Assessing Operating Room Preparedness for Coronavirus Disease 2019 Patients Through In Situ Simulations

To the Editor

Coronavirus Disease 2019 (COVID-19) has been shown to be highly contagious, and Singapore has seen a significant rise in the number of new cases. It is therefore likely that there will be patients with COVID-19 who might require urgent surgery. There are many expert opinions and practical guidelines in the literature regarding the perioperative management of COVID-19 patients. However, the implementation of these guidelines will require local adaptation to be effective. For example, our institution’s operating room (OR) complex does not have a negative pressure OR to contain aerosol contamination, which necessitates new workflows and processes to minimize movement through OR doors. To assess the effectiveness of these adaptations and uncover latent hazards, we designed and implemented high-fidelity in situ simulations (ISS) to replicate the scenarios of COVID-19 patients needing surgery. We present the findings from our ISS experience.

Two anesthesiologists with experience in simulation training designed and conducted 3 high-fidelity ISS scenarios involving COVID-19 patients. These included emergency laparotomy involving major hemostatic and resuscitative efforts for intraabdominal pathology; open tracheostomy after prolonged intubation, which is a high-risk aerosol-generating procedure (AGP); and posterior spine decompression designed to test the complexities of requiring additional equipment, ancillary medical staff, and teamwork in positioning of the patient.

For each ISS, participants were organized into OR teams in the minimum number required to conduct surgery safely. They included surgeons from the relevant disciplines, scrub nurses, anesthesiologists, anesthesia nurses, OR attendants, environmental services, porters, and allied health professionals. The observers were resource personnel from each of the above-mentioned professions who had developed OR workflows and from other surgical disciplines not involved in the simulation. The participants and observers engaged in tabletop exercises before each ISS to discuss the workflow and processes. Debriefing was conducted at the end of each ISS. It focused on the critical review of 7 chronological key phases: notification of surgery, organization of OR preparation, donning of personal protection equipment (PPE), transport of the patient to OR, conduct of anesthesia and surgery, postsurgery doffing of OR team, and transport of patient out of OR. Each debriefing led to further improvements in the workflow and processes, which were tested in the subsequent simulation. A summary of the observations, improvements, and results in the 7 key phases is shown in the Table.

We recommend using repeated ISS involving different surgical specialties in the OR to uncover logistical issues and improve evolving work processes before the actual management of surgery in COVID-19 patients. The ISS should encompass the workflow in entirety: from notification of the OR of planned surgery in a COVID-19 patient to the safe transfer of the patient out of the OR complex after surgery. In our experience, the participants and observers became more familiar with the infection control measures through the ISS. Pre- and post-ISS surveys also indicated increase in scores for confidence in roles. The debriefings highlighted gaps in the processes and generated solutions that could be tested in subsequent ISS for suitability. Through our ISS, we developed cognitive aids and checklists, improved our workflows, defined various roles and responsibilities, and reconfigured the donning and doffing spaces and protocols. These interventions increased the capability and confidence of our OR team to care for a COVID-19 patient presenting for surgery.

We recognize that our findings might not be generalizable to all institutions, but they might be useful in institutions with similar OR setup. Given time and resource constraints in a pandemic, our methodology does not provide enough evidence to show that the improvements made through ISS will reduce COVID-19 infections among health care workers or improve COVID-19 patient outcomes in the OR. Nonetheless, ISS was a useful tool in enhancing our OR preparedness to manage surgical patients with a highly infectious disease.

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| Key Phases                     | Observations, Improvements, and Results                                                                                                                                                                                                 |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Notification of OR team       | Observation: Delayed notification as OR nurse had to ascertain that it was a COVID-19 patient before alerting rest of the OR team.                                                                                                           |
|                               | Improvement: The primary surgeon would indicate clearly on the listing form that the patient was COVID-19 positive and inform the anesthesiologist personally. On receiving the listing, the OR nurse would use a checklist to gather nursing staff and necessary equipment. |
|                               | Result: Key members of the OR team were alerted within 5 min.                                                                                                                                                                          |
| Organization of OR preparation| Observation: OR nurse contacted the surgeon and anesthetist individually, before appointing nursing staff to prepare the equipment. This led to extended time spent on information relay with some requesting for equipment not prepared. |
|                               | Improvement: A planning team huddle on notification of surgery was formally included in the workflow. Members in this initial team huddle would include the primary surgeon, anesthesiologist, anesthesia nurse, OR nurses, and OR attendants. The team huddle was conducted with a checklist to allow rapid clarification of surgical and anesthesia plans and equipment. Before the arrival of the patient, a second team huddle comprising all members of the OR team would be conducted to ensure that preparation was adequate. |
|                               | Result: Time needed for OR preparation was reduced and OR team members were aligned with a shared mental model with clarity on their respective roles and responsibilities.                                                                      |
| Donning of PPE                | Observation: Donning area was crowded with all members of the OR team donning the PPE at the same time. Some OR team members had minor breaches in PPE.                                                                                         |
|                               | Improvement: Reconfiguration of the donning area into separate stations, arranged in sequential order for each stage of donning. Each station had cognitive aids and mirrors for self-checks. Order of priority for donning was established to reduce crowding. A designated nurse checked the integrity of PPE of each OR team member before entry into the OR. |
|                               | Result: There was order in PPE donning process with significantly reduced amount of time required for each OR member. Breaches in PPE donning were eliminated.                                                                           |
| Transport of patient to OR    | Observation: Unable to provide a separate isolated route from the patient’s ward to the OR without risk of contamination to the environment.                                                                                            |
|                               | Improvement: The institution’s Environmental Services was engaged to coordinate the transfer. They directed the hospital’s human traffic and provided decontamination of the route after transfer. The patient was protected with a surgical mask. If high-flow oxygen therapy was used, the aerosols would be contained within a clear plastic barrier draped over the patient and his bed. |
|                               | Result: Contamination to the environment was reduced during transfer to the OR.                                                                                                                                                        |
| Conduct of anesthesia and surgery | Observation: PPE and PAPR (3M Versaflo) hindered identification of each OR team member and interfered with communication both within the OR and with members outside the OR. PAPR prevented the use of surgical microscopes. Management of PAPR battery failure involved multiple movements in and out of OR for donning and redonning. Repeated opening and closing of OR access doors due to requests for items or for communication caused breaches in infection control measures. |
|                               | Improvement: PPE was labeled with designated roles and names for identification. White boards with markers were used for written communication. Closed-loop communication with read back was emphasized. Speaker phones were installed for communication with members outside the OR. Surgeons would use alternatives such as surgical loupes instead of microscopes. Direct exchange of PAPR battery without donning was tested. Checklist for items required during surgery was edited. An additional nurse coordinator would consolidate all items requested intraoperatively. |
|                               | Result: Improved communication that resulted in faster work processes and reduced risk of errors. Process of battery change for PAPR battery failure was faster. Consolidated requests resulted in reduced number of times OR doors were opened. |
| Postsurgery doffing of OR team | Observation: Limited space in doffing area resulted in cross contamination of OR members during doffing. Unfamiliarity of OR members with doffing sequence that risked contamination to self and others.                                      |
|                               | Improvement: Doffing was restricted to 1 OR member at a time. The order of doffing was established with priority given to OR members responsible for transfer of the patient out of OR. Cognitive aids and mirrors were added to the doffing area. A designated nurse in PPE supervised the doffing process. |
|                               | Result: There was order in the PPE doffing process. Prioritizing members responsible for transfer of patient out of OR for doffing reduced the time patient remained in OR.                                                   |
| Key Phases                   | Observations, Improvements, and Results                                                                 |
|-----------------------------|----------------------------------------------------------------------------------------------------------|
| Transport of patient out of OR | Observation  
Environmental services needed time to clear the route of human traffic and this delayed the exit.  
Delay due to time required to bring transport ventilators from the intensive care unit.  
Primary anesthesiologists needed to doff and re-don PPE to transfer patient out of OR.  
Improvement  
Established time required for environmental services to clear route of traffic so as not to delay the exit of the patient from OR.  
Postsurgery disposition of the patient would be decided during the initial team huddle and necessary equipment prepared ahead of time.  
Primary anesthesiologist was given priority to doff PPE.  
Result  
Safe and timely transfer of patient was achieved.  
Environmental contamination was reduced during transfer out of OR. |

Abbreviations: COVID-19, Coronavirus Disease 2019; OR, operating room; PAPR, powered air-purifying respirators; PPE, personal protective equipment.

REFERENCES
1. John Hopkins University & Medicine. Coronavirus Resource Centre. Available at: https://coronavirus.jhu.edu/map.html. Accessed April xx, 2020.
2. American College of Surgeons. COVID 19: Considerations for Optimum Surgeon Protection Before, During, and After Operation. Available at: https://www.facs.org/covid-19/clinical-guidance/surgeon-protection. Accessed April xx, 2020.
3. Anesthesia Patient Safety Foundation. Perioperative Considerations for the 2019 Novel Coronavirus (COVID-19). Available at: https://www.apsf.org/news-updates/perioperative-considerations-for-the-2019-novel-coronavirus-covid-19/. Accessed April xx, 2020.
4. Wong J, Goh Q Y, Tan Z H, et al. Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore. Can J Anesth. 2020.
5. Dieckmann P, Torgeirsen K, Qvindesland SA, Thomas L, Bushell V, Langli Ersdal H. The use of simulation to prepare and improve responses to infectious disease outbreaks like COVID-19: practical tips and resources from Norway, Denmark, and the UK. Adv Simul (Lond). 2020;5:3.

DOI: 10.1213/ANE.000000000004935