Rapid development of interprofessional in situ simulation-based training in response to the COVID-19 outbreak in a tertiary-level hospital in Ireland: initial response and lessons for future disaster preparation

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ABSTRACT

Introduction The first case of COVID-19 in Ireland was diagnosed on 29 February 2020. Within the same week, our Department of Anaesthesia and Critical Care at University Hospital Galway began to tackle the educational challenge by developing an in situ interprofessional simulation programme to prepare staff for the impending outbreak.

Principles and approaches used for simulation-based training We describe principles applied to identify core educational and system engineering objectives to prepare healthcare workers (HCWs) for infection control, personal and psychological safety, technical and crisis resource management skills. We discuss application of educational theories, rationale for simulation modes and debriefing techniques.

Development of the simulation programme 3 anaesthesia (general, obstetric, paediatric) and 1 critical care silo were created. 13 simulated scenarios were developed for teaching as well as for testing workflows specific to the outbreak. To support HCWs and ensure safety, management guidelines, cognitive aids and checklists were developed using simulation. The cumulative number of HCWs trained in simulation was 750 over a 4-week period.

Challenges and future directions Due to the protracted nature of the pandemic, simulation educators should address questions related to sustainability, infection control while delivering simulation, establishment of hybrid programmes and support for psychological preparedness.

INTRODUCTION

The COVID-19 outbreak continues to impose a heavy burden on healthcare systems. A key challenge of the pandemic thus far is its rapid spread, resulting in a sudden surge of cases requiring critical care management for which most of the healthcare systems' capacity is inadequate.[1] Rapid reorganisation of resources often leads to new roles and challenges for healthcare workers (HCWs).[2] The enhanced and urgent need for infection control calls for redefinition, testing and implementation of almost every existing work practice.

Simulation has been widely used to prepare HCWs during previous outbreaks.[3 4] Simulation plays a central role in system testing, identifying latent hazards and improving safety.[5] Regular simulation training may also support resilience and reduce stress on HCWs during the outbreak.[5]

The current report describes our experiences in the first 4 weeks of our simulation programme's development and implementation, and provides useful tips for preparations during COVID-19 or similar outbreaks.

PRINCIPLES AND APPROACHES USED FOR SIMULATION-BASED TRAINING

Rapidly evolving disaster situations may preclude systematic development of 'state-of-the-art' simulation-based curriculums,[6] and a 'good enough' initial approach may be more feasible for ramping up training.[7] Needs assessment, planning and implementation may run in parallel and often change rapidly with significant impact on the trajectories of training. Educational objectives must be defined quickly, accurately and with direct relevance to the clinical situation. There are three important objectives of simulation in the context of the current outbreak. First, infection control must be maximised through personal protection and upskilling of the workforce for management of infected and non-infected patients. Second, work systems must be developed and optimised to ensure safety for patients and HCWs. Third, training and debriefing must address the issues of psychological stress in response to the outbreak.

Education theories and training strategies that may best support learning in this situation include 'just-in-time' simulation training, a work-based education strategy that places training in close temporal proximity to the actual clinical event.[8] Rapid cycle deliberate practice involves immediate directed feedback—"microdebriefing"—within simulation in the form of coaching. This approach allows for brief corrective instruction for learners, followed by an opportunity to try again.[9]

We used system engineering principles to define and teach changed workflow processes associated with the COVID-19 outbreak.[5] The Plan-Do-Study-Act (PDSA) cycle is an iterative process improvement method, which allows HCWs to perform rapid, small-scale testing of processes before implementation.[10] The framework allows adaptation to local needs and problems, thereby facilitating the development of relevant educational objectives.

Managing patients with COVID-19 in the intensive care unit (ICU) and the operating room (OR) requires an interprofessional (IP) team approach. Several studies have shown that IP simulation training improves team performance and thus may contribute to better patient outcome.[11 12] In situ training also allows training of entire teams in the actual clinical environment, including all the associated physical barriers, and is an important tool for system testing and detection of latent safety threats.[13]

High-fidelity simulation is not a prerequisite for effective preparation for COVID-19 patients' care: using lower-fidelity manikins in situ may provide greater authenticity due to the presence of contextual clues.[14] Furthermore, lower-fidelity manikins may be more readily available, easier to handle with minimal training and more feasible for scaling up simulation training.

Facilitators preferably should be trained in simulation-based education and have an understanding of the principles of system testing/integration; however, rapid development of a large-scale programme may require clinicians and nurses with context expertise acting as facilitators supported by simulation-trained educators.

DEVELOPMENT OF THE SIMULATION PROGRAMME

University Hospital Galway is the large tertiary referral hospital for the Saolta University Health Care Group in the West of Ireland. The Department of Anaesthesia and Critical Care provides services for 16 theatres, obstetrics/gynaecology OR and labour ward, a 26-bedded ICU, postanaesthesia care unit, and other remote services. The Department consists of more than 400 nursing, medical and allied healthcare staff who required training for the crisis.

Three core educational objectives were identified and integrated in all simulated scenarios alongside scenario-specific objectives: application of personal protective equipment (PPE), minimising aerosol generation and crisis resource management (CRM) principles. Although the objective of dealing with psychological stress was not directly addressed, our training likely supported resilience indirectly by providing skills acquisitions, reinforcement of internal locus of control, CRM principles and preparatory information.[15] The PDSA cycle was applied simultaneously for system testing and scenario development.[10] 'Plan': a hypothetical scenario blueprint was created for a walk-through exercise with context experts. 'Do': the blueprint was modified and the new scenario was tested with a new set of HCWs. 'Study': feedback was analysed and integrated into the scenario. 'Act': the final scenario was used for training; guidelines, checklists and protocols were developed. Manikins were borrowed from the hospital's resuscitation officer and from the simulation centre; the SimMan App was used as an interface for vital signs. Equipment and props included PPE, cognitive aids, airway equipment, simulated drugs and the actual clinical environment.

Due to the increased volume of education, a departmental simulation group was set up led by a clinical educator in simulation. Four educational silos were created with guidance from context experts with expertise in medical education. Faculty guidance for simulation training was based on the principles and approaches outlined in the previous section. Anaesthesia silos included obstetric OR, general anaesthesia OR and paediatric OR, led by seven consultant anaesthesiologists. The team also included two trainees and three senior nurse educators. The critical care silo included two consultant intensivists, one ICU fellow and two nurse clinical facilitators.

Scenarios in each silo were developed by multidisciplinary teams using the PDSA cycle. Teams included infection control physicians, microbiologists, anaesthesiologists, intensivists, radiologists, biomedical engineers, obstetricians, neonatologists, midwives and nurses. A total of 13 scenarios were developed (table 1).

All simulation scenarios included IP teams. Many of the participants trained on multiple scenarios and more than once during the 4-week programme. The majority of learners were anaesthesiologists, intensivists, ICU and OR nurses; however, midwives, obstetricians, surgical trainees, neonatologists and a small number of allied workers also participated (table 1).

Simulation-based system testing helped to identify locations for donning/doffing in the individual areas, to create guidelines, to review ergonomics for airway management and transfer, to create cognitive aids, checklists and COVID-19-specific equipment packs (table 2).

CHALLENGES

Previously, most of the simulation training occurred in the hospital's simulation centre; there was no established in situ simulation training in the OR nor the ICU before the COVID-19 crisis. Rapid development of such training to support safety was essential, and leadership and collaboration with stakeholders was central to this process. In our case, departmental leadership provided dedicated time for the simulation lead person to oversee and coordinate the programme; however, other faculty members had to balance teaching and clinical responsibilities. This introduced a temporary scheduling problem for both faculty and learners. During the second week, we noticed that silos were taking learners from each other; on some days, lack of learners in a specific silo—because staff attended other silos' training—necessitated cancellation of training. We quickly reviewed the educational plans and needs for each silo and introduced scheduling with priority for ICU training from the third week.

Another important challenge for in situ simulation is to ensure safety by maintaining social distancing. This became very important as more patients presented in ICU and OR, and the country introduced stricter lockdown measures at the end of the second week. Initially, while extra staff were permitted to observe the simulation sessions, we later limited this to learners taking part directly in simulation. We also replaced some of the teaching sessions with online resources. Reduced PPE availability for training was addressed with video teaching and mental rehearsal.

Most of our HCWs underwent simulation training during the first 4 weeks; however, a new phenomenon, 'simulation fatigue', appeared among staff. Faculty often ran training for 2–4 days/week while also attending clinical commitments. HCWs also had other non-simulation education training due to redeployment, that is, OR nursing staff had to be upskilled on mechanical ventilators, infusion pumps, and ICU care in general. From the third week, most of the staff had already received training and HCWs were already practising in real situations. From this point, our programme was maintained on a smaller scale in the ICU,

Table 1 Summary of clinical scenarios, educational objectives, principles used and number of healthcare workers (HCWs) trained each week on various scenarios

Scenario	Educational objectives		Principles used for simulation design	
Critical care silo				
► Application of PPE in the ICU	Donning/doffing. Concept of negative pressure isolation room.		IP or single professional training, low fidelity, mental rehearsal	
► Intubation of patient with COVID-19 from 100% non-rebreather mask	CRM. Standardised team (consultant/NCHD/nurse). Minimising AG for RSI. Correct attachment of mechanical ventilator. Ergonomics. Initial setting for mechanical ventilation.		'PDSA' cycle, 'just-in-time' training, IP training, in situ, high fidelity, RCDP	
► Intubation of patient with COVID-19 from CPAP hood	CRM. Standardised team (Consultant/NCHD/nurse). Safe CPAP hood removal. Minimising AG for RSI. Ergonomics.		'PDSA' cycle, IP training, in situ, high fidelity, RCDP	
► Extubation of patient with COVID-19 from ventilator	CRM. Standardised steps of safe extubation using a plastic sheet.		'PDSA' cycle, IP training, in situ, high fidelity, RCDP	
► Transfer of critically ill patients with COVID-19 from ICU to CT scan	CT scans for two separate sites: contrast and non-contrast. Communication with radiology to identify physical routes to each site. Communication with security and cleaning services. 'Clean' ICU team member's role: brings emergency equipment and medication and remains in the clean console room during scanning. Communicates with transporting team if a clinical issue arises.		'PDSA' cycle, IP training, in situ, low fidelity	
► Transfer of critically ill patient with COVID-19 from ED to ICU	Safe patient assessment in ED. Minimum amount of HCWs in room/standardised team. Outside room: assisting ICU doctor or nurse with emergency equipment, PPE, medications. Plan a safe route to transfer patient to the ICU.		'PDSA' cycle, IP training, in situ, low fidelity	
► Proning of patient with COVID-19 in ICU	CRM. Allocation of roles. Multidisciplinary proning team. Proning steps. Safety checks at pre, intra and post-proning. Timing of proning to allow appropriate management of multiple prone patients. Management of unexpected events.		'just-in-time' training, IP training, in situ, low fidelity, RCDP	
► Tracheostomy for patient with COVID-19	CRM. Performing tracheostomy using special plastic sheets with sleeves to minimise AG.		IP training, in situ, low fidelity	
General anaesthesia OR silo				
► Application of PPE in the OR	Donning/doffing. Concept of positive pressure OR.		IP or single professional training, low fidelity, mental rehearsal	
► Airway management of patients with COVID-19 undergoing general anaesthesia	WHO checklist. CRM. Minimising AG during intubation/extubation. Management of unexpected events: difficult airway, circuit disconnection, PPE damage. Handling tissues and blood samples, documentation.		'PDSA' cycle, 'just-in-time' training, IP training, in situ, high fidelity, RCDP	
► Airway management of pediatric patient with COVID-19 undergoing general anaesthesia	WHO checklist. CRM. Premedication. Minimising AG. Safe intravenous and gas induction. Intubation/extubation. Management of unexpected events: difficult airway, circuit disconnection, PPE damage. Managing parents at induction.		'PDSA' cycle for system testing and guideline development, in situ, high fidelity	
General anaesthesia obstetrics silo				
► Emergency C-section in *Gynae OR* (neuraxial anaesthesia/GA)	CRM. Minimum amount of people in the room. Minimising AG for RSI. Management of new born and transfer to NICU. Donning/Doffing.		'PDSA' cycle, 'just-in-time' training, IP training, in situ, high fidelity, RCDP	
► Emergency C-section in *labour ward OR* (neuraxial anaesthesia/GA)	CRM. Minimum amount of people in the room. Minimising AG for RSI. Management of new born and transfer to NICU. Donning/Doffing.		'PDSA' cycle, 'just-in-time' training, IP training, in situ, high fidelity, RCDP	
Number of HCWs trained on various simulated scenarios/week				
	First week	Second week	Third week	Fourth week
Consultants (anaesthesia/ICU/surgical/obstetrics)	25	65	16	3
NCHDs (anaesthesia/surgical/obstetrics)	28	108	18	5
ICU nurses	28	95	35	30
OR nurses trained in ICU (anaesthesia/scrub/recovery)	30	70	89	40
Theatre nurses/Midwives trained in OR	0	44	22	14
Total*	**111**	**382**	**180**	**77**

*HCWs participated in multiple simulated scenarios and some of them multiple times. Allied healthcare workers are not included in the total number.

AG, aerosol generation; CRM, crisis resource management; CPAP, continuous positive airway pressure; C-section, Caesarean section; ED, emergency department; GA, general anaesthesia; ICU, intensive care unit; IP, interprofessionals; NCHD, non-consultant hospital doctor; NICU, neonatal intensive care unit; OR, operating room; PDSA, Plan-Do-Study-Act; PPE, personal protective equipment; RCDP, rapid cycle deliberate practice; RSI, rapid sequence induction.

Core educational objectives for all scenarios—apart from specific objectives— included PPE application, minimising aerosol generation (AG), team work principles.

while in situ OR simulation training was stopped after the fifth week. However, this allowed us to support innovative projects with simulation, including testing intubation boxes, ventilators and specially designed plastic sheets for tracheostomy.

LESSONS AND FUTURE DIRECTIONS

The development of a large-scale in situ IP simulation programme in preparation for an emerging crisis cannot be envisioned without strong leadership. Simulation has a potential not only to provide hands on training but also to be a system engineering tool for safety and an indispensable platform to improve IP teamwork. When designing a large-scale programme, effective communication with stakeholders is key to deal with practical issues such as scheduling and assessing human resources. Due to the protracted nature of the current pandemic, future simulation training programmes should address questions related to sustainability, infection control while delivering simulation, establishment of multimodal/hybrid programmes and support of psychological

Table 2 Output of system engineering process including guidelines, educational videos, checklists, cognitive aids and equipment to support HCWs in managing patients with COVID-19 safely

Guidelines
▶ Management of suspected/confirmed COVID-19 infected patient undergoing urgent surgery.
▶ Management of suspected/confirmed COVID-19 infected paediatric patient undergoing urgent surgery.
▶ Management of obstetric patient with suspected/confirmed COVID-19 undergoing emergency Caesarean section (general anaesthesia/neuraxial anaesthesia) in labour ward OR.
▶ Management of obstetric patient with suspected/confirmed COVID-19 undergoing emergency Caesarean section (general anaesthesia/neuraxial anaesthesia) in gynae OR.
▶ Critical care assessment of patients with COVID-19 and intubation guideline.
▶ Critical care conscious proning guideline.
Videos
▶ Donning and doffing for aerosol-generating procedures in theatre and ICU.
▶ Application of CPAP hood.
▶ Extubation of ICU patient using plastic sheets to prevent AG.
Checklists and cognitive aids
▶ Critical care intubation checklist from 100% non-rebreather mask.
▶ Critical care CPAP hood removal and intubation nursing checklist.
▶ Critical care CPAP hood removal and intubation checklist.
▶ Critical care trilogy set-up for NIV using full face mask/visor checklist.
▶ Critical care proning/unproning checklist.
▶ General anaesthesia for emergency Caesarean section intubation checklist.
▶ General anaesthesia for suspected/confirmed COVID-19 patient's intubation/extubation checklist.
Equipment
▶ Intubation/extubation tray in OR.
▶ Intubation/extubation tray in ICU.
▶ PPE packs for ICU outreach.
▶ Emergency drug pack in ICU.
▶ Emergency CVC and arterial line packs in ICU and OR.

AG, aerosol generation; CPAP, continuous positive airway pressure; CVC, central venous catheter; HCWs, healthcare workers; ICU, intensive care unit; NIV, non-invasive ventilation; OR, operating room; PPE, personal protective equipment.

preparedness. Simulation training to care for patients with COVID-19 and non-COVID-19 should go in parallel, driving patient safety practices and research to develop best educational interventions to help our patients and HCWs during the current and future pandemics.

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