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Critical Care Simulation Education Program During the COVID-19 Pandemic

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Background: Coronaviruses are important emerging human and animal pathogens. SARS-CoV-2, the virus that causes COVID-19, is responsible for the current global pandemic. Early in the course of the pandemic, New York City became one of the world's "hot spots" with more than 250,000 cases and more than 15,000 deaths. Although medical providers in New York were fortunate to have the knowledge gained in China and Italy before it came under siege, the magnitude and severity of the disease were unprecedented and arguably under appreciated. The surge of patients with significant COVID-19 threatened to overwhelm health care systems, as New York City health systems realized that the number of specialized critical care providers would be inadequate. A large academic medical system recognized that rapid redeployment of noncritical providers into such roles would be needed. An educational gap was therefore identified: numerous providers with minimal critical care knowledge or experience would now be required to provide critical-level patient care under supervision of intensivists. Safe provision of such high level of patient care mandated the development of "educational crash courses."

Methods: The purpose of this special article is to summarize the approach adopted by the Institute for Critical Care Medicine and Department of Anesthesiology, Perioperative and Pain Medicine's Human Emulation, Education, and Evaluation Lab for Patient Safety and Professional Study Simulation Center in developing a training program for noncritical care providers in this novel disease.

Results: Using this joint approach, we were able to swiftly educate a wide range of nonintensive care unit providers (such as surgical, internal medicine, nursing, and advanced practice providers) by focusing on refreshing critical care knowledge and developing essential skillsets to assist in the care of these patients.

Conclusions: We believe that the practical methods reviewed here could be adopted by any health care system that is preparing for an unprecedented surge of critically ill patients.

Key Words: COVID-19, educational simulation, pandemic, patient safety, staff training

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As we are witnessing, COVID-19 can be an extremely deadly disease. Its unprecedented rate of transmission and severity of illness have significant implications for health care, the economy, and social interactions. Because of COVID-19's highly contagious nature and severe short- and long-term complications, safely and efficiently caring for patients with COVID-19 presented unique challenges.

The key aspects of our efforts were a multidisciplinary training program geared toward noncritical care providers that were redeployed to staff intensive care units (ICUs) across the health care system. The training included proper personal protective equipment (PPE), effective treatments, and resource utilization to ensure all patients receive the best care. We developed interventions that made use of just-in-time learning, constantly updating ever-changing therapeutic guidance, modification of standard workflows, and rapid innovation.

The COVID-19 pandemic has presented many challenges, including containment, personnel shortage, provider safety and well-being, scarcity of PPE, and the paucity of effective evidence-backed therapeutic options. We prepared our health system to meet these challenges with a large-scale simulation training program that can be easily replicated at other health care systems preparing for a similar unprecedented demands on constrained resources.

METHODS

Three courses were designed to address the immediate educational needs:

- Management of a patient with acute decompensation with COVID-19
- Critical care basics for the non-ICU provider
- Manual proning of a mechanically ventilated patient

A brief informal needs assessment was performed, with consultation from members of the surgical, critical care, and anesthesiology departments. Specific educational gaps were identified in preparation for redeployment of non-ICU staff to critical care environments, and the 3 courses were identified as those filling identified gaps. Members of the critical care and anesthesiology departments with formal departmental educational responsibilities were involved in initial needs assessment and design of a corresponding curriculum. The content of all 3 courses was developed simultaneously over a 3-day period using a modified Delphi approach where faculty worked in small teams to develop each course efficiently and expeditiously, whereas other faculty members oversaw their consistency, elimination of redundancy, and alignment with institutional goals and policies. This was done using Zoom

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and e-mail to avoid large group meetings and to follow institutional policy.

Select members of the Institute for Critical Care Medicine (ICCM) and Department of Anesthesiology, Perioperative and Pain Medicine's Human Emulation, Education, and Evaluation Lab for Patient Safety and Professional Study Simulation (HELPS) were deployed to the simulation center at the beginning of COVID pandemic in New York City to implement these educational initiatives swiftly. The simulations took place simultaneously at the HELPS laboratory (first 2 courses) and ICCM laboratory (third course) to maximize time and space for expedited training.

Each session was designed for in-person training, physical distancing safeguards in place. An enrollment document was available online and regularly updated. Next, the leaders of various preidentified clinical departments were instructed to send their staff for training in the sequence that they were designated for COVID duty.

Online spreadsheets were created to schedule the courses and track attendance. Administrative support was provided by the hospital and included automated reminder e-mails to the next day's attendees. Similarly, redeployment of qualified house staff to these educational initiatives to serve as instructors, as well as identifying nursing and surgical education champions, helped to scale up the training quickly. In addition, educational materials were created for virtual distribution to the entire Mount Sinai System (materials provided in Supplemental Digital Contents (SDCs) 1–3, http://links.lww.com/JPS/A423, http://links.lww.com/JPS/A424, http://links.lww.com/JPS/A425).

Concurrent development of digital educational content was quickly incorporated into the system-wide online resource page, providing instant dissemination of content and guidelines among other hospitals within Mount Sinai Health System. Finally, access to the learning materials was made available to several institutions globally, upon request. Links to the created video content are included in the section.

PARTICIPANT

All health care providers likely to participate in the care of patients with COVID-19 were encouraged to participate in these courses. Large groups of faculty, house staff, nursing staff, and advanced practice providers (APPs) from anesthesiology, cardiology, general surgery, and surgical subspecialties participated. There were a total of 1198 learners in the 3 courses (most of the learners went to more than 1 course). Specifically, for the first 2 courses, 22% of participants were attendings, 9% were fellows, 32% were residents, 18% were physician assistants, and 19% were nurse practitioners. For the third course, 12% were attendings, 14% were fellows and residents, 15% were nurse practitioners, 9% were respiratory therapists, 43% were nursing staff, and 7% were operating room technicians. Of these participants, 13% had never been on a critical care rotation, 35% had been in the ICU setting within the past year, 29% reported 1 to 5 years before the courses, 10% reported 5 to 10 years before the courses, and 13% reported more than 10 years prior. Anonymous feedback using a 5-question survey questioner with an additional comment section for feedback was collected at the completion of each session. A follow-up short survey was administered 3 months after administration of these courses, See Appendix D, http://links.lww.com/JPS/A426.

MANAGEMENT OF A PATIENT WITH ACUTE DECOMPENSATION WITH COVID-19

With provider safety of the essence, the PPE donning/doffing module was swiftly created and implemented, and 432 providers from a variety of clinical areas were trained (Table 1). Like the other courses, this session and its accompanying instructional video (SDC 1 Part 1, http://links.lww.com/JPS/A423) was available to any provider within the health system.

Modules on safe airway intervention and Advanced Cardiac Life Support (ACLS) administration were also created and rolled out. Subsequently, these educational materials became the basis for our system-wide implementation of "COVID intubation teams" and served as a resource for any provider within the system. The COVID intubation teams were implemented on the wards to streamline a unit workflow and consisted of providers trained in the simulation laboratories.

Design of the Course

The course consisted of 3 distinct educational modules: PPE, airway intervention, and use of automated ACLS assist devices. Each session was 30 to 45 minutes long, dedicating about 20 minutes to PPE and 10 to 15 minutes to each of the other 2 topics. See Table 1 for the total number of trained personnel.

Content: PPE

The objectives of this module were to become familiar with available PPE and to learn proper donning and doffing without self-contamination. Once proper donning and doffing technique was demonstrated by the presenter in the front of the room, the participants were paired up and practiced their own donning and doffing. Partners served as evaluators of each other's techniques to spot any potential deficiencies. To preserve PPE, gowns were reused and only one pair of gloves was used for the training. The participants were encouraged to ask questions and familiarize themselves with available PPE.[1] Step-by-step instructions and a link to the accompanying video were made available online (SDC 1

TABLE 1. Summary of Courses Administered and Total Number of Providers Trained

Course Title	Total No. Sessions Administered	Maximum No. Participants Per Session	Session Length, min	No. Training Days	Actual Total No. Providers Trained
Management of a patient with acute decompensation with COVID-19	90	8	45	10	432
Critical care basics for the non-ICU provider	38	9	90	8	294
Manual proning of a mechanically ventilated patient					
Leaders	12	8	45	3	80
Teams	56	7	30	7	392

Some participants were trained in more than one listed course and were counted each time as a participant in the course. In addition, some sessions offered did not fill to maximum capacity.

Part 1, http://links.lww.com/JPS/A423; video link: https://youtu.be/ShiSLGqDPDw.

Content: Airway Intervention

The goals of the module were to review the newly developed institutional COVID-specific airway management guidelines, practice setting up equipment for impending intubation, and practice 2-provider mask ventilations and intubations using part-task mannequin. The participants were divided into groups of 2, and after a demonstration by the simulation leader, each group came up to the front of the room for supervised practice. The simulation leader provided feedback in real time to each group for just-in-time learning. Full group debrief was conducted at the end of the module.

In the setting of potential aerosolized virus, video laryngoscopy was the preferred device for all intubations. Based on consensus, an airway management workflow guideline was developed and subsequently implemented across the health care system. It specifically emphasized preoxygenation, rapid sequence induction/intubation, avoidance of manual ventilation, and use of a HEPA (viral) filter between the self-inflating bag and mask and then between tracheal tube and ventilator circuit.[2,3]

In addition, an intubation team approach was standardized, with 2 providers in the room and additional staff outside the room to pass needed items, and the third provider available for emergency airway intervention. Intubations per se were performed by a designated skilled airway expert (either anesthesiologist, critical care attending, or rapid response team attending), whereas preparation, setup, and assistance during intubation were provided by any other trained personnel. This model decreased the number of staff exposed to the virus while engaged in this potentially high-aerosolization procedure. This approach also minimized supplies entering the contaminated room, allowing for conservation of these supplies. Finally, PPE use was also preserved, as the same intubation team remained in the room after intubation for additional line placements. An instructional video was available online (SDC 1 Part 2, http://links.lww.com/JPS/A424).

Content: Automated ACLS Assist Devices

In patients with COVID-19 requiring cardiopulmonary resuscitation, manual chest compression and intubation present a unique infection prevention challenge.

Automated compression devices allow for consistent mechanical compressions while minimizing provider exposure. Although there are rare reports of adverse patient outcomes from improper device positioning, the benefit of minimizing number of providers exposed to aerozolization while performing cardiopulmonary resuscitation far outweighed any risks that automated devices may present. The providers therefore needed to be trained on using and troubleshooting this new piece of equipment in a crisis.

The goals for this portion of the course were to become familiar with automated compression devices and review the logistics of using such a device. After an initial demonstration by the simulation leader, participants engaged in a hands-on workshop, which included learning to troubleshoot common scenarios. To properly disinfect the device after each use without damaging the device mechanism was demonstrated by the use of chlorhexidine-based (nonbleach) wipes. Questions were answered for just-in time learning. An instructional video was available online (SDC 1 Part 3, http://links.lww.com/JPS/A425; video link: https://youtu.be/iyAQR_Zpf6U.

CRITICAL CARE BASICS FOR THE NON-ICU PROVIDER

Design of the Course

This course consisted of a lecture on the basics of critical care and 3 progressively evolving simulation scenarios. Each session was 90 minutes long, dedicating the first 30 minutes to the lecture, followed by three 20-minute simulation scenarios with debriefs. An intensivist taught the lecture, whereas an anesthesiologist led simulation scenarios and debriefs. See Table 1 for the total number of trained personnel.

Content: Lecture and Simulation

The objectives of this course were to identify the patient with progressively worsening respiratory status, to recognize timing for escalation of care, to become familiar with ICU workflow, to review medical management of shock, and to review ACLS protocols.[4]

The lecture provided a brief overview on the recognition of a critically ill patient, assessment of respiratory status, current ICU workflow, ventilator settings, and evolving treatment modalities. The lecture was also made available online (SDC D Part 1, http://links.lww.com/JPS/A423).[2,5–11]

The participants were then divided into smaller groups to participate in 1 of the 3 simulations; the other groups watched the performing group. The simulation scenarios included progressive respiratory failure ultimately requiring intubation, management of distributive shock, and ACLS for cardiac arrest.[4] Detailed debriefs were performed with the whole group after each simulation scenario, focusing on provider safety, workflow, and appropriate escalation of medical care.

Specifically, the first scenario emphasized recognition of a patient's declining respiratory status, quick escalation in oxygen therapy to nonrebreather, and early intubation, with proper PPE and intubation equipment, medication, and staff. Discussion of timing for additional line placements (arterial line, central line) was also included. The second scenario reviewed different etiologies of shock and treatment strategies for each. In addition, timely involvement of the infectious disease specialist, as well as the crucial need for timely and frequent family discussions regarding patient's status, was discussed. In the third scenario, etiologies of cardiac arrest and several ACLS protocols (bradycardia, pulseless electrical activity, ventricular fibrillation) were reviewed. Refer to SDC 3 (http://links.lww.com/JPS/A425) for details of the simulation scenarios (video link: https://youtu.be/UaZw_ENCyf0).

MANUAL PRONING OF A MECHANICALLY VENTILATED PATIENT

Rationale for Turning Patients to Prone Position

Although the exact pathogenesis of lung injury caused by SARS-CoV-2 virus currently remains unclear, the mainstay of respiratory therapy revolves around proposed 3 mechanisms of injury: induction of an acute respiratory distress syndrome (ARDS)–like high A-a gradient hypoxemia with noncardiogenic pulmonary edema and diffuse alveolar damage,[6,7,12,13] resultant microthombi-mediated ventilation-perfusion (V/Q) mismatch,[6] and a highly toxic inflammatory pneumonitis process.[6,14] One of the statistically and clinically significant components of ARDS management, and now COVID-19 management, is early proning.[10,15] Early proning is associated with an increase in effective lung volume, reduction in atelectatic lung regions, an overall homogenous lung perfusion, increased oxygenation, and overall improved outcomes with decreased in 28- and 90-day mortality in patients with severe ARDS.[11,15,16]

Design of the Course

This course was rolled out in a 2-step process to scale up the number of trained personnel and to separately train the would-be leaders of manual proning maneuvers. First, the course was offered to the doctors of medicine and APPs, in 45-minute sessions, where the first 15 minutes was focused on the leadership role—to oversee, manage, and coordinate the team during the manual proning maneuver, whereas the last 30 minutes was dedicated to the practice of this maneuver (details hereinafter). See Table 1 for a total number of leaders trained. Second, the course was offered to nursing staff and respiratory therapists in 30-minute sessions, including during night shifts. These sessions specifically focused on the manual proning protocols and practice (details hereinafter). The residents also participated in the 30-minute proning sessions, together with the nursing staff. See Table 1 for a total number of trained personnel.

Content: Manual Proning Maneuver Indications and Simulation

The objectives of the course were to review the need for proning in COVID+ ventilated patients, to understand the specifics of the proning maneuver, to practice proning maneuver in a team setting, to recognize common critical steps during maneuver performance, and to recognize and practice team coordination and close-loop communication.

Detailed algorithms and checklists were developed, and instructional videos were provided to the attendees before the sessions. Each session provided a dedicated space and impromptu teams to practice proning maneuver, de-proning maneuver, and patient head repositioning. The maneuver simulation was not limited to the steps of the maneuver or individual roles alone, but also incorporated potential safety hazards (such as dislodgement of the endotracheal tube, indwelling lines and tubes, hyperextension of the patient neck, and posterior dislocation of the shoulder). To emphasize the importance of these concerns, teams practiced proning on a team member volunteer. This further enhanced fidelity of the simulation and allowed the maneuver leader to identify and problem-solve these concerns in real time. Refer to SDC 3 Part 1 (http://links.lww.com/JPS/A425) for a link to an instructional video.

In addition, the sessions for providers reviewed relevant premaneuver and postmaneuver checklists, and briefly reviewed ACLS protocol for prone-positioned patients where ACLS is started in the prone position until return to supine position is possible. The checklists were developed by the proning maneuver leaders of the critical care department. These staff members were directly involved in supervising proning patients, and the checklists underwent multiple rounds of iterations until final version was accepted as institutional policy. The revisions were made after several rounds of simulations. Portions of the checklist were adapted from the preoperating room checklists (such as all members of the team present, patient identified, etc). Refer to SDC 3 Parts 2 and 3 (http://links.lww.com/JPS/A425) for step-by-step checklists (video link: https://www.youtube.com/watch?v=ECdxhNFLwVo).

RESULTS

Participant enrollment in the 3 aforementioned courses is summarized in Table 1. Specifically, this educational effort trained and cross-trained health care providers at the Mount Sinai Hospital within the first 2 weeks of the epidemic surge in New York City. There were a total of 1198 providers in the 3 courses (most of the learners went to more than 1 course). The providers included APPs, residents, fellows, and attendings (Fig. 1A), and the providers ranged from never being in an ICU to not being in an ICU for more than 10 years (Fig. 1B). These providers gained skills in donning/doffing PPE, basic critical care, and proning patients. In addition, educator champions within nursing and surgery departments were identified to carry out additional sessions.

The training and simulation sessions were intended to combine the previous critical care training of the COVID unit providers with additional tools, to continue to provide excellent critical care. Across these courses, in any clinically unstable emergency situation, both provider and patient safety were consistently emphasized and reinforced.

The team from ICCM and the HELPS center were divided into 3 groups, each working on one of the courses. The courses were rapidly designed and shared with the entire group for feedback. Although the course design was being finalized, leadership from the group e-mailed the department chairs as well as residency and fellowship leadership about the upcoming training for their staff that would be deployed to the ICU units. A brief overview pamphlet of the courses was created and was included in the e-mail communication. The courses constantly incorporated feedback from course attendees. Senior leadership of the health system was pivotal in coordinating and distributing the educational material and videos across the system to all campus locations.

A 5-question feedback form was required to be completed at the end of each session, with a comments section provided. A follow-up short survey was sent 3 months after administration of these courses (Table 2). Feedback was overwhelmingly positive. Identified advantages of our training program included opportunities for hands-on practice as opposed to a "virtual only" or videoconference-based program. The interdisciplinary nature of the sessions was also cited as beneficial and gave each group insight as to the function, training, and experiences of other service lines. Lastly, the digital resources that were available for prelearning were deemed beneficial by the participants. In terms of requests for new topics or materials, additional sessions to allow for more simulation time and in-depth ALCS reviews were requested.

DISCUSSION

Educational Efforts and Simulation Training: Design and Rollout

Herein we have described the rationale for and experience of the development of a simulation-based "crash courses" for providers to care for patients with COVID-19.

Our courses were designed and implemented because of the immediate need to educate numerous providers in a short period to get them ready for functioning on the needed units, while contending with a highly contagious pathogen. Course objectives were developed for each portion of the course.

Educational Efforts and Simulation Training: Challenges and Solutions

As with any new initiatives, multiple challenges were encountered while developing, organizing, and administering the training and simulation sessions.

Logistical concerns of course organization, enrollment, and administration needed to be addressed. The enrollment document was created to be accessible online and regularly maintained by a faculty member with open access to anyone who wanted to register. This gave flexibility to learners and leadership to ensure that courses were full and that learners could substitute in and out given the fluid needs of the clinical environment. The departmental leadership became crucial in supporting clinical coverage on the wards to ensure the rollout of these courses; timing of course offerings shifted to span both day shift and night shift hours.

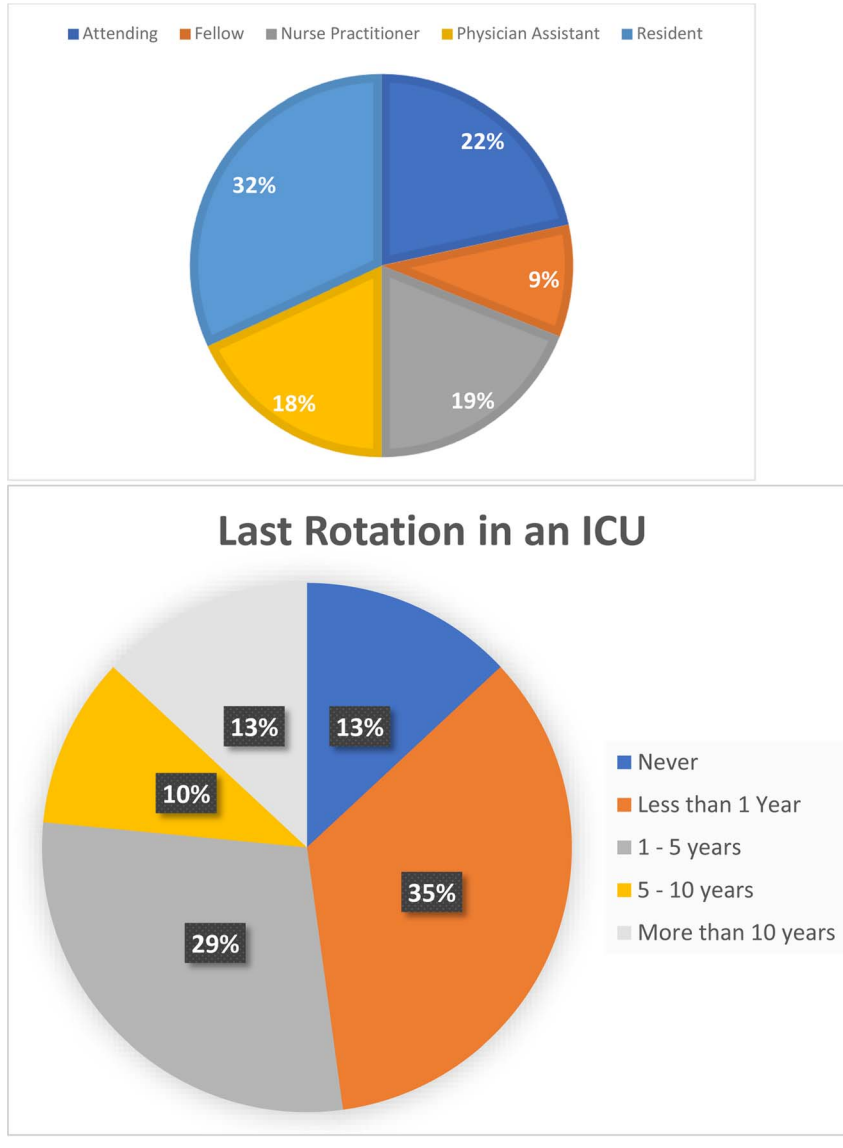

FIGURE 1. Course participant characteristics. A, Level of training. B, Last time providers did an ICU rotation.

Finally, multiple residents and fellows were recruited to aide in physical administration of courses and simulations to minimize the amount of faculty needed to run the program. Under the guidance of faculty members, these house staff helped with day-to-day logistics, ironing out feasibility, and collecting informal feedback from the participants, so that each course's content underwent adjustment and iteration to meet the educational, simulation, and practical needs of its participants.

TABLE 2. Postcourse Evaluation Survey Results

	Precourse: How Prepared Did You Feel to Work in the COVID ICU	Postcourse: How Prepared Did You Feel to Work in the COVID ICU	After COVID: How Well Did You Feel This Course Prepared You for the COVID ICU	How Useful Did You Find the Course
Critical care basics for the non-ICU provider	2.27	3.27	3.5	3.64
Management of a patient with acute decompensation with COVID-19	2.56	3.56	3.78	4.22

Scale 1 to 5, with 5 being the best.

Implementation on the Wards: The Mount Sinai Hospital Experience and Lessons Learned

The ultimate test of this educational initiative came from staff performance in the ICUs.

With rapid scaling up of the ICU workforce, maintaining staffing for the courses can become increasing difficult. We were given additional resources from the health system, including a project manager, who was able to help organize courses, send reminder e-mails, collect and organize feedback, and answer questions. Moreover, starting the training before the full surge of critical ill patients was key to be able to get as many providers through the courses within initial 2 weeks. In addition, a system-wide Web site of COVID-19 resources was created by a working group, and all developed content was made available as videos and posted on the site (https://www.mountsinai.org/about/covid19/staff-resources/critical-care-education).

With continuing close collaboration between the ICCM and the Department of Anesthesia, a multidisciplinary team was created to help manage all COVID+ airways, hospital-wide. The team was composed of either the rapid response team critical care attending (for hospital-wide intubations) or the ICU attending (for ICU intubations) and a senior resident or Certified Registered Nurse Anesthetists. The training and courses helped build these airway teams and made the process a success.

The providers that were put through the critical care for the nonintensivists course were used in different units throughout the hospital and were better equipped for management of critically ill patients with the baseline knowledge they had received. These providers were also deployed to other hospitals in the Mount Sinai System to help when additional resources were needed.

For the proning maneuver, although the original intention was for the primary team of each patient to prone that patient whenever clinically indicated, it was quickly realized that such a model did not meet the highly increased demand from a surge of patients needed to be prone. To standardize a unit workflow, a "proning team" was designed, consisting of operating room technicians, nursing assistants, nurses, residents, and respiratory therapists, scheduled into 12-hour "proning shifts." Each provider on the proning team had already undergone the proning simulation in the simulation laboratory, such that creating these "proning teams" with trained providers was a quick and smooth transition for the unit workflows. The maneuver leader was designated to be the primary provider of the specific patient. The leader's responsibility evolved to include the safety of the proning team (e.g., requesting additional staff to aide in proning in certain patients), hemodynamic stability of the patient during the maneuver with all necessary lines intact, and recognition when to abort the maneuver. Close-loop communication and team coordination became vital.

CONCLUSIONS

Health care providers are facing an unprecedented crisis in caring for patients during the COVID-19 pandemic. One important way the Mount Sinai Hospital was able to help train and support its providers during this time was the development of the critical care simulation curriculum. Herein we discussed our institutional experience in expeditious training and retraining of numerous providers to be able to function safely in unfamiliar work environments, and to provide exceptional safe critical care during times of crisis. We believe that the practical details mentioned here would be helpful to any health care system that is currently preparing for the surge of critically ill patients.

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