Rapid Intensive Care Unit Onboarding in Response to a Pandemic

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ABSTRACT

BACKGROUND: In the wake of the coronavirus disease 2019 (COVID-19) pandemic, hospital resources have been stretched to their limits. We introduced an innovative course to rapidly on-board a group of non-intensive care unit (ICU) nurse practitioners as they begin to practice working in a critical care setting.

OBJECTIVE: To assess whether a brief educational course could improve non-ICU practitioners' knowledge and comfort in practicing in an intensive care setting.

METHODS: We implemented a multi-strategy blended 12-week curriculum composed of bedside teaching, asynchronous online learning and simulation. The course content was a product of data collected from a targeted needs assessment. The cognitive learning objectives were taught through the online modules. Four simulation sessions were used to teach procedural skills. Bedside teaching simultaneously occurred from critical care faculty during daily rounds. We assessed learning through a pre and post knowledge multiple choice question (MCQ) test. Faculty assessed learners by direct observation and review of clinical documentation. We evaluated learner reaction and comfort in critical practice by comparing pre and post surveys.

RESULTS: All 7 NPs were satisfied with the course and found the format to work well with their clinical schedules. The course also improved their self-reported comfort in managing critically ill patients in a medical ICU. There was an increase in the mean group score from the pre- to the post-course MCQ (60% vs 73%).

CONCLUSIONS: The COVID-19 Critical Care Course (CCCC) for NPs was implemented in our ICU to better prepare for an anticipated second surge. It focused on delivering practical knowledge and skills as learners cared for critically ill COVID-19 patients. In a short period of time, it engaged participants in active learning and allowed them to feel more confident in applying their education.

KEYWORDS: COVID-19, ICU, critical care, accelerated curriculum, blended learning, eLearning

Introduction

Six million patients are admitted to ICUs across the United States (US) annually.[1] While traditionally ICUs in the US have been staffed by intensivist physicians and physician trainees, the use of advanced practitioners in ICUs is established practice in many parts of the country.[2] The shift in staffing models comes as a consequence of nationwide intensivist physician shortages.[2] The coronavirus disease 2019 (COVID-19) pandemic has exacerbated this challenge and is projected to lead to critical shortages in trained staff during peak patient periods.[3] Augmenting critical care staffing will be necessary as the country braces for future surges. Though, the barriers brought by social distancing along with the pre-existing limitations of time and space in the healthcare setting makes onboarding of new medical staff a particular challenge.

The global pandemic disrupted medical education and very quickly in-person classes were restricted in an effort to minimize group gatherings.[4] The pandemic expedited the shift to virtual and blended learning strategies, which are both tools that have the potential to effectively teach new critical care professionals.[4,5] Blended learning combines online self-directed learning with face-to face teaching.[6-8] This maximizes in-person time and allows the learner an opportunity to apply what they learn independently.[7,8] The educational method has gained popularity in medical education and has been effective in improving knowledge and satisfaction outcomes.[7,8] In a metanalysis by Vallée et al[8] comparing blended learning to traditional learning (defined as all non-blended learning), blended learning was found to have a positive effect on learners' knowledge. Similar findings were found in an earlier review by Liu et al.[7]

We sought to assess whether a brief blended educational course would improve non-ICU nurse practitioners' (NP) knowledge and comfort in practicing in an intensive care setting. The purpose of the course was to teach NPs how to evaluate and

Table 1. Course modules and simulation sessions.

THE WEEK THE TOPIC WAS COVERED	ONLINE MODULE TITLE	THE WEEK THE TOPIC WAS COVERED	IN-PERSON SIMULATION SESSIONS
1-3	Time to vent	1	Mechanical ventilation
4-5	Circulatory shock	4	Surgical scrubbing
6	Sepsis	4	Central venous and dialysis catheter placement
7	Pain, Sedation, Agitation, Neuromuscular Blockade	5	Arterial puncture/arterial line placement
8	Delirium	10	Critical care ultrasound
9	Renal failure		
10	Critical care ultrasound		
11-12	Therapeutics in COVID-19		

formulate a thoughtful management plan for critically ill patients with COVID-19. We also strived to create an evidence-based critical care educational resource that augments NP's bedside training in the fundamentals of critical care medicine. The online component would lend itself to quick updates as new information about the disease emerged.

Methods

Pre-implementation

We obtained a targeted needs assessment by surveying our learner NPs and frontline critical care physicians. Learners participated in this program on a voluntary basis and were diverted from their usual work to participate in this training course and ICU clinical duties. They were asked about the extent of their critical care experience, given that some practiced as critical care registered nurses before becoming NPs. We gathered data about course content that they were already familiar with (e.g. palliative care and breaking bad news) and other topics they were less familiar with (e.g. critical care ultrasound). The needs assessment from critical care physicians was obtained by an open response survey and were based on common recurring themes. In addition, we conducted a knowledge multiple choice question (MCQ) test that highlighted areas of deficiency, which influenced the course content. Questions were adapted from *Self-Assessment in Adult Multi-Professional Critical Care* to make them relevant for core topics related to the critical care management of COVID-19 patients.[9] The curriculum proposal and its planned evaluation were submitted to the Institutional Review Board (IRB). This was determined to not constitute as "human subjects research" and thus IRB review was not needed.

Curriculum design and implementation

We designed a 12-week blended-learning curriculum targeted to non-critical care nurse practitioners. The course ran from

May 2020 to August 2020 both online and in the medical ICU conference rooms. The course consisted of 8 online modules and 4 procedural skills sessions (Table 1). The bulk of learning was self-directed in the form of reading and online learning. The course ran in tandem with NP's direct clinical work in the ICU. Their clinical responsibilities were reduced to allow time for the learners to complete their coursework. For example, each NP would be responsible for only 1 to 3 ICU patients as the course began and would later care for 4 to 5 patients as they became more skilled in managing these patients. We covered the various modules in 1 to 3-week blocks and each had separate learning objectives outlined in Appendix 1.

We used Blackboard CourseSites, a free learning management system (LMS), to deliver the online content. The content was curated by faculty with expertise in adult critical care medicine (FA, DC, BT, MT, VP) based on the feedback generated from the learner knowledge and survey assessment and faculty survey formed the content of the course. Required readings, optional readings, multimedia presentation(s), and a discussion or an activity were included on the online platform. Readings were integrated with the weekly topic and presentation. Weekly course discussion posts on the LMS integrated the learned concepts and showcased the learner's reflections on the relevant subject. They were expected to comment on each other's online posts as a way to collaboratively learn. They also had the opportunity to interact in-person when they were assigned to work together in the ICU. Nearly all the online content was asynchronous. To clarify concepts, we held several 30 minute synchronized sessions via Zoom.

Simulation was used to teach procedural skills. Learners were expected to review an assigned video that demonstrated the specific steps of a procedure. The skill topic was tied to the online module being covered. Critical Care fellows (NR, JC) led these simulation sessions and supervised the practice of these skills.

Critical care faculty simultaneously taught at the bedside during daily ICU rounds. The NPs were expected to present

Table 2. Student responses to comfort with managing critically ill patients, performing procedures and interpreting point of care ultrasound pre and post course.

STUDENT RESPONSE	HOW COMFORTABLE ARE YOU IN MANAGING CRITICALLY ILL PATIENTS? (N)		HOW COMFORTABLE ARE YOU IN PERFORMING CRITICAL CARE PROCEDURES? (N)		HOW COMFORTABLE ARE YOU IN THE INTERPRETATION OF CRITICAL CARE ULTRASOUND IMAGES? (N)	
	PRE	POST	PRE	POST	PRE	POST
Extremely comfortable	2	1	0	0	0	0
Somewhat comfortable	1	4	3	2	1	4
Neither comfortable nor uncomfortable	3	2	2	1	0	1
Somewhat uncomfortable	1	0	1	2	3	1
Extremely uncomfortable	0	0	1	2	3	1

their patients and put into practice what they learned in the online learning environment and from simulation. The NPs were assigned to care for COVID-19 patients in our specified ICU, though as the disease admissions declined, they were reassigned to critically ill patients not infected with the virus.

Post-implementation

To assess attainment of the cognitive learning objectives and the core concepts of the curriculum, NPs completed a 20-question post-course knowledge MCQ test. This test was similar in content to the knowledge test given to the learners before they started the course. To assess the skills and affective learning objectives, faculty directly observed the NPs and provided the course director with written or verbal feedback about the learners. Lastly, NPs gave feedback on both the curriculum as well as their medical ICU experience in an anonymous survey.

The pre and post course surveys included 3 or 5-point Likert scale responses (agree-disagree, satisfied-dissatisfied) as well as open-ended free responses. Due to the small class size, biographic data such as age and gender were not obtained to maintain anonymity.

Results

Six practicing hospital medicine nurse practitioners and one pulmonary medicine nurse practitioner (N = 7) voluntarily participated in this training course. The majority (N = 5) of the learners had at least 3 years' experience as nurse practitioners but only one had previously worked as a critical care NP. Just over half (N = 4) had previously worked as an ICU nurse. All participants completed the pre and post knowledge MCQ tests and pre and post surveys.

The mean student's knowledge post-course MCQ scores did increase after the completion of the course (60% vs 73%). Most improved their score but 2 showed no change. Learners highly rated their knowledge increase (Mean 4.16, SD 0.69, of a maximum 5). Additionally, their self-reported comfort in managing ICU patients increased after the course. Before the

course, only 3 NPs felt comfortable (somewhat comfortable or extremely comfortable in a 5 five point Likert scale) managing ICU patients and but that number increased to 5 after the course (Table 2). A similar increase in comfort level (Pre = 1/7 vs Post = 4/7) was observed with critical care ultrasound interpretation (Table 2). The opposite was observed with procedural comfort after the course (Pre = 3/7 vs Post = 2/7).

Reaction to the course was positive and all learners expressed satisfaction (either extremely satisfied or somewhat satisfied). All agreed that the technology was easy to use and most (N = 5) thought that the online format worked well. Additionally, both simulation and the bedside learning aspects were perceived as helpful by the majority (N = 6).

Learners expressed that they found the content of the online material to be convenient, enjoyable and effective. Some expressed that introducing the ultrasound content in the beginning of the course would have been more helpful as this would have allowed them time to practice the skill throughout. Students felt that they did not perform enough procedures or simulations during the course to make them feel proficient in them.

Discussion

We successfully implemented a 12-week course that blended online learning, simulation, and bedside teaching to deliver the course content of our unique COVID-19 critical care course. While nearly all NPs demonstrated an increase in knowledge, 2 scored highly and had no change in pre and post scores. This could be explained by their extensive prior experience working in the ICU. Ultrasound imaging interpretation comfort level increased across the board and that could be explained by the daily integration of point-of-care ultrasound in our institution and its routine practice with procedures. Interestingly, confidence with procedures did decrease after the course indicating that there may have been a gap in the perceived difficulty with actual practice. Additionally, the course overlapped with July 1st where new residents and fellows were new to the medical ICU and also needed to perform patient procedures. Limitation of in-person contact meant that simulation encounters had to

be limited in time and space. While we followed best-practices of COVID-19 infection control, this process was also time consuming and difficult to coordinate with the varied work schedules of the NPs.

Learner's reaction to the educational content was overwhelmingly positive. Several reasons may explain the positive reception of the online curriculum. First, learners were able to study at their own pace. For example, the lecture videos could be paused, repeated and forwarded as desired. Second, the LMS was very user friendly. Third, the asynchronous learning environment permitted peer-peer and peer-faculty interaction while juggling differing work schedules with the need for social distancing.

In addition to being free, Blackboard CourseSites was very user-friendly and made it easy to post as well as modify useful educational content. We ran into some issues with electronic file storage as some of the video files were too large. As a solution, we transferred some of the educational content to Google Drive and YouTube then linked the media to its corresponding location on CourseSites.

The challenges of fostering a motivational learning environment while adhering to the social distancing requirements meant that simulation sessions had to be very small (ie, 3-4 learners per instructor). We maximized the learners' experience by having them complete pre-session activities as part of their e-simulation practice. For example, they would have to review a video on the placement of a central venous catheter prior to attending the corresponding simulation lesson. This maximized time together and permitted a shorter synchronized simulation session. If we were to run this course again, we would likely eliminate procedural teaching and instead focus on critical care ultrasound since the learners would unlikely complete enough invasive procedures to gain mastery.

Our Project had some limitations. First, the evaluation of this curriculum was limited to a pre and post knowledge test and survey. Second, a more rigorous evaluation that includes reassessment of knowledge retention at a later interval would have provided more specific information on knowledge recall. Third, assessing a larger group of learners would have increased the power of our measurable results by permitting sound statistical analysis. Attributable educational efficacy is difficult to study because while we assume that all NPs completed the online curriculum and learned from it we cannot control for what is learned independently. We also acknowledge that since this was a once-off course the learners would be susceptible to knowledge decay over time and a repeat assessment of their knowledge and skills would be necessary to determine competency particularly if there are gaps in critical care practice. Though, some of our NPs chose to continue practicing their skills and remained in the ICU even after the course was completed which helped the critical care team as the number of patients increased in the ICU.

In summary, the COVID-19 Critical Care Course for NPs was implemented in our ICU to better prepare for a second pandemic surge. It engaged participants in active learning and allowed them to feel more confident in applying their education. Beyond the pandemic, the number of Americans aged 65 or older is projected to double by the year 2060.[10] With that, the number of patients with complex medical conditions requiring critical care will also likely increase. Thus, it is imperative that we start now by training the healthcare work force for today and tomorrow's needs. This innovative approach to teaching lays the groundwork for augmenting training healthcare workers in the intensive care setting.

Author Contributions

FA is the principal designer of the curriculum. He created, designed and implemented the course and its content with consultation with the listed co-authors. DC, NR, JC, BT, VP co-authored, designed and taught both some online and bedside educational content. They were also responsible for interpreting and analyzing the course evaluation and co-authoring this report. MT was responsible for critically revising the manuscript for important intellectual content. All authors and approved the final version of the manuscript and are responsible for the accuracy and integrity of the work.

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Appendix 1

The goals of the course are outlined below

Goals
1. To teach NPs how to evaluate and formulate a thoughtful management plan for critically ill patients with COVID-19.
2. To create an evidence-based critical care educational resource that augments NP's bedside training in the fundamentals of critical care medicine.
3. To prepare competent compassionate health professionals who will be equipped to care for the critically ill and their families.

Learning objectives per module

Module 1: Time to vent module (3 weeks)

Learning objectives
1. Accurately define the key terminology concerning mechanical ventilation as outlined by the learning activity and handout review.
2. List the similarities and differences among the most commonly used modes of mechanical ventilation.
3. Methodically interpret arterial blood gases and propose the necessary changes on a ventilator needed to treat the patient's underlying pathologic process.
4. Describe what initiates the breath (trigger) and what terminates the breath (cycling) in mechanical ventilation.
5. Demonstrate a safety focused attitude by utilizing a low tidal volume lung protective strategy on patients with acute respiratory distress syndrome (ARDS) or those at risk of ARDS.

Module 2: Circulatory shock (2 weeks)

Learning objectives
1. Accurately define circulatory shock.
2. Outline an approach to classify the categories of shock.
3. Describe the main components of hemodynamic monitoring.
4. Apply hemodynamics to determine the etiology of shock.
5. Describe the various methods of assessing fluid responsiveness in a critically ill patient.
6. Discuss the core strategies in managing critically ill patients with shock.
7. List the main effects and adverse effects of vasoactive agents.
8. Safely place a central line under supervision.
9. Safely place an arterial line under supervision.
10. Recall the steps involved in scrubbing and gowning for sterile procedures.
11. Safely perform an arterial puncture under supervision.

Module 3: Sepsis in the ICU (1 week)

Learning objectives
1. Accurately define septic shock.
2. Outline an evidence-based approach to evaluate patients with suspected septic shock.
3. Describe the assessment of organ dysfunction by using the SOFA score.
4. Describe the first and second line vasopressors used in the management of patients with septic shock.
5. List the components of the sepsis care bundles as outlined by the surviving sepsis guidelines of 2018.
6. Summarize the role of lactic acid in predicting mortality in the setting of sepsis and septic shock.
7. Illustrate the ways in which volume status and tissue perfusion can be assessed in septic shock.

Module 4: Analgesia, sedation and neuromuscular blockade (1 week)

Learning objectives
1. Develop an analgesic strategy to treat patients in the critical care setting.
2. Evaluate both verbal and non-verbal ICU patients for pain using the Critical Care Pain Observation Tool (CPOT).
3. Evaluate both verbal and non-verbal ICU patients for agitation-sedation using the Richmond Agitation-Sedation Scale (RASS).
4. Summarize an ideal sedation strategy for critically ill patients based on the recommendations from the 2018 PADIS guidelines.
5. Describe the role of neuromuscular blockade in the ICU.
6. List the main short and long term adverse effects of commonly used analgesics, sedatives and neuromuscular blocking agents.

Module 5: Delirium in the ICU (1 week)

Learning objectives
1. Accurately define Delirium.
2. List the risk factors for the development of ICU delirium.
3. Apply the Confusion Assessment Method for Intensive Care Units (CAM- ICU) in identifying patients with delirium.
4. Devise a differential diagnosis for possible underlying etiologies of delirium in the critically ill patient.
5. Describe both non-pharmacologic and pharmacologic strategies used in managing patients with delirium.

6. Summarize the components of the ABCDEF (A to F) Bundle including its role in improving patient outcomes.

Module 6: Acute renal failure in the ICU (1 week)

Learning objectives
1. Accurately define Acute Kidney Injury.
2. Describe the proposed pathophysiology of acute kidney Injury in COVID-19.
3. List the commonest causes of Acute Kidney Injury in the ICU.
4. Summarize the role of renal replacement therapy (IHD, PIRRT and CVVH) in the treatment of renal failure in the critical care setting.
5. Identify patient who are at risk of renal failure.
6. Select strategies to prevent or mitigate the risk of acute renal failure.
7. Describe the postulated pathophysiology of AKI in the COVID-19 patient.

Module 7: Critical care ultrasonography (1 week)

Learning objectives
1. Accurately compare the main indications and proper patient positioning when using the various ultrasound probes (linear, curvilinear, phased-array) in the critical care setting.
2. Differentiate between A-line, B-line artifacts and rib shadow.
3. Identify the sonographic signs associated with pneumothorax, pleural effusion, pulmonary edema, and consolidation.
4. Identify some sonographic features that are characteristic of transudative and exudative pleural effusions.
5. Rapidly acquire ultrasound images of the heart, lungs and abdomen and distinguish between pathologic and normal studies.

6. Demonstrate the ability to survey the anatomy as it pertains to the 2 most commonly performed ultrasound guided invasive procedures in the ICU (central line placement, arterial line placement).
7. Identify at least one-way that ultrasound makes the above procedures safer.
8. Appropriately identify patients in whom ultrasound will assist in diagnosis and clinical problem solving.
9. Interpret key findings and clinically relevant images in:

   - The Thorax
   - A Focused cardiac Exam
   - Inferior Vena Cava (volume assessment)
   - The assessment of peritoneal fluid (ascites)

Module 8: Therapeutics in COVID-19 + Presentations (2 weeks)

Learning objectives
1. Describe how the 6 therapeutic agents' mechanism of action.
2. Summarize the evidence on the efficacy of the below therapeutic agents specifically in COVID-19.
3. State who would benefit the most form each of the therapeutic agents below.
4. Outline any adverse risks associated with each of the therapeutic modalities listed below.

Therapeutic agents:

- Systemic Corticosteroids (Focus on Dexamethasone)
- Antivirals (Focus on Remdesivir)
- Convalescent Plasma
- Anti-IL6 agents (Focus on Toclizumab)
- Pulmonary Vasodilators
- Extracorporeal membrane oxygenation