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The important role of in-situ simulation in preparing surgeons for the COVID-19 pandemic

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ABSTRACT

Background: Effective training is vital when facing viral outbreaks such as the SARS Coronavirus 2 (SARS-CoV-2) outbreak of 2019. The objective of this study was to measure the impact of in-situ simulation on the confidence of the surgical teams of two hospitals in assessing and managing acutely unwell surgical patients who are high-risk or confirmed to have COVID-19.

Methods: This was a quasi-experimental study with a pretest-posttest design. The surgical teams at each hospital participated in multi-disciplinary simulation sessions to explore the assessment and management of a patient requiring emergency surgery who is high risk for COVID-19. The participants were surveyed before and after receiving simulation training to determine their level of confidence on a Visual Analog Scale (VAS) for the premise stated in each of the nine questions in the survey, which represented multiple aspects of the care of these patients.

Results: 27 participants responded the pre-simulation survey and 24 the one post-simulation. The level of confidence (VAS score) were statistically significantly higher for all nine questions after the simulation. Specific themes were identified for further training and changes in policy.

Conclusion: In-situ simulation is an effective training method. Its versatility allows it to be set up quickly as rapid-response training in the face of an imminent threat. In this study, it improved the preparedness of two surgical teams for the challenges of the COVID-19 pandemic.

Introduction

The SARS Coronavirus 2 (SARS-CoV-2) outbreak of 2019 (and subsequent COVID-19 disease) rapidly became a pandemic and is potentially the greatest threat humanity has faced in modern times. Its impact is virtually incalculable. The worldwide economy grinded to a halt. Experiences in the most affected regions tell of entire healthcare systems overrun in a matter of days, requiring disaster triaging of patients on a massive scale, particularly for access to Intensive Care."1-4

As of August 2020, approximately 23 500 000 cases of COVID-19 and 812 000 deaths have been confirmed worldwide, with 333 000 and 41 500, respectively, occurring in the United Kingdom; these are likely to be gross underestimates, and will be higher by the time of publication of this study. It is vital that lessons rapidly be learnt in regions where there is still the...
chance to act proactively, rather than reactively, in the face of this crisis.

The East Kent Hospitals University Foundation Trust (EKHUFT) is the 6th largest Trust in the United Kingdom. It collectively serves a local population of 695,000 people. Of its three main hospitals, two provide emergency services; the William Harvey Hospital (WHH) is a moderate-sized District General Hospital located in Ashford, Kent with around 500 beds, with 16 in the Intensive Care Unit (ICU), while the Queen Elizabeth the Queen Mother Hospital (QEQM) is located in the coastal town of Margate, Kent, with approximately 390 beds with 9 in the ICU. These hospitals are, respectively, 40 miles and 70 miles southeast of the Greater London area, where the situation has rapidly escalated; there are approximately 37,000 confirmed cases and 7,000 deaths to date. The window to prepare at EKHUFT was small, as the Intensive Care Units (ICU) struggled to keep up with the number of COVID-19 patients requiring mechanical ventilation, and the COVID-19 designated wards filled up at an increasing pace. At the time, it was expected that the peak caseload was yet to come, and therefore efforts to prepare had to continue.

The Surgical teams at both the WHH and QEQM were, as expected, seeing a reduction in their usual workload as only operations classified as 'Immediate' or 'Urgent' were being carried out. While pathways were being explored to deal with 'Expedited' and 'Elective' operations, it was paramount to prepare the teams to deal with acutely unwell patients, particularly those requiring emergency surgery, who were concomitantly suspected/confirmed to have COVID-19.

A steering group designed a framework to implement measures to prepare for the challenges arising from the COVID-19 pandemic (Appendix A). It was initially designed for the WHH, but then expanded across the Trust.

The concerns of the team members and their perceptions on competency deficiencies regarding COVID-19 were established in previous surveys and training activities, and guided the designing of simulation-based training, which was the staple component in this framework. The aim of this study was to measure the impact of in-situ simulation on the confidence of the surgical teams in the Trust in assessing and managing acutely unwell surgical patients who are high-risk or confirmed to have COVID-19. The process of setting up and carrying out the simulation training is described for the benefit of other centres, now and in posterity, who may benefit from our experience.

Methods

This was a quasi-experimental study with a pretest-posttest design. The simulation involved multi-disciplinary teams (Surgeons, Emergency Doctors, Anaesthetists, Theatre staff, Nursing staff) partaking in the scenarios as well as observing. However, only the doctors within the Surgical teams, irrespective of grade, were invited to participate in surveys. The Consultants and Senior Registrars were interviewed to establish the key aspects of interest to be addressed during the simulation sessions.

The simulation

In the initial stages of the crisis, when preparations for operating theatres were being planned and the Standard Operating Procedures (SOPs) drafted, a trial simulation was carried out at the WHH involving the surgical, anaesthetic and theatre teams. This activity was led by a Consultant Anaesthetist, who was also the Simulation Lead in the Trust, and two surgical trainees formally trained in delivering simulation training. It was instrumental in identifying challenges that would need to be addressed in pathways involving suspected/confirmed COVID-19 patients requiring surgical intervention. Following this, two formal simulation sessions were carried out; one at the WHH and one at QEQM. The scenario (identical in both sessions) explored the journey of a highly suspicious COVID-19 patient who presents to the Emergency Department (ED) with an acute surgical abdomen and requires emergency surgery.

It was important to get the right balance between simplicity and covering all the desired learning objectives. These are listed in Table 1, along with the skills being explored.

The scenario was simulated to be set in the designated respiratory cohort area in the ED, which was unavailable due to clinical demands and the exposure risk, and hence an alternative vacant assessment area was used. The candidates were the on-call Surgical team. They were called by the ED team and on arrival would receive a more detailed briefing from the ED doctor, including investigations (CT findings and blood results). The candidates would proceed to assess the patient. The progression of the scenario is outlined in Fig. 1 (a)–(f).

A laptop computer with a high-resolution webcam was placed on a portable trolley and the simulation session was live-streamed from via an online-based video-conferencing application (Zoom © Video Communications, Inc. Version 5.0.3). This application is free to use and facilitated social distancing by allowing the majority of the team to view the simulation and participate in the debrief remotely. One of the focuses of this activity was for it to be low-cost, low-resource and easily reproducible by other centres wishing to adopt similar training sessions. The equipment and resources required are outlined in Table 2.

Data collection and statistical analysis

Participants of the Surgical teams at the WHH and QEQM were surveyed, via SurveyMonkey®, within 48 h before and after the simulation sessions. After reading the initial instructions, the participants would determine their level of confidence on a Visual Analog Scale (VAS) for the premise stated in each of the questions (Fig. 2).

The instructions also clarified that responses remained anonymous and by filling out the survey the participants were consenting for responses to be included in the analysis and be disseminated in publications and/or presentations. Demographic data of the participants were not recorded due to lack of relevance and to avoid response

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*The National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) Classification of Interventions, 2004.

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bias arising from more senior team members sensing that they ought to appear more confident than their more junior colleagues.

Once the surveys closed, the quantitative data from the responses were transferred to a single database on Microsoft® Excel, which was also used to plot graphs. The statistical calculations were performed using R® version 3.6.1. The pre- and post-simulation VAS scores were presented as medians and the Mann–Whitney U-test used to compare both datasets. The null hypothesis for each of the questions on the survey was that any difference between the pre- and post-simulation responses was the result of random chance, and hence not significant. This would be rejected if the p-value was equal to or less than 0.05.

Qualitative data was also collected in the form of observations made during the sessions, which would be synthesised and described.

Results

There were 27 participants in the pre-simulation survey and 24 in the post-simulation. The median VAS Score, representing the level of confidence, for each of the questions in the pre- and post-simulation surveys are presented in Fig. 3. The p-values are included in the graph, resulting from the Mann–Whitney U-test used to compare the responses for each question pre- and post-simulation.

The simulation allowed specific themes for improvement to be identified and incorporated directly into the SOP for suspected/confirmed COVID-19 surgical patients. These are outlined in Table 3.

Discussion

This study showed that in-situ simulation training significantly improved the level of confidence of its participants regarding multiple aspects of dealing with high-risk/confirmed COVID-19 surgical patients. Similarly, the study highlights how the simulation allows teams to run through common scenarios and rapidly identify adaptations required in policies such as SOPs, checklists, guidelines, etc.

Previous viral outbreaks in the last few decades such as the Severe Acute Respiratory Syndrome (SARS) (China, 2003), the Middle East Respiratory Syndrome (MERS) (Saudi Arabia, 2012) and the Ebola (West Africa, 2013–2016) virus outbreaks showcased the importance of training and preparing for these highly infective pathogens with the potential for pandemic propagation. However, we are seeing that countries are clearly still ill-prepared for this nature of menace.

There is evidence that simulation is an effective training method which is feasible across multiple specialties and clinical settings. Furthermore, it is suggested to improve clinical skills, teamwork and observed behaviours, as well as have a positive impact on patient safety. In-situ simulation has the virtue of being high-fidelity and cost-effective, as it can be carried out in real-life clinical settings as opposed to dedicated simulation centres, and an actor used, such as in this study, as opposed to high-tech, expensive mannequins. For this same reason, in-situ simulation can be very versatile and rapidly set up, and therefore used as a rapid response to prepare participants for an imminent threat. Similarly, additional human resources are not necessarily required. In this study, the teams participating in the session were those...
scheduled to be on-call. However, this may vary based on the daily workload at different centres.

The majority of studies to date on the use of simulation in the preparation for viral outbreaks are directed at the Ebola virus, arising from serious concerns following the 2014 epidemic in West Africa, and most are descriptive in nature. Abualenain et al. published their experience carrying out simulation-based training for Ebola virus for 179 healthcare workers in a large university hospital in Saudi Arabia. Pretest and posttest scores assessing participants' response to simulated Ebola virus cases showed a significant competency improvement. Similarly, O'Keefe et al. improved 220 frontline healthcare professionals' confidence in the use of PPE for Ebola virus in a simulation program. Though successful, these simulation programs were carried out in high-spec simulation centres, and recognised that reproducibility was a likely limitation.

There are far fewer studies on the use of simulation for the MERS and SARS epidemics. These are more pertinent to the current pandemic, having also been caused by viruses of the Coronavirus family and therefore also transmitted through droplets or aerosolization, which is relevant to the PPE and other preventive strategies required. Also, of note, all the referenced simulation-based training activities occurred several months or years after the outbreaks they relate to had finished with a view to future incidents. This study, on the other hand, has been carried out in the midst of the current pandemic, highlighting how in-situ simulation can be versatile and rapidly set up, and

Fig. 1 – Progression of the in-situ simulation session (a) Assessment of the patient - Appropriate PPE discussed by not used due to limited supply (b) Consenting patient – specific risks related to COVID-19 discussed (c) Anaesthetic review (d) Exploring team brief – specific aspects in view of risk of COVID-19 considered (e) Exploring preparation for surgery once the patient arrives in theatre (f) Debrief – In-depth recap of the scenario, highlighting key aspects in relation to the learning objectives.

Table 2 – Equipment and resources required for in-situ simulation training.

| Settings                             | Equipment                              | Human resources                      |
|--------------------------------------|----------------------------------------|--------------------------------------|
| - Setting to simulate an ED bay       | - Bed trolley                           | - Simulation faculty member to carry out pre-simulation briefing, facilitate session and lead the debrief |
| - Available operating theatre        | - Appropriate bed linen and patient gown | - Faculty member to handle laptop and portable trolley, manage broadcasting of session and communication with observers |
| - Conference room suitable for debrief, maintaining adequate physical distancing | - Monitoring equipment                 | - Surgical team                       |
|                                      | - Intravenous line and bag of fluids   | - Anaesthetic team                    |
|                                      | - Laptop computer with webcam          | - Theatre staff members               |
|                                      | - Portable trolley                     | - Nursing staff members               |
|                                      | - Personal protective equipment        |                                      |
|                                      | - Paperwork – simulated patient case notes and consent form |                                      |
|                                      | - Printed out scenario briefing        |                                      |
|                                      | - Feedback forms                       |                                      |
therefore used as a rapid response to prepare participants for an imminent threat. Wong et al. also successfully portrayed this by testing the preparedness of their operating theatre and procedures dedicated to known or suspected COVID-19 patients through in-situ simulation. However, a quantitative analysis of this benefit was not carried out in that study.

A few challenges in carrying out this kind of training have been identified, however. In this rapidly changing situation there has been a flurry of information, advice and guidance which, in turn, changes on almost a daily basis. The content of the simulation relies on this guidance, and hence the lessons gained from it can rapidly become obsolete if the changes in policy are significant. Following the aforementioned trial simulation, changes in guidance from governing bodies (NHS England, the Royal Colleges, etc) were taken into account for the simulation training. This, in turn, allowed new guidance to be put into practice and incorporated into

Fig. 2 – Example of the VAS representing the level of confidence, ranging 0–100, for the premises in each question of the pre- and post-simulation surveys.

![Fig. 2](image)

*1. What guidance to follow (eg. SOP) and where to find it

*2. Clinically recognising high risk COVID-19 patients

*3. What PPE to use and where to find it

Fig. 3 – Median level of confidence (VAS Scores) for each question in the pre- and post-simulation surveys. Question 1: What guidance to follow (eg. SOP) and where to find it, Question 2: Clinically recognising high-risk COVID-19 patients, Question 3: What PPE to use and where to find it, Question 4: What specific investigations to request for high-risk patients, Question 5: Documentation, including consent form, Question 6: Specific aspects of the team brief prior to surgery, Question 7: Logistics of transferring patient from the ED/Ward to the Operating Theatre, Question 8: Appropriate PPE to wear in theatres based on risk assessment, Question 9: Role/location of the Surgeons during intubation and extubation.

![Fig. 3](image)
the SOP. Simulation training also requires that the team providing it be adequately trained in doing so, and particularly be confident in facilitating the debrief, which is the most essential aspect to achieve good learning outcomes. The authors recognise that this will not uniformly be the case across different centres, and would therefore advise that organisations encourage their staff to attend simulation trainer training courses.

Finally, there is the possibility that the simulation training was most beneficial to those directly involved in the simulation sessions in comparison to those merely observing. The design of this study did not account for this upon comparing the pretest-posttest scores assessing the impact of the simulation sessions, and given the anonymity of the surveys, it would have been impossible to adjust for this retrospectively. It is expected, however, that a thorough debrief with active participation of all the partakers, including the observers, would reduce that potential difference. The authors would also recommend that future studies regarding in-situ simulation training be designed bearing this limitation in mind.

Conclusions

In-situ simulation is an effective training method. Its versatility allows it to be set up quickly as rapid-response training in the face of an imminent threat. In this study, it improved the preparedness of two surgical teams for the challenges of the COVID-19 pandemic. It was also a key strategy in rapidly testing and adapting SOP in the assessment and operative management of emergency general surgical cases. Wider participation in in-situ simulation in times outside of crisis situations would reinforce skills and lead to better prepared, more cohesive units when dealing with these scenarios. Larger studies are needed to establish the role of simulation in these circumstances.

Declaration of competing interest

The authors of this research manuscript have no conflicts of interest to declare.
Appendix A

Framework for Preparing the Surgical Teams in EKHUFT for the Impact of the COVID-19 Pandemic

1. Occupational Health risk assessments on all surgical team members
2. Rapid-use questionnaire to be used by team members clerking new patients to identify risk of COVID-19
3. Departmental meetings on at least a weekly basis to discuss new challenges and adaptive changes to daily proceedings; additional meetings to discuss urgent matters. Online-based videoconferencing and large meeting spaces used to comply with social distancing
4. Agile rota - Re-designed on almost a weekly/fortnightly basis. Team size limited at all levels to minimum required to cover urgent service provision safely. Remainder of team on standby from home to provide cover for sick leave, self-isolation, surges in patient influx, redistribution of team members to cover other specialties, etc.
5. Surveying team members (including clinicians, managers, educational staff) to establish
   a. Concerns regarding staff wellbeing and safety, patient safety, career progression, personal and family related factors.
   b. Level of confidence regarding finding and using guidance for prevention and management of COVID-19, use of Personal Protection Equipment (PPE), suspecting and testing for COVID-19, initiating management, escalation of care
6. Adaptation to online meeting spaces generated for the entire team, both clinical and non-clinical to facilitate open communication, rapid-response to gaps in the rota, updates and constant morale-boosting and comradery
7. Setting up support systems for staff i.e. Buddy systems
8. Simulation training for the General Surgical team in partnership with Anaesthetics, Critical Care and Emergency Medicine teams, Theatre Staff and Nurses
   a. To adapt the current standard procedures in assessing and booking emergency cases
   b. Rapidly disseminate the changes to standard procedures across the department
9. Setting up avenues for continuous liaison between the different specialties (predominantly the Surgical, Emergency Medicine, Critical Care, Anaesthetic and Medical teams) to coordinate efforts and assign roles

Appendix B

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