

COVID-19 preparedness: A Bronx, New York, inner-city hospital's experience with medication management and readiness for a second surge

The Bronx, New York, 1 of the 5 boroughs of New York City and home to the poorest congressional district in the United States, was recognized as one of the epicenters of the coronavirus disease 2019 (COVID-19) pandemic in New York State in early 2020.^{1,2} In addition, New York State was one of the first epicenters in the United States for COVID-19 in early April, and Bronx County ranked among the top 4 counties in the state for the highest number of COVID-19 cases and fatalities.² Among the boroughs it ranked highest for hospitalizations and fatalities per 100,000 population.³

Being in the Bronx, we are accustomed to our Yankees always figuring out a way in the bottom of the ninth, with 2 down, to rescue victory from the jaws of defeat. That same mentality applied to our approach to COVID-19. Our health system, which is a voluntary, not-for-profit, integrated health care delivery network composed of a general acute care hospital, a psychiatry/substance abuse hospital, and a long-term care hospital totaling 859 beds, galvanized resources and staff to secure victory—that is, successful treatment and discharge of more than 1,000 patients with COVID-19.

From the first known patients who tested positive for COVID-19 who arrived at our doors in early March 2020 to the sudden explosion of COVID-19 cases in our emergency rooms and inpatient floors, our hospital, like others in our area, experienced an increased demand for neuromuscular blocking agents, intubating and sedating agents, and vasopressors that overwhelmed an already fragile drug delivery infrastructure. With the entire United States encountering the same clinical quagmire almost simultaneously, drug manufacturers' supply could not keep up with demand. In addition, the surge of suspected and confirmed COVID-19 cases was overwhelming for routine daily care. We needed to adapt to a new crisis mode and change our operational and clinical workflow of securing, processing, and dispensing medications.

Workflow changes. We encountered several challenges to the smooth flow of normal pharmacy services. Social distancing as mandated by the governor was difficult to achieve considering limited workspace available in the

pharmacy and in medication rooms on inpatient nursing units, coupled with the number of personnel needed to meet our health system's medication needs. Competition for limited elevator space was also a consideration. In addition, employees were fearful of the possibility of infection and inadvertent transmission to vulnerable family members, such as children and older parents. To address these concerns:

1. Workload shifting was implemented. Major responsibilities usually concentrated during the day shift—medication cart fills, automated dispensing machine refills, and batching of compound intravenous (IV) medications—were allocated to the evening and night shifts.
2. Some employees were moved from the day shift to the night shift to reduce crowding.
3. A couple of managers were moved to the night shift, which provided oversight for workflow changes and addressed their personal needs.
4. Registered 503B outsourcing facilities were used to provide ready-to-use packaged drugs because of increased need for patient-specific IV drug preparations.
5. Staff members with suspected or confirmed COVID-19 were immediately removed from their posts and given the option to assist via remote order verification.
6. Pharmacy residents were temporarily shifted from their normal learning experiences to daily pharmacy operations, including processing prescriptions and dispensing medications for a limited number of hospital employees with suspected or confirmed COVID-19.
7. Employees were trained on the proper use of personal protective equipment (PPE) and underwent fit testing for N95 masks, which were individually distributed.

Securing medications. During the early days of the pandemic as we experienced a surge of patients, there was a severe national shortage of critical medications. Hospitals across the country ordered medications to fill anticipated and/or current needs in quantities that far exceeded normal drug purchasing requirements, and suppliers were unable to meet such demands. A state of disaster was declared in our hospital on March 15, 2020, and our mobile morgue delivery from the New York State Department of Health arrived shortly afterward as the number of patients requiring intubation steadily increased to nearly threefold, and the average ventilator patient census reached the 80s, peaking at 115. This necessitated our taking the drastic step of converting all

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nursing units into ventilator units and redistributing needed medications accordingly.

Our highest COVID-19 patient load peaked at 255 confirmed cases and 78 under investigation, which accounted for 80% of our census that day. Meanwhile, our hospital was running low on intubating, sedating, narcotic, and paralytic agents, and the allocation from our drug wholesaler, initially predicated on our average drug purchasing history, was insufficient to treat all of our intubated patients. Drug wholesalers were consistently out of stock of most preferred and alternative agents. In addition, as soon as published data suggested benefit of a particular therapy for COVID-19, such as hydroxychloroquine and azithromycin, hospitals rushed to acquire those medications as well. It seemed that the US drug supply chain, which accounts for the movement of medications from suppliers, manufacturers, and wholesalers to hospitals, pharmacies, and patients, was not prepared for this pandemic. The surge in demand for the same drugs all across the country could not be effectively handled by usual means of drug purchasing. To address these concerns, we performed the following:

1. Reached out to manufacturers and registered 503B outsourcing facilities to request direct shipments of critical medications
2. Contacted the Federal Emergency Management Agency and the US Department of Health and Human Services' Strategic National Stockpile to supplement our drug supply
3. Explained to various drug manufacturers the serious situation we were facing in the Bronx (Manufacturers subsequently revised their allocation criteria to make it dependent upon a facility's COVID-19 patient census. They also agreed to provide direct shipments of narcotics and propofol, reversing their original decision.)

4. Communicated with the New York State Department of Health to receive direct medication shipments
5. Adjusted automated dispensing machine inventories to include intubating and sedating agents, vasopressors, and medications included in the COVID-19 order sets on all nursing units and increased par levels because of the high influx of suspected and confirmed COVID-19 cases (Table 1)

Clinical challenges. Due to the lack of a defined treatment plan for COVID-19, our medical staff had to rely on experiences gained from treating patients during prior outbreaks. Since many patients with COVID-19 presented with rapidly deteriorating renal function and multiorgan failure due to cytokine storm, we used many US Food and Drug Administration-approved drugs (such as tocilizumab, an interleukin-6 inhibitor) for nonapproved indications, based on current best practice recommendations to reduce cytokine storm. The pharmacy and therapeutics (P&T) committee also expanded clinical pharmacists' privileges, authorizing them to adjust medication doses based on renal function. Before the pandemic our pharmacists were required to call physicians before making such adjustments. Other interventions to address our clinical challenges included the following:

1. Consolidation of medication administration to specific times to minimize nurses' exposure to patients with COVID-19: Previously, medication administration times were concentrated on the day shift (10 AM, 2 PM, 6 PM). To minimize repeated exposures by one nursing shift, pharmacists updated medication administration times to 6 AM and 6 PM whenever possible, which spread out responsibilities between both 12-hour nursing shifts.

Table 1. Automated Dispensing Machine Medication Availability at Nursing Units

Medication	Prior ADM Availability	Changes During COVID-19 Surge
Intubating agents: succinylcholine, rocuronium, vecuronium, propofol	CCUs	Available in all nursing units
Paralytic drips: cisatracurium, atracurium	CCUs	Available only in nursing units with trained critical care nursing staff
Sedating agents: etomidate, morphine, fentanyl, dexmedetomidine, midazolam, lorazepam, oral diazepam	CCUs	Available in all nursing units
Pressors: norepinephrine, phenylephrine, dopamine	CCUs	Available in all nursing units
Oral antibiotics: amoxicillin/clavulanate acid, doxycycline, azithromycin, cefpodoxime	All nursing units	Par level increased in all locations
Anticoagulants: low-molecular-weight heparin, apixaban	All nursing units	Par level increased in all locations
COVID-19 experimental therapies: hydroxychloroquine, tocilizumab	Not stocked	Hydroxychloroquine: available in all nursing units; tocilizumab: patient-specific medication orders only

Abbreviations: ADM, automated dispensing machine; CCU, critical care unit; COVID-19, coronavirus disease 2019.

- Optimization of medication regimens by pharmacists to decrease frequency of administration. For example, once-daily enoxaparin was used for prophylaxis against deep vein thrombosis instead of conventional 2- or 3-times-daily dosing of heparin.
- Recommendations to administer medications via oral, intramuscular, or IV push routes to overcome the IV infusion pump shortage.
- Coordination of investigational and emergency use medication dispensing in a manner consistent with clinical research requirements, which was accomplished because of close working relationships between clinical pharmacists and the P&T committee chair.
- Relaxation of privileges to allow all physicians to order restricted intubating and sedating agents (ie, propofol, dexmedetomidine).
- Creation of a hospital committee composed of pulmonary and critical care, cardiology, nephrology, rheumatology, neurology, and infectious diseases physicians to appraise current literature and create a user-friendly COVID-19 management guideline. This was updated as needed to incorporate changing worldwide experience.
- Implementation of COVID-19 order sets for adult and pediatric inpatients to standardize care as per our hospital's guideline. Order sets included nursing care, respiratory, fluid, medication, laboratory, and diagnostic test orders; medication categories in the order sets were preferred and alternative antibiotics, deep vein thrombosis prophylaxis, and acetaminophen.
- Avoidance of long infusion tubing (initially used to keep pumps outside rooms to further reduce nurse exposure to patients with COVID-19), which later became a concern for tripping hazards and back pressure occlusion.
- Discharge prescriptions were coordinated for patients going home and for those transferred to alternate level-of-care facilities in New York City, including the Jacob K. Javits Convention Center, which was managed by the US Department of Defense, and the US Navy hospital ship *Comfort*.
- Additional patient care areas were created by adding beds, medical supplies, automated dispensing machines, and refrigerators to locations such as the general auditorium, procedural areas, and ambulatory surgery locations.

Preparing for the second surge. Because the Bronx was among the first areas to experience the surge of patients with COVID-19, we are now able to share some of our lessons learned, including the need for the following:

- Cross-training of staff: Our ambulatory care pharmacy residents, for example, who were already trained in staffing and managerial functions, were redeployed to the main pharmacy where they assisted with in-house operations. This underscores the importance of cross-training in staffing and managerial functions so that all staff can be deployed to areas of greatest need regardless of primary areas of responsibility.
 - Access to remote order verification: This allowed willing pharmacists who were exposed to COVID-19 but had only mild symptoms to remotely assist with larger-than-normal order verification queues during their mandated quarantines.
 - A reserve supply of critical medications: Previously, our hospital maintained a 3- to 5-day rolling inventory of medications in our automated carousel. This resulted in a grave shortage of lifesaving medications, including intubating and sedating agents.
 - Direct accounts with manufacturers to order medications: This will help to avoid delays, such as we experienced, when wholesalers are unable to meet the demand for medications on shortage.
 - Training on proper PPE use and maintenance of adequate supply: While the infections among clinicians in our hospital and beyond might not be directly tied to improper PPE use or nationwide shortages, appropriate donning and doffing of PPE and fit testing for N95 masks are crucial to ensure adequate protection.
 - Telemedicine: This tool was indispensable in helping us maintain contact with vulnerable patients who required medication counseling, monitoring, and adjustment.
 - Virtual conferencing platforms: This allowed for adherence to social distancing rules as we continued with our departmental meetings and prepared for various surveys by the Joint Commission and residency accreditation organizations. This also helped us to balance service and training in light of our ongoing responsibilities to residents and pharmacy students.
- Putting these lessons into practice while continuing with social distancing and implementing creative ways to prevent infection of health care workers and beyond is critical to maintaining readiness for a potential second surge. As

Administrative challenges. Challenges in keeping medications organized, staying up-to-date with treatment protocols, maintaining daily drug deliveries, being knowledgeable of drug supply chain interruptions, and conducting staff education cannot be overstated. In addition, hospitals in New York City were ordered to increase bed capacity by 50%, which resulted in the opening of new patient care locations requiring additional medications and storage compliance. These challenges were met in the following ways:

- Pharmacy directors throughout New York State regularly met several times weekly to strategize regarding supply chain problems. These conversations led to the US Drug Enforcement Administration's lifting of bulk manufacturing limitations and subsequent increased production of opioids (fentanyl, morphine, and hydromorphone) used in the care of patients with COVID-19.⁴
- Our hospital's creation of a daily dashboard that provides the location of patients who test positive for COVID-19 and patients under investigation.

Table 2. Pharmacy Disaster Planning Checklist

Need	Recommendation
Adequate stock of PPE: gowns, N95 masks, hair covers, shoe covers, facial shields	Maintain sufficient inventory (minimum 4-week supply) to meet demand, taking patient surge into consideration. Refer to CDC and ASHP for additional guidance. ^{5,6}
Adequate stock of critical medications: narcotics, paralytics, sedatives, other COVID-19–related medications	Maintain sufficient inventory (minimum 4-week supply) to meet demand, taking patient surge into consideration. Refer to ASHP’s assessment tool for additional guidance. ⁶ Order medications on shortage directly from manufacturers, including controlled substances, if unavailable from wholesalers. Set up CSOS procedures with manufacturers, in case of shortage.
Adequate supply of pumps, ventilators, tubing	Maintain sufficient inventory to meet demand, taking patient surge into consideration. For pump shortage, utilize oral, intramuscular, intravenous push route when possible. Purchase additional PCA pumps that can be converted to regular infusion pumps if needed.
Protocol for social distancing	Maintain at least 6 feet distancing between individuals by moving desks, chairs, and workspaces and/or using plastic barriers. Redistribute workload and personnel from day shifts to evening/night shifts.
Prompt identification of sick employees	Daily self-monitoring of temperatures and electronic verification of this practice. Ensure sick workers are quarantined. Provide remote work access, if possible, to quarantined employees with mild symptoms.
Human resource planning	Utilize available human resources, including ambulatory staff, residents, per diem employees, and agency workers. Cross-train employees.
Ongoing infection control	Train staff, perform spot checks to assess proper handwashing techniques and equipment cleaning.
Plan for patient surge	Identify potential surge locations. Obtain additional supply or relocate existing supply of ADMs, medical supplies, and refrigerators to new patient care areas from closed areas, such as elective procedure locations, and outpatient clinics. Ensure each new patient care area has approximately 1 refrigerator and 1 dispensing cabinet per additional 15–25 beds.
Emergency planning	Revise emergency preparedness policies and procedures to include COVID-19.

Abbreviations: ADM, automated dispensing machine; ASHP, American Society of Health-System Pharmacists; CDC, Centers for Disease Control and Prevention; COVID-19, coronavirus disease 2019; CSOS, Controlled Substance Ordering System; PCA, patient-controlled analgesia; PPE, personal protective equipment.

we prepare for a second surge due to relaxation of social distancing, COVID-19 disaster planning is also necessary (Table 2). In light of recommendations from the US Centers for Disease Control and Prevention and the American Society of Health-System Pharmacists, coupled with lessons learned from our own experience, we believe we are better prepared for the impact of this ongoing pandemic.^{5,6}

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