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Lessons Learned in Critical Care at a 23 Hospital Health System in New York During the Coronavirus Disease 2019 Pandemic

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In March of 2020 as coronavirus disease 2019 (COVID-19) spread rapidly throughout New York, hospitals and ICU capacities were quickly overwhelmed. Our health-system, located in the New York metropolitan area, treated >17,000 patients who were hospitalized with COVID-19, of which approximately 3,000 patients required mechanical ventilation. Based on our experience, we provide a breakdown of considerations during surge planning.

Supplies and Equipment

Due to the sudden need for a large number of ventilators, many of which we received through the Federal Emergency Management Agency, it was not uncommon for physicians and respiratory therapists to encounter a different type of ventilator on each patient. This caused frustration and decreased the efficiency of their workflow. We also encountered shortages of replacement parts and tubing, which rendered some machines unusable. We suggest:

- Standardizing the types of ventilators in each ICU.
- Conducting training sessions on all ventilator models.

ABBREVIATIONS: COVID-19 = coronavirus disease 2019

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- Stockpiling ventilator replacement parts and ventilator tubing.

To reduce viral aerosolization, ventilator heating circuits were turned off, which resulted in frequent endotracheal tube obstruction due to thick secretions. With the inability to use traditional nebulizers, chest physiotherapy, and bronchoscopy, secretion mobilization was challenging. We used sodium bicarbonate instillation through the endotracheal tube to mobilize secretions

To minimize the staff risk, high-flow nasal cannula and noninvasive ventilation were not used during the surge. We later adapted to the use of high-flow nasal cannula and noninvasive ventilation in negative pressure rooms or with a hood. We suggest:

- Increasing the number of negative pressure rooms in ICUs and the floors.
- Use of nonvented bilevel masks.
- Stockpiling of high-efficiency particulate-air filters.

A large number of patients with COVID-19 experienced acute renal failure with the presence of shock precluding hemodialysis. Shortages of dialysis machines, filters, and dialysate solutions limited our ability to provide continuous renal replacement therapy. We used various innovative strategies to increase our dialysis capacity, which included the use of sustained low-efficiency dialysis. We suggest:

- ICU surge preparations should include plans to conduct dialysis at a large scale.
- Stockpiling filters, machine parts, and dialysate solutions.

Point-of-care ultrasonography was an invaluable tool for rapid bedside evaluation and diagnosis of patients with COVID-19. We suggest that:

- Each ICU be equipped with an ultrasound machine with both phased array and linear transducers.
- Smaller portable ultrasound units, which may be less cumbersome, allow for more rapid disinfection after each use.

Pharmacy and Medications

We encountered medication shortages for numerous frequently used sedatives and paralytics. Rapid communication by pharmacists with assistance in

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dosing helped streamline transitions to substitutes. We suggest ensuring adequate supplies of frequently used sedatives, paralytics, and substitute drugs.

A multidisciplinary guideline committee allowed for the rapid development of treatment protocols according to the latest evidence. We suggest:

- Creation of a multidisciplinary team for evaluation and implementation of treatment protocols.
- Development of standardized order sets for treatment protocols.

Staff Protection and Personal Protective Equipment Distribution

A system-wide masking policy for staff and patients helped reduce the spread of infection throughout the surge. Streamlining distribution of personal protective equipment (PPE) is extremely important during a surge. In our health system, each ICU and floor was provided with a stockpile of PPE. Employees who checked out PPE had to complete an electronic survey to track usage. Donning and doffing training videos were created to allow rapid review prior to deployment. A buddy system to check PPE before entering a room helped reduce anxiety and keep up morale. We suggest:

- Creation of an easily accessible and trackable system for PPE distribution.
- Donning and doffing training prior to entering a surge period.

ICU operations

New ICU Locations

Elective surgeries were canceled at the peak of the surge; spaces such as postoperative care units, tents, and auditoriums were converted to patient care areas. While creating patient-care space during a surge, be aware that:

- Temporary spaces can house stable patients while regular hospital rooms are converted into ICU rooms.
- Rooms with closed doors and little audibility may be dangerous for critically ill patients.

Team Creation

Due to the scale of this pandemic we had to use non Intensivists to staff several ICUs. Our staffing model and special considerations are listed:

- Critical-care education sessions were conducted via our tele-ICU prior to deployment.

- Our seasoned team of pulmonary and critical care physicians set up and ran each new ICU as it opened.
- Non-Intensivist teams took over once the patients' conditions were stabilized, and the ICU reached its full capacity.
- A mobile team staffed by a pulmonary critical care physician and fellows provided daily ventilator management support to the non-Intensivist-run ICUs.
- The use of rotating locum providers allowed us to ensure regularly scheduled days off for our team members to reduce burnout.
- Off-loading procedures by creating a mobile procedure team staffed by interventional radiology and anesthesia allowed the ICU teams to concentrate on medical management.
- A mobility team that was staffed by operating-room technicians who were familiar with proning patients streamlined the proning process.

Repatriation of Teams

As the number of patients with COVID-19 began to plateau and then slowly decrease, the non-Intensivists who were staffing our ICUs were anxious to reopen their practices and return to elective surgery and normal procedures. Retaining these providers on our teams until the number of patients were low enough for our division to staff was challenging. We suggest the creation of a staggered deployment schedule to ensure adequate staffing during various phases in the surge

Communication

Effective communication was of paramount importance during the surge. We found the following to be the most effective:

- Applications like Microsoft Teams allowed the creation of group chats for rapid updates and discussions.
- Regularly scheduled divisional conferences to discuss staffing, deployments, management updates, and issues of concern to frontline providers were vital in keeping up morale.
- Partnering with psychiatry to adapt rapidly preexisting wellness programs to ensure that all staff had a safe avenue to seek help.

Discussion

These are the major lessons that we learned while planning and executing on the job during this unprecedented surge of critically ill patients. Our hope is that sharing this information will allow hospitals and health systems to plan ahead and mitigate risk for staff and patients during a COVID-19 surge.