The novel coronavirus emerged in Wuhan Province, China in December 2019\(^1\). Twenty-seven cases of pneumonia with unknown etiology were identified to be caused by a novel coronavirus (SARS-CoV-2) isolated from deep airway suctioning samples. Patients presented with similar symptoms including dry cough, fever, and dyspnea. Nearly all were noted to have bilateral lung infiltrates on imaging and in severe patients, common lab findings include elevated neutrophil count, D-dimer, BUN, and creatinine, and decreased lymphocyte count. Inflammatory markers have also been noted as increased\(^2,3\). The disease caused by SARS-CoV-2 was named COVID-19 by the World Health Organization (WHO)\(^4\). On January 30, 2020 the WHO declared the COVID outbreak a Public Health Emergency of International Concern\(^1\). COVID-19 landed in New York City with its first confirmed case on March 1, 2020\(^4,4\) and now is responsible for over 187,848 cases and 15,422 confirmed deaths as of May 14, 2020\(^5\). As cases started to rise, people were encouraged to stay home and only leave for essential reasons, termed social distancing by public health officials. New York City closed nonessential businesses and schools mid-March in an attempt to limit viral transmission. Currently only essential personal are allowed to be working outside the home.

St John’s Episcopal Hospital (SJEH) is a 257 bed urban community hospital in Queens that is home to 8 residency programs and a medical school clinical training program. SJEH was the first hospital in Queens to have a confirmed case of COVID-19. The patient was admitted on March 7, and up to 40 health care workers were quarantined for possible exposure from direct contact\(^6\). The General Surgery residency was the first to modify scheduling, reducing housestaff to a skeleton crew to decrease exposure. On March 8, surgical residents transitioned to 12-hour shifts with reduced coverage. This eliminated 24-hour shifts, with the hope that residents would be better rested, maintain high efficiency, and decrease fatigue-related errors in anticipation of a significant increase in patient volume. Simultaneously, elective surgeries were canceled due to limited coverage and to avoid possible exposure for noncritical patients.

As the number of cases grew, New York State mandated that hospitals increase intensive care unit (ICU) bed capacity by 50%. The standard ICU capacity of SJEH is 16 beds. An ad-hoc ICU (termed the COVID-19 PACU ICU) was created in the post anesthesia care unit (PACU) to be staffed by surgical residents, 2 of whom were fellowship trained in critical care, and a board-certified surgical critical care attending. A critical care medicine attending was also available for backup coverage. Resident schedule was divided between 3 teams (each subdivided into day and night teams): 2 for the COVID-19 PACU ICU and 1 general/vascular surgery team working outside of the unit. This division allowed for adequate coverage of the COVID-19 PACU ICU, consults, and emergency surgeries. It also allowed for appropriate rest and a built-in redundancy to allow for coverage in the event of illness.

As of May 14, 2020, Queens County had the highest number of confirmed cases in the United States at 57,865\(^5,7\). Queens County also had the second-highest number of deaths at 4610 in the United States\(^5,7\). Including the 9 ICU beds available in our COVID-19 PACU ICU, our hospital ICU capacity increased to 30 beds. The total number of beds available in Queens County was 146.

Below is the prototype designed and implemented by the Department of Surgery to convert the PACU into the COVID-19 PACU ICU. The PACU is an open unit of 7 monitored bays with 1 room capable of holding 2 additional patients for isolation. A Pyxus MedStation, supply room, soiled utility room, and multiple work stations are within the unit. The entire PACU was converted to negative pressure. This study was registered with Research Registry under the UIN: researchregistry5627 and prepared in accordance to the STROCSS guidelines\(^8\). Ethics committee approval was not necessary as no patient treatment protocols or interventions were being investigated. All treatment was within the current standard of care and the aim of the study is a retrospective observational discussion of the rapid setup of an ad-hoc ICU.
Unit setup and patient criteria

Unit setup focused on equipment availability to limit delays in care, traffic in and out of the unit, and anticipation of potential complications. This included ventilators for each bay, 2 EKG machines, bedside ultrasound, code cart, and emergent airway cart. Additional central line, arterial line, thoracostomy tube, Foley catheter, and nasogastric tube kits, as well as lab draw and patient care supplies, were available. Each bed was outfitted with a kit of common supplies such as gauze, saline flushes, syringes, oral care kit, thermometer, and Toomey syringe/NG supplies.

Ethics approval was not necessary as this was an observational study in the height of the COVID-19 pandemic and did not involve treatment protocols or investigations. All study results were collected in a retrospective, observational manner. No cohort groups or comparison groups were used.

All beds had curtains for privacy in the event of approved visitations for terminal patients, but curtains were otherwise open to allow providers full visual access to the unit. Maximum patient beds are 9, with an average census of 8.

Acceptance criteria included intubated patients with COVID-19 positive serology and no other positive cultures at the time of unit admission. Recruitment was based on available beds and patients meeting criteria that were not already in a critical care unit. Because of equipment restrictions, no hemodialysis patients were accepted. All patients were ventilated with viral filtered circuits. Circuit disconnections were limited to only acute necessary interventions (ie, ETT exchange) and not disconnected during codes. Patients who were successfully extubated were placed on supplemental oxygen with a surgical mask, or on CPAP/NIVPS with vent ports sealed and viral filtered circuit.

All patients received a Foley catheter, Salem Sump NG tube, triple lumen central venous catheter, and arterial line upon entrance. Patients had COVID-19 serology repeated 2 weeks after the first positive test, then weekly to assess for negative conversions. Treatment protocols were standardized as much as possible to decrease the possibility of errors.

Staffing

Surgical residents were in the unit and attending physician available by phone or on the unit at all times. Residents were assigned in 1-month blocks of 12-hour shifts, with 2 teams alternating in 3 and 4-day rotations (ie, 3 on, 3 off, 4 on, 4 off). Team members did not change during the month rotation with exception to cover for illness. Day teams consisted of a surgical critical care fellow and 2 residents (PGY 1–4), along with a Physician Assistant on weekdays. Night teams consisted of a senior resident (PGY 4 or 5) and 2 junior residents (PGY 1–3). Residents assisted in all areas of patient care and preformed all lab draws.

The nursing staff was OR or PACU nurses and surgical scrub techs (CSTs), many without any critical care experience. All staff (including respiratory and anesthesia departments) received training on donning before opening the unit, including hands-on practice. Nursing staff met with IT to learn the proper use of the charting system (MediTech) outside of perioperative requirements. The average nursing ratio was 3–4 patients per nurse, with 1–2 CSTs per shift. Anesthesia and respiratory therapists were available as needed but not exclusively assigned to unit coverage.

Of note, nurses and CSTs also covered the operating room in the event an emergency case.

All staff wore full personal protective equipment (PPE) while in the unit, including N95, the hospital provided scrubs, gowns, gloves, face shield, and head covering. Gloves were changed between patients, but the remaining PPE was not removed while in the unit. Shower facilities were available.

Results

Literature and recommendations are continuously changing as the pandemic grows, and the treatment protocols used within the unit were altered frequently to represent current best practices. From the opening of the unit on March 27, 2020, to the closing of the unit on May 13, 2020, 20 patients were treated in the COVID-19 PACU ICU. Of those, 7 patients were extubated and left the unit in stable condition (35%), 4 patients had tracheostomy tubes placed, and left the unit in stable condition (20%). Three patients were discharged home (15%), 3 patients were discharged to a skilled nursing facility (15%), 1 patient was transferred to the JAVITS center, and 1 patient was transferred to the USNS Comfort. Although no published data existed as to successful extubation rates, New York State governor Andrew Cuomo estimated that “about 80% of the people who are intubated will not come off of the ventilator.”

One resident has been positive for COVID-19, with the confounding factor of a physician spouse who works at a different institution testing positive several days prior. We attribute this low rate of provider illness to adequate PPE and a schedule that accommodates days off to reduce exposure and promote rest.

Discussion

The conversion of PACU to a COVID-19 ICU was a vital capacity increasing move during the overwhelming rise of patients during the coronavirus pandemic. Careful planning to supply the unit with adequate equipment, allow around the clock in-unit resident coverage, and ensure proper PPE allowed the unit to run smoothly and efficiently. The role of team-based medicine was highlighted as the residents, nurses, and CSTs worked together in overlapping roles to ensure high-quality care despite higher than usual critical care staffing ratios.

Throughout the initial set up of the unit, several challenges were experienced. First, the nursing staff had minimal critical care training and EMR training. This improved quickly with time; however, having an ICU nurse to assist and train for the first few days would have made the transition easier. In addition, many outside consulting services were initially unaware of the training and capabilities of the attending and fellows within the unit, leading to confusion and hesitation from other services over patient management. We also quickly identified several things that made the unit function more efficiently; notably having a tube system that allowed pharmacy, lab, and central supply to quickly send urgent medications and small supplies, and having technicians available from the operating room staff to run labs, obtain narcotics and blood products that can’t be delivered through the tube system, and assist in restocking bedside care kits. A major key to success was the staffing of the unit with resident physicians around the clock, which allowed anticipatory treatment of patient decompensation, immediate attention to
acute events or change in patient status, and helped to reduce nursing workload by assisting with lab draw, patient care, and family communications. Consistent teams of resident physicians also allowed for easy flow of care, recognition of unique patient patterns, and continuity of care while allowing for isolation of teams and redundancy in staffing to minimize the effects of any illness. This study has several limitations; all patients were in critical care and intubated at admission to the unit, The experience described was a single-center study with limited variability in staff, and follow-up was limited. The experiences we had developing an ad-hoc intensive care unit during the COVID-19 pandemic can be applied globally in times of mass casualty incidents, epidemic/pandemic infectious diseases, or for any acute need to increase hospital critical care capacity. Focus on the team-based patient care, close provider attention, preemptive management of supply availability, and constant reevaluation of areas for improvement are vital to the success of an ad-hoc intensive care unit. Each pandemic is unique and one must encourage flexibility to change as the situation unfolds.

Ethical approval
Ethics committee approval was not necessary as no patient treatment protocols or interventions were being investigated. All treatment was within current standard of care and the aim of the study is a retrospective observational discussion of the rapid setup of an ad-hoc intensive care unit.

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