Building surge ICU capacity during COVID-19

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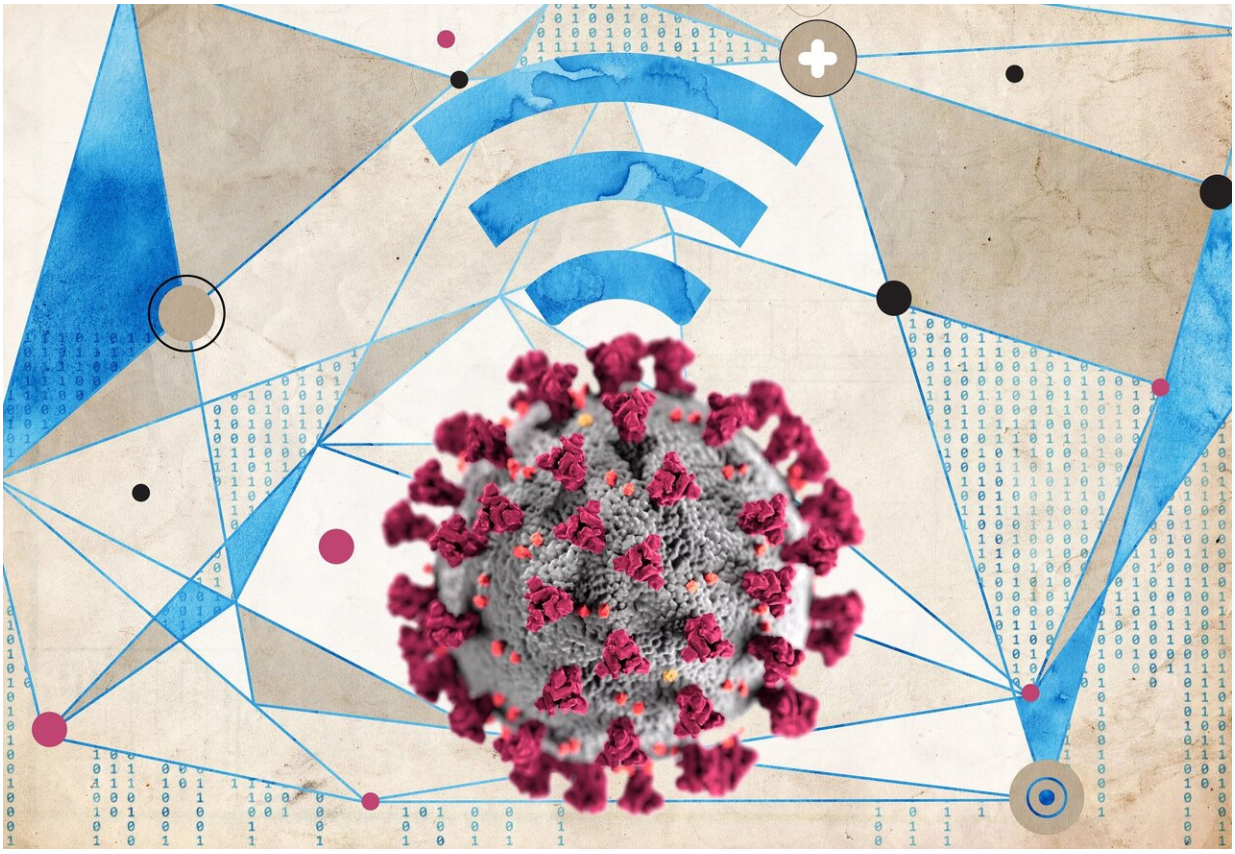

To help address surges in ICU cases, the Medical University of South Carolina team will leverage networking technologies to connect medical devices and smartphone applications to the electronic health record. Credit: Emma Vought, Medical University of South Carolina

To prepare for current and future waves of COVID-19, the U.S. Army's Telemedicine and Advanced Technology Research Center asked teams from across the country to compete to build a telehealth prototype that would provide adequate ICU capacity when cases surge. Of the 78 teams that competed, only nine were invited to complete a series of tasks designed to establish the feasibility of their prototypes. A Medical University of South Carolina team of bioinformatics, telehealth and critical care experts was one of those nine.

The ultimate goal of the competition is to create and coordinate a "virtual ward" that would offer technology-based and patient-centered care solutions. Networking technologies would connect medical devices and smartphone applications to health care information technology systems, such as the electronic health record. These virtual wards are intended to bring high-quality critical care capability to nearly every bedside, be it a health care facility, field hospital or gymnasium. They will be low-resource and flexible so that they can be mobilized to provide superior intensive care to places that lack adequate critical care expertise and the resources necessary for care of COVID-19-related illnesses.

Each of the nine teams was awarded up to $1 million dollars and given 15 days to complete the first of five tasks necessary to deploy its prototype. MUSC has just completed Task 1 and submitted it for evaluation. Only those teams whose efforts at completing Task 1 are judged successful will be invited to participate in Task 2. The ultimate goal is to narrow down to three or so teams that will collaborate to roll out these virtual critical care networks nationally.

The MUSC team is led by Leslie Lenert, M.D., MUSC assistant provost for data science and informatics and chief research information officer, and Dee Ford, M.D., director of the MUSC Telehealth Center of Excellence and professor in the Division of Pulmonary and Critical

Care.

"We are a great team in that I can provide the technical foundation, but Dee can offer the practical telehealth experience and critical care expertise to make sure this is more than a science project," said Lenert.

Their proposed prototype, known as Portable Remote Operational Wireless Enabled Surge Specialist ICU, or Prowess-ICU, builds on MUSC's more than 15 years of experience with telehealth, including tele-ICU, and the strong regional partnerships that it has created. Since 2013, MUSC has partnered with Advanced ICU Care to provide remote monitoring of ICUs throughout the state, invaluable experience for the task at hand.

"We were selected to develop a prototype because, as a national leader in telehealth, we have the institutional knowledge, expertise and experience on how to build outreach tools," explained Ford.

According to Ford, the project management and research infrastructure provided by the South Carolina Clinical & Translational Research Institute has also been invaluable. SCTR is one of about 60 Clinical and Translational Science Awards hubs nationwide funded by the National Institutes of Health. Their purpose is to help speed research breakthroughs into the clinic.

Lenert agrees. "This project would not have been possible without the substantial and highly enthusiastic logistical and organizational support provided by SCTR," he added.

Also key was the technical expertise of Lenert and the teams at the Biomedical Informatics Center, which will be building the digital infrastructure for the project and customizing off-the-shelf sensors, such as pulse oximeters and thermometers, to collect COVID-19-relevant

data. Information Solutions, the Epic team and the analytics team run by Matt Turner, MUSC chief data officer, are all making critical contributions to the project.

"I think that this particular combination of technical, operational, clinical and telehealth expertise that we were able to bring was quite compelling," added Ford.

One strength of PROWESS-ICU is that it proposes a model for COVID-19 care that is tightly integrated within existing regional health care networks. According to Ford and Lenert, lack of such integration has thus far limited the usefulness of field hospitals, making providers less likely to refer patients and preventing the sharing of data about treated patients back to local providers.

"If providers don't know you, at least by reputation, they're not going to trust you and send you patients," said Lenert. "So we don't want field hospitals or surge ICUs that are untethered from existing health care delivery. That can lead to lack of trust, lack of knowledge and inadequate data sharing."

Prowess-ICU would build on long-standing relationships between MUSC Health and regional providers to provide comprehensive solutions to addressing COVID-19 surge capacity. These include virtual care visits to determine whether a patient needs testing; remote home monitoring, for those who test positive but do not develop severe symptoms; and austere or advanced surge ICUs for sicker patients. Austere ICUs, or makeshift ICUs that can be deployed very rapidly in response to a surge, would be replaced in time by more robust and better-equipped advanced ICUs, if needed. MUSC Health, a regional critical care and telehealth leader, would act as the "mothership," caring for the sickest of the sick.

The ICUs would be fitted with wireless monitoring technology, tailored

to collect data that is clinically relevant to COVID-19. Data from the sensors and monitoring technology will stream to the Azure cloud, where artificial intelligence algorithms will analyze them for indications that a patient is improving or declining clinically. Those data will then be "downstreamed" hourly into a common electronic health record, where they can be accessed by remote specialists at MUSC or other motherships to decide whether the patient needs to be moved to a different level of care.

An impressive array of partners has signed onto the project, including Microsoft, whose Azure cloud technology is essential to its infrastructure and which has been instrumental in forging key partnerships; Advanced ICU Care, which will assist with monitoring the austere and advanced ICUs and help to train remote staff; Masimo and Medtronic, which will provide the sensors both for home monitoring and ICUs; and Doxy.me, a telehealth platform that can facilitate video visits and communications between providers and patients. The project will also leverage the expertise of technology, emergency response and patient safety experts at a number of other universities, including Massachusetts General Hospital, university hospitals affiliated with Case Western Reserve University, Dartmouth University and University of California, San Diego.

Lenert and Ford are particularly proud of the "modular" structure of PROWESS-ICU. Teams are organized in the same way at every level of care from the surge ICU teams in the community to remote specialists at MUSC.

"Each surge unit is a replica of the organizational structure of the mothership so that respiratory therapy experts at one unit can talk to respiratory therapists at another unit or the mothership, nurses can talk to nurses and so on," explained Lenert. "The idea is that there's an organized way for people to get help and to communicate with the

person that has their role inside the mothership organization."

Another advantage of this modular approach is that surge ICUs can be built and moved nimbly as the epidemic evolves, and even the mothership function can be moved to another institution should the first one become overwhelmed.

Ford believes that another strength of MUSC's prototype is its responsiveness to the needs of rural and minority communities during the COVID-19 crisis.

"How to deploy 1,000 beds in a major urban center is an important component of any COVID-19 response," explained Ford. "But equally important is how to deploy eight or 12 beds in a rural underserved community to make sure all citizens are getting the support they need. We've been intentional about how we think through those kinds of health disparities issues."

Responding to COVID-19 will require a united front, according to Lenert and Ford.

"The problem is bigger than any one hospital or health system or region can handle, and so we need to work together," said Lenert.

Provided by Medical University of South Carolina