Rapid Dissemination of a COVID-19 Airway Management Simulation Using a Train-the-Trainers Curriculum

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Abstract

Problem

The most effective way to train clinicians to safely don and doff personal protective equipment (PPE) and perform aerosol-generating procedures (AGPs), such as intubations, is unknown when clinician educators are unavailable, as they have been during the COVID-19 pandemic. Proper PPE and airway management techniques are critical to prevent the transmission of respiratory illnesses such as COVID-19.

Approach

In March 2020, the authors implemented a structured train-the-trainers curriculum to teach PPE techniques and a modified airway management algorithm for suspected COVID-19 patients. A single emergency medicine physician trainer taught 17 subsequent emergency medicine and critical care physician trainers the proper PPE and airway management techniques. The initial trainer and 7 of the subsequent trainers then instructed 99 other emergency medicine resident and attending physicians using in situ simulation. Trainers and learners completed retrospective pre–post surveys to assess their comfort teaching the material and performing the techniques, respectively.

Outcomes

The surveys demonstrated a significant increase in the trainers' comfort in teaching simulation-based education, from 4.00 to 4.53 on a 5-point Likert scale ($P < .005$), and in teaching the airway management techniques through simulation, from 2.47 to 4.47 ($P < .001$). There was no difference in the change in comfort level between those learners who were taught by the initial trainer and those who were taught by the subsequent trainers. These results suggest that the subsequent trainers were as effective in teaching the simulation material as the initial trainer.

Next Steps

Work is ongoing to investigate clinician- and patient-specific outcomes, including PPE adherence, appropriate AGP performance, complication rate, and learners' skill retention. Future work will focus on implementing similar train-the-trainers strategies for other health professions, specialties, and high-risk or rare procedures.

Problem

In a pandemic, especially one that is as severe as COVID-19, safety precautions and attention to personal protective equipment (PPE) are paramount.[1] Clinicians must correctly don and doff

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PPE and perform aerosol-generating procedures (AGPs), such as intubations, in a modified manner to minimize disease transmission. For example, intubations can be customized to maximize safety using techniques such as video laryngoscopy, addition of a viral filter, and modification of preoxygenation strategies to limit aerosol generation. In situ simulation training, or simulation that is integrated into the clinical environment, provides a valuable opportunity for clinicians to practice PPE and airway management techniques in situations where failure to perform properly has significant consequences.[2,3]

The availability of traditional clinical educators became limited during the COVID-19 pandemic as these educators were needed to provide patient care. To train clinicians to safely don and doff PPE and perform proper airway management techniques, an effective instructional strategy was needed to rapidly disseminate this important knowledge. The train-the-trainers model

was an attractive and sustainable option.[4] To our knowledge, although a train-the-trainers curriculum has previously been implemented to teach clinical skills, such as point-of-care ultrasound, emergency care, and PPE adherence,[5–7] it has never been used to teach in situ simulation training for airway management during a pandemic.

In this report, we describe the rapid and effective dissemination of a PPE and airway management in situ simulation training using a structured train-the-trainers curriculum. We demonstrate that a single trainer was able to quickly train additional trainers who had no specialized education background to then teach frontline clinicians appropriate PPE and airway management techniques, all during the COVID-19 pandemic. Furthermore, we developed assessment tools to quantitatively measure trainer and learner outcomes. We propose that other specialties and institutions can implement similar strategies to disseminate and sustain essential clinical

knowledge during future pandemics or in other resource-limited settings.

Approach

We developed a structured curriculum to teach appropriate donning and doffing of PPE and a modified airway management algorithm for suspected COVID-19 patients using in situ simulation.[8,9] The modified airway management algorithm and simulation scenario were developed by institutional leaders, including our initial trainer (C.H.H.), who had experience in health care operations, education, and critical care.[8,9] The algorithm was tested and revised multiples times using the plan–do–study–act process and feedback from its use in both the simulated and clinical environments.[8,9] Our prior work had demonstrated that learners achieved significant improvement in comfort with donning and doffing PPE, role identification, and AGP management for suspected COVID-19 patients after the in situ simulation.[8] The work we describe in this report focuses on the implementation of a structured train-the-trainers curriculum to disseminate material to multiple clinicians with consistent outcomes.

The initial trainer used a structured curriculum to teach other clinicians to become trainers (see the Outcomes section for a timeline of curriculum implementation and evaluation). This curriculum was based on prior work on objective structured teaching exercises that emphasize the following steps[10]: (1) clarification of the goal, (2) clarification of the target audience, (3) identification of teaching skills to be addressed, (4) preparation of a scenario, (5) assessment of the new teacher, (6) identification of the learner, and (7) evaluation of the activity.

The primary educational goal was to train trainers to effectively teach appropriate PPE and airway management techniques for suspected COVID-19 patients using in situ simulation. To assess the teaching skills of the trainers, we developed and piloted a skills assessment checklist that evaluated critical actions including: adherence to the algorithm, assessment of learner understanding, and management of multiple learners of different skill levels (see Supplemental Digital Appendix 1 at http://links.lww.com/ACADMED/B95).

This tool was developed by education and critical care faculty (W.J.P., C.H.H.) and reviewed by education faculty (B.W.M., E.D.L., C.Harvey) to assess for clarity and completeness and to contribute to content and face validity. The checklist was piloted with a group of emergency medicine physicians performing the in situ simulation training.

The curriculum lasted 60 minutes, during which the initial trainer first prebriefed the subsequent trainers on the learning objectives of the airway management algorithm and in situ simulation. The initial trainer then summarized in detail the airway management algorithm and simulation script. Anticipated questions and potential learner errors were also discussed, and strategies to answer these questions and correct these errors were highlighted. Next, the initial trainer provided the subsequent trainers with the opportunity to practice and ask questions. Finally, videos of the simulation scenario and appropriate donning and doffing of PPE were available to the subsequent trainers to review asynchronously.[9]

Our target trainers were emergency medicine and critical care physicians. Through this approach, the initial trainer (a dual-boarded emergency medicine and critical care physician) taught 14 emergency medicine and 3 critical care trainers. Seven of the 14 emergency medicine trainers along with the initial trainer then taught 99 additional emergency medicine learners using in situ simulation.

All 17 subsequent trainers completed a retrospective pre–post 5-point Likert scale survey (1 = extremely uncomfortable, 2 = somewhat uncomfortable, 3 = neither comfortable nor uncomfortable, 4 = somewhat comfortable, 5 = extremely comfortable) to assess their comfort level in teaching the simulation training and airway management algorithm before and following the train-the-trainers curriculum. In addition, the learners completed a separate retrospective pre–post 5-point Likert scale survey (same scale as above) to assess their comfort with the PPE and airway management techniques. These surveys were developed by education and critical care faculty (W.J.P., B.W.M., C.H.H.) and reviewed by education faculty (R.V.T., E.D.L., C.Harvey) to ensure content and criterion

validity. The surveys were created using the Qualtrics online platform (Provo, Utah) and were piloted among the author group to assess clarity.

Two-tailed paired t tests were performed to compare the subsequent trainers' responses before and after attending the train-the-trainers curriculum and to compare responses from learners in the sessions taught by the initial trainer to those from learners in the sessions taught by the subsequent trainers. We considered $P < .05$ to be statistically significant, and we used SAS 9.4 (SAS, Cary, North Carolina) to perform the statistical analysis.

The University of Michigan Medical School Institutional Review Board deemed this study exempt.

Outcomes

To demonstrate rapid dissemination of COVID-19 airway management knowledge, we measured the following outcomes: number of learners and timing of teaching sessions, trainer evaluations of the train-the-trainers curriculum, and comparison of learner evaluations from sessions taught by the subsequent trainers and from those taught by the initial trainer. The primary focus of our evaluation was the emergency medicine trainers, and further work is ongoing to assess outcomes from the critical care trainers.

Development of the airway management algorithm and simulation training began in early March 2020. On March 16, the initial trainer trained 14 emergency medicine and 3 critical care trainers to teach PPE techniques and a modified airway management algorithm for suspected COVID-19 patients. Over the next week (March 16–22), the initial trainer and 7 of the emergency medicine trainers taught 71 resident and attending emergency medicine physicians (57% of all emergency medicine physicians at our institution) the PPE techniques and modified airway management algorithm by holding 45-minute just-in-time in situ simulation sessions 3 times a day, before the standard shift change. The number of sessions decreased to 2 times a day after that first week. These 8 trainers reached 99 learners (80% of all emergency medicine physicians) in 23 days, with sessions ending on April 7 (see Supplemental
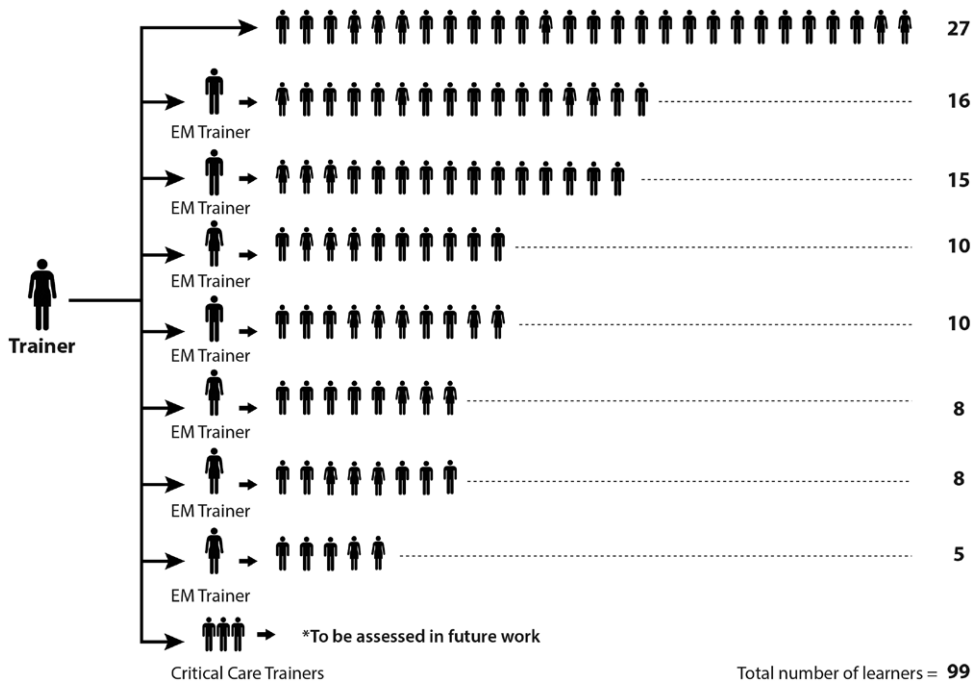
Figure 1 Flowchart for a train-the-trainers curriculum focused on teaching appropriate personal protective equipment (PPE) and airway management techniques for suspected COVID-19 patients, University of Michigan Medical School, 2020. The initial trainer trained 14 emergency medicine (EM) and 3 critical care physicians as subsequent trainers. The initial trainer and 7 of the EM subsequent trainers then taught 99 EM physicians the PPE and airway management content using in situ simulation.

Digital Appendix 2 at http://links.lww.com/ACADMED/B95 for the number of simulation learners by date).

The initial trainer taught 27 learners, while the 7 subsequent emergency medicine trainers taught 72 learners (see Figure 1). The remaining 7 emergency medicine trainers were taught the PPE techniques and modified airway management algorithm in anticipation of expanding the curriculum to other clinicians, including nurses, respiratory therapists, and technicians.

Evaluations of the train-the-trainers curriculum revealed statistically significant increases in trainers' comfort teaching both simulation-based education and airway management simulation. All 17 trainers (100% response rate) completed the survey, which demonstrated an increase from 4.00 to 4.53 in comfort teaching simulation-based education ($P < .005$) and an increase from 2.47 to 4.47 in comfort teaching COVID-19 airway management simulation ($P < .001$; see Table 1).

The emergency medicine learners completed their evaluations at the end of each session (82/99, 83% response rate). Overall, their comfort level in donning and doffing PPE and in airway management techniques significantly increased from 2.93 to 4.35 ($P < .01$, n = 82) after the in situ simulation.[8] Notably, there was no significant difference in learners' comfort levels with donning and doffing PPE (4.37 and 4.38, $P = .975$), knowing their role in AGP management of suspected COVID-19 patients (4.59 and 4.53, $P = .670$), or AGP performance for suspected COVID-19 patients (4.44 and 4.35, $P = .556$) between learners taught by the initial trainer and those taught by the subsequent trainers (see Table 2).

Learners did not differ in their baseline comfort levels in donning and doffing PPE, knowing their role in AGP management, or AGP performance before

Table 1
Trainer Evaluations of a Train-the-Trainers Curriculum, University of Michigan Medical School, 2020[a]

Questions	Mean score (95% CI)	Difference in scores (95% CI)	P value
Teaching simulation			
Before this session, how comfortable were you teaching simulation-based education?	4.00 (3.59 to 4.41)	0.53 (0.21 to 0.85)	< .005
Following this session, how comfortable were you teaching simulation-based education?	4.53 (4.26 to 4.79)		
Teaching COVID-19 AGP simulation			
Before this session, how comfortable were you teaching COVID-19 AGP simulation?	2.47 (1.89 to 3.05)	2.00 (1.49 to 2.51)	< .001
Following this session, how comfortable were you teaching COVID-19 AGP simulation?	4.47 (4.15 to 4.79)		

Abbreviations: CI, confidence interval; AGP, aerosol-generating procedure.
[a] All 17 participants completed a retrospective pre–post 5-point Likert scale survey (1 = extremely uncomfortable, 2 = somewhat uncomfortable, 3 = neither comfortable nor uncomfortable, 4 = somewhat comfortable, 5 = extremely comfortable) to assess their comfort level in teaching the simulation training and airway management algorithm before and following a train-the-trainers curriculum.

Table 2

Learner Evaluations of Sessions Taught by the Initial Trainer Compared With Those Taught by Subsequent Trainers, University of Michigan Medical School, 2020[a]

Question and trainer	Mean score (95% CI)	Difference in scores (95% CI)	*P* value
How comfortable do you feel in appropriately donning and doffing PPE for an AGP in a suspected COVID-19 patient?			
Initial trainer	4.37 (4.10 to 4.64)	−0.01 (−0.29 to 0.30)	.975
Subsequent trainers	4.38 (4.24 to 4.51)		
How comfortable do you feel in knowing your role in the management of an AGP in a suspected COVID-19 patient?			
Initial trainer	4.59 (4.32 to 4.87)	−0.06 (−0.37 to 0.24)	.670
Subsequent trainers	4.53 (4.38 to 4.67)		
How comfortable do you feel in performing your responsibilities (intubating, giving medications, transitioning patient to vent, etc.) without violating PPE precautions during the management of an AGP in a suspected COVID-19 patient?			
Initial trainer	4.44 (4.15 to 4.74)	−0.09 (−0.44 to 0.24)	.556
Subsequent trainers	4.35 (4.18 to 4.51)		

Abbreviations: CI, confidence interval; PPE, personal protective equipment; AGP, aerosol-generating procedure.
[a]Questions asked about learners' comfort with proper PPE and airway management techniques following participation in an in situ simulation. Respondents included 27 learners who were taught by the initial trainer and 55 who were taught by subsequent trainers. They completed a retrospective pre–post 5-point Likert scale survey (1 = extremely uncomfortable, 2 = somewhat uncomfortable, 3 = neither comfortable nor uncomfortable, 4 = somewhat comfortable, 5 = extremely comfortable).

participating in the in situ simulation sessions (2.95 and 3.00, *P* = .831; 3.65 and 3.26, *P* = .155; and 2.98 and 3.26, *P* = .350, respectively). Importantly, these data demonstrate that the subsequent emergency medicine trainers were just as effective in teaching COVID-19 airway management as the initial trainer.

Next Steps

In a pandemic, new clinical knowledge often needs to be disseminated rapidly in resource-limited settings. Maximizing clinician safety and prioritizing patient care are paramount, necessitating expeditious innovation of policies and approaches. Here, we demonstrated the rapid and effective dissemination of a train-the-trainers curriculum to teach the appropriate use of PPE and a modified airway management algorithm via in situ simulation. In these sessions, a single trainer was able to quickly train additional trainers to then exponentially scale up the dissemination of these techniques for suspected COVID-19 patients.

While we focused on emergency medicine physicians in the work described in this report, the train-the-trainers curriculum was also taught to clinicians from other disciplines, including anesthesia critical care, pulmonary critical care, and neurocritical care, and it could be expanded further to include other specialties.

Work is ongoing to investigate clinician- and patient-specific outcomes, including PPE adherence, appropriate AGP performance, complication rate, and learners' skill retention. Future work will focus on implementing similar train-the-trainers strategies for other specialties, such as critical care physicians; health professions, such as nurses, technicians, and respiratory therapists; and high-risk or rare procedures, such as cardiac arrest management for COVID-19 patients.

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Teaching and Learning Moments
Unspoken Challenges

"Please, could we ask the nephrologist for an opinion again? We still believe that dialysis will save her, no matter how difficult it is. After all, COVID-19 is difficult, but we are still dealing with it!" The piercing words of Mdm. C's son still reverberate in my head, weeks after our phone conversation.

Mdm. C had been in the intensive care unit (ICU) for months before the outbreak of COVID-19. She had been admitted for a soft tissue infection that was complicated by septic shock, requiring intubation and a tracheostomy for prolonged ventilation. Thus began her tumultuous journey in the ICU, where she developed repeated bouts of hospital-acquired infections, the next bug always more resistant to treatment than the previous one. Recurrent pneumonia resulted in extensive scarring in her lungs and multiple attempts at weaning her off the ventilator proved unsuccessful. Other organs then began failing and she required dialysis to make her way back from the jaws of death. There was no end in sight to her suffering as the multiresistant organisms chipped away at her existence, each time dwindling her already-depleted reserves while we provided her with an arsenal of antibiotics and dialysate to fend off each attack—only for them to come back hungrier than ever.

It came to a point where our ICU team decided to reevaluate her resuscitation status. By then, it was clear to us that any attempt at cardiopulmonary resuscitation would be futile. Further dialysis was also deemed to be more harmful than beneficial, given her increasingly difficult vascular access and the lack of utility to her overall outcomes.

Conveying this difficult information to her family in the pre–COVID-19 era would have already been challenging; they had expressed their distrust of the health care team on many previous occasions. Alas, this situation coincided with the pandemic, which shrouded the world in a cloud of uncertainty and necessitated government-sanctioned restrictions on face-to-face meetings. Thus, the conversation with her family was conducted virtually and expectedly, it was an emotionally charged discussion spanning several sessions. Mdm. C's family repeatedly expressed a starkly contrasting opinion to ours in regard to her future care.

Discussing a patient's resuscitation status is rarely straightforward and often involves navigating through a minefield of contrasting opinions among relevant stakeholders. In this case, the views of members of her care team stemmed from acting in what we believed was Mdm. C's best interests, while her family was perhaps struggling with the idea of letting go of a loved one who, in their eyes, had been healthy not too long ago.

Another factor that made the discussion even trickier, and probably contributed to their frustrations, was the hospital's restriction on visitors. At a time when social distancing rules dictated limitations on family members visiting even the sickest of patients, it became commonplace to hear people trying to bargain to allow more visitors. Who could blame them? The grim news of the worsening COVID-19 pandemic certainly paled in comparison with the idea of a loved one fighting for his or her life in the ICU all alone. Consequently, the burden of balancing an individual's interests against the greater good so frequently fell upon the doctor's shoulders, like a specter falling upon the see-saw of utilitarianism and deontology.

The importance of fostering trust with families cannot be overstated, and effective communication techniques make up just one part of the complex puzzle. Body language is often considered to be the most important part of communication, but in extraordinary times when family conferences were conducted virtually, we had to rely on other tools such as tone of voice and content of speech. In an increasingly digital age, the experiences I have gained during this stint in the ICU will undoubtedly be invaluable as remote communication becomes more prevalent.

Mdm. C passed away peacefully one month after I first met her, with her closest family members by her side after having come to terms with the reality of her condition. She taught me the importance of effective communication and the intricacies required in these exceptional circumstances. It is a skill that is arguably more fundamental to all doctors than suturing is to the surgeon or intubation is to the intensivist. We attempt to distill it down to a teachable scientific skill, yet it is mostly an art that is impossible to master completely. In my opinion, there is no single way to become the perfect communicator; one must simply continue learning along the way, adopting best practices from role models—a humbling thought during a testing time in the ICU.

Author's note: The name and identifying information in this essay have been changed to protect the identity of the individual described.

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