqualifications due to exceeding the time to complete the task on two separate occasions, one in Fall and one in Winter. Interestingly, these disqualifications were for different residents, suggesting that the resident disqualified in Winter had forgotten how to complete the task (as they had previously completed it successfully). Finally, one resident in Winter and two residents in Spring were disqualified for tearing the Penrose drain while suturing. Regarding intra-corporeal suturing, only one resident was disqualified due to an inability to complete the task. This disqualification occurred during the Winter assessment, again suggesting that the trainee had forgotten how to complete the task in the time between Fall and Winter. Going over the allowed time to completion was also noted as a reason for disqualification in the intra-corporeal suturing task. Specifically, one resident in the Winter and one resident in the Spring were disqualified for exceeding the time allowed to complete the task. On average, there were significant decreases in time to completion for the peg transfer and suture with extra-corporeal knot tying tasks, from 187 to 91 s and from 441 to 233 s, respectively ($P = 0.026$, $P = 0.002$). While there was a trend to decreasing time to completion for the other laparoscopic tasks, no significant

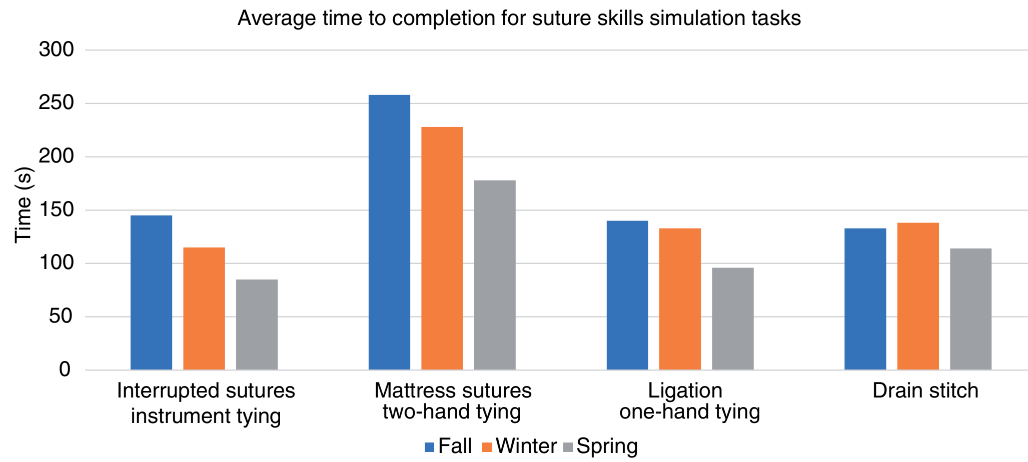

Figure 1. Average time to completion for suture skills simulation tasks during the Fall, Winter, and Spring testing sessions.

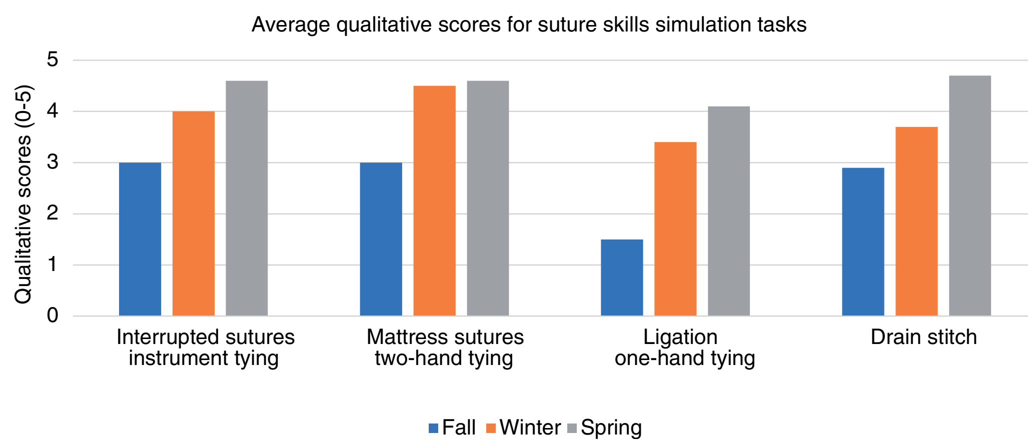

Figure 2. Average qualitative scores for suture skills simulation tasks during the Fall, Winter, and Spring testing sessions.

differences were observed. In terms of quality scoring, the only significant change was that of the peg transfer task, with the average quality scores increasing from 2.0 in the Fall session to 10.0 in the final Spring session (P = 0.010). Although there was a trend in increasing quality scores from the Fall and Spring sessions in the other laparoscopic tasks, none of these changes were statistically significant.

Discussion

While authentic intra-operative experience cannot be replaced, simulation-based training has become an integral component of modern surgical training. With an abundance of literature supporting the benefits of simulation in surgery training, it is now recommended that all surgical residents in the US participate. Additionally, residents must also pass a simulation-based test to become board certified. Despite its importance in the modern era, there has been a paucity of literature in regard to the practical aspects of implementing a simulation curriculum in new residency general surgery residency programs which are likely to increase in the near future given the expected shortage of general surgeons in the US.[12]

In order to develop a successful simulation curriculum, i.e. one which improves the true operative skills of trainees without interacting with real patients, a residency program must first identify the specific skills and procedures they will expect of their trainees in order to graduate into competent surgeons.[13] For example, the skills necessary to be a competent general surgeon may differ from those of an

Table 3. Time (seconds) to completion for laparoscopic skills simulation tasks among PGY2–3 residents.

	Peg transfer	Precision cutting	Ligating loop	Suture with extra-corporeal knot	Suture with intra-corporeal knot
Fall					
PGY2-a	95	143	50	620	218
PGY2-b	340	322	120	540	905
PGY2-c	235	234	73	387	416
PGY2-d	145	220	96	348	405
PGY3-a	NA[a]	NA	NA	NA	NA
PGY3-b	NA	NA	NA	NA	NA
PGY3-c	NA	NA	NA	NA	NA
PGY3-d	119	87	68	312	324
Average	187	201	81	441	454
Winter					
PGY2-a	143	182	66	179	385
PGY2-b	158	290	107	245	600
PGY2-c	154	300	83	235	300
PGY2-d	140	207	66	310	399
PGY3-a	140	221	69	258	282
PGY3-b	148	209	49	300	258
PGY3-c	160	210	45	110	477
PGY3-d	90	285	50	195	185
Average	142	229	67	217	355
Spring					
PGY2-a	51	154	72	NA	191
PGY2-b	95	200	81	180	600
PGY2-c	124	270	63	190	387
PGY2-d	77	160	60	246	421
PGY3-a	115	152	118	182	341
PGY3-b	88	107	85	410	434
PGY3-c	NA	NA	NA	NA	NA
PGY3-d	86	232	71	190	220
Average	91	182	79	233	371
P-value	0.026	0.383	0.445	0.002	0.627

[a] NA: not available due to absence.

Table 4. Qualitative scores (0–10) for laparoscopic skills simulation tasks among PGY2–3 residents.

	Peg transfer	Precision cutting	Ligating loop	Suture with extra-corporeal knot	Suture with intra-corporeal knot
Fall					
PGY2-a	0	10	10	0	10
PGY2-b	0	2	10	0	9
PGY2-c	0	4	10	8	8
PGY2-d	0	8	4	6	9
PGY3-a	NA[a]	NA	NA	NA	NA
PGY3-b	NA	NA	NA	NA	NA
PGY3-c	NA	NA	NA	NA	NA
PGY3-d	10	8	0	0	9
Average	2.0	6.4	6.8	2.8	9.0
Winter					
PGY2-a	10	8	10	10	9
PGY2-b	0	5	10	8	0
PGY2-c	10	0	10	8	10
PGY2-d	0	8	10	9	0
PGY3-a	10	6	8	8	7
PGY3-b	10	8	8	0	8
PGY3-c	0	6	6	10	7
PGY3-d	0	8	10	8	10
Average	5.0	6.4	6.8	2.8	9.0
Spring					
PGY2-a	10	8	8	0	8
PGY2-b	10	5	8	0	0
PGY2-c	10	8	10	8	6
PGY2-d	10	7	10	8	9
PGY3-a	10	10	8	10	6
PGY3-b	10	8	10	8	8
PGY3-c	NA	NA	NA	NA	NA
PGY3-d	10	10	8	10	10
Average	10	8.0	8.9	6.3	6.7
P-value	0.010	0.362	0.285	0.272	0.366

[a] NA: not available due to absence.

orthopedic surgeon. Additionally, certain techniques, while necessary for a competent general surgeon, may be rarely performed during a resident's training as a result of their specific program's case volume and exposure. Once these skills have been identified, a shorter list can then be refined based on an individual program's needs which are likely to vary based on case volume and faculty expertise. A schedule for the entire academic year can then be formulated focusing on the program's particular needs. When planning individual simulation sessions, one should keep in mind that knowledge and skills should be taught, used, and assessed in order to maximize retention and thus efficiency of the session.[14] Additionally, these data can be later utilized to evaluate the productivity of particular sessions and exercises. Ideally, simulation sessions should include time for deliberate practice with experienced oversight and feedback. Frequent, sequential sessions have proven to be an optimal strategy for skill acquisition and retention among surgical trainees.[15] While likely impractical for most programs, simulation exercises should be timed in close relation to opportunities for use in clinical situations. For example, a simulation on vascular anastomoses would ideally be

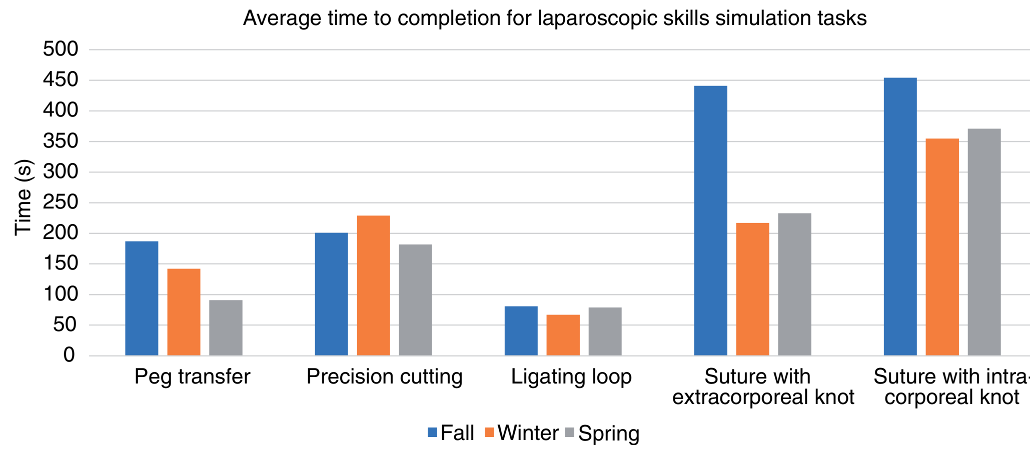

Figure 3. Average time to completion for laparoscopic skills simulation tasks during the Fall, Winter, and Spring testing sessions.

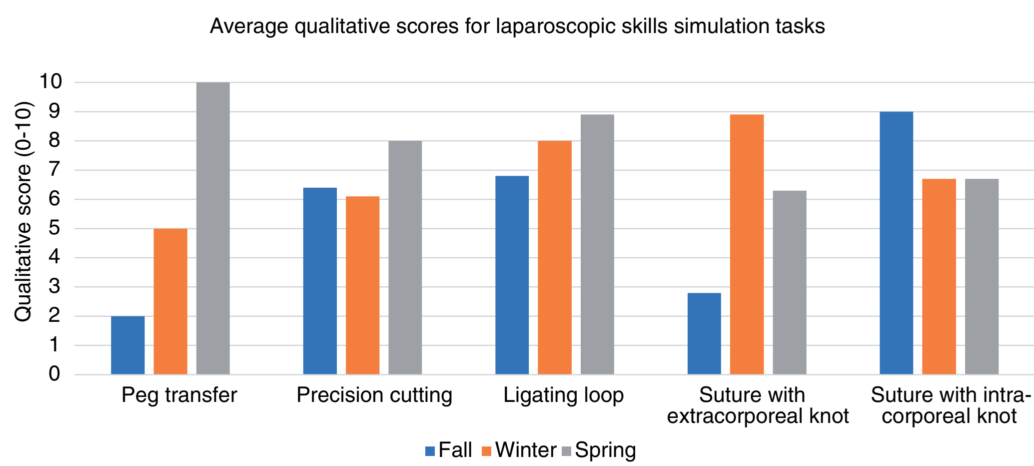

Figure 4. Average qualitative scores for laparoscopic skills simulation tasks during the Fall, Winter, and Spring testing sessions.

scheduled during a vascular surgery rotation. Regardless of scheduling, we feel it is imperative that each residency program identify the particular needs of their trainees.

Depending on the goals of a particular program, funding can prove a significant barrier towards implementing simulation. Without including the additional cost of staffing, implementing a simulation curriculum into a residency program has been estimated to cost from US \$12 500 to US \$33 000 per resident.[16] Indeed, given that our program is new and associated with a community hospital which did not have any prior experience in surgical education, acquiring funding and resources proved to be a significant obstacle to overcome in implementing our simulation curriculum. Our primary method of overcoming this issue was to focus on low-fidelity simulation exercises for which the necessary materials are readily available within most modern hospitals. Intuitively, the cost of surgical simulation increases as fidelity increases. High-fidelity simulations are created with the goal of mimicking real operations and human tissue as closely as possible. While this may seem beneficial, from a practical standpoint, high fidelity surgical simulation has major drawbacks. Arguably the most important is that, despite higher costs, high-fidelity simulation has not been shown to result in greater improvement in trainee performance when compared to low-fidelity simulation.[17] While high-fidelity simulation attempts to mimic authentic surgical experience, low-fidelity simulation simply focuses on improving hand–eye coordination, motor skill, and muscle memory. While seemingly dull, low-fidelity simulation offers a powerful platform that has proven benefits when it comes to improving trainee skills in the operating room during surgery on real patients.[18] Indeed, at the completion of our academic year and novel simulation curriculum, we did not feel that 'settling' for low-fidelity simulation had any negative effects on our educational mission. However, while low-fidelity simulation usually focuses on a single maneuver or portion of an operation, one true benefit of high-fidelity models is the ability to simulate entire procedures such as laparoscopic cholecystectomy and hernia repairs.[19] Nonetheless, our opinion is that today's technology limits the practical use of high-fidelity simulation. Ignoring the exorbitant costs, computer glitches and the need for frequent updates, as well as specialized equipment and staff, are among a few of many limitations of contemporary high-fidelity surgical simulation. Given the equivalence in outcomes, ease of use, and far lower costs, we recommend that new surgery residency programs give strong consideration towards low-fidelity simulation, especially during initial implementation.

While it can surely become a taxing process, our experience with implementing a formal simulation curriculum was positive overall. We would caution other programs to always keep the primary goal of surgical simulation in mind when implementing a new curriculum, that is, to improve operative skills and knowledge of trainees. This may seem intuitive; however, it is easy to become preoccupied in the arduous process inherent to the initial phases of implementation, as was our experience during the program's first year of a formal simulation program. Towards the end of the year, we felt that trainees would have benefited from less effort towards assessing their performance and more effort towards the education itself. As such, we recommend that new programs remain mindful of this pitfall; while important, assessment efforts should not outweigh those in teaching and practicing techniques. Additionally, navigating the inevitable challenges involved with organizing events, such as scheduling, logistics, funding, and other resource allocation, can all potentially distract from the primary goals of surgical simulation. While it would be ideal to have staff dedicated to simulation, many surgery programs will not have such a luxury at their disposal. As such, faculty and trainees with an innate passion for simulation should be sought out as these human resources are invaluable and play a critical role in implementing a successful simulation program. In addition to having the simulation schedule for the entire academic year readily available to all in the program, we found that frequent communication among simulation team members as well as the other residents in the program was vital to proctoring successful simulation sessions. More specifically, we observed that trainee preparation generally correlated with meaningful participation. In coordinating with faculty, we recommend frequent, clear communication prior to sessions they are expected to attend. Overall, communication is vital to successfully navigating the logistical challenges inherent in implementing a simulation program.

In addition to our simulation team's subjective observations, our inaugural year of simulation proved objectively successful as shown by improved trainee performances. We observed significant improvement in time to completion as well as quality scores in regard to suturing tasks throughout the year. While there were trends towards similar improvements with respect to laparoscopic skills, we did not observe such convincing evidence. There are several potential explanations for these observations. As previously mentioned, in retrospect, it may have been beneficial if trainees participated in more sessions dedicated towards practicing the FLS tasks under guided supervision and less sessions dedicated solely towards assessment. It is well known that assessment plays an important role in maintaining a successful simulation program.[20] While assessing trainee performance should not be overlooked, we feel that resident training should always remain at the forefront of a program's focus, especially if time dedicated to simulation is limited. Additionally, we deliberately made the FLS scoring more difficult in an attempt to challenge trainees. While in theory this should not affect the ability to improve, it may account for some of the disqualifying scores. The ability of residents to readily practice particular simulation tasks may have also played a role in the discrepancy we observed in regard to suturing versus laparoscopic tasks. Suturing materials are readily available for trainees in our program, often seen lying out in resident work areas from recent practice. Moreover, as early as their first month of training, residents have ample opportunities for suturing in real clinical scenarios. On the other hand, laparoscopic practice is more limited. Time to set up and break down equipment can act as a barrier to self-initiated practice for residents who are busy with clinical responsibilities. Additionally, meaningful experiences in laparoscopic surgery are often limited during the early years of training. In any case, with these observations, the simulation team plans to initiate efforts to make laparoscopic simulation practice more readily accessible to residents in the program in hopes this will attract more self-initiated practice when time allows. Likewise, we would advise that other new surgery residency programs consider putting forth efforts to make simulation materials not just available but readily accessible to their trainees.

In accordance with their proven benefits, we found low-fidelity simulations were both practical and highly beneficial towards improving trainee skills. We were able to create simulation exercises using improvised materials readily available at most US hospitals at little to no direct cost from our program's budget. Moreover, by designating a team of residents dedicated to simulation, there were no additional staffing costs incurred. We agree with other authors who have advised that simulation sessions should be mandatory for successful program integration.[21] Although we cannot speak from experience with voluntary sessions, our biggest challenges were logistical in nature, so it can only be assumed that participation would have been negatively affected if sessions were not designated as 'protected time,' that is, time in which residents are excused from clinical duties. Having the majority of residents participate in every session made for optimal monitoring of trainee progress as well as avoiding time wasted debriefing absent trainees on topics of prior sessions. Senior resident attendees were also available to provide education when their experience allowed. The logistical issues we faced were those one would expect in a new community surgery program in which most faculty are busy private practice surgeons. While we aimed to have faculty present at every simulation session, there were weeks in which clinical duties precluded faculty attendance. One method of amending this issue was to designate faculty for specific simulation sessions several weeks in advance. Frequent follow-up and confirmation proved beneficial to assuring attendance. Even so, we observed that some of our most fruitful simulation sessions were those lacking faculty in which case senior and chief residents provided much of the education. The enhanced educational quality may stem from senior residents being more relatable towards the experience of junior trainees. Moreover, junior residents may feel less intimidated and are more likely to ask questions. Nonetheless, faculty attendance is always encouraged. In addition to safeguarding against provision of incorrect information to trainees, faculty offer invaluable insight and wisdom gained through their career experience.

There are several limitations of this study worth noting. Our results and discussion are based on limited experience and data, albeit the primary purpose of this article was to discuss the integration of surgical simulation in a new general surgery residency program. Additionally, our methods were subject to many confounding variables. Although we attempted to limit the potential for bias, particularly that of qualitative scoring, there were subjective elements in our data collection that were unavoidable. Specifically, the accuracy of data recording was dependent on individual proctors. Moreover, the participation of individual proctors was not consistent throughout the year due to clinical obligations such as outside rotations and post-call absences. This inconsistency also added another layer of potential confounding. Finally, the simulation setting and materials were not consistent throughout the year due to logistical challenges and availability, all of which could have potentially affect our results.

Conclusion

The changing landscape of surgical training has demanded that simulation-based curricula be implemented into general surgery residency programs. From our limited experience with introducing surgical simulation into a community general surgery residency, we feel several factors are important to keep in mind when developing a simulation program. Programs should consider the particular simulation needs of their trainees. Once this is done, a schedule can be developed specific to the program. It is beneficial to make the schedule far in advance and readily available to all who are involved in the program, both faculty and trainees, so that there is ample time for everyone to prepare. Simulation sessions should be mandatory and scheduled during time when residents are relieved from clinical duties so that they can focus on the task at hand. Furthermore, sessions should be targeted towards specific tasks and proctored by experienced senior residents and/or appropriate faculty. In terms of logistics, we feel it is imperative to engage in follow-up and send frequent communications with faculty and participating trainees. Lastly, new programs must remain flexible and able to adapt, for last minute changes will prove inevitable.

Supplementary material

Supplementary files 1–4 are available at: https://doi.org/10.5281/zenodo.8239648.

Supplementary file 1. Instructions for suturing tasks.

Supplementary file 2. Instructions for laparoscopic tasks.

Supplementary file 3. Scoring sheets for suturing tasks.

Supplementary file 4. Scoring sheets for laparoscopic tasks.

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Conflict of interest

The authors have no declarations of interest to disclose.

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Appendix 1. Annual simulation schedule

Date	Simulation	Description
14 July	Overview of simulation Introduction to open surgical instruments	Review of sim schedule and resources (sim trainers, robotic accounts, sim room) Review instrument names and practice proper handling
28 July	Introduction to laparoscopy – part 1	Review laparoscopic instrument names and practice proper handling
11 Aug	Suturing, open – part 1 Knot tying – part 1	Practice interrupted suturing and burying the knot Practice running/whip stitch Practice two-handed knot tying and instrument tying (with braided and monofilament)
25 Aug	Suturing, open – part 2 Knot tying – part 2	Practice mattress, subdermal, and subcuticular suturing Practice drain stitch Practice one-handed knot tying (with braided and monofilament)
8 Sep	Suturing and knot tying skills – baseline test	Obtain baseline times for the year for several basic tasks Simple interrupted nylon with one- and two-handed knots Running closure nylon with one- and two-handed knots
22 Sep	Introduction to surgical staplers and retractors	Review surgical staplers and proper handling Review Thompson and Bookwalter retractors
13 Oct	Introduction to laparoscopy – part 2	Laparoscopic Operation Game Review of FLS requirements (pdf of FLS tasks)
27 Oct	Laparoscopic skills – part 1	Practice FLS task 1 and 2 – peg transfer, precision cutting
10 Nov	Laparoscopic skills – part 2	Practice FLS task 3 and 4 – ligating loop, extra-corporeal knot tying
24 Nov	Laparoscopic skills – part 3	Practice FLS task 5 – intracorporeal knot tying
8 Dec	Laparoscopic skills – baseline test	Obtain baseline times for the year for all five FLS tasks
12 Jan	Suturing and knot tying skills – progress test	Obtain progress times for the year for several basic tasks Simple interrupted nylon with one- and two-handed knots Running closure nylon with one- and two-handed knots
26 Jan	Intubation and central lines – part 1	Practice intubation and central lines
9 Feb	Intubation and central lines – part 2	Practice intubation and central lines
23 Feb	Introduction to bowel anastomosis	Review of principles of hand sewn and stapled anastomoses Practice techniques
9 Mar	Introduction to vascular anastomosis	Review of principles of vascular anastomoses Practice techniques
23 Mar	Surgical anastomosis – part 1	Practice bowel and vascular anastomosis
13 Apr	Surgical anastomosis – part 2	Practice bowel and vascular anastomosis
27 Apr	Suturing and knot tying skills – final test	Obtain final progress times for the year for several basic tasks Simple interrupted nylon with one- and two-handed knots Running closure nylon with one- and two-handed knots
11 May	Laparoscopic skills practice test	Dry run of FLS station tasks
25 May	Laparoscopic skills – final test	Obtain final times for the year for all five FLS tasks
8 Jun	Awards for best final times for each station Simulation feedback discussion	Announce winners Discuss what worked and what didn’t