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Does being in the hot seat matter? Effect of passive vs active learning in surgical simulation☆

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A B S T R A C T

Background: Participation in simulation can improve future performance, but it is unclear if observation of simulation scenarios can produce an equivalent benefit.
Methods: First-year surgical residents were exposed to various simulation scenarios in groups of 4 or 5, either through active participation or passive observation. Residents were individually assessed on 3 of the scenarios. Scores were categorized based on resident level of exposure to the scenario and analyzed using a multivariate analysis.
Results: 32 residents were enrolled and 28 underwent testing. Previous exposure to the scenario as a participant or observer led to improved performance on medical management and overall performance compared to those who had not been exposed ($p < 0.02$). However, active participation did not improve performance relative to passive observation ($p > 0.1$). Previous exposure did not improve communication aspects of the scenarios.
Conclusion: Analyses confirmed the advantage of simulation-based training, but additionally suggest that the benefits for similar in both active participants and passive observers. This supports the idea of group based simulation training which can be more cost and time efficient.

Introduction

Competency based training, increased focus on patient safety, and more stringent requirements on resident duty hours have all prompted changes in medical education. Modern work-hour restrictions designed to limit resident burnout have had an unwanted negative impact on training and education[1]; the effects are particularly felt in surgical training programs, where time in the operating room is often correlated with overall proficiency and skill.[2] Furthermore, competency-based educational training is increasing in prevalence which can put additional demands on training centres to maximize learning opportunities for trainees.

Simulation has been increasingly thought of as a solution to the challenges of medical education and used as a substitute for clinical exposure. Studies have established the effectiveness of simulation to improve clinical assessment scores, and well-thought-out sessions that involve more than one clinical scenario lead to better overall performance.[3] Simulation training has also been shown to benefit patients, with improved clinical outcomes.[4]

The use of simulation for pre-exposure and preparation for clerkship and residency in the form of "bootcamps" has also become increasing prevalent. Pre-surgical residency bootcamps have been shown to improve performance scores in clinical and procedural skills.[5,6] Aside from the clear improvement in procedural performance, bootcamp and simulation training can improve confidence for up to 6 month after training.[7,8] However, accommodating a large number of trainees in a simulation can be resource intensive. Advanced simulation systems can cost upwards of $200,000 US.[9] In addition to equipment, running simulated scenarios is labour-intensive. A study by Morgan et al. published in 2017 showed good benefit for students who had pre-clinical simulation to prepare for working on the wards. The simulation was run in pairs, and student start times were staggered to

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maximize the use of the facilitators.[8] The study still required three faculty members to run the scenarios, and a fourth to provide feedback. This means two faculty-hours were required for each student-hour of simulation exposure.

Simulated clinical scenarios typically require a minimum of one examiner (usually a clinician) and either a simulated staff or a standardized patient. Multiply this by the number of surgical trainees participating in the scenario and desire to have residents exposed to many different scenarios, and the cost and time required quickly balloons to make this unsustainable. In recent literature, the idea of active participation vs passive observation has become increasingly popular. In several instances, residents have demonstrated benefits from observing the participant rather than active participation.[10,11] But outcomes have been variable, and outcomes have often focused on self reported learning, non-technical skills, or written knowledge.[12–14] However, if group based simulation can improve clinical performance, it could allow us to economize resources for the same effect and ensure that exposure is standardized for all trainees.

This study was designed to assess the effectiveness of a group-based surgical simulation, where multiple trainees are exposed to a simulation scenario at the same time. This model significantly decreases cost, allowing for creation of more high-fidelity simulation sessions, and increasing resident exposure to multiple scenarios. The study seeks to determine if observing live simulated scenarios and participation in the debrief session is as beneficial as direct participation.

Methods

Participant selection

The University of Ottawa organizes a mandatory surgical foundations boot camp during the first week of residency where all first-year surgical residents are introduced to core concepts of surgery. This includes residents from cardiac surgery, general surgery, neurosurgery, obstetrics/gynecology, orthopaedic surgery, otolaryngology, plastic surgery, urology, and vascular surgery. All residents starting in the academic year were included. There were no exclusion criteria for age, gender, or previous training.

Technical information

The 32 residents were divided into 7 groups of 4–5 residents per group. 14 stations were designed to simulate scenarios for commonly encountered clinical events during surgical residency. These "core" competencies were designed based on surveys of senior surgical residents and allied health staff. Divided across two days, these stations included simulated scenarios related to the management of post-operative issues such as hypotension, delirium, chest pain, and communicating surgical error.

Simulation stations were developed specifically for this boot camp based on training requirements and junior resident surveys. Telephone stations were conceptually based on surgery telephone on-call scenarios published in 2014 by Frishknecht et al.[15] Original study telephone scenarios were provided by the authors with permission for use, but are now part of the NYU School of Medicine's WISE On-Call series.[16]

The bootcamp included high fidelity scenarios using the SimMan® (Laerdal Medical, USA), a high fidelity mannequin which can be controlled to respond to appropriate questions, and have vital signs change as the scenario unfolds, thus challenging the residents' ability to reassess the situation and react accordingly. These stations had a nurse in the room with the SimMan® "patient", and a clinician on the other side of a one-way mirror controlling the scenario and vital signs based on resident interventions. SimMan® response to different interventions was standardized. Others were completed via telephone for scenarios simulating answering a page from the ward, and some scenarios used standardized patients to convey symptoms and assess communication skills.

Prior to the commencement of each station, one resident per group was assigned to participate in the scenario, and referred to as being in the "hot seat". Some other members of the team were assigned to observe the resident in the hot seat, while others rotated breaks during the course of the day. Due to time restrictions, not all teams saw all the scenarios. All stations were 10 min long followed by 10 min of debriefing. All residents in a team participated in the debriefing. Over two days, trainees were exposed to between 10 and 12 of the 14 stations, including being in the hot seat for 2 to 4 stations.

At the end of the bootcamp week, all residents underwent a series of Objective Structured Clinical Examinations (OSCEs) and technical skills tests. This examination included 3 clinical stations which were selected from the core 14 stations (Table 1). Each clinical station was graded using a rating scale on specific domains (medical expert and communication), and a global rating scale. Each section was rated on a scale from 1 to 5. Only results from the 3 OSCEs highlighted were analyzed as other examination stations tested different skills taught with different methodology.

Statistics

Scores for each station were normalized to a mean of 3 and standard deviation of 0.5. Scores were then grouped based on prior exposure to the specific station; Participated, Observed, and Novice. Performance was assessed using paired T-tests.

Sample size calculation was performed retrospectively based on the study data. With a standard deviation of 0.5, alpha of 0.05 and power of 80%, a sample size of 52 scores was required for a difference of 0.2.[17]

Results

Twenty-eight residents underwent final OSCE examinations. Attrition of residents was due to conflicting scheduling with an alternate mandatory academic activities.

Three simulation scenarios were used for the evaluation. These included one high fidelity simulation using a SimMan Mannequin, and two telephone scenarios. Table 1 shows the variety of stations for bootcamp training and those chosen for the evaluation. Normalized scores were then grouped based on exposure, and mean scores can be found in Table 2.

Table 1
Simulation scenarios used for resident training. (*) indicates scenarios used for final testing.

Scenario	Type
Septic shock	Standardized patient
ST-elevation myocardial infarction (STEMI) *	SimMan Mannequin
Hemorrhagic shock	SimMan Mannequin
Atrial fibrillation	SimMan Mannequin
Pulmonary embolism	Standardized Patient
Stroke	Telephone
Electrolyte imbalance	Telephone
Abdominal pain *	Telephone
Fever NYD *	Telephone
Post-operative pain	Telephone
Delirium	Telephone
Difficult staff communication	Telephone
Allied Health staff communication 1	Standardized Patient
Allied Health staff communication 2	Standardized Patient

Table 2
Mean normalized scores based on previous exposure to the simulation scenario.

(Number of scores)	Participated (18)	Observed (42)	Novice (24)
Medical Management	3.24	3.06	2.72
Communication	2.99	3.05	2.92
Global Rating	3.16	3.07	2.76

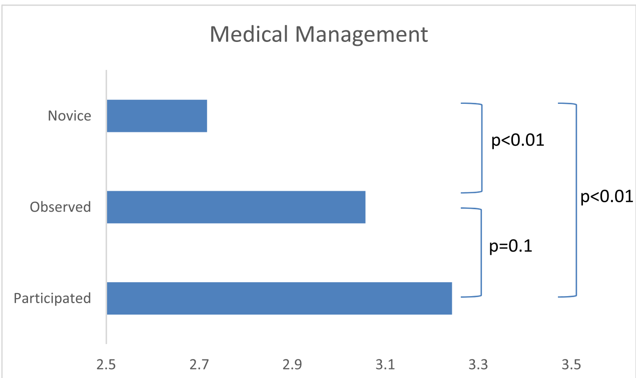

Fig. 1. Mean performance of residents on their medical management of the clinical scenarios based on prior exposure to the scenarios.

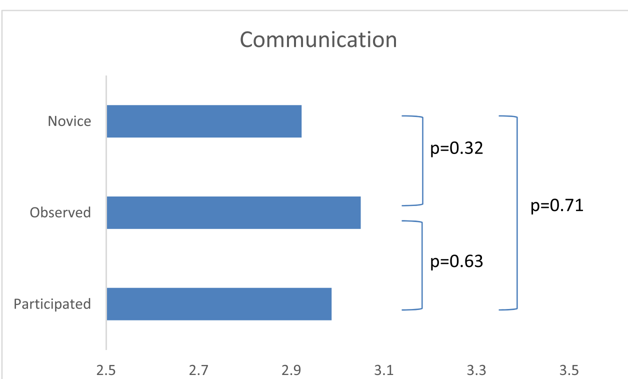

Fig. 2. Mean performance of residents on their communication in clinical scenarios based on prior exposure to the scenarios.

Residents showed an improvement in medical management of a clinical scenario improved with prior exposure to the scenario (Fig. 1). However, being in the hot-seat did not improve their performance compared to those who watched the scenario. Similarly, their global rating scale on the station performance improved with any prior exposure (Fig. 3)

However, prior exposure to the scenario did not improve resident performance on communication in the clinical scenario (Fig. 2).

Discussion

Simulation has been recognized as an important part of medical education, with participation shown to improve trainee performance on future OSCE performance, improve resident comfort with clinical performance, and improve patient outcomes.[5,9,18] However, high fidelity clinical simulation is a costly and labour-intensive endeavour.

Our study has demonstrated multiple findings which lend guidance to the future design of simulation training schemes.

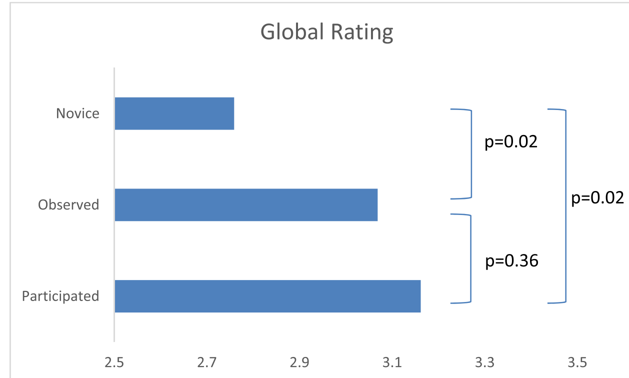

Fig. 3. Mean overall performance of residents on clinical scenarios based on prior exposure to the scenarios.

Firstly, prior exposure to a specific scenario improved performance on medical competency, but not communication.

This difference between resident performances on these two different aspects of OSCEs could be due to the emphasis on communication skills in current medical school curricula. The lack of statistical difference could imply that this skill has been well enforced prior to residency. Communication skills are often practiced and assessed early in medical school, and likely also simulated in many different scenarios. Indeed, most of the experts evaluating the scenarios mentioned that the residents functioned at a highly professional level.

Alternative explanations could include the need for a greater number of training sessions to be able to produce a measurable improvement in communication skills, or the lack of feedback and coaching provided during the bootcamp to improve communication. Despite communication skills being on the marking rubric for all teaching scenarios, it is possible that facilitators were more focused on providing feedback on medical management of the case than communication skills. There were two stations during the training that focused specifically on communication skills without medical management. These stations involved communication with family members to break bad news, but these could require a different set of communication skills than working with colleagues in more acute settings. It is also possible that the rating scale was not adequate to detect differences in communication skills, or evaluators unable to detect such differences.

Unlike communication scores, medical performance did improve with prior exposure to the scenarios. Although residents should have learned the medical material for all the clinical scenarios prior to starting residency, they may not have been sufficiently exposed to similar acute clinical scenarios (in clinical practice or simulation). Exposure to a clinical scenario is beneficial for future performance, especially for novice learners, which is not a novel concept.

However, what we found was that participation in a scenario did not offer a measurable overall performance advantage compared to those who observed the scenarios ($p = 0.36$). Both groups showed an advantage over those who had never been exposed to the clinical scenario at all ($p < 0.01$). The improvement was even greater when only looking at their medical management of the scenario. This improvement in performance can be due to simply watching their colleague perform in the scenario. However, all members of the group participated in the debriefing following the scenario. Debriefing is considered a crucial part of simulation training. It is through the debriefing that trainees can learn from their mistakes, and the mistakes of their colleagues.

This ability to learn equally through observation of scenarios and participating in the debrief session has significant implications on curriculum development. This is an important finding because it demonstrates that debriefing can be done in larger groups, allowing for more trainees to benefit from the experience at the same time. In high fidelity simulation, it is usually not possible to have many participants in the "hot seat" at the same time. Simulation scenarios are often therefore limited to one-on-one or pairs with different roles in order to allow trainees to be part of the simulation. Our study shows that actively participating in the scenario itself may not be as crucial to its education benefits.

Having each trainee participate in each scenario instead of in groups of 5 would take 5-times longer with a proportionate increase in cost. Cost of simulation training can be high, and with increased use of simulation in medical education, there is increasing competition for access to simulation facilities. As simulation is increasingly used for training, the prospect of cost-saving schemes with equal educational benefit is appealing and applicable to every institution.

Perhaps an even greater challenge than the cost of running more simulations is the ability to find clinicians to provide supervision and feedback for the simulations. At academic institutions, surgeons volunteer their time for teaching and OSCEs, which is considered part of their academic responsibilities. However, their availability is limited, and training programs often struggle to staff their simulation and teaching sessions. Having to run the scenario for each trainee would require five times more surgeon hours, which would not be realistic in our institution if we wanted each resident to experience 14 different clinical scenarios. Surgeons who have an interest or expertise in medical education are also often oversubscribed for educational activities. Surgeons need to be trained in how to be good supervisors and give good feedback, so increasing the pool of surgeons to supervise simulation would also require a significant investment of time and money.[19]

As postgraduate medical education moves towards competency-based training, there are concerns about the increased cost of training, and time burden on teachers to conduct such training. This study shows the possibility of performing simulation in groups rather than in individual settings. If prior exposure to a specific clinical scenario can improve patient outcomes, then it would be preferable to expose larger numbers of residents simultaneously to more clinical scenarios. Performing scenarios in groups can decrease the time and financial burden for training programs, making simulation more affordable, and allowing residents the opportunity to see more scenarios.

Limitations of this study include the relatively small sample size of 28 trainees that participated in the final test scenarios, increasing risk of a Type II error. In addition, the final examination OSCE was identical to the practice simulation scenario. It is not clear if trainees have learned the broader concept, and exposure to similar, but not identical, clinical scenarios would have a similar improvement in performance.

Future direction of this work could include studying if the participation in debriefing of a scenario would be sufficient to gain the same benefits. The ability to use asynchronous viewing of videos followed by a live, or video debrief would greatly decrease the requirements for simulation resources, and increase the number of scenarios that could be covered during a bootcamp week. As well, the translation of learning from one scenario to other similar clinical scenarios would also guide the development of future simulation scenarios.

Conclusion

This study in simulation confirms multiple findings. Firstly, prior exposure to a can improve a resident's medical management and overall performance. However, there was no improvement in communication performance on the same scenarios. This exposure can be in the form of active participation or passive watching with participation in team debriefing, with no measureable difference between the two. This has profound effects on future simulation training programs, and supports the idea of simulation-based training in a group-settings which are more labour and cost effective.

Disclaimers

No disclaimers to report.

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Declaration of competing interest

The authors deny any conflict of interests.

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