

Mobilization and Preparation of a Large Urban Academic Center During the COVID-19

Pandemic

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Coronavirus disease 2019 (COVID-19) is a global pandemic that has affected 188 countries at the time of this writing. SARS-CoV-2, the causative virus of this disease, has the potential of causing a fatal severe respiratory distress syndrome. The initial reports from hotspots like China and Italy indicate that about 15% of affected patients will develop severe pneumonia requiring hospitalization and 5-6% will require intensive care (1).

The exponential spread of this virus in major metropolitan areas has led to escalating health care utilization, thereby placing a massive burden on acute care resources, including hospital beds, personal protective equipment (PPE), and ventilators. An equally distressing problem is a shortage of trained medical personnel who are capable of treating the surge of patients necessitating intensive care, especially as more healthcare workers become infected, quarantined, or hospitalized. Containment has been difficult in the United States (US) and the magnitude of community spread is unknown. Restrictions on travel and everyday life have been imposed in an attempt to curb the infection rate, but the number of patients requiring hospitalization and intensive care is predicted to be high.

In anticipation of a surge in hospitalizations, it is paramount for every medical center in the country to rapidly establish contingency plans to accommodate increased demand. Concurrently, hospitals need protocols as well as training to minimize healthcare worker exposure and ensure proper active and reserve staffing. Logistical deficiencies can stress a healthcare system but with adequate preparation, we hope to reduce COVID-19 mortality by ensuring that the standard of care is preserved despite the increase in healthcare utilization. Meanwhile, efforts to reduce the possible spread of COVID-19 to patients, visitors, and

essential healthcare providers through early detection, isolation, and triaging needs to be emphasized. Here we wish to report our institution's plan in addressing these challenges.

Staffing/Training

Temple University Hospital is a 722-bed academic medical center located in urban North Philadelphia. Our hospital is centered within a medically underserved residential region of the city. Temple has approximately 50 available ICU beds during normal operations. These beds are often close to 80-90% capacity during normal operations.

Staff training on safety and precaution measures was initiated immediately after the outbreak. A designated hospital committee on infection control drafted pertinent protocols on PPE. Live in-services were conducted educating healthcare providers techniques to safely don and doff PPE. Simulation exercises in advanced cardiac life support (ACLS) and rapid response were conducted to garner familiarity with the time consumptive process of wearing PPE.

All staff was required to report symptoms via an online application and have aural temperature monitoring before and after shifts. Daily departmental teleconference with involved staff has been integral in maintaining a uniform and consistent stream of evolving information. Additionally, daily updates have kept remote individuals effectively informed of new protocols and contingencies.

First Screening

Based on experiences of Wuhan, China, we instituted a screening protocol to classify patients into low, intermediate, and high risk groups based on exposure history and clinical signs/symptoms. The goal of this risk stratification was to identify high probability patients to minimize transmission risk. Individuals were considered low risk if they presented with afebrile viral prodromes and/or unilobar pneumonia < 5 days duration since symptom onset.

Intermediate group included febrile viral prodromes, hypoxemia, and unilobar pneumonia > 5 days duration since symptom onset. High risk group included a recent history of travel to level III countries (i.e.: China, Italy) or US areas with community transmission, known contact of confirmed COVID-19 patient, healthcare worker with unexplained lower respiratory tract infection, or unexplained multifocal pneumonia with hypoxemia. As the infection spread in the community, our protocol changed to include only clinical signs, symptoms, and radiographic signs. Travel history was discarded from the algorithm as community spread was assumed to be the primary vector of disease.

In regards to inpatients, any reports of a viral prodrome, change in oxygen requirement, or imaging suspicious of viral syndromes were considered as criteria for screening. Any rapid responses or cardiac arrests that had suspicion of COVID were immediately transferred to the COVID unit for screening to avoid staff contamination in the non-COVID hospital.

Initially all SARS-CoV-2 tests were sent out to a third party diagnostic company that had a 4 to 5 day turnaround time. This resulted in an inappropriate use of PPE, delay of discharge of non-COVID patients, and ultimately an increase in our total census. We eventually developed our

own in-house testing which yielded results in five to ten hours. Once faster testing became available, we were able to effectively triage and discharge our patients efficiently. Table 1 highlights the algorithm we have used since POC test became widely available.

Units

Containment of COVID suspected individuals; inadvertent contamination of non-infected healthcare workers, as well as sequestering those critically ill due to COVID is paramount. In lieu of a widely available vaccine, the neutralization of COVID is through isolationist practices and eventual viral extinction. Within our institution, this was exercised through temporary designated units, stratified by the following parameters: COVID positivity, probability of COVID infection of those awaiting testing results, and overall traditional clinical illness parameters.

We determined three units were necessary. First, an isolated unit in a building separate from the main hospital was created. The unit comprises of two floors that has 14 medical-surgical and 10 intensive care beds on each floor. All medical-surgical beds have the capability to turn into ICU beds if necessary. This unit was designed for patients with intermediate-to-high probability of COVID-19 infection and is staffed only by pulmonary faculty and fellows.

The second unit was designated for patients with low probability of COVID infection. This 100 bed unit has been managed under the medicine service.. As our census increased, we converted all floors of this building into a COVID medical-surgical unit. We have also arranged extra beds in the lobby and operating areas if necessary. This entire building has the capacity of

250 total beds. Once patients are ruled out for SARS-CoV-2 infection, they are transferred to a general medicine service or discharged.

Due to increased demand of computed tomography in assessment of suspected COVID cases, we established a dedicated CT scanner in the same building as the unit described earlier. This kept patients and staff from asymptomatic transmission. The staff at this radiology unit has been instructed to take maximal PPE precautions as well as appropriate equipment sanitation. We also took measures to reduce the frequency of unnecessary physical patient-healthcare provider contact. Unnecessary blood draws or portable imaging has been discouraged in clinically stable patients. In room tablets are available primarily for non-English speaking patients so that in room translation can be facilitated without using phones, which may lead to contamination. As with other institutions, it has been difficult to find an available number of tablets for every patient who needs it.

Lastly, a third unit functioned as an outpatient COVID-19 screening unit. Established outpatients are screened via preclinic telephone encounters with a COVID-19 symptom questionnaire. Any patient suspected of having COVID-19 receive referrals for the COVID-19 screening unit. Moreover, all patients triaged at the emergency department main entrance with mild symptoms suspicious of COVID-19 are also referred to this clinic using a separate main hospital entrance.

Contingency Plans

If the inpatient surge overwhelms existing facilities, backup units should be designated. We arranged an additional 27 ICU capable rooms. These rooms are located in the operating room, post-anesthesia care unit, and neurosurgical ICU located in the same building as our intermediate-high risk unit.

We have mobilized ventilators from our smaller satellite campuses. Since non-emergent procedures have been held we have been able to relocate ventilators from operating rooms from these hospitals. A few local long-term acute care facilities (LTACS) have also provided extra ventilators.

To prevent staff shortage in the inevitable occurrence of medical personnel infection, staff members who are not on essential inpatient services are asked to remain at home on reserve for staffing shortage. Several contingency plans were put in place to utilize health care workers in other departments in case of severe staffing shortage. We developed a model in which several teams work together in a shift based model with remote help. This applied to all essential departments such as physicians, nurses, and respiratory therapists. This strategy helps minimize staff exposure and PPE use. Non-urgent procedures have been tentatively postponed to reduce hospitalizations and to maintain operating room and intensive care unit vacancy.

Due to the high risk of contamination of family members and visitors, a strict no-visitor policy is enforced at our hospital. However, to keep family members updated, nursing and physicians spend time daily in updating families. We have incorporated remote physicians that

are responsible for daily updates. Tablets for virtual visits between family/patients would be very helpful and is a goal we are striving towards.

Conservation of PPE has been a major priority at our institution. Employees in the COVID unit receive one N95 and surgical mask per shift. They also receive a protective face shield which they can reuse with specific instructions on doffing. Each of our nursing units has an ultraviolet light disinfection box for solid objects such as phones, glasses, and pens.

Admission Protocols

We created a COVID-19 admission order set inclusive of isolation precautions, specimen collection, imaging, and laboratory testing. Once admitted, patients are maintained in airborne/droplet and contact isolation until SARS-CoV-2 is ruled out or if an alternative diagnosis is made. High risk patients are maintained in airborne precautions, whereas low and intermediate risk patients with abnormal CT findings are maintained in droplet precautions. If positive for SARS-CoV-2, patients are maintained in airborne and contact isolation until clinically improved and SARS-CoV-2 PCR is negative. If the patient's symptoms resolve but PCR remains positive, they are discharged with home quarantine with daily telemedicine checkups. The patient's home quarantine is continued until PCR is negative.

Discharge

In a time of public health crisis, discharge follow up becomes an important measure of epidemic mitigation. Most patients admitted to our unit will not need inpatient care shortly after testing is performed. These patients should therefore self-quarantine at home and await testing results. These patients should be reliable enough to respond to phone follow up and have home infrastructure in place in case of worsening symptoms. A family member should be spoken to so the discharge plan can be reinforced. Written information on contingency plans should be provided in the patient's preferred language. The responsibility of communicating negative or positive results is carried out by our microbiology laboratory with mandatory reporting to the state public health department.

Due to limitations with testing supply, we commonly do not re-test patients before discharge. We work with our case managers and social workers to ensure that each discharged patient can self-isolate into a room away from family members or roommates. Patients are asked to wear a mask at all times after discharge. In addition, at discharge patients are also provided with social support as needed for food, housing and other day to day needs in conjunction with the Department of health.

At discharge, COVID-19 positive patients were provided with an online portal, where they were required to login daily and report their symptoms. In addition, the patients were asked to perform mandatory quarantine for 14 days post discharge. The online symptom log is followed by a remote physician on a daily basis. Any worsening in clinical status is dealt promptly by the physicians.

If patients continue to improve, an initial follow-up call will be made within 48 hours after discharge. The outpatient follow-up is carried out in 1 week, 2 week, and 1 month intervals at date of discharge. On a case to case basis, the need for liver and renal function, sputum and stool PCR, imaging, and lung function testing is determined. Follow-up phone calls are also made at 3 and 6 months post discharge.

Outpatient Care

As a high volume lung center we perform 33000 outpatient visits, 7000 pulmonary function tests, 2500 sleep studies per year. We converted all scheduled in-person outpatient appointments to telemedicine visits. All non-emergent pulmonary testing/procedures were cancelled.

Telemedicine facilitated a practical solution allowing us to evaluate the symptoms of our established outpatients while keeping those who are well away from unnecessary risks of illness. Office staff called patients to confirm their appointment and obtain consent for a telephone visit. At that time, all patients were asked COVID-19 risk screening questions. All phone calls were documented in the medical chart similar to a face to face visit. Our information technology team has been developing a simple web-based application that can be used to detect symptoms for patients, healthcare personnel, and family members.

Our bronchoscopy suite policies were revised to only performing urgent procedures with appropriate PPE.

Trainee Experience and Education

Our institution is home to one of the largest Pulmonary Diseases & Critical Care fellowships in the country with an aim to balance clinical training with academia. Program leadership and fellows worked together to continue lectures, conferences, and research meetings remotely through teleconferencing. Similar to the 1980's AIDS pandemic, as a newly described and rampant illness, trainees learned to adapt to the evolution and volume of COVID-19. Moreover, the international response generated a deluge of literature and research. Trainees faced the task of reviewing, interpreting, and applying the expanding compendium on COVID-19 data.

Generally, public health and its logistical aspects is not a focal point throughout training. Out of necessity, trainees have dedicated education on proper PPE use, reporting guidelines, and self-screening for illness and work readiness.

Clinically, the deficiencies of health care workers has forced trainees to assume more responsibilities than before, functioning as surrogate care providers. This clinical experience is highlighted by its autonomy and acuity, accelerated trainee proficiency skillfulness. The unique experiences gained from this global event will be more invaluable to any trainee's education.

Conclusion

The major disease outbreak of COVID-19 calls for urgent healthcare workflow restructuring. Essentially a call to arms, infrastructural adjustments were made to achieve the following principles: Identify and triage those of suspected COVID-19 infection, optimize and reconfigure

hospital operations to match the needs to confront the current pandemic, curb the worldwide viral spread, and avoiding excessive exposure to the immunocompromised.

All institutions should have protocols and measures to mitigate the transmission of the novel virus, while also utilizing available resources appropriately. We understand that all institutions do not have the same capabilities or resources. But it is imperative that an action plan be prepared in order to face the outbreak. With our protocols we aim to provide a roadmap for other institutions in the United States to deal with this crisis optimally.

Table 1: COVID-19 Severity Stage protocols (one of the following clinical characteristics in a COVID-19+ patient)							
			Symptoms (SX) Description				
Stage	COVID-19 Status	Presence and Level of sx.	Symptoms	CXR/HRCT	Respiratory Support	Hemodynamic Support	Triage
0	+	none	None	Normal	None	None	Home
I	+	Mild	Tmax < 38.3°C, sore throat, nasal congestion cough, chest tightness, myalgias, body aches, fatigue, diarrhea	None	NC < 3L O ₂ Rest	None	Home
II	+	Moderate	Stage I <i>plus</i> SOB, RR 20-25, HR < 110 bpm, Tmax < 38.3°C	GGO or peripheral lobar consolidation	NC > 4L O ₂ Rest	None	COVID Floor Unit
III	+	Severe	Stage I <i>plus</i> Tmax < 38.3°C, RR > 25, HR > 110bpm	GGO, “crazy paving”, or multilobar consolidation	O ₂ > 40%, HFNT, BIPAP	One Vasopressor	COVID ICU
IV	+	Very Severe	Stage I <i>and/or</i> Encephalopathy, Hypotension, SBP < 90 mmHg	Diffuse infiltrates resembling ARDS	Mechanical ventilation, ECMO	≥ 2 vasopressors	COVID ICU

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