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Use of the Donabedian Model as a Framework for COVID-19 Response at a Hospital in Suburban Westchester County, New York: A Facility-Level Case Report

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Contribution to Emergency Nursing Practice

- Current literature on emergency department response to coronavirus disease demonstrates that widespread screening and infection control measures are necessary for controlling viral spread.
- The main finding of this paper is that pandemic response can be structured using a known quality model to seek patient and staff safety outcomes.
- Key measures for emergency department leadership to include in clinical practice are to identify modifiable structure and process measures which can result in improved safety.

Abstract

The purpose of this facility-level case report was to describe our facility's leadership process of applying the Donabedian model to structure an early response to the coronavirus disease pandemic relative to emergency care. Using the Donabedian model as a guide, both structure and process changes were implemented to maintain high-quality clinical outcomes as well as ED staff safety and engagement. Rapid changes to the model of care, both architecturally and through the expansion of universal precautions through personal protective equipment, created the foundation for what was to follow. Clinical, service quality, and staff safety outcomes were evaluated to demonstrate that the collaborative changes that follow a known process improvement model can be used to address the coronavirus disease pandemic. Further study is needed to compare the outcomes of this facility-level case study with those of others to evaluate the success of the measures outlined.

Keywords: Hospitals; Donabedian Model; Pandemics; Emergency Department; COVID-19

Background

In January 2020, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified as the novel coronavirus responsible for the cases of pneumonia in the Hubei province of China earlier reported to the World Health Organization (WHO).[1] In the following weeks, outbreaks of the virus were reported in Iran, Italy, Spain, and finally the United States. New York was among the first states to report a positive case of coronavirus disease (COVID-19) and as of June 2020 remained the US state with the highest number of confirmed cases.[2] In this manuscript, we present a single-facility case report of the leadership's application of the Donabedian model[3] to guide the modifications made to a high-volume nonteaching emergency department in Westchester County, NY, during the first wave of patients seen during the COVID-19 pandemic.

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Problem Description

Westchester County is home to a diverse population of nearly 1 million residents,[4] including those who work in the county and those who commute to the boroughs of New York City. White Plains Hospital serves a large portion of lower Westchester County, in addition to parts of Bronx, New York City. The hospital's emergency department is the highest-volume emergency department in Westchester County, surpassing 65 000 ED visits in 2019. The nature of the region dictates that public health issues affecting the greater metropolitan area have a direct impact on the county and its inhabitants. Public transportation is commonly used to travel into and out of Manhattan. It is reasonable to assume that the geographic proximity of New York City to Westchester County had a significant impact on the rate and severity of the cases seen.

Westchester County reported its first positive case of COVID-19 on March 2, 2020. Positive cases peaked on March 25, 2020, surged again on April 8, 2020, and began to decline steadily after April 15, 2020.[5] The initial outbreak in Westchester occurred 9 miles from White Plains, in New Rochelle, NY. Hundreds of community members were exposed at a synagogue in New Rochelle, many of whom lived in the neighborhoods adjacent to White Plains that are served by White Plains Hospital.

Available Knowledge

Peer-reviewed literature was emerging and notably scarce during this facility's initial response to the COVID-19 pandemic. Publications and updates from the Centers for Disease Control and Prevention (CDC) and the WHO were the primary sources of information used by this facility's ED leadership team during the initial outbreak. Available evidence in the literature supported the use of infection control strategies such as the addition of anterooms to care areas for donning and doffing of personal protective equipment (PPE); designated areas for patients at high or low risk for COVID-19; and refresher education for staff on the application and removal of PPE,[6] surface decontamination, and frequent cleaning practices.[7] The successful response strategies employed during the Middle East respiratory syndrome pandemic for routine infection control measures, including the use of PPE, handwashing, and contact tracing for exposed employees, were also considered.[8]

Rationale

As leaders at the facility, we sought a shared mental model to structure our facility's pandemic response. We evaluated the Donabedian, Systems Engineering Initiative for Patient Safety 2.0, and Plan-Do-Study-Act models. The Plan-Do-Study-Act model[9] demonstrated the ability to test the changes made but was not applied in real time because the changes in the department occurred too rapidly to evaluate the outcomes of each intervention. Although the Systems Engineering Initiative for Patient Safety 2.0 model[10] exhibited the capacity to clearly stratify the factors in the work environment that affected outcomes, the elegant simplicity of the Donabedian model was used here as the best fit for the crisis situation of the pandemic response.

The Donabedian model[3] has been used as a framework for health care quality since 1966.[11] The model describes structure, process, and outcome measures as having synergistic relationships, each important to the evaluation of health care quality. Structural measures are described as characteristics of the space where care occurs, including architecture and availability of equipment; process measures include delivery of care to patients and the workflows encompassed therein; and outcome measures describe the effects of health care on populations.[12] The Donabedian model has been used to evaluate ED triage processes and has successfully validated the relationship between structure and process measures.[13] Another study[14] described the specific structure, process, and outcome measures as either barriers to or enablers of quality of care. Although the body of research surrounding SARS-CoV-2 was not yet established, we postulated that the structure and process measures would provide a framework to enable a comprehensive pandemic response, as well as to further research the demonstrating enablers of positive patient and staff outcomes.

Specific Aim

The purpose of this facility-level case report was to describe our facility's leadership process to apply the Donabedian model to structure the COVID-19 pandemic response relative to emergency care. The desired outcomes identified by the ED leadership during the initial outbreak at the facility site included the safety of patients and staff, the provision of quality care to all patients presenting to the emergency department, including those solely seeking COVID-19 tests, and the continuous availability of PPE for staff protection.

Methods

DESIGN

A facility-level case report of the application of the Donabedian model was used to retrospectively evaluate structure, process, and outcome measures. As a quality improvement

project, this project was not considered human subjects research at this facility.

CONTEXT

White Plains Hospital is a 292-bed nonprofit medical center located in lower Westchester County, NY. From March 2020 through April 2020, this emergency department was challenged by the nearby threat of increasing illness burden and death being faced by the health systems in nearby New York City as the pandemic surged. As infection rates rose, nearly 30 000 people tested positive for the virus in Westchester County. This resulted in more than 1000 deaths, stretching the health system beyond its capacity and presenting an enormous challenge to hospitals countywide.

INTERVENTIONS

The creation of innovative systems during the pandemic response was necessary to care for the volume and acuity of patients presenting to the emergency department at the time. The pandemic response interventions implemented at the facility's emergency department are described in detail according to the Donabedian model, classifying the changes as structural, process, or outcome. For clarity, these interventions will be described chronologically, with a further breakdown of the measures using the Donabedian model in supplementary charts. The interventions included initial screening and triage changes, capacity management, expanded screening and capacity interventions, addressing staff safety and morale, testing and surveillance, and telehealth. The team involved in making high-level decisions for the initial response included the physician director and assistant director of the department, the registered nurse (RN) nurse manager, and the RN clinical quality analyst, all of whom are leaders in the department and, in addition, provide direct patient care. Given the rapidly evolving and fluid nature of the pandemic response interventions, we have made our best efforts to describe the risks considered acceptable in the context of this crisis situation and the countermeasures employed to negate them.

STUDY OF THE INTERVENTIONS

The Donabedian model was used to conceptualize, plan, and evaluate the facility's pandemic response interventions (Figure 1). Extended measures, such as complications, were not included in this evaluation because the field of COVID-19 response measures was in its infancy, and the disease's complications were not yet well documented.

MEASURES

The measurements that may reflect the staff safety outcomes include the number of staff sick calls, number of staff who contracted COVID-19, and quantity of available PPE. Service quality is reflected in the overall number of patients who received care in the emergency department, the percentage of these patients who received a COVID-19 diagnostic test, and the percentage of patients who left the emergency department without being evaluated.

For this quality evaluation, the measures collected were those able to be analyzed retrospectively from administrative data. Daily sick calls were recorded in real time in the facility's staff scheduling system and were queried later for analysis. ED patient census, patients who left without being evaluated, and the percentage of patients receiving a COVID-19 test were tracked using real-time analytics software. The software used was populated by the electronic medical record system, recording the number of patients registered daily as well as their disposition and the procedures performed. Our department was unable to retrospectively analyze PPE quantity; therefore, this measure was not quantified in this analysis.

ANALYSIS

Descriptive analytics were applied to the aforementioned data to create the charts in Figures 2, 3, and 4. The data gathered allowed our team to identify and demonstrate when patients and staff were most affected by illness during the initial pandemic surge.

Results

PHASE 1: INITIAL SCREENING AND TRIAGE CHANGES

The hospital began screening all patients for exposure to SARS-CoV-2 on February 28, 2020. In early March 2020, the hospital confirmed its first cases of COVID-19. The ED leadership team immediately recognized the potential for infectious spread in the care areas and set about to mitigate the risk to noninfected patients and staff members.

Under normal operations, patients and families were quick-registered and then seated in the waiting room before being triaged. Patients classified as infectious and those classified as noninfectious sitting alongside one another without the opportunity to implement social distancing demonstrated potential danger.

Recognizing that a waiting room nurse could potentially expedite care for patients at clinical risk,[15] a "quick-look"

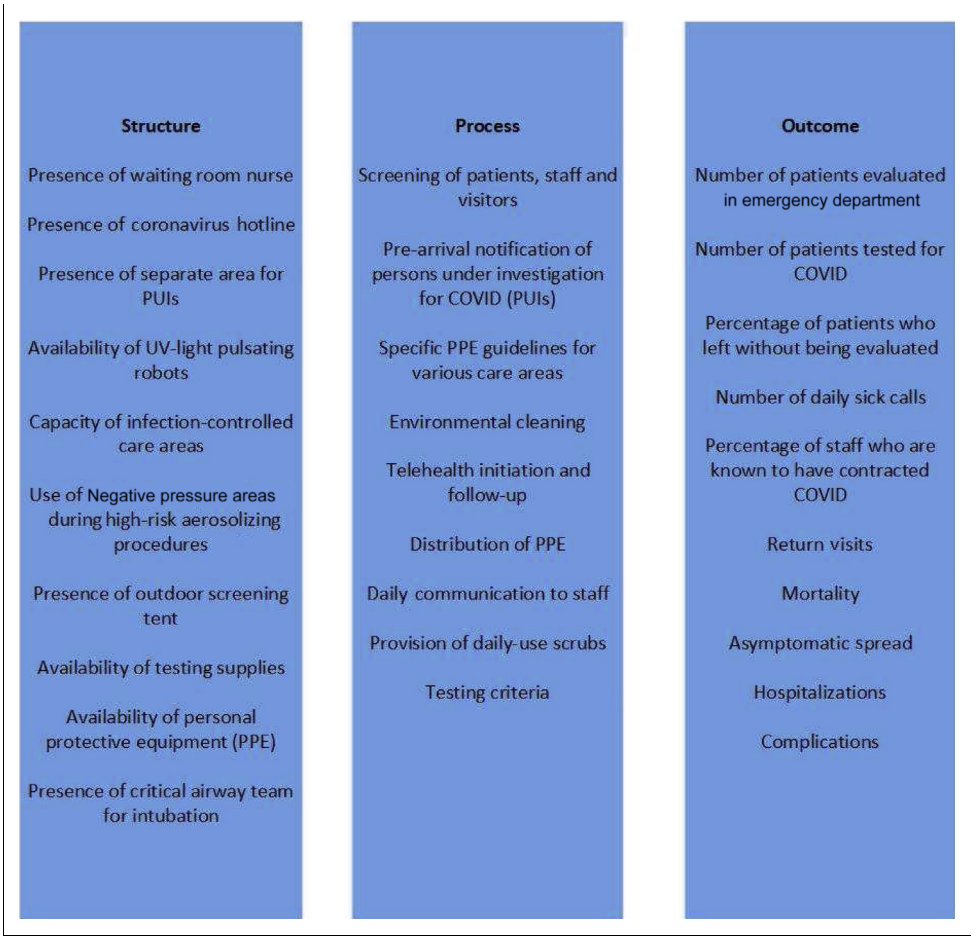


FIGURE 1

Measures as described using the Donabedian model. COVID-19, coronavirus disease; PUI, person under investigation for COVID-19; UV, ultraviolet.

RN was implemented on March 10 to perform the initial screening of patients and visitors. This RN, installed in the waiting room wearing full PPE, was tasked with screening all patients and visitors who presented to the emergency department by measuring oral temperature and asking 2 screening questions. The initial screening questions were an inquiry about travel to affected countries (Figure 5, question 1) and about the presence of fever and cough.

Changes to screening occurred almost daily in the following days. On March 17, community spread in our area was recognized, prompting the CDC as well as local and state health departments to provide guidance for process changes, including suggested screening measures and goals of mitigation strategies.[16] Early in our surveillance of COVID-19 cases in the emergency department, we observed multiple exposures of patients and staff to patients who initially screened negative but later tested positive for COVID-19. The screening of patients at the time of presentation was not always effective. During their visit, many patients with symptoms such as abdominal pain or diarrhea were found to have pneumonia on chest radiographs; these patients then tested positive for COVID-19. For each situation in which the initial screening failed to capture a patient classified as positive, dozens of staff were exposed. Notifying the exposed staff added to the workload of the leadership team as well as contributed to the fear and anxiety expressed by the frontline staff at daily team meetings. Healthy patients and their family members were also exposed to SARS-CoV-2 during the screening in place at the time. The screening questions were progressively pared down to the chief complaint and presence of fever or cough; this made screening more efficient and captured patients requiring investigation for SARS-CoV-2 as well as prevented staff exposures.

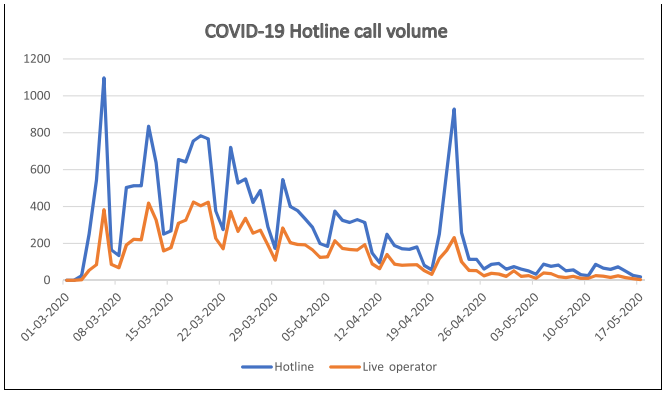


FIGURE 2

Coronavirus disease 2019 hotline call volume. COVID-19, coronavirus disease.

As an additional measure to mitigate staff and patient exposures as well as to provide support to the community, our hospital operated a COVID-19 hotline to provide information about symptoms, exposures, and testing. The phone number for the hotline was publicized in local government communications, and community members calling in were able to be triaged over the phone by ED physicians and redeployed nurses from nonclinical areas. The ED director oversaw the hotline staff and developed the hotline screening and referral procedures in collaboration with the local department of health. This ED prearrival contact helped to provide the earliest possible warning of patients who may present for testing so that the staff could take appropriate precautions when receiving the patient into the facility. From March through May 2020, the hotline received more than 20 000 calls from community members, with nearly half of those speaking with a staff member, whereas the other half heard a recorded message. This service

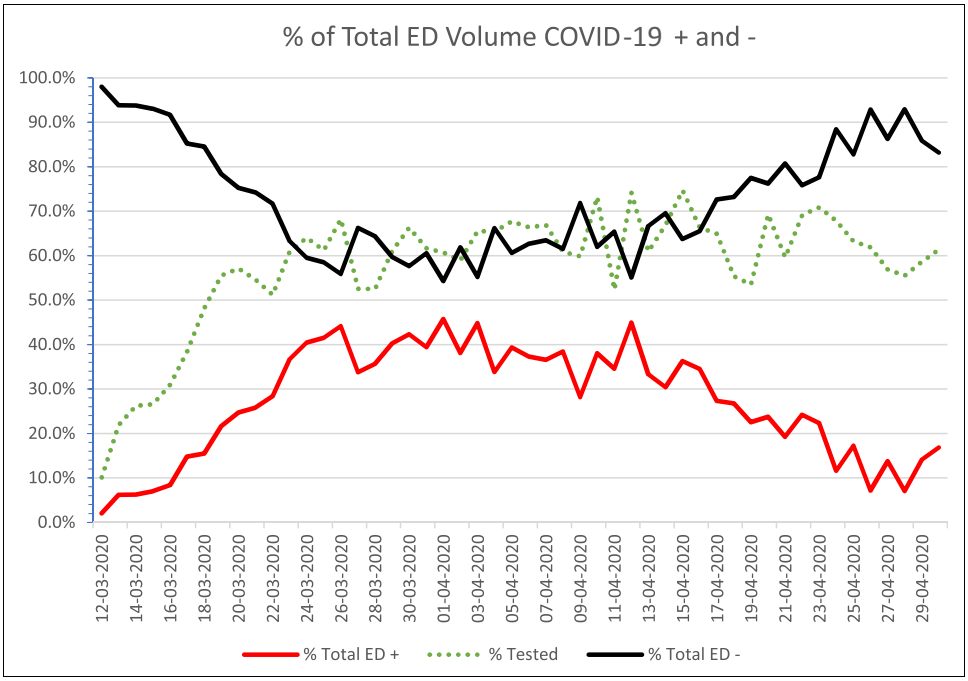


FIGURE 3

Percentage of ED volume tested for coronavirus disease 2019. COVID, coronavirus disease; ED, emergency department.

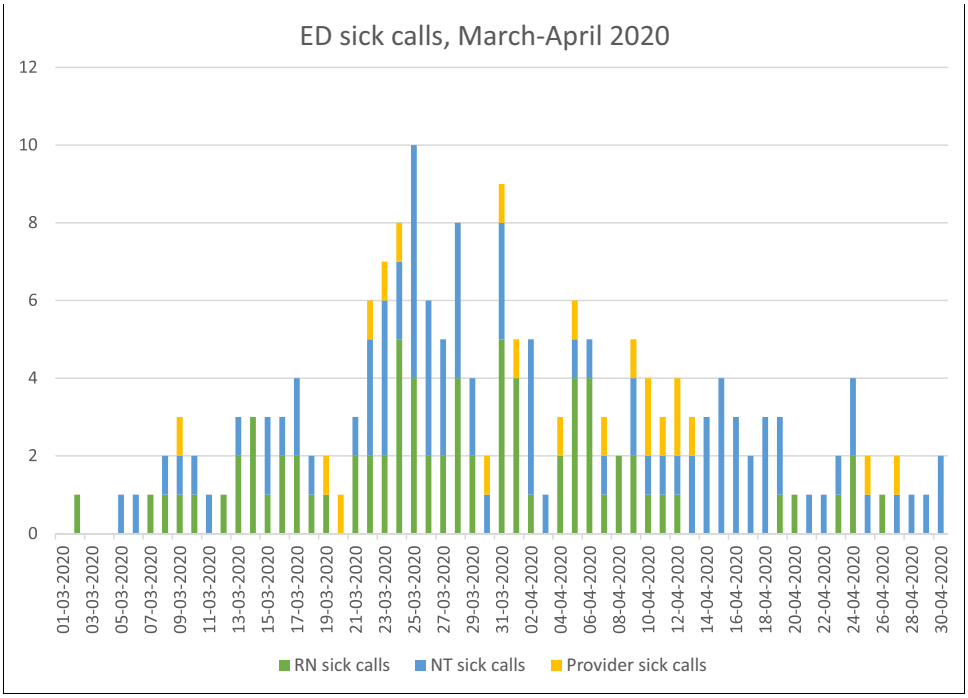


FIGURE 4

ED, emergency department; RN, registered nurse; NT, nursing technician.

provided an educational resource to the community and may have prevented countless ED encounters that threatened to overwhelm the health care system (Figure 2).

In consideration of the risk to visitors, visitation was limited in the emergency department beginning when we first placed patients under investigation for COVID-19 (PUIs). Visitation was limited to 1 person per patient beginning March 9 in the emergency department and throughout the entire facility on March 10. On March 16, visitation was eliminated by the facility except for pediatric patients arriving with a caregiver. These decisions were supported by the CDC[17] and later by the Department of Health; on April 10, the state announced that hospitals were required to suspend visitation.[16]

On March 15, the PPE guidelines were modified to further protect patients and staff. Each patient presenting to the emergency department was given a surgical mask on entry. All employees were required to don N95 particulate respirators for the duration of their shifts to offset the risk of exposure to patients not considered to have initially screened positive.

ED employees' screening on presentation to work was implemented on March 11 and hospital-wide on March 13. After March 13, this intervention was managed by hospital operations, not the emergency department. Employees reporting to work were required to undergo screening each day and were given a colored sticker on their badge to indicate that they had passed a contactless temperature screening on arrival. The alternative entry points to the hospital were closed to ensure that all staff passed a screening checkpoint on arrival each day and were turned away if they had a fever or reported any signs of illness. This screening was an important measure taken by the hospital, which was suggested by the CDC[17] to reduce viral transmission among employees. Communications from occupational health were emailed to all staff, encouraging them to report any signs of illness and to stay home from work if they experienced any symptoms.

PHASE 2: CAPACITY MANAGEMENT

Capacity management was an obvious challenge to our emergency department because an increasing number of patients with positive risk screenings for COVID-19 presented to the emergency department for care. Under normal operations, the emergency department had 5 negative pressure rooms and 2 high-efficiency particulate air filters, allowing for the care of 7 patients under airborne isolation at a given time. After implementing multiple iterations of structural changes, the capacity increased to care for 46 patients under

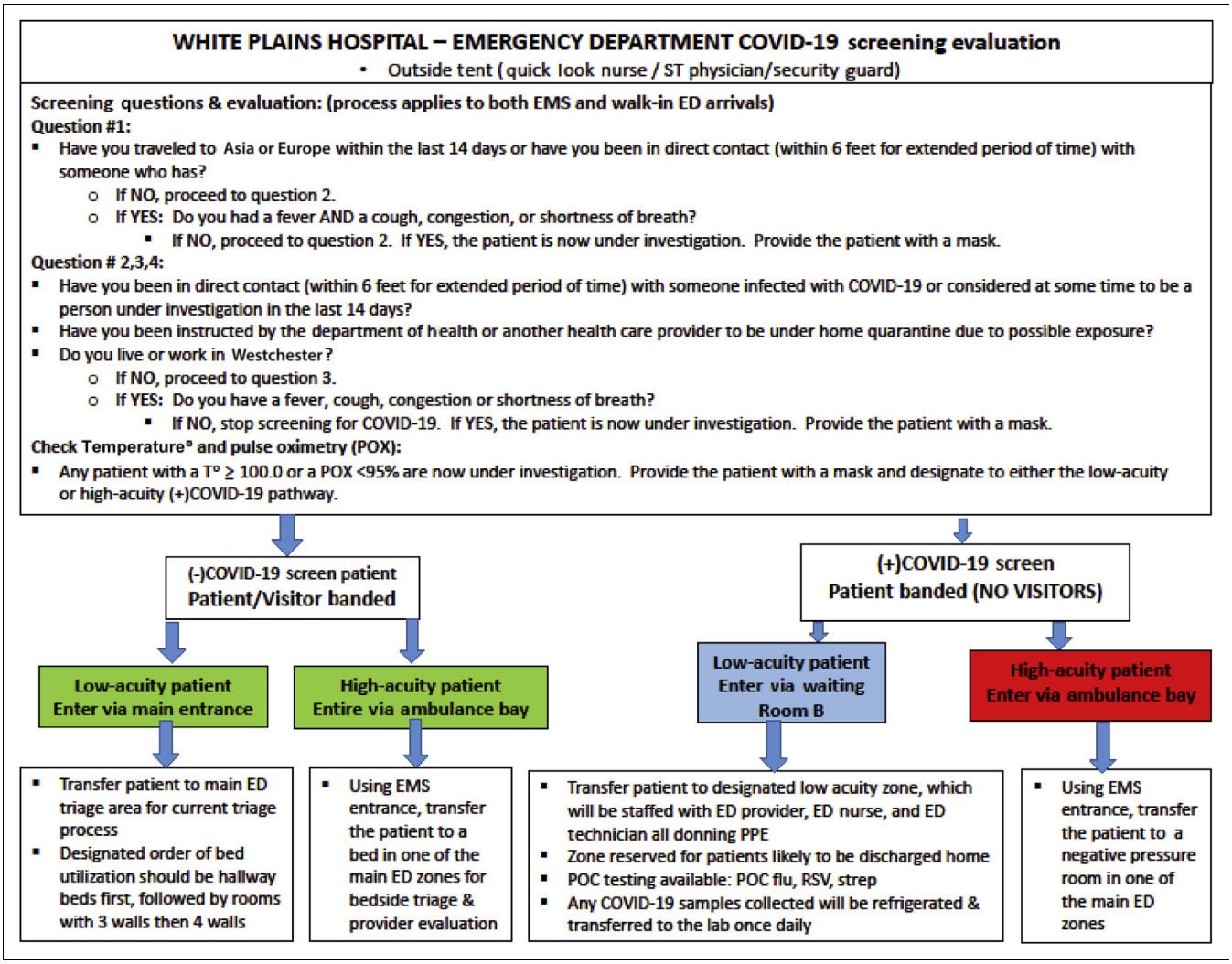


FIGURE 5

Coronavirus disease 2019 screening performed in outdoor screening tent. COVID-19, coronavirus disease; EMS, emergency medical services; PPE, personal protective equipment; POC, point of care; RSV, respiratory syncytial virus; strep, group A streptococcal infection.

isolation for SARS-CoV-2 while maintaining the best possible infection control practices.

Under usual operations, the department was separated into 3 distinct sections over 2 floors, and the negative pressure rooms were evenly spread among them. In addition, there were several rooms with doors that allowed the addition of a high-efficiency particulate air filter; these too were evenly spread among the 3 care areas. Under these conditions, each zone was receiving PUIs, with nurses and providers caring for a mix of patients classified as potentially infectious or noninfectious. As the volume of PUIs increased, the rooms would fill up quickly, causing the care team to use less-than-ideal spaces for these patients. Examples included rooms with a curtain rather than a door, hallway beds while waiting for a negative pressure room, or holding in the triage area. Such conditions contributed to the exposure of other patients and staff, as well as high PPE burn rates and inefficiencies related to infection control measures. Increasing the capacity for patients classified as infectious quickly became a top priority.

The first example of structural change to increase our capacity for PUIs was the development of a low-acuity zone for ambulatory patients whose risk screen was positive and who required assessment and care. This area, colloquially known to staff as the "COVID café," opened on March 13, 2020. It was constructed using half of the ED waiting

room, an area of 1043 square feet. Modular hard wall panels were used to divide the waiting room; half would become the low-acuity zone, whereas the other half would remain an entry point to the main emergency department. A former security booth was converted into a nurses' station with telephones, computers, and handwashing stations installed. A medication box was mounted on the wall, and airflow was modified in the area to make the entire zone negative pressure relative to the adjoining spaces.

Sixteen vertical (chair) care spaces were ultimately created in this area to care for mostly healthy young adults presenting with fever and cough. Patients were given a surgical mask on initial screening and immediately escorted to the low-acuity zone for triage. The chairs were sanitized between each patient visit. Staff working in this area donned full PPE and spent 4- to 6-hour stretches staffing this zone, switching out at break times to prevent burnout and PPE fatigue. Diagnostic tests performed in this area included COVID-19 nasopharyngeal swabs, the rapid group A streptococcal infection test, rapid influenza test, rapid respiratory syncytial virus test, and chest radiographs. Most patients were treated and discharged within 60 minutes. Limitations of the electronic medical record prevented the extraction of all patient data from the COVID-19 low acuity zone. However, a sample of 100 patients seen in this zone by 6 different providers in April 2019 revealed that 69% of patients had an arrival to departure time of less than 60 minutes. Mean arrival to departure time was 55.2 minutes (median 47.5 minutes, standard deviation 27.6 minutes). The common treatments given in this area included oral administration of acetaminophen, ibuprofen, and ondansetron. Rarely, patients required transfer to the central area of the emergency department for further evaluation and admission, which was easily done through a back door leading to the ambulance bay.

The primary risk in this area included patient-to-patient transmission. Although the patients cared for in this area were given surgical masks on initial presentation, we recognized the possibility of droplet transmission among patients in the zone. Whenever possible, patients were placed more than 6 feet apart. The entire area was terminally cleaned each day, and ultraviolet (UV)-light–pulsating robots were used by our environmental services (EVS) department once daily to reduce surface contamination.

PHASE 3: EXPANDED SCREENING AND CAPACITY MEASURES

The second structural change implemented in the emergency department was the installment of a 594-square-foot outdoor screening tent on March 17. Installed in the parking lot outside the department's ambulance bay, this space became the entry point for all patients entering the emergency department, including those brought in by ambulance. The shelter provided an additional barrier between the main emergency department and patients with potentially infectious conditions. On entering, patients were provided with a surgical mask, and patient screening measures (Figure 5) were performed. Patients who screened positive were then placed on isolation precautions when they entered the emergency department and sorted to the aforementioned low-acuity zone, into a private ED room, or into the high-acuity area that was developed the following week.

When the outdoor screening tent was set up, it was already recognized that there were more patients classified as high acuity with positive COVID-19 screenings than available isolation rooms. Room turnover was a challenge, with terminal cleaning after patient departure taking up to 90 minutes. A COVID-19 high-acuity zone was created to respond to this issue and to add another layer of protection for our staff. In this space, a supply room was converted into a vertical care area, whereas an examination room and an office were converted into supply rooms. This separate and distinct high-acuity zone opened on March 23 with 8 rooms, 12 upright chairs, and 6 hallway beds. On March 29, the area was expanded to include an additional 4 rooms and ED radiology (computed tomography scanner and plain film radiology were included). Colloquially called the "COVID Suites" by our staff, this entire area was made negative pressure to reduce airborne exposures and was designed with designated donning and doffing rooms at the entry and exit points. Employees working in this area remained in full PPE for their time spent in the area, typically 4 to 6 hours, before switching with other staff. The area was considered a contaminated space because each room did not have individual airflow, but the overall space was negative pressure relative to the adjoining areas. The layout of the department after creating this change is illustrated in Figure 6.

Nosocomial spread of the virus in the high-acuity zone was a recognized risk. Nurses and caregivers were instructed to change outer gloves and isolation gowns between patients, patients were masked, and the airflow of the area helped to mitigate the risk of droplet transmission. Many patients were intubated in this area, reaching a peak of 4 intubations in 24 hours on March 26. Intubation was performed with as few participants in the room as possible because aerosolizing procedures were recognized to pose the most significant risk of viral transmission. Those performing and assisting with intubation were instructed to wear a full-body suit and hood in addition to the baseline PPE (Figure 7).

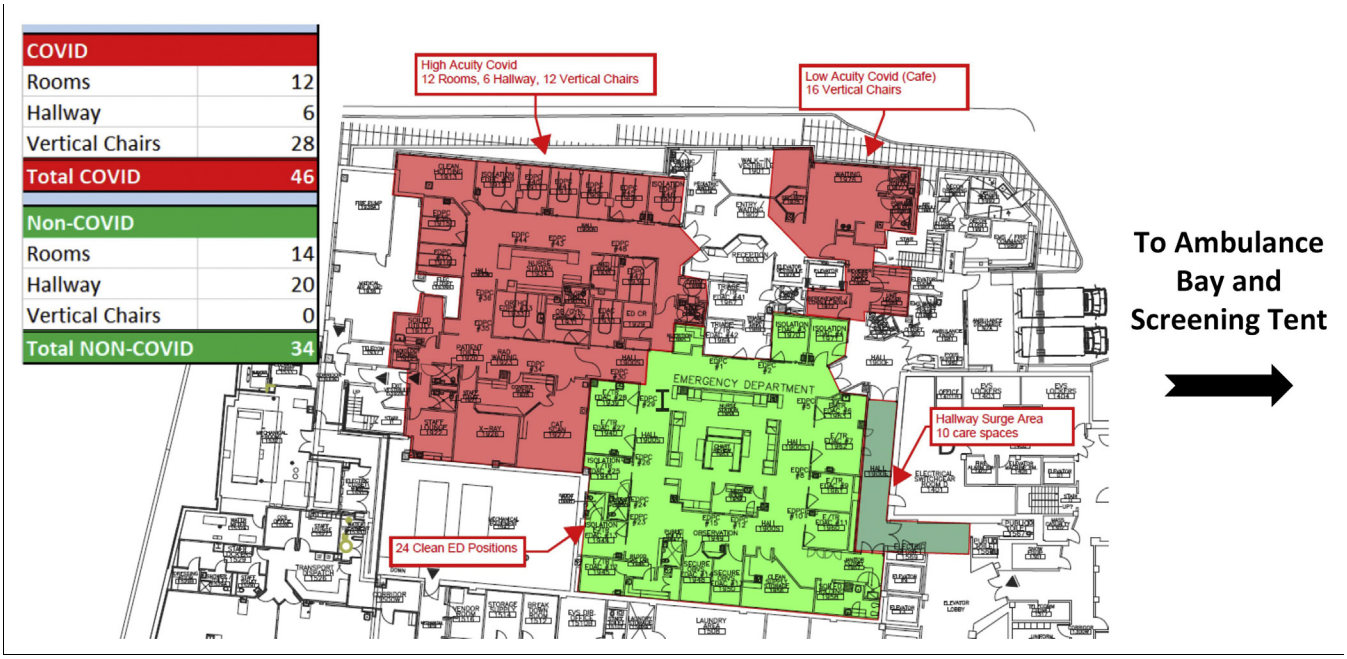


FIGURE 6

Departmental layout after structural changes. COVID-19, coronavirus disease; ED, emergency department.

Room turnover guidelines relaxed as new data emerged regarding the transmission of SARS-CoV-2. Initially, terminal room cleaning, including UV-light pulsation, was required for all PUI rooms after patient departure. Later, the UV light was deemed necessary only if an aerosolizing procedure had occurred in the room. This change, approved by the hospital's infection control department, trimmed the time required for each room cleaning by approximately 30 minutes, creating additional capacity for patients as they arrived.

ED throughput is well known to be dependent on overall hospital capacity and inpatient efficiency. As ED volume rose, there was a concern whether the hospital, despite the cancelation of elective procedures, could manage the surge in volume and acuity. The emergency department partnered with clinical colleagues throughout the organization to make changes to admission criteria on the basis of current epidemiologic patterns. The emerging evidence was evaluated frequently by those involved, and the observations of the patient population were integrated when modifying the admission criteria. Lower oxygen saturation levels and higher respiratory rates were permitted on patients who were discharged home. Patients were referred for admission only if their oxygen saturation level was 93% or less or if they had other symptoms of severe disease (Figure 8). Patients traditionally slated for inpatient care were discharged with home oxygen and the option of telemedicine visits on days 2, 5, and 7 after the index ED encounter to ensure their ongoing safety. These changes were enacted with trepidation from the staff. Maintaining the safety of our patients was a primary concern while conserving hospital capacity, and by extension ED capacity, for the patients who were the sickest at the time and into the future.

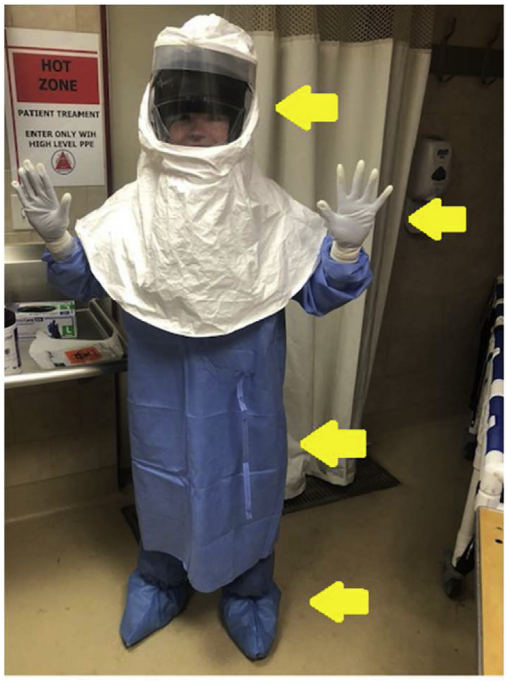
The inpatient census at our facility peaked in early April 2020. As a result of both the hospital's and the emergency department's success in expanding overall capacity, there were no recorded bed shortages. This facility had been so successful in controlling inpatient volume that COVID-19 transfers were received from other regional hospitals. As ED volume dissipated, but the length of stay for hospitalized patients remained extended, the emergency department's upper level was used as an inpatient unit caring for patients classified as COVID-19–negative. This structural change reduced the capacity of the emergency department but did not affect our operations because of the downward trend in ED volume.

STAFF SAFETY AND MORALE

The threat of insufficient PPE availability owing to the disrupted supply chain and global shortage[18] affected this hospital, with the biggest concern being availability of N95 particulate respirators. Under ideal conditions, all face coverings, including N95 masks, were considered single

Main ED Emergency Department + Camp COVID-19 Frontline Staff (RN, NT, Provider, Rad tech, Resp Therapist for all patient care)

- *N95 Mask
- *Goggles
- *Bouffant (if hair longer than shoulder length)
- *Yellow Gown (change between patients in main ED)
- *1 Pair Gloves (change between patients)



Intubation team (RN, Provider, RT)

Base intubation team gear

- *PAPR (goggles + N95 if no PAPR available)
- *Bouffant cap
- *Double glove - blue gloves + surgical gloves
- *White full body suit
- *Shoe Covers

(add when intubating)

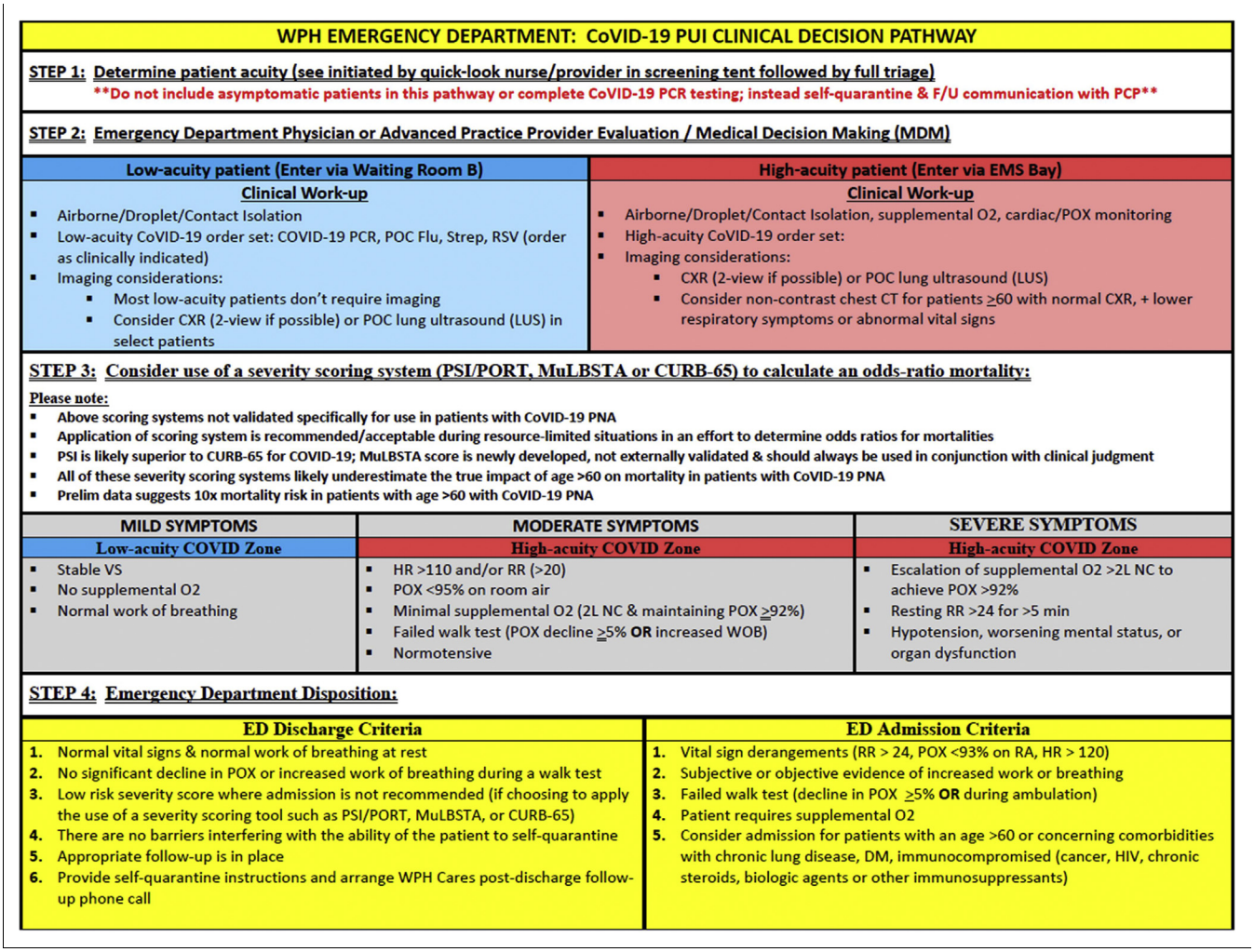
- *Surgical Gown
- *Hood over PAPR

N95 should be stored in donning room

** **2 RN & 2 MD** must be wearing base intubation gear at all times in zone 3. In other zones, add when intubating. **

FIGURE 7

Examples of personal protective equipment guidelines provided to staff. PPE, personal protective equipment; RN, registered nurse; NT, nursing technician; Rad, radiology; Resp, respiratory; COVID-19, coronavirus disease; PAPR, powered air-purifying respirators; MD, physician.



WPH EMERGENCY DEPARTMENT: CoVID-19 PUI CLINICAL DECISION PATHWAY

STEP 1: Determine patient acuity (see initiated by quick-look nurse/provider in screening tent followed by full triage)

****Do not include asymptomatic patients in this pathway or complete CoVID-19 PCR testing; instead self-quarantine & F/U communication with PCP****

STEP 2: Emergency Department Physician or Advanced Practice Provider Evaluation / Medical Decision Making (MDM)

Low-acuity patient (Enter via Waiting Room B)	High-acuity patient (Enter via EMS Bay)
Clinical Work-up	**Clinical Work-up**

▪ Airborne/Droplet/Contact Isolation
▪ Low-acuity CoVID-19 order set: COVID-19 PCR, POC Flu, Strep, RSV (order as clinically indicated)
▪ Imaging considerations:
  ▪ Most low-acuity patients don't require imaging
  ▪ Consider CXR (2-view if possible) or POC lung ultrasound (LUS) in select patients
	▪ Airborne/Droplet/Contact Isolation, supplemental O2, cardiac/POX monitoring
	▪ High-acuity CoVID-19 order set:
	▪ Imaging considerations:
	  ▪ CXR (2-view if possible) or POC lung ultrasound (LUS)
	  ▪ Consider non-contrast chest CT for patients ≥60 with normal CXR, + lower respiratory symptoms or abnormal vital signs

STEP 3: Consider use of a severity scoring system (PSI/PORT, MuLBSTA or CURB-65) to calculate an odds-ratio mortality:

Please note:

- **Above scoring systems not validated specifically for use in patients with CoVID-19 PNA**
- **Application of scoring system is recommended/acceptable during resource-limited situations in an effort to determine odds ratios for mortalities**
- **PSI is likely superior to CURB-65 for COVID-19; MuLBSTA score is newly developed, not externally validated & should always be used in conjunction with clinical judgment**
- **All of these severity scoring systems likely underestimate the true impact of age >60 on mortality in patients with CoVID-19 PNA**
- **Prelim data suggests 10x mortality risk in patients with age >60 with CoVID-19 PNA**

MILD SYMPTOMS	MODERATE SYMPTOMS	SEVERE SYMPTOMS
Low-acuity COVID Zone	**High-acuity COVID Zone**	**High-acuity COVID Zone**
▪ Stable VS ▪ No supplemental O2 ▪ Normal work of breathing	▪ HR >110 and/or RR (>20) ▪ POX <95% on room air ▪ Minimal supplemental O2 (2L NC & maintaining POX ≥92%) ▪ Failed walk test (POX decline ≥5% **OR** increased WOB) ▪ Normotensive	▪ Escalation of supplemental O2 >2L NC to achieve POX >92% ▪ Resting RR >24 for >5 min ▪ Hypotension, worsening mental status, or organ dysfunction

STEP 4: Emergency Department Disposition:

ED Discharge Criteria	ED Admission Criteria
1. Normal vital signs & normal work of breathing at rest 2. No significant decline in POX or increased work of breathing during a walk test 3. Low risk severity score where admission is not recommended (if choosing to apply the use of a severity scoring tool such as PSI/PORT, MuLBSTA, or CURB-65) 4. There are no barriers interfering with the ability of the patient to self-quarantine 5. Appropriate follow-up is in place 6. Provide self-quarantine instructions and arrange WPH Cares post-discharge follow-up phone call	1. Vital sign derangements (RR > 24, POX <93% on RA, HR > 120) 2. Subjective or objective evidence of increased work or breathing 3. Failed walk test (decline in POX ≥5% **OR** during ambulation) 4. Patient requires supplemental O2 5. Consider admission for patients with an age >60 or concerning comorbidities with chronic lung disease, DM, immunocompromised (cancer, HIV, chronic steroids, biologic agents or other immunosuppressants)

FIGURE 8

Admission criteria and clinical workflow. WPH, White Plains Hospital; COVID-19, coronavirus disease-19; ED, emergency department; PUI, Person Under Investigation for COVID-19; PCR, Polymerase Chain Reaction COVID-19 test; F/U, Follow Up; PCP, Primary Care Provider; RSV, Respiratory syncytial virus; CXR, Chest X-Ray; POC, Point-of-care; LUS, lung ultrasound; CT, Computed Tomography Scan; PSI, Pneumonia Severity Index; PORT, Pneumonia Patient Outcomes Research Team; MuLBSTA, (**Score for Viral Pneumonia Mortality**); CURB-65: (**Score for Pneumonia Severity**); PNA, Pneumonia; VS, Vital Signs; O2, oxygen; HR, Heart Rate; RR, Respiratory Rate; POX, Pulse Oximetry; NC, Nasal Cannula; WOB, work of breathing; HIV, human immunodeficiency virus; DM, diabetes mellitus.

use, to be disposed of on exiting a room. Owing to shortage concerns, conservation of masks was required from week 2 of the pandemic response, beginning March 15. Staff were required to use only 2 masks for their shift duration. By March 30, the hospital distributed masks to individual staff members during their daily temperature screening, with those in clinical areas receiving 1 mask per shift. A second mask was to be supplied if a high-risk aerosolizing procedure occurred. The hospital obtained powered air-purifying respirators, to be worn as alternatives to N95 masks in the appropriate care areas. A video demonstrating the PPE doffing process and procedures for cleaning powered air-purifying respirators was sent out to staff to provide a refresher on infection control.

Furthermore, our department provided the staff with guidelines for different PPE levels to be worn, depending on the care area where they were working. These guidelines were disseminated by email as well as by flyers and posters in the donning and doffing areas. ED caregivers received a pair of scrubs daily to be used during their clinical shift and to be returned to be laundered by the hospital at the end of the day. Throughout the emergency department, the universal

precautions included the addition of the N95 mask. In the low- and high-acuity COVID-19 zones, higher levels of PPE were worn, with the highest level being donned by nurses and providers who were expected to intubate patients. Photographs were provided to staff to serve as examples (Figure 7) for staff to select the appropriate PPE for the care area where they would be working for the day.

Early on, the department struggled with the distribution and conservation of PPE. Potential overuse of high-level equipment was observed, and other departments removed PPE from the emergency department to bring to their respective areas of the facility. To combat the waste of PPE, the ED leadership team repurposed supply carts so that the department's unit leader could distribute PPE as designated. This process change effectively promoted conservation and decreased waste. By matching daily demand with what was supplied through the carts, staff members were always provided the necessary PPE without observed gaps in protection. The consistent run rate also made it more efficient for hospital operations to anticipate and address the ED needs daily. We are now able to reliably forecast future PPE requirements in anticipation of the second wave of infections.

The EVS team worked to decrease the bioburden inherent to any patient care area and reduce the likelihood of contact exposures. In response to the aforementioned evidence regarding surface decontamination, the frequency of ED cleaning rounds increased by 4 times the baseline. A member of the EVS team was embedded with the high-acuity COVID-19 zone team to ensure the efficiency of room turnover in that region. The EVS team's efforts were an additional structural and process improvement that fostered the environment of safety outcomes.

Throughout the month of March, the physician leaders used simulation to demonstrate safety measures during the intubation of PUIs. Staff from the emergency department, intensive care, anesthesia, and respiratory therapy collaborated to reduce potential exposures to nurses, nursing technicians, and other staff who may have traditionally been present during intubation. The factors taught included the use of the equipment and procedure modifications to decrease the aerosolization of viral particles, as well as measures to reduce the number of staff in the room during intubation. Those who took the class became part of the COVID-19 Critical Airway Team, a measure that went live on April 2, 2020. This team could be activated to assist with the intubation of PUIs to decrease staff risk during this high-risk procedure (Figure 9). Seventy-three clinicians participated in the class, and 69 intubations were performed by the COVID-19 Critical Airway Team in the month of April.

As care spaces and processes transformed overnight, many staff members expressed frustration that they were uninformed of new changes and often had to "catch up" on arrival to their shift. In response, the leadership sent out daily briefings each evening describing the changes that had occurred throughout the day. The categories of information disseminated in these briefings included patient safety, staff safety, operations, other essential notes, and affirmations. The communications were well received by the

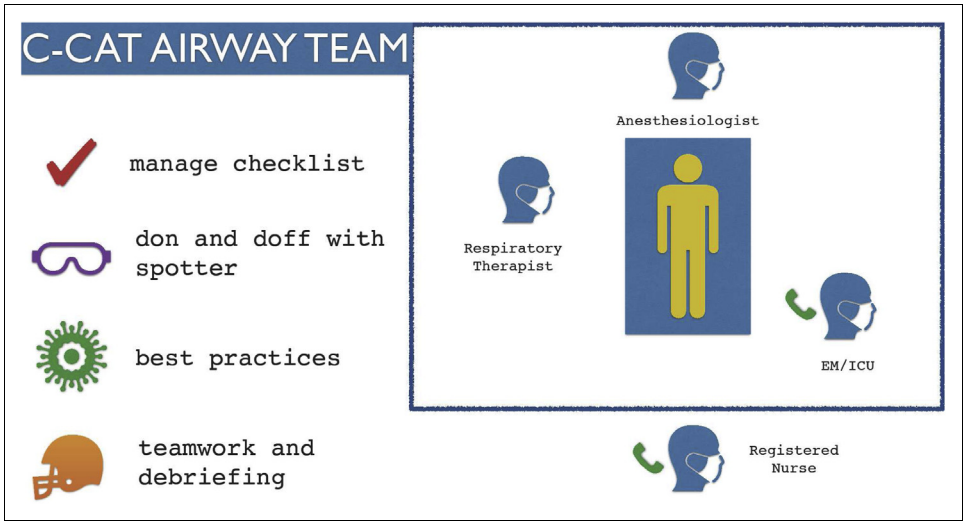


FIGURE 9

COVID-19, coronavirus disease; C-CAT, COVID-19 Critical Airway Team; EM, Emergency Medicine Provider; ICU, intensive care unit.

staff who provided positive feedback. Furthermore, the staff were encouraged to join an online portal, initiated on March 27, which contained copies of the most current processes and procedures and allowed staff to discuss the changes in real time on a secure Web platform.

Our team introduced a weekly happy hour beginning April 10 over a video-conferencing platform. This virtual gathering provided an additional opportunity for staff to decompress, bond, and enjoy the presence of their team members outside of the stressful work environment.

In July 2020, our leadership team held several debriefs with ED staff to identify issues that remained prominent to the staff as our population of patients presenting with COVID-19–related symptoms decreased. The themes that emerged included communication issues, need for supplies, and anticipation of a potential second wave. The leadership is in the process of responding to the concerns of the staff while preparing for future occurrences.

TESTING AND SURVEILLANCE

The availability of testing for COVID-19 has remained a challenge throughout the pandemic in Westchester County. When our facility sent out the first COVID-19 test on March 7, 2020, the guidelines for testing were strictly controlled by the department of health and required that we received approval from it as well as the staff infectious disease physician. Furthermore, only the department of health was conducting tests at the time, and there were no private laboratories to use. In the first week of testing, 10% of the patients presenting to the emergency department qualified for COVID-19 testing (Figure 3). The testing guidelines were subsequently relaxed in the following weeks so that providers could determine the appropriateness of testing independently, and the capacity for testing also increased. By March 12, a private laboratory began to conduct tests with a faster turnaround time than the state laboratory. On March 15, our hospital's partner facility began to receive our tests as well, further easing the testing bottleneck.

On April 3, in-house point-of-care testing was initiated with a 1-hour turnaround time, and we were able to drastically reduce send-out tests being conducted. This newfound testing capability was especially helpful in terms of managing inpatient capacity and sorting patients to the appropriate inpatient units. On April 6, we began the practice of testing all inpatients to ensure that no patients who had tested positive for COVID-19 were presumed to be negative and sent to inpatient units where they could potentially expose others to the virus. Testing peaked in mid-April 2020, with more than 70% of the patients receiving a COVID-19 test while in the emergency department.

TELEHEALTH

Telehealth became a vital process measure implemented early in our COVID-19 response, beginning with video follow-ups for those discharged patients deemed clinically high risk on March 20, 2020. Although the ED staff did not directly perform these subsequent visits, they were responsible for the identification and handoff to the outpatient team to ensure clinical quality through maintaining continuity of care. There were more than 1700 attempted video follow-ups, with 727 patients ultimately having 1 scheduled. Given that most medical practices were ill-equipped to safely care for these patients in an office setting, this process provided a patient-centered approach to care that helped maintain the safety of the greater medical staff and the community. A telehealth visit platform was installed in the outdoor screening tent as well, beginning April 6. This visit type allowed ED providers to remain inside the hospital and perform a medical screening examination of patients remotely. After being seen by the provider through a tablet computer, patients in the outdoor screening tent with normal vital signs could be swabbed for COVID-19 and then discharged home without entering the hospital. Ultimately, the emergency department cared for 273 patients in this manner, which assisted in limiting PPE use and potential staff exposures.

OUTCOMES

Positive identified pandemic response outcomes have mainly been achieved. In March and April 2020, there was never an identified inability to care for a patient because of a capacity constraint. Our internal quality measurements revealed that the patients who were sent home and subsequently returned within 48 hours of their index ED encounter requiring hospitalization remained relatively stable at a rate of 1.1% over the same time frame.

Although these outcome measurements highlighted operational efficiencies, they also served as a marker for clinical quality. What they failed to assess was the perception of care as measured by patients. The service quality measured by Press Ganey (Press Ganey Associates LLC) was noted to be nationally in the upper quartile during our pandemic response. The department ranked in the 92nd and 95th percentiles in the domains of overall assessment and likelihood of recommending, respectively. These outcomes demonstrated that even during an anxiety-provoking and clinically stressful period, the department structure and processes kept the patient at the center of all employed efforts.

Staff sick calls peaked with 10 calls on March 25, 2020, representing 18.5% of the nursing staff scheduled for that

day (Figure 4). A low census in other areas of our hospital system, including radiology and ambulatory surgery, resulted in the redeployment of staff to assist our department during this time. Many of these "floating" staff members were nurses with emergency room experience who were able to fully function as RNs in our department. Others were used in more focused roles such as supply management or infection control; for example, a nurse would be stationed outside a doffing area to provide feedback to staff as they doffed PPE to reduce contamination.

The hospital never ran out of PPE for staff to safely provide care to patients. The New York State Department of Health conducted antibody testing of a sample of health care workers as well as residents of Westchester County; the results were provided to some senior leaders of the hospital demonstrating that 11% of the ED staff tested positive for COVID-19 antibodies. Many variables affect the development of COVID-19 antibodies, including community exposure, home environment, and exposures at work. The leadership at the hospital site interpreted 11% ED staff testing positive for COVID-19 antibodies as providing supporting evidence that this ED team was adequately protected from the virus. Moreover, the antibody rates observed further assured that PPE availability, instruction, and use effectively prevented health care worker infections.

COVID-19–related ED volume peaked on April 1, 2020, and afterward steadily declined. The ability to provide adequate testing increased throughout March and April, starting with the provision of tests to 10% of the ED patients and eventually reaching 75% of the patients by the end of April.

As our ED volume of patients who had tested positive for COVID-19 decreased, structural measures that allowed for a high volume of patients testing positive for COVID-19 were scaled back. The first phase of this was the closure of the low-acuity COVID-19 zone. Even as the department is working toward the resumption of routine operations, it remains prepared for the future, recognizing that the resurgence of SARS-CoV-2 in the community is likely.

Outcomes not measured as part of this case study include inpatient mortality, overall COVID-19 hospitalizations, disease complications, asymptomatic spread, and ED return visits beyond 48 hours.

Discussion

LESSONS LEARNED

This hospital's responsiveness in developing key structure and process measures to address the rapidly changing health care environment serves as an example of innovation during such a time of crisis. In the months since the initial outbreak of COVID-19 in New York, the body of literature surrounding the response to this pandemic has grown significantly. The rapid emergence of new literature to review during this facility's initial pandemic response resulted in the need for daily changes to existing structure and process measures. In hindsight, armed with the currently available literature, this emergency department recognizes successes as well as areas of opportunity for a potential second wave of COVID-19.

Perhaps paramount in terms of process measures, the use of face coverings for patients could have been implemented earlier. Early literature regarding mask use included case reports of asymptomatic viral transmission that was reduced with mask use,[19] but the WHO recommended mask use in public only for those with respiratory symptoms. Universal mask use is believed to be a factor in countries that demonstrate lower rates of COVID-19[20] and was mandated by authorities in New York beginning March 17.[21]

Face coverings worn by staff also underwent multiple iterations before it was decided on March 15 that N95 masks should be worn universally by staff in direct contact with patients at the hospital site. As previously noted, the screening of patients early on was inadequate to capture all patients with COVID-19; this problem was not unique, and asymptomatic transmission of the virus has been observed.[22] The universal use of N95 respirators could have potentially been more effective in preventing health care worker infections at this facility, especially during exposure to patients who had screened negative for COVID-19 but were later found to be infected. However, the use of N95 respirators for all staff in direct contact with patients at this facility went beyond what was called for by the WHO, which advised the use of standard medical masks except during aerosol-generating procedures.[18] The emergency department continues to mandate the use of N95 respirators for all health care workers in direct contact with patients.

Another process measure that was important to the facility's ability to provide care spaces for all patients was the ED admission and discharge workflow demonstrated in Figure 8. The 48-hour return rate of 1.1% demonstrates that the criteria were successful in measuring disease severity, although this case study is limited, in that at-home mortality cannot be measured and must be considered as a possibility. Other nearby hospitals used a similar risk-stratification strategy, using oxygen saturation level, respiratory rate, and other criteria to determine care pathways for patients presenting with COVID-19 symptoms.[23]

The transforming space in which care was provided in the emergency department during the pandemic was a key structure measure. Infection control should be a high

priority in the design of emergency departments, with the ability to create large sections of negative pressure space if needed. Multiple points of entry into different sections of the department allowed for reduced contacts between patients classified as infectious and those classified as noninfectious. These lessons will be considered when embarking on a remodeling of the emergency department in the future.

Finally, we consider the ED staff infection rate of 11%. Compared with the 1.1% of the health care workers infected at a hospital in Wuhan, China,[24] and 2.4% in South Korea,[25] this rate seems undesirable or modestly successful. However, the multifactorial challenges that this region faced included population density, supply-chain issues, delays in the closure of schools and public spaces, hesitation of the public to accept universal face coverings, and other factors that may have contributed to COVID-19 exposure at, and outside of, work. This department's success was demonstrated in comparison with that of the general public in Westchester County, which had an infection rate of 13.8%, as well as that of New York City, which demonstrated a rate of 20% among the general public and 12% among health care workers.[26] One hospital in the region experienced a staff COVID-19 antibody seroconversion rate of 46%,[27] further demonstrating the challenge of protecting health care workers in the New York metropolitan area. Structure and process measures that differed among the hospitals in the region may be examined in future studies to determine possible reasons for the disparity.

It should be considered whether the aforementioned lessons learned may have reduced the number of staff who contracted COVID-19. In preparation for the potential second wave of infections, this department considers the protection of staff and patients to be of the utmost importance.

Limitations

The described interventions were used during the emergence of the COVID-19 epidemic in an institution and emergency department with its own set of challenges and advantages. Information on transmission and the resources that would be required were continually changing, as was the availability of PPE and other supplies. For example, the processes required regular reevaluation as the CDC updated its guidelines regarding the mode of transmission of COVID-19 from droplet to airborne. An institution more equipped with validated information about the virus perhaps would have structured its response differently or according to another timeline.

Furthermore, it is recognized that there are limits to this hospital's response in terms of generalizability. The setting of a private hospital in Westchester County with many available specialists and partnering hospitals for possible transfers needing increased level of care is not applicable to all settings. In addition, the layout of the existing emergency department was such that it lent itself relatively easily to the creation of a larger negative pressure area. A challenge of the setting was that the personnel were perhaps stretched more thinly than those at teaching hospitals or in larger hospital systems that were able to redeploy large numbers of staff.

More information regarding the success of this intervention might also be gleaned from the outcomes not measured, including inpatient mortality, overall COVID-19 hospitalizations, disease complications, asymptomatic spread, and ED return visits beyond 48 hours.

Implications for Emergency Nurses

The COVID-19 pandemic presented many serious challenges from which there are important implications for emergency nurses. The importance of examining departmental structure and process measures to have a positive impact on outcome measures should not be overlooked when preparing for, or managing, a disaster or crisis.

ED structure measures, including the architecture of the department, may be examined on an ongoing basis to evaluate readiness to respond to crises, including infectious disease, mass casualties, and natural disasters. The addition of a waiting room nurse was a key structure measure in this department's response, serving an important role in infection control, which may be replicated in other departments.

Process measures, including interdisciplinary communication methods, environmental cleaning, and PPE guidelines, were paramount to this facility's success in managing the initial wave of the pandemic. Again, communication methods may be examined on an ongoing basis, ensuring that all staff members have access to communications from management describing rapidly evolving crises. Collaboration between frontline workers and ancillary departments such as EVS to achieve a common goal is reliant on the processes for communication between these departments. Improved communication and transparency from department leaders streamlined the implementation of the outlined interventions. Virtual happy hours and debriefing sessions functioned to keep the lines of communication open with staff and helped to improve morale during an otherwise demoralizing time.

As in many other settings, the use of telehealth was extremely helpful in triaging patients and decreasing exposure to patients and staff. Practical screening tools facilitated

this process and will likely have applications in other disease scenarios once formally validated.

Until this crisis, items of PPE, including N95 respirators were very rarely, if ever, reused. Emerging evidence and effective processes to conserve PPE resources might be required in future pandemics.

Conclusion

COVID-19, the information surrounding its spread and management, and the response to its prompt advent has made an indelible mark on the way emergency care is delivered. This facility-level case study reflects the response of 1 department at the epicenter of the outbreak in New York. Whereas change is often met with anxiety and resistance, multidisciplinary cooperation and strong leadership allowed for important and necessary structure and process measures to be amended along a tight and tense timeline. It remains to be seen whether these measures demonstrate significant success, and therefore more research is needed to determine whether such measures are associated with causal improvements.

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