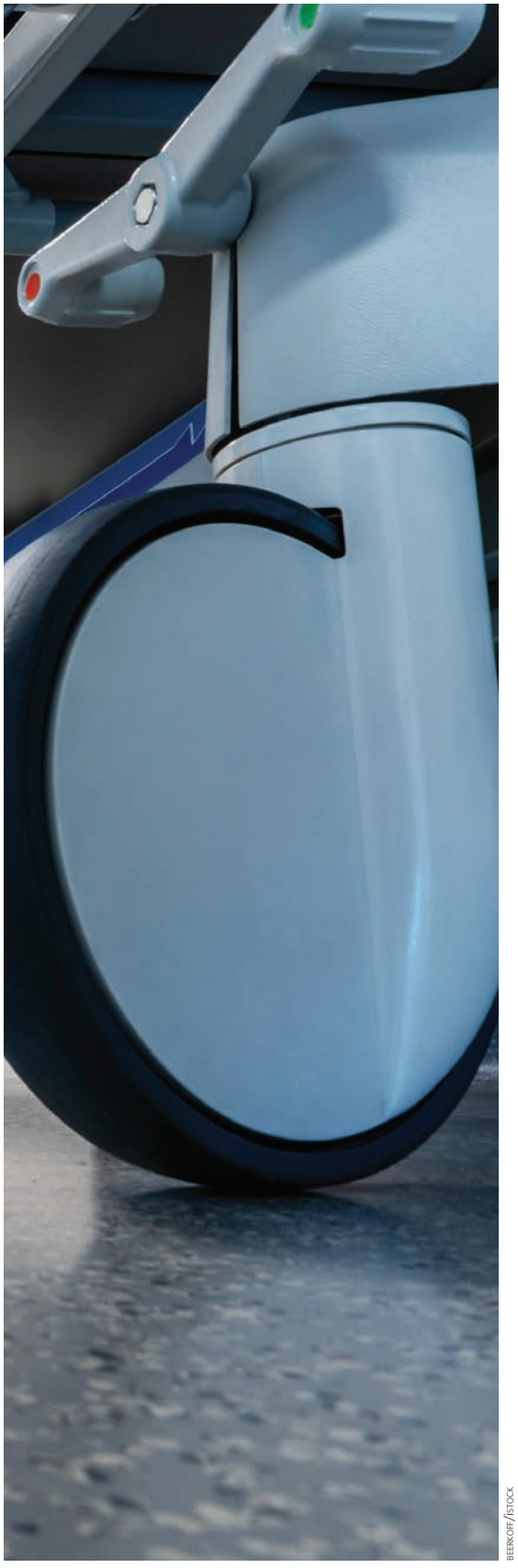

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COVID INSIGHTS

Caring for critically ill patients with COVID-19

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Abstract: The pandemic caused by the novel coronavirus has challenged healthcare systems around the world. Learn how one medical facility incorporated key guiding principles to quickly adapt normal policies and protocols in order to safely care for patients with COVID-19.

Keywords: COVID-19, critical care nursing, infection prevention, personal protective equipment, PPE, proning

AS WE WATCHED THE COVID-19 pandemic unfold in China and Europe last spring, we braced ourselves for the impact in the US. Little did we know during the early days of March 2020 that the authors' facility would soon be at the epicenter of the pandemic in the New York/New Jersey area.

The first cases in Seattle prompted an acceleration of preparations at the authors' facility. Our medical intensive care unit (MICU) was the first unit to care for critically ill adults with COVID-19. The biggest question we faced in those early days was: How does an ICU prepare to care for patients with COVID-19 in the face of so much uncertainty and minimal scientific evidence?

To aid development of structure and processes for care of patients with COVID-19, the critical care leadership team identified five guiding principles:

- preventing secondary transmission to other patients and to healthcare workers (HCWs)
- continuing to provide safe and fundamental critical care based on the best available evidence
- minimizing long-term consequences of critical illness
- communicating new information related to effective processes and treatment to the critical care team so best practices could be replicated
- providing ongoing emotional and psychological support to HCWs and the families of patients with COVID-19.

In the following discussion, we explain how processes in our facility were implemented or adapted to support each of these principles and provide optimal patient care.

Preventing secondary transmission

To prevent secondary transmission of COVID-19 to HCWs and patients, one of our first priorities was to redesign the physical environment required to care for critically ill patients with COVID-19. The infrastructure

for these patients and staff (corridors, elevators, staff work areas, break areas, unit/patient supplies, medication dispensing, and restrooms) should be separated from non-COVID-19 areas of the hospital. To accomplish this, we designated physical units as COVID-19 and non-COVID-19 areas. Temporary walls were erected to separate COVID-19 units from non-COVID-19 units and to prevent foot traffic through designated COVID-19 areas. Team members who were assigned to a COVID-19 unit did not leave that unit to enter non-COVID-19 areas.

We identified three work zones within the COVID-19 units:

- ***Hot zone:*** the patient's room or any area within a 6-ft radius of an infected patient (such as during transport) that requires full personal protective equipment (PPE), including an N95 mask and face shield or a personal power air purifying respirator (PAPR).
- ***Warm zone:*** a 3-ft-square area taped off outside the patient's door as a designated transition zone. Donning/doffing of PPE, handing off lab specimens, and double bagging any other contaminated items for removal from the patient's room occurred in this area. In this zone, staff were required to wear an isolation gown, gloves, and surgical mask. The warm zone is also the area where staff removed and left the plastic clogs worn into the patient's room. Clogs are easy to slip on and off compared with shoe coverings, which have a high risk of self-contamination during removal, and can be cleaned before reuse.[1,2]
- ***Cold zone:*** work areas such as desks, supply rooms, break rooms, and medication-dispensing areas in which staff were required to wear only a standard surgical mask. Identifying work zones set a structure for what was required as new units were opened and repurposed.

We identified supplies that were used at higher volumes for patients with COVID-19 and began placing them on large rolling mobile rack systems. This allowed for easy separation of COVID-19 and non-COVID-19 patient supplies and facilitated monitoring of usage. Identifying these supplies allowed our materials management team to prestock the rolling racks in preparation for new units being opened.

The second major consideration for preventing secondary transmission was ensuring adequate air filtration and ventilation. Due to the design of some units, we were able to reverse the airflow and achieve negative airflow in the entire department. For units where total negative airflow could not be achieved, the use of portable in-room high-efficiency particulate air (HEPA) filtration systems were utilized.

While many nurses have experience using PPE, most do not have experience wearing it for extended periods while caring for highly infectious patients. Additionally, none of the clinical nurses had experience with PAPRs. To address these concerns, nurses collaborated with the infection prevention department and our chief medical officer (CMO), who had expertise in donning/doffing PPE and disaster management from caring for patients during the Ebola and severe acute respiratory syndrome (SARS) epidemics (see *Becoming familiar with PAPR*).

Our team utilized the simulation lab to review nursing care processes and surgical procedures that we would need to implement or modify when caring for patients with COVID-19; for example, performing physical assessments, helping patients with activities of daily living, and assisting with procedures such as chest tube insertion. All aspects of patient management from presentation to the ED through critical care admission were considered, including methods of transport and transportation routes for patients with COVID-19 through the hospital. See *Adapting procedures to enhance safety* for a summary of key procedural changes.

Becoming familiar with PAPR

Nurses review appropriate PAPR donning before entering a patient's room

PHOTO COURTESY OF THE AUTHORS

Adapting procedures to enhance safety

Process	Key process modifications
Delineating clear workflow areas	Hot, warm, and cold zones were designated based on the risk of contamination.
Managing contaminated body fluids, bed linens, and trash	Minimizing potential backsplash/aerosolization of body fluids required biohazard containers for fluids. • Linens were double-bagged in water-soluble bags and received by a second nurse outside the room for placement in a biohazard bin. • Trash was placed in biohazard bags and received by a second nurse outside the room as well.
Drawing and handling of lab specimens	Nurses assumed the responsibility for drawing lab specimens to reduce exposure of other HCWs. A process was developed to allow the nurse to disinfect the lab collection vials and place them in a transport envelope that was received by a second nurse outside the room.
Donning and doffing PPE	A PPE monitor (buddy) system and checklists were instituted to ensure strict compliance with infection prevention protocols.
Footwear	Staff wore plastic clogs rather than using disposable shoe covers to minimize self-contamination during removal. Clogs were never worn outside the warm zone.
Cardiac arrest protocols	Changes were made to minimize aerosolization and facilitate response. • Use of a bag-valve mask was always a two-person procedure using a HEPA filter. • Intubation was performed using a videoscope, rapid sequence intubation protocol, and an endotracheal tube introducer (rather than stylet). The intubator always used a PAPR. • Portable automated external defibrillators and mini-Advanced Cardiovascular Life Support medication packs were placed strategically throughout the unit.
Environmental cleaning	Nurses assumed responsibility for daily disinfection and cleaning in patient rooms.
Handoff communication	Important parameters specific to the care of patients with COVID-19 were identified and use of a whiteboard in the main unit was implemented.
Minimizing exposure time during I.V. management	Extension tubing was used to place pumps outside the room, which allowed nurses to frequently check and titrate I.V. infusions without entering the room.
Communication between staff, patients, and family members	To minimize healthcare worker exposure yet ensure patients received the care they need, we implemented tablets and web meeting software in all patient rooms. This allowed practitioners to assess patients and make treatment recommendations. Virtual conferencing technology was also used to facilitate family communication with the patient and healthcare team.

Fundamental critical care/ preventing long-term consequences

It quickly became apparent that we needed to increase the number of nurses, providers, and respiratory therapists able to care for the rapidly escalating number of critically ill patients with COVID-19 at our hospital, which had 5 adult ICUs with 68 beds. Over the course of 3 weeks, we converted 6 additional units to enable us to care for a peak census of 107 patients critically ill with COVID-19. Of these patients, 102 required mechanical ventilation and 40% required prone positioning, which supports oxygenation by improving gas exchange, reducing dorsal lung compression, and improving pulmonary perfusion.[3] Staffing models were adapted and the following specialty teams were developed to care for the growing number of critically ill patients.

A ***proning team*** was developed using personnel from physical therapy (PT) and occupational therapy (OT), and certified wound care nurses. This team functioned under the guidance of PT to ensure safe and effective repositioning. The presence of a wound care nurse allowed us to optimize the plan of care to minimize skin injury associated with prone positioning for 16 hours. The respiratory therapist (RT) assigned to the COVID-19 unit would also be present during proning. The proning team created a daily schedule that was distributed to the ICUs so staff would be ready for the team when they arrived at the unit.

An ***intubation team*** was composed of an anesthesiologist and an RT. As our elective surgical volume decreased and our COVID-19 volume exploded, it became apparent that an anesthesiologist was the ideal healthcare professional to obtain airways in patients with COVID-19.

Critical care transport teams were composed of nursing staff from surgical and ambulatory services who were reassigned due to closure or decreased volume in their home department. These teams were

developed to safely transport patients for diagnostic testing, from the ED to an ICU, or from the non-ICU units to an ICU unit using predetermined routes. Personnel from the environmental services department were also part of this team to ensure that elevators and hallways were disinfected appropriately after use.

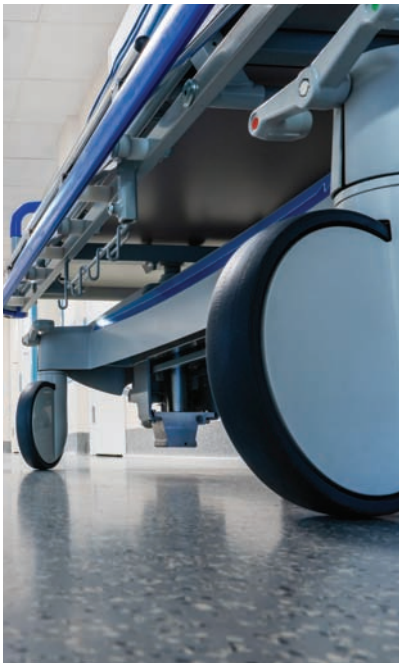
The ***vascular access team*** inserted extended-use peripheral I.V. catheters under ultrasound guidance if the patient did not require a central venous access device (CVAD).

The ***procedure team*** was composed of senior surgical residents, who were available because they were not performing elective surgeries during the crisis. They inserted arterial catheters, CVADs, chest tubes, and dialysis catheters.

Critical care teams were composed of an intensivist, an advanced practice nurse or resident, a critical care nurse, a support nurse, an RT, and a palliative care/bioethics specialist. The priority was to ensure that an intensivist and a critical care nurse were involved in the care of every critically ill patient.

All critical care nurse staffing occurred through a central command center to facilitate the redeployment of staff from noncritical care units and pair them with an experienced critical care nurse. Additionally, some redeployed staff from office practices were educated to monitor donning and doffing PPE in the ICUs and assist with appropriate use of PPE.[1]

Nursing care delivery changed from a primary care model (one critical care nurse caring for two critically ill patients) to a team model with a critical care nurse and redeployed nurse caring for five critically ill patients with COVID-19. Just-In-Time Training was offered by the nursing education department to prepare step-down unit and high-acuity nurses to assist with these ICU patients.[4,5] Presented on multiple days at multiple times, educational sessions were based on the American Association of Critical-Care Nurses' online course for acute respiratory distress syndrome, commonly used critical care medications, prone positioning, and basic ventilator management. This course was expanded to include two more modules that covered concepts of hemodynamics, arterial catheters, noninvasive monitoring, and case simulation.



Personnel from the environmental services department were part of the critical care transport team to ensure that hallways and elevators were disinfected after use.

An intensivist oversaw the plan of care for patients in each ICU and in some cases worked collaboratively with a non-ICU physician such as a general surgeon or anesthesiologist who had received some basic training in critical care.

An RT was involved in the care of every endotracheally intubated patient. To achieve this goal, RTs need to adapt their care model: One RT was now responsible for up to 12 intubated patients instead of the usual 6 to 8 intubated patients. Additionally, many of the standard treatments and ventilator checks were bundled, much like the nursing care delivery process discussed below.

A palliative care clinical resource was included on the care team and assigned to each critical care unit to support families. During this time, they could not be present at the bedside yet were often faced with making difficult, heart-wrenching decisions.

Daily care of an ICU patient normally requires a nurse to enter and exit a patient's room frequently over the course of an hour, but this was not an option during the pandemic. The delivery of nursing care to patients with COVID-19 was modified to minimize exposure time and to optimize use of PPE. Nursing care was bundled so that medication administration, point-of-care glucose monitoring, phlebotomy, assessments, and other patient-focused activities would occur at the same time rather than separately.

One of the most common reasons a nurse enters a patient's room is to titrate an I.V. infusion. To facilitate titration and minimize the need to enter a patient's room, one of our nurses successfully used extension tubing and placed the tubing under the door so the pump was accessible from outside the room. This practice was quickly adopted by others and became the way I.V. medications were delivered for all patients with COVID-19. Securement devices for indwelling urinary catheters and damage-free adhesive wall strips were used to help secure the tubing to the wall, keeping it off the floor and reducing risk of contamination.

To prevent errors from misidentification of patients and medications, bright neon room numbers were placed on the I.V. poles. A patient wristband was attached to the tubing outside the room as well.

We also used rapid infusion extension tubing for continuous renal replacement therapy (CRRT) in patients with renal failure, allowing us to maintain flow rates on our CRRT units outside of the patient's room. Eventually small rubber grommets were placed in the walls by the facility's engineering department and the tubing was threaded through the wall. This allowed us to place some of our ventilator screens outside of the room as well.

Communicating and replicating what was effective

The previously discussed workflows and processes were initially trialed on a small scale in a wing of the MICU. By the time we reached peak patient surge, we had effectively replicated the small-scale model refined in the MICU to an additional six COVID-19 ICUs. The following are key components used to replicate the unit model:

- Daily critical care clinical huddles were held with nursing leadership, intensivists, RT managers, and the CMO to provide updates from each COVID-19 ICU on the following: number of positive COVID-19 test results; number of patients enrolled in clinical trials; number of patients intubated, receiving paralytics and/or nitric oxide; number of patients being proned; and plan for the day. The topics discussed were drug supply issues, organizational surge planning (for example, new units opening), new evidence/guidelines that had been published, and changes to our treatment guidelines and/or algorithms. Key points from daily updates were then published in a COVID-19 newsletter that was sent out through email and posted on the hospital's COVID-19 web page. An online manual with important COVID-19 guidelines was also provided for staff (see *A wealth of information online*).

Baby monitors were employed so nurses could hear ventilator alarms in clinical areas where ventilator alarms were not centrally connected. This also facilitated communication with staff outside the room, especially when a PAPR was in use.

PPE donning and doffing posters were placed in all rooms. In addition, staff serving as PPE monitors were stationed outside rooms during the donning and doffing process to ensure correct procedure.

Central command communication boards were used on the unit with key patient information, such as COVID test status, paralytic use, proning, use of nitric oxide, ICU length of stay, code status, and key treatments (such as clinical trial drugs, antivirals, steroids, and convalescent plasma). Patient safety information placed on the glass door of patient rooms included QTc interval, turning times, airway pressures, and treatment plan.

Discharge instructions for home monitoring included information about post-ICU syndrome and our hospital's critical care recovery support group.

A wealth of information online

Pandemic planning included giving staff access to an online manual with important guidelines, which included the following:

- procedure for using PAPRs
- procedure for obtaining a nasal swab specimen
- COVID-19 isolation signage and criteria for removing patients from COVID-19 isolation
- intubation procedures
- modified Advanced Cardiovascular Life Support cardiac arrest algorithm
- transport procedures
- proning and self-proning procedures
- environmental cleaning procedures
- lab specimen collection procedures
- hazardous waste management procedures
- escalation of care for patients on medical-surgical COVID-19 units who need to be admitted to a COVID-19 ICU.

Supporting critical care staff and patients' family members

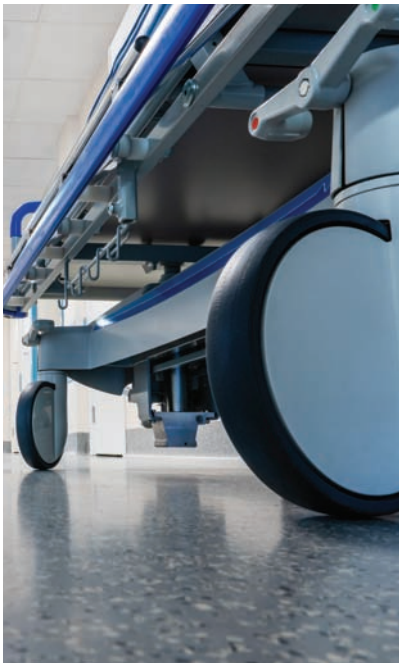
Due to the high acuity of their patients, the clinical team was often required to have very complex conversations with family members and other decision-makers. These conversations could not occur in person because state department of health regulations prevented visitors from entering the hospital during this time, with few exceptions. This restriction generated tremendous anxiety for both family members and critical care staff and rendered the usual approaches to patient- and family-centered care very difficult to maintain.

It became vital to create a system for managing communication that ensured family members could obtain information about their loved one but did not overwhelm clinical nurses and other clinicians with questions and requests. To address this need, we utilized the Zoom virtual conferencing system via a computer tablet on a gooseneck stand in every patient room. The unit receptionist would send the identified family member an email invitation to access the virtual conferencing room specific for that patient. Family members were placed in the "lobby" until the nurse confirmed it

was appropriate to allow them access. At that time, the nurse would update family members while they could see and speak with the patient, if the patient was able to communicate with them. In some cases, family members requested that the video be left open so they could continually see the patient, and the nurses would simply turn the camera and microphone off when they needed to provide privacy for patient care.

During end-of-life care, the online conferencing service allowed multiple family members to be present and to request that certain prayers, songs, poems, or last rites be provided by the nurse under the direction of the hospital chaplain. The conferencing service was also used for multidisciplinary family meetings, an essential method of updating families and communicating with key decision-makers.

These families had significant emotional and psychological needs, and we felt it was important to ensure they were given ongoing support beyond what could be provided by the critical care team. We utilized redeployed patient experience liaisons, social workers, and pastoral care personnel to connect with these families and provide support and counseling to them. Our behavioral health team set up a virtual peer support group for family members. It met weekly and offered one-on-one counseling for family members who needed additional support.



For some nurses, the toll of caring for patients with COVID-19 did not fully impact them until several weeks after the peak surge.

Caring for critically ill patients with COVID-19 was physically exhausting and emotionally draining for staff. Nurses often felt overwhelmed, depressed, and anxious, all while being disconnected from their own family, friends, and community. It was vital for the mental health of our nurses to recognize the challenges they faced and provide psychological and emotional support from social workers, psychologists, and psychiatrists. Our organization facilitated several activities to address this critical need:

- A mental health support hotline for HCWs was created.
- Full or partial hotel costs were covered for staff who did not want to return home due to concern about exposing family members to COVID-19.
- Many lunch and dinner donations were provided by the community.
- The hospital cafeteria stocked high-use common shopping items such as paper towels, toilet paper, soap and hand sanitizers, milk, bread, cold cuts, and prepared meals so staff would not have to worry about going to a store to shop for their families.
- A virtual HCW support group was offered by our behavioral health and integrative medicine departments.

For some nurses, the toll of caring for patients with COVID-19 did not fully impact them until several weeks after the peak surge. In response to this feedback, the authors sent out a survey asking nurses to complete a self-assessment and inquiring whether they wanted information regarding mental health support for burnout and posttraumatic stress disorder. The results of the survey demonstrated that about 20% of our staff wanted additional resources and the opportunity to participate in a formal debriefing session. We provided several in-person and virtual sessions offered with a mental health crisis specialist, which many of our staff attended.

Innovation and collaboration

The COVID-19 pandemic forced us to be innovative and collaborative.

Resources

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The crisis created a stronger respect and regard for the contributions of each discipline as we collectively cared for some of the most critically ill patients we have ever encountered. The use of our guiding principles helped us to not only survive the initial surge of patients with COVID-19 but also to thrive as one of the hospitals at the center of this crisis.

As of February 2021, we had cared for 367 adult patients critically ill with COVID-19. The model we put in place to manage the initial surge of critically ill patients with COVID-19 has been effectively utilized for successive waves of the pandemic. ■

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The authors and planners have disclosed no potential conflicts of interest, financial or otherwise.

DOI-10.1097/01.NURSE.0000736896.37125.23