In the early phase of the Covid-19 pandemic in New York City, NYU Langone Medical Center — Brooklyn increased its general inpatient medicine capacity by 85% and quadrupled its medical ICU capacity. We created a Discharge Command Center to review pending discharges and address barriers to discharge. The center reduced length of stay, increased throughput, and further expanded capacity. By partnering with our largest vendor of medical equipment, we were able to reduce turnaround time for home oxygen setup by at least 50% and save at least 0.5 hospital days per case. These strategies helped optimize the use of resources while maintaining patient safety with no significant increase in readmission rates. It is our hope that other institutions in the midst of their local Covid-19 peaks will find these measures useful.

We share two strategies implemented at NYU Langone Medical Center — Brooklyn, a 400-bed academic medical center, to safely and expeditiously discharge as many recovering patients home as possible in order to improve hospital throughput and maximize the availability of the inpatient service.

NYU Langone Hospital — Brooklyn cares for a largely minority patient population with low socioeconomic status. Early data from China showed that risk factors for severe disease due to Covid-19 included hypertension and diabetes. A New York study of Covid-19 patients had similar findings and identified obesity and other cardiovascular disease as additional risk factors. Patients
who experience racial and/or socioeconomic disparities are known to be at higher risk for these conditions.\textsuperscript{3,4} The literature thus suggests that these populations have been disproportionately affected by Covid-19 due to higher rates of comorbidities and poorer access to health care.\textsuperscript{5,6} As such, we assumed that our institution would be disproportionately affected by the disease.

Our hospital, like many others, expanded its capacity in planning for the pandemic. We expanded acute inpatient medicine beds by 85\% (from 151 to 279) and medical ICU capacity by 305\% (from 20 to 61). We realized that this increased capacity could create more challenges than usual for safe and expeditious discharge, at a time when it was essential to use our bed capacity as efficiently as possible.

Our first step to address these challenges was to create a Discharge Command Center to coordinate all discharges to reduce avoidable delays. The Discharge Command Center remains in place now and we intend to make it a permanent part of our workflow.

Our second step was to have our Social Work and Case Management departments work closely with our largest DME vendor (who provides over 90\% of all oxygen and medical equipment for our patients) to streamline the process for discharging patients home with supplemental oxygen, a process that has historically extended hospitalizations by an entire day or more.

We realized early on that simply expanding our bed capacity was not enough. To best utilize our expanded inpatient services, it was imperative to move patients through their admissions efficiently and minimize barriers to safe discharge which could result in extra hospital days. Given the expected rapid influx of patients, we prioritized throughput to improve patient outcomes, limit ED overcrowding, and optimize utilization of resources for the ongoing surge.

The first strategy involved refocusing efforts on all patients anticipated for discharge through the Discharge Command Center. Our standard workflow involves geographic, unit-based, interdisciplinary teams that huddle twice daily with the unit’s nurse manager to review discharges for the next 24-hour period, to identify potential barriers. To augment this process, in early March we instituted a twice-daily call involving the nurse managers and leadership from Social Work, Case Management, rehabilitation services, and physicians to discuss these barriers, which included diagnostic testing, pending consultations (for example, physical therapy or subspecialties), delays in response from post-acute care facilities, and pending insurance authorizations. The calls followed the unit huddles and provided additional oversight, allowing potential delays to be prioritized in a centralized fashion and flagged for attention by the corresponding stakeholders. For example, physician leadership would ask consultants for expedited recommendations, and radiology leadership would expedite pending studies.

Given the differences in cases during Covid-19 and prior to this pandemic, we assessed our impact on throughput by using observed to expected length of stay (O:E LOS), a standardized ratio that compares a patient’s actual length of stay with an estimate based on their medical conditions. We aimed for a reduction in this ratio. This methodology is not perfect, as Covid-19 is still only marginally understood, and risk stratification models are thus limited in their ability to predict severity of illness for Covid-19 patients. We have historically compared our hospital’s performance
against hundreds of others using models provided by a consortium of similar institutions. The model used by this consortium is universally applied by other hospitals in the absence of a more accurate risk stratification tool. This limitation unfortunately stretches beyond the scope of our study given the nature of the pandemic; however, we suspect the severity of Covid-19 illness has been consistently underestimated given the severe morbidity and mortality of Covid-19 as compared to other more-studied respiratory illnesses.

For reference, we used historic O:E LOS for the months of March and April. In 2018, this value was 0.89 and in 2019 it was 0.92 (mean 0.91). With the described intervention, however, our O:E LOS for March and April 2020 was 0.84: a 7.7% reduction from baseline despite the higher volumes referenced above. Thus, we concluded that our Discharge Command Center was a major factor in the decrease of our observed-to-expected length of stay.

The key challenges we had anticipated were accuracy of information and buy-in for the time commitment of the calls. Since patient-level data was communicated through the unit nurse managers rather than primary teams, all information was secondhand. When we began, it was often necessary for various departmental leaders to communicate directly with the primary teams to verify pieces of information. Since there were typically nine units to be presented, it was not uncommon for each call to last an hour. As we gained more experience, not only did the accuracy improve (reducing the need for doublechecking with primary teams) but the nurse managers created an informal schedule amongst themselves for when to call in, so that each one had to spend only a few minutes on the call. Currently, our calls last approximately 40 minutes.

The second strategy centered on early discharges home with supplemental oxygen. Historically, the process of discharging patients with home oxygen from our institution has cost at least one full hospital day (and often two or more days as such discharges did not happen over weekends) due to the process of documenting medical necessity, obtaining insurance approval, and scheduling home delivery of the oxygen and equipment. Much of this discharge delay was driven by issues with either documentation or authorization, and by coordinating with family members to accept deliveries in the home.

From March 2019 to February 2020 (the 12 months before Covid-19), our hospital discharged an average of 11 patients home with oxygen per month (range 8 to 15). Planning for markedly increased volume and identifying this delay as a critical chokepoint, we met with our largest vendor of durable medical equipment in late March 2020 to discuss methods of reducing this time. Our hospital had a dedicated full-time representative. After meeting, both parties agreed to provide him with an on-site working space for improved face-to-face communication and thus a reduction in turnaround time.

We observed that many patients with Covid-19 had a persistent need for low levels of supplemental oxygen after their more rapid initial recovery. Assuming that most patients being discharged home on oxygen would likely not need it for more than a few weeks, we were able to create a workflow by which patients on 3 liters per minute (lpm) or less of supplemental oxygen by nasal cannula could be discharged with a portable concentrator delivered to bedside by the on-site representative (Figure 1). Compared with a traditional system, portable concentrators do not require a compressed
tank of oxygen. They are self-contained oxygen delivery devices that can provide up to 3 liters per minute of flow. As such, the equipment can be delivered to the bedside with no need for further supplies such as tanks or tubing to be delivered to the patient’s home. The major disadvantage of these concentrators has historically been the cost, which is two to three times the cost of traditional oxygen tanks.

FIGURE 1

**Home Oxygen Workflow**

![Home Oxygen Workflow Diagram](image)

This workflow assumed that these patients were able to follow directions to self-wean and that they had no other post-discharge needs at home (such as physical therapy, need for other equipment, or visiting nursing services). Meanwhile, patients who were on more than 3 lpm, who were unable to self-wean (for example, patients with cognitive impairment or complex home nursing needs), or who had other post-acute needs at home were discharged with a traditional tank delivered to home. In addition to the portable concentrator or oxygen tank, patients requiring oxygen were provided with a pulse oximeter and standardized instructions for weaning based on symptoms and oximetry measurements.
The expanded use of portable concentrators and the on-site presence of the representative greatly reduced the turnaround time from identification of the need for home oxygen to the patient actually being discharged. For the period from March 29 to April 30, out of a total of 505 Covid-19 patients discharged home, 110 patients (22%) were discharged with some form of oxygen: a nine-fold increase compared with our previous pre-pandemic monthly average. Of these 110 patients, 84 (76%) fell into the early discharge group and received a portable concentrator; they did not require home delivery of oxygen. The average length of stay for Covid-19 patients who did require home oxygen was only 0.5 days longer than for those who did not: more than a 50% reduction in turnaround compared with our pre-pandemic timeframe for home oxygen setup. This change saved at least 0.5 inpatient days per case. Based on the volume of patients, we conservatively estimate 55 patient-days saved during the period in question, or 50 patient-days saved per 30-day period. We attribute this improvement to: better communication between unit managers and discharge control center; earlier identification of barriers; on-site representative for home oxygen; streamlining of the documentation and authorization processes; providers learning how to optimize documentation; and time saved by many patients not requiring home delivery.

It is particularly poignant to note that we successfully discharged 16 (15%) of these 110 patients home on a Saturday and 10 (9%) on a Sunday. Before we created this intervention, these discharges would not have occurred until at least the following Monday.

Our major concern with this approach to discharging patients was that outpatient follow-up would be limited. Like many other institutions, our outpatient offices and clinics were closed to in-person visits during the height of the pandemic and it took time to set up an infrastructure for regular telehealth follow-up, especially given our underserved patient population. We suspected that readmissions related to worsening disease, oxygen inadequacy, or device failure would occur within 14 days of discharge. For this group, the associated 14-day readmission rate was 3.6%. The more standard CMS metric of 30-day all-cause readmission rate was 5.5%, well below national standards and our average rate. During the same time period, our overall 30-day-all-cause readmission rate for patients going home with services (including oxygen, visiting nursing services, home health aides, home physical therapy, home infusions, etc.) was 15.3%. The 30-day-all-cause readmission rate for patients who required no services and no oxygen was 4.4%. As such, the readmission rate for the intervention group was nearly identical to the latter which reaffirmed our hypothesis that patients with low level oxygen needs after rapid recovery could generally be discharged home safely.

There was a cost associated with distribution of the portable oxygen concentrators as most payers strongly prefer traditional oxygen tanks. The cost of the concentrators was approximately twice the cost of the room and board for a single night in our hospital and also approximately two to three times the cost of a traditional home oxygen tank. While we therefore cannot say that there was a dollar-cost saving, we were able to offset much of this cost through grants and charitable donations which occurred during the pandemic. As such, the ultimate cost to our institution was nominal. This support also allowed us to offer the described intervention to our uninsured and undocumented patients, who made up 35% of the patients requiring home oxygen. If necessary in the future, we will again perform community outreach in order to secure further donations and continue this program.
The operational and efficiency improvements offered by both interventions discussed above can be used as general strategies to improve discharge planning and throughput, not solely as they pertain to the Covid-19 pandemic. Even after New York City’s Covid-19 burden waned at the end of the summer, we have continued to use the Discharge Command Center in its described form to address delays that existed prior to the pandemic. We believe many institutions would benefit from having a formal centralized process for prioritizing and addressing barriers to discharge.

The on-site representative who assisted us with medical equipment and oxygen currently remains on-site. Even though fewer patients require oxygen, he can expedite access to other home equipment such as assistive devices for ambulation, commodes, and hospital beds. We feel the improved professional relationships forged by his presence during the pandemic, and the feedback and instruction he’s able to provide regarding accurate and necessary documentation, will help us going forward. Many physicians, case managers, and social workers are now on a first-name basis with the representative, and we hope this continuity and camaraderie will help us maintain a more efficient workflow.

Both these strategies in combination allowed us to discharge patients in a safe and expeditious manner while optimizing the capacity of our hospital. We had to redefine how we look at value: inpatient beds became scarce resources and freeing them up as quickly and as safely as possible became the highest value target, even when there may have been a higher dollar cost in doing so, as in the case of the portable oxygen concentrators. In addition, this pandemic forced us to examine and address our systemic inefficiencies and it only makes sense to apply this new knowledge to our operations going forward. Such strategies may be of use to institutions that are now in the midst of their local Covid-19 peaks and may have significant roles in the future to improve overall hospital efficiency and throughput.

Amarpreet S. Bains, MD, SFHM
Medical Director of Care Management, NYU Langone Hospital—Brooklyn

Erwin Wang, MD, MHA
Clinical Lead for Brooklyn Campus, Value Based Management Assistant Professor of Medicine, NYU Grossman School of Medicine; Hospitalist, NYU Langone Hospital—Brooklyn

Deserie Duran, RN, MHA
Director of Care Management, NYU Langone Hospital—Brooklyn

Lorna Lee-Riley, MSSW, LCSW, CCM
Director of Social Work, NYU Langone Hospital—Brooklyn

Frank Volpicelli, MD
Chief of Medicine, NYU Langone Hospital—Brooklyn

Disclosures: Amarpreet Bains, Erwin Want, Deserie Duran, Lorna Lee-Riley, and Frank Volpicelli have nothing to disclose.
References:

1. Zhou F, Yu T, Du R. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020;395(6):1054-62

2. Petrilli CM, Jones SA, Yang J. Factors associated with hospitalization and critical illness among 4,103 patients with Covid-19 disease in New York City.

3. Wang L, Southerland J, Wang K. Ethnic Differences in Risk Factors for Obesity among Adults in California, the United States. J Obes.

4. Bell CN, Thorpe RJ, Bowie JV, LaVeist TA. Race disparities in cardiovascular disease risk factors within socioeconomic status strata. Ann Epidemiol. 2018;28(6):147-52

5. Azar KMJ, Shen Z, Romanelli RJ. Disparities In Outcomes Among COVID-19 Patients In A Large Health Care System In California. Health Aff (Millwood). 2020;39(6):1253-62

6. Kirby T. Evidence mounts on the disproportionate effect of COVID-19 on ethnic minorities. Lancet Respir Med. 2020;8(6):547-8