6-5-2023

Implementation of a Virtual Interprofessional ICU Learning Collaborative: Successes, Challenges, and Initial Reactions From the Structured Team- Based Optimal Patient-Centered Care for Virus COVID-19 Collaborators

Simon Zec

Nika Zorko Garbajs

Yue Dong

Ognjen Gajic

Christina Kordik

See next page for additional authors

Authors

Simon Zec, Nika Zorko Garbajs, Yue Dong, Ognjen Gajic, Christina Kordik, Lori Harmon, Marija Bogojevic, Romil Singh, Yuqiang Sun, Vikas Bansal, Linh Vu, Kelly Cawcutt, John M. Litell, Sarah Redmond, Elly Fitzpatrick, Kirstin J. Kooda, Michelle Biehl, Neha S. Dangayach, Viren Kaul, June M. Chae, Aaron Leppin, Mathew Siuba, Rahul Kashyap, Allan J. Walkey, and Alexander S. Niven

OPEN

Implementation of a Virtual Interprofessional ICU Learning Collaborative: Successes, Challenges, and Initial Reactions From the Structured Team-Based Optimal Patient-Centered Care for Virus COVID-19 Collaborators

IMPORTANCE: Initial Society of Critical Care Medicine Discovery Viral Infection and Respiratory illness Universal Study (VIRUS) Registry analysis suggested that improvements in critical care processes offered the greatest modifiable opportunity to improve critically ill COVID-19 patient outcomes.

OBJECTIVES: The Structured Team-based Optimal Patient-Centered Care for Virus COVID-19 ICU Collaborative was created to identify and speed implementation of best evidence based COVID-19 practices.

DESIGN, SETTING, AND PARTICIPANTS: This 6-month project included volunteer interprofessional teams from VIRUS Registry sites, who received online training on the Checklist for Early Recognition and Treatment of Acute Illness and iNjury approach, a structured and systematic method for delivering evidence based critical care. Collaborators participated in weekly 1-hour videoconference sessions on high impact topics, monthly quality improvement (QI) coaching sessions, and received extensive additional resources for asynchronous learning.

MAIN OUTCOMES AND MEASURES: Outcomes included learner engagement, satisfaction, and number of QI projects initiated by participating teams.

RESULTS: Eleven of 13 initial sites participated in the Collaborative from March 2, 2021, to September 29, 2021. A total of 67 learners participated in the Collaborative, including 23 nurses, 22 physicians, 10 pharmacists, nine respiratory therapists, and three nonclinicians. Site attendance among the 11 sites in the 25 videoconference sessions ranged between 82% and 100%, with three sites providing at least one team member for 100% of sessions. The majority reported that topics matched their scope of practice (69%) and would highly recommend the program to colleagues (77%). A total of nine QI projects were initiated across three clinical domains and focused on improving adherence to established critical care practice bundles, reducing nosocomial complications, and strengthening patient- and family-centered care in the ICU. Major factors impacting successful Collaborative engagement included an engaged interprofessional team; an established culture of engagement; opportunities to benchmark performance and accelerate institutional innovation, networking, and acclaim; and ready access to data that could be leveraged for QI purposes.

CONCLUSIONS AND RELEVANCE: Use of a virtual platform to establish a learning collaborative to accelerate the identification, dissemination, and implementation of critical care best practices for COVID-19 is feasible. Our experience offers important lessons for future collaborative efforts focused on improving ICU processes of care.

KEY WORDS: COVID-19; critical care; learning collaborative; quality improvement; severe acute respiratory syndrome coronavirus 2

Simon Zec, MD[1,2]
Nika Zorko Garbajs, MD[1,3]
Yue Dong, MD[4]
Ognjen Gajic, MD[1]
Christina Kordik, MA[5]
Lori Harmon, RRT, MBA, CPHQ[5]
Marija Bogojevic, MD[1,6]
Romil Singh, MD[1,7]
Yuqiang Sun, MD[1]
Vikas Bansal, MD[1]
Linh Vu, MD[1]
Kelly Cawcutt, MD[8]
John M. Litell, DO[9,10]
Sarah Redmond, PhD[11]
Eleanor Fitzpatrick, RN[12]
Kirstin J. Kooda, PharmD[13]
Michelle Biehl, MD[14]
Neha S. Dangayach, MD[15]
Viren Kaul, MD[16]
June M. Chae, MD[1,17]
Aaron Leppin, MD[11]
Mathew Siuba, MD[14]
Rahul Kashyap, MBBS[4]
Allan J. Walkey, MD[18]
Alexander S. Niven, MD[1]
on behalf of the Structured Team-based Optimal Patient-Centered Care for Virus COVID-19 (STOP-VIRUS) Collaborative

DOI: 10.1097/CCE.0000000000000922

KEY POINTS

Question: Can an interprofessional virtual learning collaborative successfully facilitate dissemination and implementation of best clinical practices in the ongoing fight against COVID-19?

Findings: The Structured Team-based Optimal Patient-Centered Care for Virus COVID-19 Collaborative used a structured and systematic method to summarize and implement the best available evidence for the care of critically ill patients with COVID-19 using weekly 1-hour videoconference sessions on high-impact topics, monthly quality improvement coaching sessions, and extensive additional asynchronous learning resources. The majority of interprofessional learners reported that topics matched their scope of practice and would highly recommend the program to colleagues.

Meaning: Use of a virtual learning collaborative to accelerate the identification, dissemination, and implementation of critical care best practices for COVID-19 is feasible. Our experience offers important lessons for future learning collaboratives targeting process of care improvements.

The severe acute respiratory syndrome coronavirus 2 (COVID-19) pandemic has had a major impact on global healthcare delivery and medical education. Large medical societies such as the Society of Critical Care Medicine (SCCM) and Discovery, SCCM's Critical Care Research Network, have played a pivotal role to curate and disseminate a vast body of new and rapidly evolving knowledge on COVID-19 to support frontline clinicians during this period (1–3). Preliminary analysis of the SCCM Viral Infection and Respiratory illness Universal Study (VIRUS) COVID-19 Registry demonstrated significant variations in mortality in participating institutions that persisted despite adjustments for patient acuity and comorbid conditions (4, 5). These findings, confirmed by other observations, suggested that strengthening ICU processes of care may be the best modifiable target to improve patient outcomes (6).

SCCM consensus statements have previously identified the importance of effective ICU organizational structure, unified processes of care, and continuous quality improvement (QI) to maximize safety and outcomes in the critically ill (7). The pandemic placed significant strain on these systems, and created an urgent need for rapid, virtual solutions to strengthen COVID-19 care processes using best available evidence (8–10). The global shift toward online education during this unprecedented time has concentrated on existing curricula, conferences, and programs. The formation of a longitudinal virtual ICU learning collaborative to speed identification and implementation of rapidly evolving best evidence based COVID-19 practices has not been described (11, 12).

Leveraging our previous experience using the Checklist for Early Recognition and Treatment of Acute Illness and iNjury (CERTAIN) program, we designed, developed, and implemented the Structured Team-based Optimal Patient-Centered Care for Virus COVID-19 (STOP-VIRUS) ICU Learning Collaborative (13). The aim of this collaborative was to drive implementation of best evidence-based care processes through education and QI in the ongoing fight against COVID-19.

MATERIALS AND METHODS

STOP-VIRUS Collaborative Support and Site Recruitment

The STOP-VIRUS Collaborative was funded in part by a cooperative agreement with the Centers for Disease Control and Prevention (grant number 1 NU50CK000566-01-00) with administrative support provided by SCCM (C.K., L.H.). Participating SCCM Discovery VIRUS COVID-19 Registry U.S. sites serving adult or pediatric critically ill patients with at least 3 months of completed data collection were recruited to participate (14). Each eligible site was required to identify an interprofessional team consisting of at least one nurse, pharmacist, respiratory therapist, and physician to participate and serve as site champions for dissemination and implementation of information and practices gained from the Collaborative (**Fig. 1**). Volunteer sites committed to continue VIRUS Registry data collection for an additional 3–6 months after Collaborative completion, with sponsorship and permissions from their senior hospital leadership. Each site also received a nominal financial incentive for its participation.

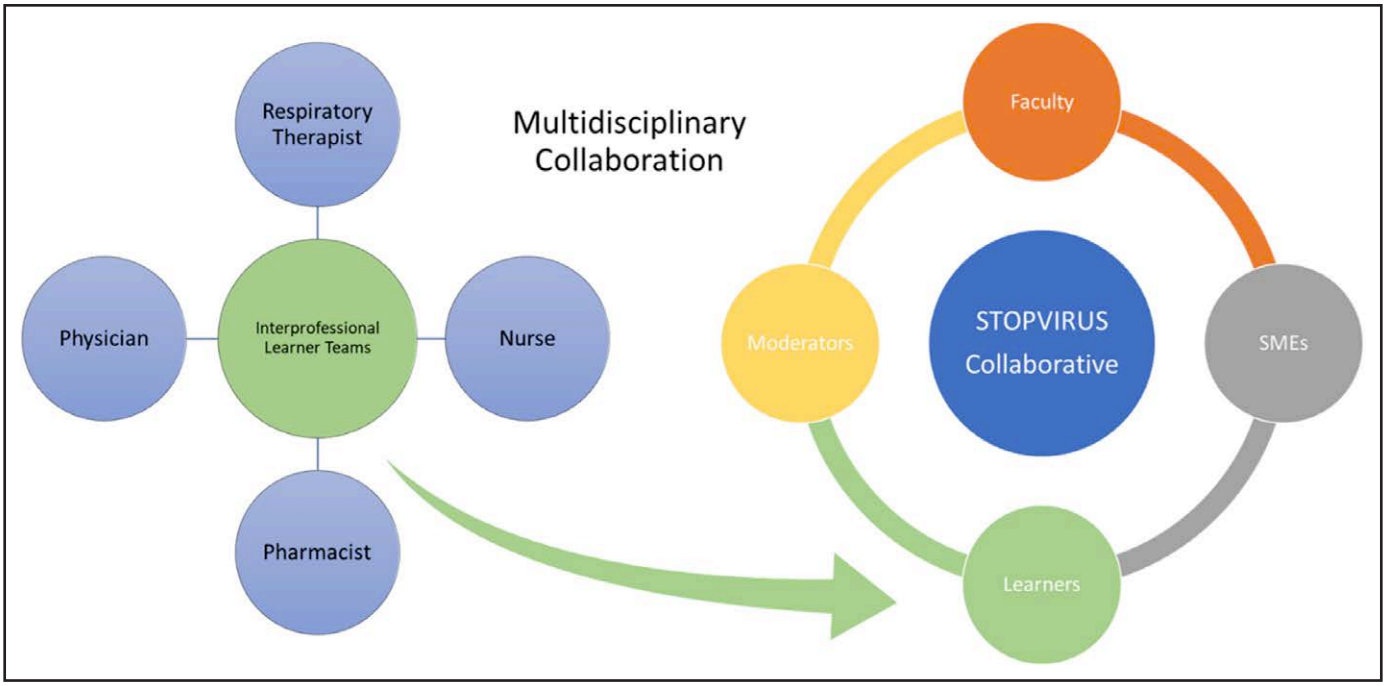

Figure 1. Each participating site who joined the Collaborative was required to identify an interprofessional team consisting of at least one nurse, pharmacist, respiratory therapist, and physician. Some sites had more than one individual in the disciplines represented. Additional nonclinical learners included research fellows and administrators. During each of the weekly Zoom sessions, a collaborative approach to learning was encouraged and facilitated through small group discussions in "breakout rooms." SME = subject matter expert, STOP-VIRUS = Structured Team-based Optimal Patient-Centered Care for Virus COVID-19.

CERTAIN Platform

All participating individuals were asked to complete 5 hours of online education on the core elements of the CERTAIN approach (**Supplemental Table 1**, http://links.lww.com/CCX/B197) (15). CERTAIN is an novel global ICU education and QI program which offers a systematic, evidence based approach to the care of the critically ill using checklists, clinical decision support tools, and an emphasis on patient- and family-centered, humanistic care (16, 17). The CERTAIN approach has been shown to increase consistent use of evidence based ICU care processes and improve patient outcomes and costs of care in a large, multicenter international QI trial performed largely in low- to middle-income countries (13). Core CERTAIN faculty had gained extensive experience in virtual delivery of CERTAIN longitudinal education programs prior to and during the pandemic (15). This CERTAIN program framework was rapidly adapted to serve as the foundation for the STOP-VIRUS Collaborative, including asynchronous, synchronous, and just-in-time learning opportunities using a blended portfolio of learner-centered educational strategies and expert QI coaching during real-time video communication sessions (18). Similar international efforts both prior to and during the pandemic have resulted in high user satisfaction and improved patient outcomes (19, 20).

STOP-VIRUS Curriculum

The STOP-VIRUS Collaborative included a core steering group that included CERTAIN course directors, implementation scientists, research fellows, and quality managers from Mayo Clinic, Boston University, and the SCCM who met weekly to coordinate curriculum planning efforts.

We used the Analysis, Design, Development, Implementation, and Evaluation multistage instructional design framework to design and implement a customized program with the goal of improving outcomes in the critically ill with COVID-19 (21, 22).

To inform the content of the program, the core steering group formulated a questionnaire consisting of high impact COVID-19 topics and asked participating sites to rank these topics in order of interest and perceived importance and to provide additional areas of focus as needed. This needs assessment guided the creation of a curriculum with 6-, 4-week learning

blocks (**Supplemental Table 2**, http://links.lww.com/CCX/B197). All synchronous video-based learning and collaborative discussion was facilitated through Zoom (Zoom, San Jose, CA). Each block was structured to begin with a state-of-the-art update, followed by two case-based discussions and a QI learning community session in subsequent weeks (**Supplemental Fig. 1**, http://links.lww.com/CCX/B197).

Invited subject matter experts (SMEs) were identified using SCCM committees and professional networks to deliver each state-of-the-art update, which included a best practices summary followed by moderated discussion to facilitate synthesis and informal peer review. Case presentations were delivered by each participating interprofessional team using the CERTAIN approach, which provided the clinical context for small and large group discussions on the validity, generalizability and application of available evidence and expert opinion into practice. Content experts provided an introduction to Define, Measure, Analyze, Improve, and Control methodology during initial QI learning community sessions, followed by monthly coaching to support individual site QI projects. Moderators chosen for their communication skills, bedside knowledge, and social media engagement facilitated our weekly videoconference discussions and chat box conversations. They also encouraged ongoing discussion between sessions via social media (Twitter, San Francisco, CA) and a dedicated STOP-VIRUS Collaborative Blackboard (Reston, VA) site. This Blackboard site provided ongoing, asynchronous access to CERTAIN online educational materials, recorded STOP-VIRUS videoconferences, a library for key references, COVID-19 checklists, and bedside decision support tools (17). Because of the clear growing importance of this information as pandemic strain increased during 2021, these materials were later publicly posted on a dedicated SCCM website (23).

Quality Improvement Interventions

Each participating site identified areas for improvement using their VIRUS Registry outcomes dashboard, benchmarked to performance across the Collaborative and supplemented by local data and discussion. Sites with similar areas of interest were separated into three groups to facilitate collaboration and peer coaching by core STOP-VIRUS faculty. In addition to their monthly learning community sessions, each interprofessional team received an online collection of QI resources that included flowcharts, common tools (i.e., fishbone diagram, effort-impact grid, Pareto chart), and presentation templates to facilitate communication with local leadership, stakeholders, and subsequent dissemination. Research fellows provided logistical support and data collection and analysis when possible. Due to significant ongoing pandemic clinical demands, Collaborative QI activities were extended for an additional 5 months with monthly voluntary videoconferences to facilitate completion of a Plan-Do-Study-Act (PDSA) cycle for each project (24). An overview and timeline of the entire project is shown in **Figure 2**.

Implementation, Outcome Evaluation, Data Collection, and Analytics

Results are reported using the Standards for Quality Improvement Reporting Excellence reporting guidelines. Our data collection consisted of post-session online surveys using Google Docs, Google (Mountain View, CA) and engagement based on Zoom, Blackboard, and Twitter analytics, and the number of site QI projects and PDSA cycles initiated or completed. We also met with each participating team midway through the 6-month Collaborative, and incorporated their feedback in subsequent planning efforts. Data collection and analytics are described within the **Supplemental Methods** (http://links.lww.com/CCX/B197). Descriptive statistics were used throughout.

Ethical Considerations

This study was approved by the Mayo Clinic (Institutional Review Board [IRB] numbers 20-007896, 20-002610) and Boston University (IRB number 21-002168) IRBs. All patient data were de-identified, and individual site outcomes remained confidential unless disclosed by team members. Access to Zoom meetings and Blackboard was limited to registered participants only. Cloud-based data and surveys were stored on a password protected site.

RESULTS

Participants

The STOP-VIRUS Collaborative ran from March 2, 2021, to September 29, 2021, and members continued to meet monthly on a volunteer basis during the 5-month extended QI phase. A total of 13 sites were initially enrolled and assigned Blackboard access to review the

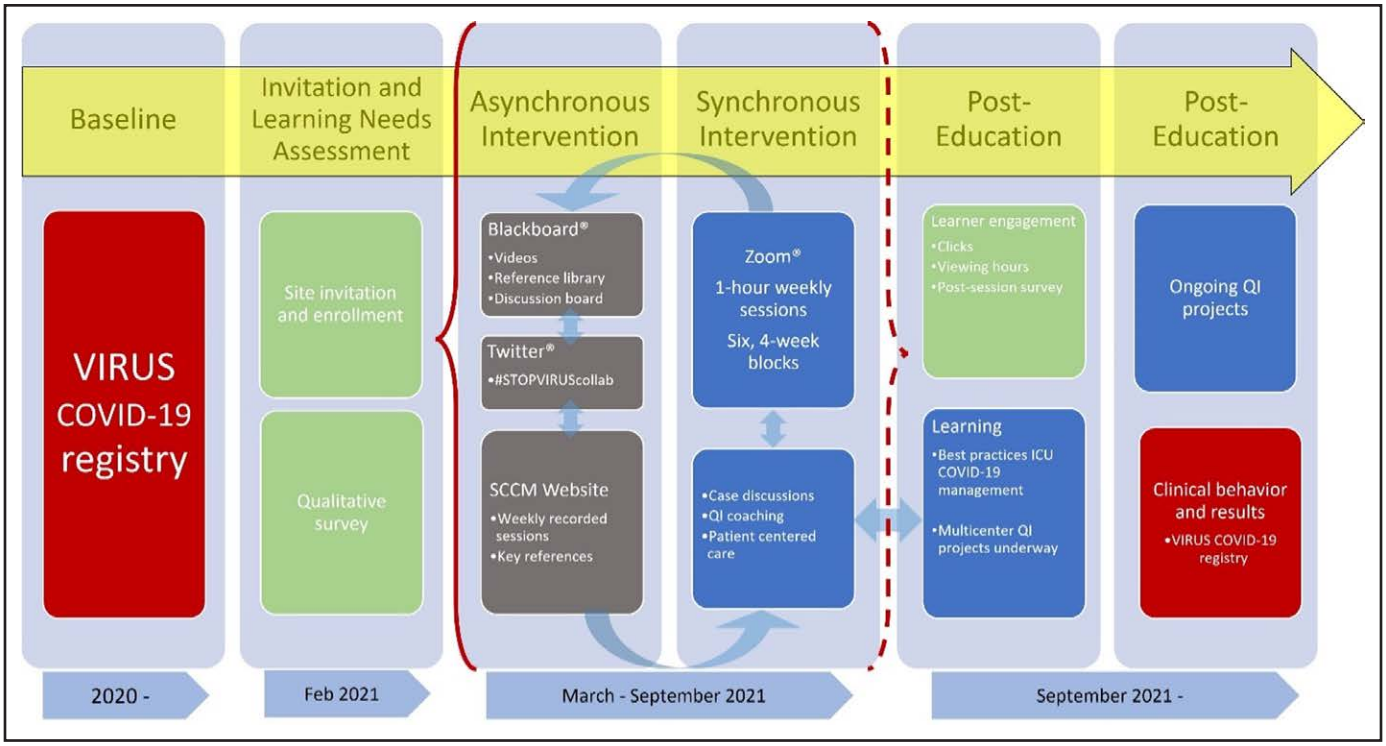

Figure 2. Design and implementation of the Structured Team-based Optimal Patient-Centered Care for Virus COVID-19 (STOP-VIRUS) curriculum was based on the Checklist for Early Recognition and Treatment of Acute Illness and iNjury program. Following site enrollment and learning needs assessment, longitudinal asynchronous and synchronous collaborative learning identified and disseminated COVID-19 management best practices and facilitated multicenter ongoing quality improvement (QI) projects. We used engagement, participant reactions and completed quality improvement Plan-Do-Study-Act cycles to measure the outcomes of this intervention. SCCM = Society of Critical Care Medicine, VIRUS = Viral Infection and Respiratory illness Universal Study.

asynchronous CERTAIN curriculum. Two sites withdrew from the Collaborative; at one site, the lead physician left the institution and the remaining team members withdrew, and at a second site, the physician champion was unable to recruit other required interprofessional members to participate. The remaining 11 learner sites were in Arizona, Florida, Minnesota, Maryland, Massachusetts, New Hampshire, Texas, and Wisconsin. Sites ranged from community-based hospitals with 137 hospital beds (six ICU beds) to large referral centers with 2,059 beds (200 ICU beds). Five of 11 participating sites were tertiary academic centers (46%). Collaborative demographics are shown in **Table 1**. Nurses and physicians made up the majority of the 67 interprofessional learners with a slight female predominance. Nine moderators and 14 core faculty planned and delivered the content with the support of 27 invited SMEs.

Engagement

Multilevel attendance and engagement is shown in **Table 2**. Site attendance across the 25 Zoom sessions ranged between 82% and 100%, with three sites providing at least one team member for all and three additional sites for 96% of videoconferences. The overall mean attendance at each videoconference was 23 individuals (34%), with pharmacists maintaining the most consistent mean session attendance. Thirteen collaborators (eight learners, four faculty, one moderator) posted 53 times on the Blackboard discussion board, mainly regarding curriculum information and session logistics. Asynchronous viewing of recorded sessions was limited. Twenty-four of the 67 learners (35%) viewed the optional CERTAIN online curriculum asynchronously for a total of 35 hours (range, 0.0–5.8 hr; mean, 1.5 hr; overall completion rate of 45%). The most viewed core module was the "Structured Approach to Critical Illness" (18 learners engaging in 25 individual viewing sessions, mean watch time 11 min, completion rate 58%). The Twitter hashtag #STOPVIRUScollab was launched on March 24, 2021, and was included in 421 tweets/retweets posted at an average rate of two tweets per day up to September 2021.

TABLE 1.
Demographics of the Structured Team-based Optimal Patient-Centered Care for Virus COVID-19 Collaborative

Participants	*n* (%)
Learner sites	
Academic/tertiary center	5 (46)
Community hospital	6 (54)
Total	11 (100)
Learners	
Gender, female	45 (67)
Nurses	23 (34)
Physicians	22 (33)
Respiratory therapists	9 (13)
Pharmacists	10 (15)
Other[a]	3 (5)
Total	67 (100)
Faculty	
Moderators	
Physicians	6 (67)
Pharmacists	1 (11)
Scientists	1 (11)
Nurses	1 (11)
Total	9 (100)
Subject matter experts	
Physicians	19 (70)
Nurses	4 (15)
Pharmacists	2 (7)
Respiratory therapists	1 (4)
Bioethicist	1 (4)
Total	27 (100)
Core faculty	
Physicians	5 (38)
Research scientists/fellows	6 (54)
Managers	1 (8)
Total	13 (100)

[a]Research fellow, administrator.

Between July 2021 and November 2021, the SCCM STOP-VIRUS resource website received 3,647 visits (**Supplemental Table 3**, http://links.lww.com/CCX/B197). The learning module "Treatment of Moderate and Severe COVID-19 Pneumonia" had the highest number of individual hits (1,337, 37% of total visits), with the majority of these visits in August 2021 and September 2021 (541, 38% and 351, 58%, respectively).

Satisfaction

Although the post-session survey response rate was only 17%, both formal and informal learner responses were overwhelmingly positive (**Table 3**). Ninety-six responses were captured from the 67 learners during the active collaboration, and informal feedback was frequent both during and between sessions as the Collaborative matured. Participants reported a high level of satisfaction, felt that topics were well matched with their clinical practice challenges, and the majority (77%) indicated they would recommend sessions to a colleague. Of the 41 survey comments collected, 42% focused on longer "breakout rooms" or longer sessions overall and 29% praised the "breakout room" collaborative learning environment. All survey feedback is displayed in **Supplemental Table 4** (http://links.lww.com/CCX/B197).

Quality Improvement Projects

Eight of the 11 collaborative sites were involved in nine ongoing QI projects across three clinical domains (**Table 4**). Four sites completed one and two sites completed two PDSA cycles.

The first QI group, included a tertiary care center and a community hospital, focused on improving ventilator-associated pneumonia bundle compliance by increasing oral hygiene rates in mechanically ventilated patients and improving the consistent use of spontaneous awakening and breathing trials (27).

The second group, which included a pediatric tertiary care center and two adult community-based hospitals, focused on patient/family interactions and goals of care across four projects. Three projects focused on increasing palliative care consultations in eligible patients. The fourth project was focused on increasing the percentage of patients with a power of attorney at admission, which addressed a unique state requirement that limits surrogate decision-making without this documentation.

The third group, included a large academic center and two community-based hospitals, that focused on reducing nosocomial complications by improving lung

TABLE 2.
Learner Attendance and Multilevel Engagement

Site Attendance			
At Least One Team Member Present at Each Session (*n* = 25)		**Sites**	
100% (25/25)		3	
96% (24/25)		3	
92% (23/25)		1	
88% (22/25)		1	
84% (21/25)		1	
72% (18/25)		1	
48% (12/25)		1	
Sessions With Representation From Each Site (*n* = 25)		Sessions, *n* (%)	
100% (11/11)		5 (20)	
90% (10/11)		12 (48)	
82% (9/11)		8 (32)	
Individual Learner Attendance (Zoom)		Total Hours; Mean Attendance, *n* (%)	
Overall (*n* = 67)		1,742; 23 (34)	
Nurses (*n* = 23)		598; 6 (28)	
Physicians (*n* = 22)		546; 8 (36)	
Respiratory therapists (*n* = 9)		234; 3 (33)	
Pharmacists (*n* = 10)		234; 5 (50)	
Other[a] (*n* = 3)		78; 2 (66)	
Asychronous Learner Engagement (Blackboard)	Total Hours Viewed	Hours Viewed, Range (Mean)	Mean Completion Rate (%)
Overall video engagement (*n* = 24/67)	35.33	5.81–0.00–5.8 (1.547)	45
CERTAIN Online Module (Duration Minutes)	Users/Views	Mean Watch Time, min (%)	Mean Completion Rate (%)
A1. Structured approach to critical illness (2019:43)	18/25	11:22 (58.0)	58
A3. CERTAIN rounding demonstration (143:50)	8/14	12:02 (89.0)	85
A2. CERTAIN admission demonstration (7:14)	8/14	4:34 (60.1)	63
B1. Patient family engagement (232:48)	4/8	18:36 (821.7)	40
Asynchronous Engagement (Twitter)	Total Tweets/ Retweets[b]	Mean Tweets per Day	Growth Trend (%)
#STOPVIRUScollab	421	2	–532.5

CERTAIN = Checklist for Early Recognition and Treatment of Acute Illness and iNjury, STOP-VIRUS = Structured Team-based Optimal Patient-Centered Care for Virus COVID-19.

[a]Research fellows, administrators.

[b]April 2021 to September 2021.

protective ventilation adherence in acute respiratory distress syndrome, improving the frequency of spontaneous awakening trials, and examining the use of a novel pillow to improve oral care in prone mechanically ventilated patients.

DISCUSSION

We describe the development and rapid implementation of a virtual interprofessional learning community with the goal of synthesizing, disseminating, and

TABLE 3.
Learner Satisfaction and Post-Session Survey Comments

Overall					
	Responses[a], *n* (%)				
Questions	Excellent	Very Good	Good	Fair	Poor
Question 1: How would you rate today's session overall? (*n* = 96)	55 (57)	37 (39)	4 (4)	0 (0.0)	0 (0.0)
Question 2: How would you rate this topic that matched the current scope of practice? (*n*= 96)	66 (69)	24 (25)	6 (6)	0 (0.0)	0 (0.0)
Question 3: How likely are you to recommend today's session to a colleague? (*n* = 96)	Extremely likely (5)	Very likely (4)	Neutral (3)	Very unlikely (2)	Not at all (1)
	74 (77)	14 (15)	8 (8)	0 (0.0)	0 (0.0)
Comments (*n* = 41)[b]			*n* (%)		
More time for the entire session			8 (18)		
Longer time in "breakout rooms"			11 (24)		
Enjoyed "breakout rooms"			13 (29)		

[a]Response rate 17%.

[b]All comments (*n* = 41) shown in Supplemental Table 4 (http://links.lww.com/CCX/B197).

rapidly implementing best evidence based COVID-19 processes of care. There is broad based precedent for medical society led, international campaigns such as Surviving Sepsis and ICU Liberation that have leveraged interprofessional collaboration and QI efforts to implement practice recommendations (1, 7, 28). However, there are number of unique aspects to the STOP-VIRUS Collaborative that are worth noting.

The challenges that the STOP-VIRUS Collaborative faced during its rapid launch were considerable. The group had to distill and deliver best COVID-19 practices from a vast volume of information to interprofessional teams from across the United States in a way that was both engaging and easy to implement using only a virtual platform—during a time when these teams were already heavily taxed and in many settings struggling with significant burnout (10, 29–32). Drawing from our prior CERTAIN program experiences, we leveraged well accepted instructional design and QI processes to serve as a framework to develop a novel community of practice—mutual engagement by over 100 total collaborators from multiple institutions from across the United States who used their shared experience and a broad range of resources to obtain a shared goal (33). The Collaborative maintained consistent weekly engagement with its videoconferences for 6 months with high levels of learner satisfaction. Utilization rates for asynchronous content and digital discussion platforms were lower, and informal feedback highlighted challenges accessing Blackboard and lack of familiarity with its user interface as primary barriers. The volume of STOP-VIRUS Collaborative website visits nonetheless suggests that the content delivery was successful and readily generalized to a broader audience. Six of participating sites (54.5%) successfully completed at least one PDSA cycle of an ongoing QI projects and shared their process and results across the Collaborative.

Our experience with the STOP-VIRUS Collaborative offers important lessons for the implementation of future endeavors. Institutions who consistently participated in Collaborative discussions and successfully completed at least one PDSA cycle of their QI projects provided an engaged interprofessional team of key stakeholders led by a local champion. Many teams identified their participation in the SCCM Discovery VIRUS Registry as the inciting factor to join the STOP-VIRUS Collaborative, highlighting the perceived value of sharing outcomes and experiences with other centers to benchmark performance, review clinical practices, and accelerate QI and innovation. The SCCM infrastructure also proved essential to foster mutual

TABLE 4.
Learning Community Quality Improvement Projects (*n* = 9)

Groups	Clinical Domain	Projects	Topic	Plan-Do-Study-Act Cycles Completed
Group 1	Management of respiratory failure	1	Increasing frequency of SAT/SBT in intubated patients	1
		2	Improve oral hygiene compliance for VAP bundle	1
Group 2	Patient, family interactions/ goals of care	3	Increasing palliative care consultation in high-risk adult patients	2[a]
		4	Increasing palliative care consultation in high-risk pediatric patients	2[a]
		5[b]	Improving percentage of patients who have power of attorney	1
		6[b]	Increasing palliative care consultation in high-risk adult patients	0
Group 3	Management of respiratory failure and reducing nosocomial complications	7	Improve adherence to acute respiratory distress syndrome ventilator management guidelines	/
		8	Increasing frequency of SAT/SBT in intubated patients	/
		9	Decreasing VAP using a novel approach to oral care during proning	1

SAT = spontaneous awakening trial, SBT = spontaneous breathing trial, VAP = ventilator-associated pneumonia.
[a]Third Plan-Do-Study-Act cycle active as of March 2023.
[b]Projects 5 and 6 started at a single adult community-based hospital.

engagement, by providing ready access to a network of experts, opportunities for networking and institutional acclaim, and essential administrative support to maintain our community. Participants also regularly identified the collaborative learning environment we designed as a strength, highlighting the importance of interprofessional engagement to create a shared repertoire of knowledge and experience. Multiple institutions also credited the success of their QI efforts on additional support that the Collaborative provided to help with project coordination, data analysis, and presentation of results. Our experience with the STOP-VIRUS Collaborative suggests that virtual multicenter learning communities may offer a promising strategy to help to close the quality gaps that persist in our healthcare system and that professional medical societies can play an important role to incentivize and facilitate their success.

There were other large virtual education courses and learning communities that emerged during the pandemic. The European Society of Intensive Care Medicine developed the COVID19 Skills PrepAration CoursE, a large scale interprofessional ICU training program that taught primarily clinical skills both virtually and in person (34). The Children's Hospital Association Improving Pediatric Sepsis Outcomes Collaborative included 56 participating hospitals engaged in ongoing online education, who also share clinical bundles and implementation strategies aimed at improving sepsis outcomes across outpatient, emergency department, and PICU and neonatal ICU settings (35). Many medical societies and institutions offered a wide variety of webinar and online discussion groups, including a single center "COVID Conversations" synchronous online learning platform similar in structure to our weekly synchronous learning sessions (36). None of these examples, however, combined the dynamic instructional design strengths of our program with ready opportunities for rapid collaborative discovery, dissemination, and

implementation of best practices and processes. A further strength of our Collaborative was the alignment of our selected QI efforts with existing SCCM initiatives and resources, including the A–F bundle and Choosing Wisely Campaign (28, 37). We also found the blending of adult and pediatric interprofessional teams to be a unique and valuable experience, which fostered an exchange of novel perspectives and significantly enriched our discussions. A testament to the success of this virtual learning platform may be the rapid implementation of an ongoing and similar collaborative effort between experts in Ukraine, the United Kingdom and the United States, aimed at providing best practices and clinical decision support to frontline and ICU trauma providers during an urban conflict (CERTAIN for Ukraine) (38).

Our Collaborative was not without its limitations. This multicomponent project was rapidly planned and implemented during an unprecedented time of clinical strain, and therefore we cannot correlate the impact of each intervention that we delivered with the outcomes our Collaborative achieved. The participating centers and teams were very heterogeneous, and a better understanding of the necessary characteristics for a participating site to fully benefit from the Collaborative experience and which elements of our program planning and delivery offered the greatest impact will be important to inform future, similar efforts. Inclusion of early mobility teams may be an important future consideration. Although participants regularly requested more time for discussion, engagement with asynchronous resources including the Blackboard discussion board and Twitter feed was limited and the reasons for this warrant further investigation. Learner feedback during the Collaborative was largely verbal during our mid-project and small group discussions, and while this offers another demonstration of the supportive environment we created, this is also likely the cause of the low post-session survey response rate. The impact of the pandemic on critical care practice settings has been significant and clearly limited the Collaborative's QI impact on care processes. Although providing Collaborative coaches and resources for project management clearly served as an important catalyst for QI efforts, further work is needed to identify additional implementation mechanisms to speed this important work during a time of ongoing clinical strain and workforce challenges.

CONCLUSIONS

Rapid deployment of this society-based, multicenter interprofessional online learning collaborative produced acceptable learner satisfaction and engagement, and resulted in nine QI interventions. We conclude that such a learning community holds promise as a method to facilitate broad-based collaboration, dissemination, and implementation of best practices to close persistent quality gaps in a wide variety of healthcare settings.

ACKNOWLEDGMENTS

STOP-VIRUS Collaborative Participants: Anthony Martinez, MD, Dean Meadows, MD, Helen Stinnett, BA, RRT, Michael Allison, MD, Olubukola Adeyemi, PharmD, Terry Herbert, BSN, RN (Ascension Saint Agnes Hospital, Baltimore, MD); Gerald L. Weinhouse, MD, Namrata Patil, MD, MPH, Gaspar Hacobian, PharmD, BCPS (Brigham and Women's Hospital, Boston, MA); Kamen Rangelov, MD, Jillian Parker, RRT, Michael P. Smith, PharmD, BCCCP, Rachel Smith, RN, MSN, MBA, CCRN, Eliza Deery, MD, Andrea Harper, MS (Concord Hospital – Laconia, Laconia, NH); Emily Davis, RN, CCRN, Grace M. Arteaga, MD, FAAP, FCCM, Jennifer L. Fleegel, RN, CCRN, Julie M. Duncan, RN, Kevin K. Graner, RPh, Tammy J. Schultz, RRT, LRT (Mayo Clinic Children's Center, Rochester, MN); Abhishek Giri, MBBS, Ashley Gill, RRT, Catherine L. Mielke, MS, APRN, CNS, Devang Sanghavi, MD, MHA, Jonathan K. Clark, RRT, Julie Shimp, RN, Lisa Marshall, MSN, RN, Michael Spiros, MSN, RN, Nirmaljot Kaur, MD, Sean P. Kiley, MD, Siva Naga Yarrarapu, MBBS, Teresa Keister, RN (Mayo Clinic Florida, Jacksonville, FL); Gage Stroope, LRT, CRT, Jackie Stark, PharmD, BCPS, Jessica Poehler, RN, Juan Pablo Domecq Garces, MD, Nitesh Kumar Jain, MD, MBBS, Syed Anjum Khan, MD, Thoyaja Koritala, MD (Mayo Clinic Health System Mankato, Mankato, MN); Abigail La Nou, MD, FACEP, Christina Hall, MS, RN, Cindy Christensen, MSN, RN, FNP-BC, Kirsten Holbrook, RRT, Sara Toufar, PharmD, RPh, Sarah Normand, PharmD, RPh (Mayo Clinic Health System Eau Claire, Eau Claire, WI); Amy Spitzner, RN, CCRN, Carissa Quinn, APRN, CNS, DNP, Christina Xia, PharmD, BCCCP, Holly D. Behrns, LRT, RRT, Erin Barreto, PharmD, RPh, Jennifer Elmer, APRN, CNS, DNP, Sarah Chalmers, MD, PCCM, Macy Cooper,

RN (Mayo Clinic Rochester, Rochester, MN); Aaron Harthan, PharmD, BCPPS, Edmundo A. Martinez, MD, Jennifer A. Bandy, RN, BSN, John Sanford, RRT-ACCS, RRT-NPS, Jackie A. Guiliani, BSRT, RRT-NPS, Megan Kupferschmid, MSN, RN, P-CCRN (OSF Children's Hospital of Illinois Saint Francis Medical Center, Peoria, IL); Anand Pariyadath, MD, Brandy Vitielliss, BSN, RN, Daniel Temas, MD, Smith F. Heavner, MS, RN, PCCN (Prisma Health, Columbia, SC); and Amanda Frary, MSN, RN, Murtaza Akhter, MD, Rania Rahman, MD, Mary Mulrow, RN, MN, CCRP, Tracy Cooper, RN (Valleywise Health, Phoenix, AZ). Moderators: John M. Litell, DO, FACEP (Abbott Northwestern Hospital, Minneapolis, MN); June Mee Chae, MD (Mayo Clinic Health System, La Crosse, WI); Kelly Cawcutt, MD, MS, FACP, FIDSA (University of Nebraska Medical Center, Omaha, NE); Kirstin J. Kooda, PharmD, RPh (Mayo Clinic, Rochester, MN); Michelle Biehl, MD (Cleveland Clinic, Cleveland, OH); Neha S. Dangayach, MD, MSCR (Mount Sinai Health, New York, NY); Sarah Redmond, PhD (Mayo Clinic, Rochester, MN); Viren Kaul, MD (Crouse Hospital, Syracuse, NY); Matthew Siuba, DO (Cleveland Clinic, Cleveland, OH). Subject Matter Experts: Aaron B. Holley, MD (Walter Reed National Military Medical Center, Washington, DC); Alexander A. Kon, MD, MS (Community Children's, Missoula, MT); Amita Avadhani, PhD, DNP, CNE, DCC, ACNP-BC, NP-C, CCRN, FAANP, FCCM (Rutgers University School of Nursing, Newark, NJ); Amy L. Dzierba, PharmD, FCCP, BCCCP, FCCM (New York-Presbyterian Hospital, New York, NY); Andre C. Kalil, MD, MPH, FACP (University of Nebraska Medical Center, Omaha, NE); Kelly Cawcutt, MD, MS, FACP, FIDSA (University of Nebraska Medical Center, Omaha, NE); Ashley D. DePriest, MS, RDN, CNSC (Wellstar Health System, Atlanta, GA); Bradley Peters, PharmD, RPh, BCSP, BCCCP (Mayo Clinic, Rochester, MN); Brenda T. Pun, DNP, RN, FCCM (Vanderbilt University Medical Center, Nashville, TN); Courtney E. Bennett, DO (Mayo Clinic, Rochester, MN); Eric Kriner, BS, RRT (Medstar Washington Hospital Center, Washington, DC); Erin S. DeMartino, MD (Mayo Clinic, Rochester, MN); Erin Strong, BSN, RN, CCRN (University of Pennsylvania, Philadelphia, PA); Giora Netzer, MD (University of Maryland School of Medicine, Baltimore, MD); Greg S. Martin, MD, MSc, FCCM (Emory University School of Medicine, Atlanta, GA); Jerry J. Zimmerman, MD, PhD, FCCM (Seattle Children's Hospital, Seattle, WA); Julia Taylor, MD, MA, HEC-C (University of Virginia, Charlottesville, VA); Karen A. Korzick, MD, MA, FCCP, FACP, FCCM (Geisinger Medical Center, Danville, PA); Katherine Fischkoff, MD, MPA, FACS (Columbia Presbyterian Hospital, New York, NY); Lewis J. Kaplan, MD, FACS, FCCM (University of Pennsylvania, Philadelphia, PA); Marlies Ostermann, MD, PhD (Guy's and St. Thomas' NHS Foundation Trust, London, United Kingdom); Mary Susan Gaeta, MD, FACP (University of Texas MD Anderson Cancer Center, Houston, TX); Mary Faith Marshall, HEC-C, PhD (University of Virginia School of Medicine, Charlottesville, VA); Nahreen Ahmed, MD, MPH (University of Pennsylvania, Philadelphia, PA); Paul Alan Nyquist, MD, MPH (Johns Hopkins School of Medicine, Baltimore, MD); Pooja A. Nawathe, MD, FAAP, CHSE-A, CHSOS, FCCM (Cedars-Sinai Medical Center, Los Angeles, CA); Preeti R. John, MD, MPH, FACS, CPE, HEC-C (VA Maryland Health Care System, Baltimore, MD); and Uzma Syed, DO, FIDSA (Good Samaritan Hospital Medical Center, Long Island, NY).

1 *Department of Medicine, Division of Pulmonary and Critical Care Medicine, Mayo Clinic, Rochester, MN.*

2 *Department of Anesthesia, Pain Medicine and Critical Care, Beth Israel Deaconess Medical Center, Boston, MA.*

3 *Department of Vascular Neurology and Intensive Therapy, University Medical Centre Ljubljana, Ljubljana, Slovenia.*

4 *Department of Anesthesiology and Perioperative Medicine, Mayo Clinic, Rochester, MN.*

5 *Society of Critical Care Medicine, Mount Prospect, IL.*

6 *Department of Medicine, Montefiore New Rochelle Hospital, New Rochelle, NY.*

7 *Department of Neurology, Allegheny Network, Pittsburgh, PA.*

8 *Department of Internal Medicine, Division of Infectious Diseases, University of Nebraska Medical Center, Omaha, NE.*

9 *Department of Emergency Medicine, Hennepin Healthcare, Minneapolis, MN.*

10 *Department of Emergency Medicine, University of Minnesota, Minneapolis, MN.*

11 *Center for the Science of Health Care Delivery, Mayo Clinic, Rochester, MN.*

12 *Surgical Intensive Care Unit, Thomas Jefferson University Hospital, Philadelphia, PA.*

13 *Department of Pharmacy, Mayo Clinic, Rochester, MN.*

14 *Department of Critical Care Medicine and Pulmonary Medicine, Respiratory Institute, Cleveland Clinic, Cleveland, OH.*

15 *Neurocritical Care Division, Mount Sinai Health System, New York, NY.*

16 *Department of Pulmonary and Critical Care Medicine, Crouse Health/State University of New York Upstate Medical University, Syracuse, NY.*

17 *Division of Pulmonary and Critical Care Medicine, Mayo Clinic Health System Eau Claire, Eau Claire, WI.*

18 *Pulmonary Center, Division of Pulmonary, Allergy, Critical Care and Sleep Medicine, Department of Medicine, Evans Center of Implementation and Improvement Sciences, Boston University School of Medicine, Boston, MA.*

The Structured Team-based Optimal Patient-Centered Care for Virus COVID-19 (STOP-VIRUS) Collaborative are listed in the Acknowledgments.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (http://journals.lww.com/ccejournal).

This educational activity was funded in part by a cooperative agreement to the Society of Critical Care Medicine with the Centers for Disease Control and Prevention (grant number 1 NU50CK000566-01-00) and Janssen Research & Development, LLC.

Preliminary data presented as Research Snapshot at Society of Critical Care Medicine 51st Congress, Virtual Event April 18–21, 2022.

Drs. Kashyap and Gajic have a financial conflict of interest with software platforms licensed to Ambient Clinical Analytics associated with the Checklist for Early Recognition and Treatment of Acute Illness and iNjury program. This software was not utilized for this project, and these individuals did not participate in analysis or interpretation of these study results. The remaining authors have disclosed that they do not have any potential conflicts of interest.

For information regarding this article, E-mail: niven.alexander@mayo.edu

The Centers for Disease Control and Prevention (CDC) is an agency within the Department of Health and Human Services (HHS). Its contents do not necessarily represent the policy of CDC or HHS and should not be considered an endorsement by the Federal Government.

REFERENCES

1. Alhazzani W, Evans L, Alshamsi F, et al: Surviving sepsis campaign guidelines on the management of adults with coronavirus disease 2019 (COVID-19) in the ICU: First update. *Crit Care Med* 2021; 49:e219–e234
2. Cook TM, El-Boghdadly K, McGuire B, et al: Consensus guidelines for managing the airway in patients with COVID-19: Guidelines from the Difficult Airway Society, the Association of Anaesthetists the Intensive Care Society, the Faculty of Intensive Care Medicine and the Royal College of Anaesthetists. *Anaesthesia* 2020; 75:785–799
3. Evans L, Rhodes A, Alhazzani W, et al: Surviving sepsis campaign: International guidelines for management of sepsis and septic shock 2021. *Intensive Care Med* 2021; 47:1181–1247
4. Walkey AJ, Kumar VK, Harhay MO, et al: The Viral Infection and Respiratory Illness Universal Study (VIRUS): An international registry of coronavirus 2019-related critical illness. *Crit Care Explor* 2020; 2:e0113
5. Domecq JP, Lal A, Sheldrick CR, et al; Society of Critical Care Medicine Discovery Viral Infection and Respiratory Illness Universal Study (VIRUS): COVID-19 Registry Investigator Group: Outcomes of patients with coronavirus disease 2019 receiving organ support therapies: The International Viral Infection and Respiratory Illness Universal Study Registry. *Crit Care Med* 2021; 49:437–448
6. Churpek MM, Gupta S, Spicer AB, et al; STOP-COVID Investigators: Hospital-level variation in death for critically ill patients with COVID-19. *Am J Respir Crit Care Med* 2021; 204:403–411
7. Weled BJ, Adzhigirey LA, Hodgman TM, et al; Task Force on Models for Critical Care: Critical care delivery: The importance of process of care and ICU structure to improved outcomes: An update from the American College of Critical Care Medicine Task Force on Models of Critical Care. *Crit Care Med* 2015; 43:1520–1525
8. Khurshid Z, De Brún A, Moore G, et al: Virtual adaptation of traditional healthcare quality improvement training in response to COVID-19: A rapid narrative review. *Hum Res Health* 2020; 18:81
9. Mann DM, Chen J, Chunara R, et al: COVID-19 transforms health care through telemedicine: Evidence from the field. *J Am Med Inform Assoc* 2020; 27:1132–1135
10. Oesterreich S, Cywinski JB, Elo B, et al: Quality improvement during the COVID-19 pandemic [online ahead of print]. *Cleve Clin J Med* 2020 Jun 3. doi:10.3949/ccjm.87a.ccc041
11. Kanneganti A, Lim KMX, Chan GMF, et al: Pedagogy in a pandemic - COVID-19 and virtual continuing medical education (vCME) in obstetrics and gynecology. *Acta Obstet Gynecol Scand* 2020; 99:692–695
12. Zuo L, Dillman D, Miller Juvé A: Learning at home during COVID-19: A multi-institutional virtual learning collaboration. *Med Educ* 2020; 54:664–665
13. Vukoja M, Dong Y, Adhikari NKJ, et al; Checklist for Early Recognition and Treatment of Acute Illness and Injury (CERTAIN) Investigators of the SCCM Discovery Network: Checklist for early recognition and treatment of acute illness and injury: An exploratory multicenter international quality-improvement study in the ICUs with variable resources. *Crit Care Med* 2021; 49:e598–e612
14. Society of Critical Care Medicine: VIRUS COVID-19 Registry. 2020. Available at: https://sccmcovid19.org/. Accessed January 13, 2022
15. Shao M, Kashyap R, Niven A, et al: Feasibility of an international remote simulation training program in critical care delivery: A pilot study. *Mayo Clin Proc Innov Qual Outcomes* 2018; 2:229–233
16. Vukoja M, Kashyap R, Gavrilovic S, et al: Checklist for early recognition and treatment of acute illness: International collaboration to improve critical care practice. *World J Crit Care Med* 2015; 4:55–61
17. Gajic O, Anderson BD: "Get to know me" board. *Crit Care Explor* 2019; 1:e0030
18. Dong Y, Niven AS, Gajic O. Checklist for Early Recognition and Treatment of Acute Illness and iNjury (CERTAIN). 2013–2022.

Available at: https://www.icertain.org/. Accessed January 15, 2022

19. Kovacevic P, Dragic S, Kovacevic T, et al: Impact of weekly case-based tele-education on quality of care in a limited resource medical intensive care unit. *Crit Care*. 2019; 23:220
20. Sakusic A, Markotic D, Dong Y, et al: Rapid, multimodal, critical care knowledge-sharing platform for COVID-19 pandemics. *Bosn J Basic Med Sci* 2021; 21:93–97
21. Durak G, Ataizi M: The ABC's of online course design according to Addie model. *Univ J Educ Res* 2016; 4:2084–2091
22. Hess AKN, Greer K: Designing for engagement: Using the ADDIE model to integrate high-impact practices into an online information literacy course. *Commun Inf Literacy* 2016; 10:264–282
23. Society of Critical Care Medicine: STOP-VIRUS ICU Learning Collaborative Resource Page. 2021. Available at: https://www.sccm.org/Clinical-Resources/Collaboratives/STOP-VIRUS-ICU-Learning-Collaborative. Accessed December 19, 2021
24. Langley GJ, Moen RD, Nolan KM, et al: *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance*. New York, NY, John Wiley & Sons, pp, 1–512, 2009
25. Kirkpatrick DL, Craig R: Evaluation of training. In: *Evaluation of Short-Term Training in Rehabilitation*. Browning PL, (Ed) Eugene, OR, Rehabilitation Research and Training Center in Mental Retardation, University of Oregon, pp 35–57, 1970
26. Proctor E, Silmere H, Raghavan R, et al: Outcomes for implementation research: Conceptual distinctions, measurement challenges, and research agenda. *Adm Policy Ment Health* 2011; 38:65–76
27. Stollings JL, Devlin JW, Lin JC, et al: Best practices for conducting interprofessional team rounds to facilitate performance of the ICU liberation (ABCDEF) bundle. *Crit Care Med* 2020; 48:562–570
28. Pun BT, Balas MC, Barnes-Daly MA, et al: Caring for critically ill patients with the ABCDEF bundle: Results of the ICU liberation collaborative in over 15,000 adults. *Crit Care Med* 2019; 47:3–14
29. Nitesh J, Kashyap R, Surani SR: What we learned in the past year in managing our COVID-19 patients in intensive care units? *World J Crit Care Med* 2021; 10:81–101
30. Raudenská J, Steinerová V, Javůrková A, et al: Occupational burnout syndrome and post-traumatic stress among healthcare professionals during the novel coronavirus disease 2019 (COVID-19) pandemic. *Best Pract Res Clin Anaesthesiol* 2020; 34:553–560
31. Shaparin N, Mann GE, Streiff A, et al: Adaptation and restructuring of an academic anesthesiology department during the COVID-19 pandemic in New York City: Challenges and lessons learned. *Best Pract Res Clin Anaesthesiol* 2021; 35:425–435
32. Escandón K, Rasmussen AL, Bogoch II, et al: COVID-19 false dichotomies and a comprehensive review of the evidence regarding public health, COVID-19 symptomatology, SARS-CoV-2 transmission, mask wearing, and reinfection. *BMC Infect Dis* 2021; 21:710
33. Wenger E, McDermott R, Snyder W: *Cultivating Communities of Practice: A Guide to Managing Knowledge*. Boston MA, Harvard Business Review Press, 2002
34. Schaller SJ, Mellinhgoff J, Cecconi M: Education to save lives: C19SPACE, the COVID19 Skills PrepAration CoursE. *Intensive Care Med* 2022; 48:227–230
35. Larsen GY, Brilli R, Macias CG, et al: Development of a quality improvement learning collaborative to improve pediatric sepsis outcomes. *Pediatrics* 2021; 147:e20201434
36. Ferguson L, Rentes VC, McCarthy L, et al: Collaborative conversations during the time of COVID-19: Building a "meta"-learning community. *Learn Health Syst* 2022; 6:e10284
37. Zimmerman JJ, Harmon LA, Smithburger PL, et al: Choosing wisely for critical care: The next five. *Crit Care Med* 2021; 49:472–481
38. Rovati L, Zec S, Dziuba D, et al: Implementation of a multimodal knowledge-exchange platform to provide trauma critical care education during the ongoing conflict in Ukraine. *JAMA Netw Open* 2023; 6:e230050