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Simulation-based uptraining improves provider comfort in the management of critically ill patients with COVID-19

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ABSTRACT

Purpose: The COVID-19 surge required the deployment of large numbers of non-intensive care providers to assist in the management of the critically ill. Institutions took a variety of approaches to “uptraining” such providers though studies describing methods and effectiveness are lacking.

Materials and methods: One hundred and seventy-five providers underwent a 3 h simulation-based session focused on management of shock, mechanical ventilation, acute respiratory distress syndrome, and critical care ultrasound. All participants were sent surveys to assess their comfort with various aspects of critical care following return to their usual work environments.

Results: One hundred and eight providers of 175 (62%) completed the survey. Overall, 104/108 responders (96%) felt training either significantly or somewhat improved their knowledge in the management of ICU patients. Responders felt most comfortable in the management of hypoxemia in intubated patients and the management of ventilated patients with acute respiratory distress syndrome (93% strongly agree or agree, and 86% strongly agree or agree, respectively). Fewer responders felt more comfortable using focused echocardiography (70% strongly agree or agree) and lung ultrasonography in following progression of COVID-19 (76% strongly agree or agree).

Conclusions: Simulation-based training improved provider comfort in the management of critically ill patients with COVID-19.

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1. Introduction

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has led to a worldwide pandemic of coronavirus disease 2019 (COVID-19) responsible for over 6 million cases in the United States alone with approximately 188,000 deaths [1]. During the New York City surge, 14%–22% of hospitalized patients required intensive care unit (ICU) admission with approximately 80% of those requiring invasive mechanical ventilation [2,3]. Patients with shock and acute renal failure requiring renal replacement therapies were common in the ICU representing approximately 30% of the critically ill cohort [2,4]. To manage the dramatic influx of patients, institutions included non-critical care providers as part of the critical care workforce [5,6]. How best to

rapidly train a large number of non-critical care practitioners in the management of critically ill patients with COVID-19 remained an important challenge [5,6].

Institutions took a variety of approaches to critical care “uptraining” of non-critical care providers. These included “just-in-time” inter-professional and in situ simulations, as well as training via a variety of online modules offered by professional societies [6,7]. However, the impact of training modalities on provider skillsets and comfort in the management of critically ill patients with COVID-19 has not been described.

The COVID-19 surge at New York University Langone Health required the deployment of large numbers of non-intensive care physicians and advanced practice practitioners to assist in the management of the critically ill. During the peak of the pandemic, we cared for approximately 200 patients with COVID-19 in our expanded ICUs. A 3 h “uptraining” simulation session was offered to these providers that focused on various aspects of ICU care (i.e. management of circulatory shock, lung ultrasonography). To better understand the impact of uptraining on provider comfort in the management of critically ill patients with COVID-19, electronic surveys were distributed after the completion of deployment. We hypothesized that simulation-based

Abbreviations: ARDS, Acute Respiratory Distress Syndrome; COVID-19, Coronavirus disease 2019; ICU, Intensive care unit; NP, Nurse Practitioner; PA, Physician Assistant; SARS-CoV-2, severe acute respiratory syndrome coronavirus-2.

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training would improve non-critical care provider comfort in the various aspects of ICU-care.

2. Methods

2.1. Simulation-based uptraining

The study was exempt by the New York University IRB. Thirty-nine, 3 h sessions were held at the Veterans Affairs New York Harbor Healthcare System simulation center between March 19, 2020 and April 23, 2020. The target audiences were non-intensive care trained faculty, fellows, chief residents, nurse practitioners (NPs), and physician assistants (PAs) who were going to be deployed to COVID-19 intensive care and stepdown units. Each class size was limited to 6 participants. Prior to attending the 3 h session, learners were asked to review fundamentals of critical care support lectures from the Society of Critical Care Medicine [8].

The following topics were addressed during simulation-based training:

1. Evaluation and management of circulatory shock
 2. Evaluation and management of acute respiratory failure
 3. Initial management of mechanical ventilation for patients with acute respiratory distress syndrome (ARDS) with modifications for patients with COVID-19
 4. Focused point-of-care ultrasound (POCUS) for evaluation of cardiac and respiratory distress using a variety of ultrasound simulators and practice of 2D and M-mode pleural evaluation on the instructor
 5. Lung ultrasonography to follow the progression of COVID-19 lung disease with practice on a lung ultrasound simulator (BodyWorks Eve, Intelligent Ultrasound @ Alpharetta, GA, USA)
 6. Evaluation and management of tracheostomy complications
 7. Doffing and donning procedures
- Specific goals and objectives for each topic are displayed in Table 1.

2.2. Surveys

All participants were sent electronic surveys after completion of their deployment. All surveys were de-identified once received for the purpose of analysis. A copy of the survey is available as a supplemental table. The first 3 questions were related to the participant's pre-COVID-19 and COVID-19 responsibilities: 1. What describes your usual position? 2. Which describes where you were deployed during the COVID-19 pandemic, 3. How much time did you spend taking care of patients in the ICU prior to the simulation? A five-point Likert scale was used to assess the program and specific topics covered as follows: 1. Strongly agree, 2. Somewhat agree, 3. Neither agree or disagree, 4. Somewhat disagree, 5. Strongly disagree.

The following questions comprised the survey:

1. I believe that the 3 h simulation based up-training session improved my knowledge regarding care of critically ill patients.
2. I believe that the 3 h simulation based up-training session improved my comfort level regarding care of critically ill patients.
3. After completion of the 3 h simulation-based curriculum I felt better equipped to evaluate and manage circulatory shock
4. After completion of the 3 h simulation-based curriculum I felt better equipped evaluate and manage acute hypoxemia in intubated patients
5. After completion of the 3 h simulation-based curriculum I felt better equipped to use focused transthoracic echocardiography to evaluate a patient in shock
6. After completion of the 3 h simulation-based curriculum I felt better equipped to use lung ultrasonography to evaluate critically ill patients
7. After completion of the 3 h simulation-based curriculum I felt better equipped to direct ventilatory management of patients with ARDS

Table 1
Specific goals and objectives of topics covered during simulation-based uptraining.

Topic	Goals and objectives
Shock	<ol style="list-style-type: none"> 1. The learner will be able to recognize and describe the clinical and metabolic features of circulatory shock 2. The learner will be able to describe the four categories of circulatory shock and how measurement of the central venous pressures, central venous oxygen saturation and use of a focused POCUS examination of the heart can help narrow the differential diagnosis 3. The learner will be able to initiate appropriate management of circulatory shock based on suspected etiology
Acute hypoxemia	<ol style="list-style-type: none"> 1. The learner will be able to develop a differential diagnosis for a patient who acutely becomes hypoxemic 2. The learner will be able to narrow the differential diagnosis once a unilateral loss of breath sounds is noted on auscultation 3. The learner will demonstrate the appropriate management of mainstem intubation, tension pneumothorax, and mucus plugging 4. The learner will be able to recognize the presence and absence of lung sliding on lung ultrasonography
Lung ultrasonography	<ol style="list-style-type: none"> 1. The learner will be able to demonstrate appropriate technique for pleural evaluation by lung ultrasonography 2. The learner will be able to demonstrate the presence of lung sliding in both 2D and M mode 3. The learner will be able to obtain appropriate views and follow the progression of COVID-19 lung disease using lung sonography on the BodyWorks Eve (Intelligent Ultrasound @ Alpharetta, GA, USA)
ARDS	<ol style="list-style-type: none"> 1. The learner should be able to define what ARDS is and describe the use of protective lung ventilation for these patients 2. The learner should be able to describe how to measure plateau pressure and how to make ventilator adjustments if the plateau pressure exceeds the goal 3. The learner should be able to describe how to assess etiologies for increases in peak airway pressure in an ARDS patient
Care of the COVID-19 Patient in the ICU	<ol style="list-style-type: none"> 1. The learner will understand potential differences in the pathophysiology of COVID-19 lung disease from traditional ARDS 2. The learner will understand how airway management of this population differs from traditional airway management 3. The learner can describe the risks and benefits of non-invasive positive pressure ventilation and high-flow oxygen in this population 4. The learner will understand how COVID-19 effects various organs

Each topic addressed during simulation-based uptraining is listed with corresponding specific goals and objectives for the learner.

ARDS: acute respiratory distress syndrome, COVID-19: coronavirus disease 2019.

8. After completion of the 3 h simulation-based curriculum I felt better equipped to use lung ultrasonography to follow the progression of COVID-19 pulmonary disease
9. After completion of the 3 h simulation-based curriculum I felt better equipped to understand some of the common problems encountered when managing patients with a new tracheostomy
10. The content of the session directly impacted my care of critically ill patients

3. Results

One hundred and eight providers of 175 (62%) completed the surveys. Cardiology fellows and faculty accounted for 36% of the responders, acute care NPs accounted for 16%, while other NPs, PAs,

Table 2
Participants Response to “Did you feel better equipped to utilize ICU skills following simulation training”.

Specific ICU skill	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
Management of circulatory shock	53 (40%)	40 (37%)	13 (12%)	2 (2%)	0 (0%)
Management of hypoxemia in intubated patients	58 (54%)	42 (39%)	6 (6%)	1 (1%)	1 (1%)
Focused echocardiography	42 (40%)	32 (30%)	26 (24%)	5 (5%)	3 (3%)
Lung ultrasonography	56 (52%)	36 (33%)	13 (12%)	3 (3%)	0 (0%)
Lung ultrasonography in COVID-19 progression	43 (40%)	39 (36%)	16 (15%)	7 (6%)	3 (3%)
Management of ventilated Patients with ARDS	49 (45%)	44 (41%)	10 (9%)	3 (3%)	2 (2%)

Each skill simulated is depicted with provider responses displayed as n (%).
ARDS: acute respiratory distress syndrome.

chief medical residents, medical and surgical fellows, hospitalists, and surgeons accounted for the remainder. Prior to simulation training, 31% regularly helped manage ICU patients and 28% occasionally helped manage ICU patients. Following training, 53% of participants were deployed to a COVID-19 ICU while 18% were deployed to a COVID-19 stepdown unit as part of their workflow. Overall, 104/108 responders (96%) felt training either significantly or somewhat improved their knowledge in the management of ICU patients. Ninety-four participants (91%) felt training impacted their care of critically ill patients with COVID-19.

Table 2 is a display of specific ICU skillsets taught in the session and if the participants felt better equipped to utilize what was covered post deployment. In each instance, at least 70% of the responders strongly agreed or somewhat agreed that they felt better equipped to utilize each skillset simulated. Responders felt most comfortable in the management of hypoxemia in intubated patients and the management of ventilated patients with ARDS (93% strongly agree or agree, and 86% strongly agree or agree, respectively). Fewer responders felt more comfortable using focused echocardiography (70% strongly agree or agree) and lung ultrasonography in following progression of COVID-19 (76% strongly agree or agree).

4. Discussion

To staff our COVID-19 ICUs, a number of non-critical care physicians, NPs, and PAs underwent simulation-based critical care uptraining and were surveyed to determine the impact of training on comfort in the management of these patients. While institutions managing the surge of COVID-19 took different approaches to improving skills of non-critical care providers, the impact of such training on provider comfort has not been reported [6,7]. Further, there is scant literature on specific approaches including goals and objectives used by institutions to address provider deficiencies in knowledge and skill.

Most of our responders felt the training significantly or somewhat improved their knowledge and care delivery following completion of deployment. In a 3 h session, multiple cognitive skills were addressed (i.e. management of hypoxemia, new tracheostomies) in addition to focused ultrasonography. Following training, more responders felt comfortable managing shock and hypoxemia than they did using ultrasonography in the assessment of critically-ill COVID-19 patients. Importantly, this was based on provider self-assessment following their work in a COVID-19 ICU rather than immediately post training. It therefore follows that providers likely applied knowledge and skill acquired during simulation and felt the training was valuable. A unique advantage of uptraining for COVID-19 is the rapid application of skills learned. This may be in contrast to other simulations where providers may not have an opportunity to apply such skills over a prolonged window of time such following advanced life support training.

Simulation-based training has been implemented in the past in preparation for the Influenza and severe acute respiratory syndrome (SARS) pandemics [6,9]. Abrahamson et al. reported training 275 healthcare workers over a 2-week period in a SARS-specific cardiac arrest protocol [9]. In a short survey, the majority of responders found

the training to be comprehensive with effective teaching methods similar to our findings. Our results are also consistent with prior survey-based assessments of simulation-based training. In a study of 256 medical students undergoing simulation training in anesthesia and critical care, over 90% of participants found sessions to be useful [10].

Sixty-two percent of participants completed the survey and therefore an important number of participants' responses are unknown which may introduce a level of bias to the results. As we did not survey participants on comfort level with various ICU skills prior to the simulation, it is difficult to isolate the impact of training on comfort level. For instance, a percentage of responders may have had adequate comfort with certain aspects of critical care prior to simulation which was not altered by training. We solely addressed provider comfort post training rather than an objective measure of knowledge or skill. A written or skills test may have been a more instructive objective measure to determine the impact of the course. From this study alone, it is not possible to gauge how self-reported comfort translated into an improved skillset in the COVID-19 ICU. Additionally, even if a correlation between comfort and skillset can be ascertained, it is unclear how a Likert scale evaluating comfort reflects the degree of skillset improvement. Lastly, we did not compare different methods of uptraining such as simulation versus online modules and videos. Plausibly, alternative training modalities are similarly effective in improving provider comfort in critical care.

5. Conclusions

Simulation-based training improved provider comfort in the management of critically ill patients with COVID-19. The majority of responders felt more comfortable in each of the specific skills presented in simulation-based training. More objective measures of provider knowledge and skill pre and post simulation would be instructive in determining the impact of such an uptraining method.

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Declaration of Competing Interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jcrc.2020.09.035>.

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