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A Roadmap to Reopening a Neurosurgical Practice in the Age of COVID-19

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■ **BACKGROUND:** The Coronavirus disease 2019 (COVID-19) outbreak has left a lasting mark on medicine globally.

■ **METHODS:** Here we outline the steps that the Lenox Hill Hospital/Northwell Health Neurosurgery Department—located within the epicenter of the pandemic in New York City—is currently taking to recover our neurosurgical efforts in the age of COVID-19.

■ **RESULTS:** We outline measurable milestones to identify the transition to the recovery period and hope these recommendations may serve as a framework for an effective path forward.

■ **CONCLUSIONS:** We believe that recovery following the COVID-19 pandemic offers unique opportunities to disrupt and rebuild the historical patient and office experience as we evolve with modern medicine in a post-COVID-19 world.

Here we present a roadmap for departmental recovery of neurosurgical efforts in the age of COVID-19. We outline steps that the Lenox Hill Hospital/Northwell Health Neurosurgery Department—located within the epicenter of the pandemic—is currently taking as the pandemic is brought under control, with the hope that this may serve as a framework for an effective path forward. We outline measurable milestones to identify transition and reopening of our practices based on international, federal, state, and local recommendations, which continue to evolve.^{1,2} This is done with the understanding that times are changing rapidly, and that our responses to the pandemic must remain fluid. The specific milestones and suggestions included in this report are judgments based on our current understanding; however, individual departmental values, regional constraints, and the overall trajectory of this global pandemic must be considered, as these will heavily influence the recommendations. It is understood that this will take time, but planning should begin now so that the infrastructure is in place when the time of transition arrives. Importantly, recovery following the COVID-19 pandemic offers a unique opportunity to disrupt and rebuild the historical patient and office experiences as we evolve with modern medicine in a post-COVID-19 world.

INTRODUCTION

The Coronavirus disease 2019 (COVID-19) outbreak has left an indelible mark on medicine globally. Recommendations regarding the initial handling of the pandemic have been published by international, federal, state, and local governing bodies. Although these organizations have begun to consider what recovery will look like, algorithms regarding recovering surgical subspecialties from the COVID-19 pandemic remain to be outlined.

STAGE I: CONTROLLING THE SPREAD

As of this writing, the COVID-19 pandemic is still growing in the United States, and community transmission is occurring in almost every state. In anticipation of hospital overcrowding with COVID-19 patients, and to contain the COVID-19 spread, the American College of Surgeons (ACS) has recommended that surgeons delay elective surgeries.³ In an effort to control the spread, most neurosurgery departments have adopted protocols triaging their currently scheduled cases, cancelling nonurgent elective surgeries and limiting their clinics or using telehealth

Key words

- Adenoma
- Brain mets
- Brain tumor
- Coronavirus
- COVID-19
- Glioblastoma
- Meningioma

Abbreviations and Acronyms

ACS: American College of Surgeons
COVID-19: Coronavirus disease 2019
OR: Operating room

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visits to facilitate social distancing mandates while continuing to treat patients.⁴ Face-to-face patient care is limited to wound care and emergent ER evaluation only. Individual departments and neurosurgical subspecialties have established algorithms and recommendations for resource utilization and case triage during this stage to curtail the spread of COVID-19.⁴⁻⁸ These measures are anticipated to remain in place as transmission measurably slows down and infrastructure is reestablished to safely manage care for patients.

STAGE II: RECOVERY

Triggering the End of Stage I

Stage II involves reopening standard neurosurgical practice in a carefully staged approach. This can occur once we are able to safely diagnose, treat, and isolate COVID-19 cases and their contacts and we see a measurable decrease in the transmission of the disease ($RO < 1$). During Stage II, physical distancing measures and limitations for those at heightened risk from COVID-19 will be critical. Viral and antibody testing should become more widespread, and routine point-of-care diagnostics may be used in offices. We suggest the following hospital system criteria as critical to initiating Stage II neurosurgical recovery:

- A sustained reduction in COVID-19 cases is seen for at least 14 days (i.e., 1 incubation period).⁹
- The associated hospital system is safely able to treat all patients needing hospitalization without resorting to crisis standards.
- Rapid point-of-care testing is widely available to all patients/providers.
- State approval is provided if necessary.

Any return to Stage I, including a second wave of COVID-19 infection necessitating a return to crisis standards, will require national/regional and system-wide reevaluation to identify better methods for safely diagnosing, treating, and isolating cases.

What Does STAGE II Look Like?

The ACS and Centers for Medicare & Medicaid Services (CMS) recently published recommendations for resuming elective surgery and nonemergent healthcare.^{1,2} In general, these recommendations reflect a hospital system's ability to 1) understand the epidemiologic effects and impact of COVID-19 within their region; 2) to be prepared to handle both resumption of "normal" hospital functions, as well as a potential reversion back to Stage I; 3) to handle patient-specific issues, such as the ability to effectively communicate with and deliver nonemergent care to patients; 4) and to ensure that high-quality care can be delivered. These broad categories must be considered regionally when planning the recovery of a department.

However, the specific goals of recovering/restructuring a neurosurgical department in Stage II must reflect that department's mission. As an example, **Table 1** summarizes the specific goals of our department for post-COVID-19 recovery. Each goal is further outlined below.

Relax Physical Distancing Measures and Reopen the Offices in a Careful Fashion to Prevent a Return to Stage I. Once we have begun moving away from the "controlling the spread" period, hospital leaders will begin an incremental and gradual easing of physical distancing measures to continue the control of COVID-19 transmission. There must be continual monitoring for any sustained rise in new cases locally and of hospital resources in the event that a system returns to a position where it cannot treat patients requiring hospitalization without resorting to crisis management. This is necessary to avoid a reversion back to Stage I.

Workflows ultimately will be department-specific. We have focused our efforts on augmenting our efforts through technological solutions. This includes continued use of telehealth platforms or app-based technologies that facilitate access using and maximizing remote synchronous and asynchronous communication and image transfer and offer the ability to continue to limit office visits. This is critical for our higher-risk patient population or patients in home quarantine. In general, the guiding principle during this time should remain "in-person as last resort."¹⁰

Fortunately, the benefits of telemedicine for both patients and neurosurgeons have been explored with positive reviews.¹⁰⁻¹² Greater utilization of telehealth platforms will 1) diminish travel times and lost work time for patients; 2) limit PPE and resource utilization in the office; 3) limit exposures to patients, family members, caretakers, and practitioners; 4) and increase the catchment area of the neurosurgical department.^{10,11,13} One proposed workflow is demonstrated in **Figure 1**.

In addition to standard operating necessities, such as verification of the reason for an appointment, imaging submission and confirmation, and insurance verification, all patients requesting an appointment should be prescreened for factors that put them at higher risk of contracting or transmitting COVID-19. Patients should be advised to complete a telehealth consent form at this time and be given adequate instruction to set up telemedicine capabilities. In-person visits should be restricted to patients whose physical examination is unclear or concerning, to patients who are unable to or refuse to participate in telehealth visits, and for in-depth discussions regarding planned procedures. Postoperative appointments will be virtual if possible, with in-office wound care as necessary. Should point-of-care testing become available, patients who wish to be seen in the office may be tested in the office setting. In addition, if widespread serologic testing capable of identifying immunity to COVID-19 became available, a COVID-recovered group of people capable of returning to work and serving in higher-risk roles could be identified within the department.

Triage the Sickest or Most At-Risk Patients Awaiting Semiurgent or Elective Surgery to Ensure Treatment in a Timely Manner in the Event of Return to Stage I. Departmental multidisciplinary subspecialty case conferences can be used to triage cases based on urgency during Stage I and can be continued during Stage II as operating rooms (ORs) become available for semielective and elective cases. In addition to guidelines recommended by the ACS during Stage I,³ individual departments and subspecialties have promulgated recommendations for triage during these times.^{4,8} We believe that recovery of semiurgent and elective surgery following transition to Stage II should not necessarily be on a first-come,

Table 1. Goals of Stage II of Neurosurgical Recovery from COVID-19

1. Relax physical distancing measures and reopen the offices in a careful fashion to prevent return to Stage I.
2. Triage the sickest or most at-risk patients awaiting semiurgent or elective surgery to ensure treatment in a timely manner in the event of return to Stage I.
3. Position the neurosurgery department to have priority access to OR availability.
4. Restructure sophisticated educational experience for residents/students/patients.
5. Reinvigorate research efforts.
6. Constant reassessment of the new normal in anticipation of transition to Stage III.

first-served basis. Neurosurgeons should consider published subspecialty suggestions in addition to obtaining multidisciplinary consensus to drive the growth of case volume in the recovery period. This is critically important as the potential for a return to stage I remains undefined.

Given the high viral load in the upper airway of infected patients and the risks identified during endoscopic endonasal procedures,

these should continue to be delayed unless emergent or until preoperative COVID-19 testing can be performed.¹⁴

Spine surgeons, as well as device companies, are planning for the imminent ramp-up of procedures to catch up on the backlog of surgical cases due to the pandemic. Ambulatory care centers, especially with overnight nursing options, and facilities that can extend care for 1–2 postoperative days have been proposed as feasible options, as these centers may be able to accommodate a significant majority of spinal care.¹⁵ This is especially possible if minimally invasive techniques are used when indicated.

All surgical patients will be required to undergo COVID-19 testing within 48 hours of surgery. This can be done in person or using home testing companies capable of providing the test. In regions where COVID-19 testing remains poorly available, all patients should be screened with a questionnaire to assess likelihood of active disease and previous exposure before surgery. Positive-screened patients should undergo testing when available or undergo a 14-day preoperative quarantine. Each OR day should have both a first group of planned OR cases and a second group of “standby” tested patients added to the schedule in the event that a scheduled case is COVID-19–positive and delayed. This will enable all usable OR time to be filled. All efforts should be made to defer surgery on COVID-19–positive

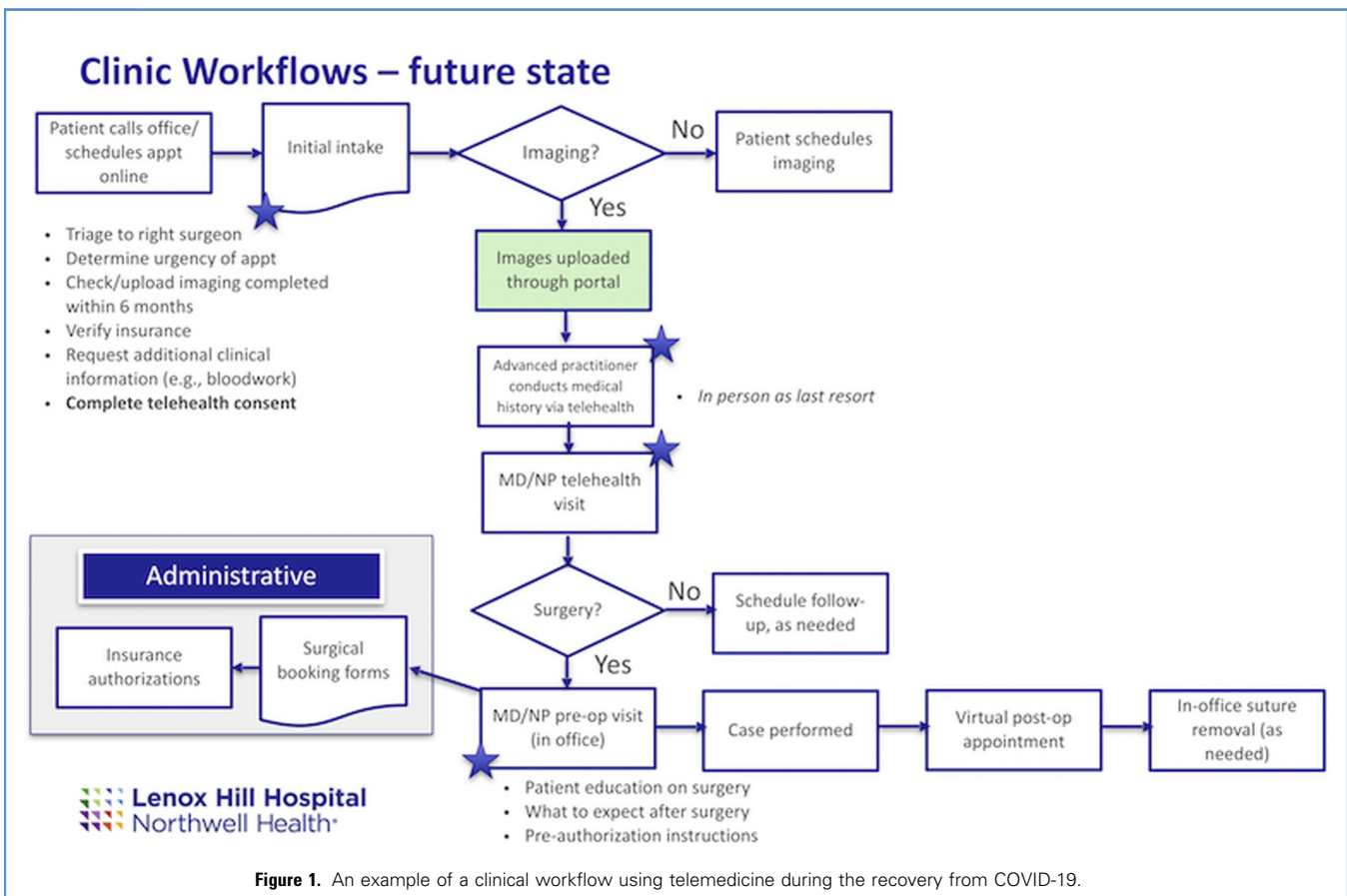


Figure 1. An example of a clinical workflow using telemedicine during the recovery from COVID-19.

Table 2. Case Prioritization Scale

Emergency procedures (priority 4)
■ Delay would cause immediate severe harm or death.
■ Delay would result in permanent disability or severe harm.
■ Patient is medically unstable related to a surgical condition.
Urgent procedures (priority 3)
■ Delay or further delay beyond 4 weeks risks significant patient harm.
■ Delay would prolong current hospital stay or increase the likelihood of transmission during the pandemic.
■ Patients have failed medical management of a surgical condition.
Semiurgent procedures (priority 2)
■ Delay or further delay beyond 3 months risks patient harm.
■ Delay would increase the risk of a hospital stay or create the likelihood of later hospital admission.
Nonurgent procedures (priority 1)
■ Delay or further delay beyond 6 months poses minor or no risks of patient harm.
Elective procedures (priority 0)
■ Timing of procedure does not affect clinical outcome

patients for at least 14 days. Enhanced PPE precautions should be used in all cases, especially in light of the risk of false-negative tests. In addition, separate COVID-19 and non-COVID-19 environments should be maintained in the intensive care unit and the OR.

Essential staff should be permitted in the OR. Given the risk of aerosolization of the virus before and during intubation, all staff nonessential to intubation should leave the room during intubation.^{16,17} In addition, we have incorporated a clear plastic drape laid over the eyes, nose, and mouth of intubated patients to limit aerosolization of viral particles during procedures.

Position the Neurosurgery Department to Have Priority Access to Elective OR Availability. OR utilization and prioritization discussions no doubt have been underway at all hospitals during Stage I, typically with tight restrictions to “emergent” patients with impending loss of life, limb, or neurologic function. During Stage II, surgical care will be progressively expanded to those patients with nonemergent but “urgent” and “semiurgent” conditions, representing severe and significant conditions.

This prioritization may be best handled within the surgical departments, led by department chairs and section chiefs, as prioritization at the hospital level might not work well. The collective wisdom and experience of department faculty should minimize conflict.

Preexisting OR block times and priority should be deprioritized during Stage II until the backlog of urgent and semiurgent cases

has been addressed in a patient-centered manner. Multidisciplinary consensus regarding the urgency of surgical cases can help triage cases by medical need. We have adopted the scale shown in **Table 2** to assist with case prioritization.

Restructure Sophisticated Educational Experiences for Residents/Students/Patients. As restrictions on physical distancing are relaxed, students and staff nonessential to clinical care will be permitted to slowly return to work. Preventing a return to Stage I remains critical to Stage II recovery, and resource utilization will remain a significant concern until we transition clearly out of Stage II.

As a department, we will use this opportunity to restructure and update our educational and patient information content. It is likely that limited or no patient visitation will be permitted, resulting in new stresses on inpatient staff. Mobile and desktop telehealth, as well as “asynchronous” video and audio messages, can be delivered to families utilizing newly designed apps. Large group video conferencing permits sophisticated and safe educational sessions. Adoption of virtual reality and augmented reality education systems will increase educational content for students, residents, and patients alike. Resident education will proceed as usual as normal resident staffing is resumed; however, every effort to utilize virtual conferencing and education should continue to maintain social distancing efforts. Should serologic testing become available, visiting students will be required to be tested for immunity as well as COVID-19 to protect patients and their communities.

Reinvigorate Research Efforts. Nonessential laboratory workers, research track faculty, postdoctoral fellows, and graduate students will undergo screening for COVID-19 exposure and will be permitted to return to work as physical distancing is relaxed. As widespread serologic testing becomes available, demonstration of immunity may be required. People at high risk will continue to maintain physical distancing. Researchers will be encouraged to continue working remotely whenever possible to mitigate the spread of disease. Any U.S. Department of Agriculture-covered animal facility will be permitted to continue basic animal care and husbandry operations. Patients being enrolled into clinical trials will be encouraged to use telehealth technologies and established in-home lab services when able.

STAGE III: OUR NEW NORMAL

Stage III involves the lifting of all physical distancing recommendations and depends heavily on the development of effect methods of prophylaxis and treatment. At the time of this writing, it is hard to predict where Stage I will end, let alone how long Stage II may last before transition to Stage III occurs. Importantly, none of this is meant to function as dogma. We have currently identified these goals with an explicit understanding that times are changing rapidly, and that our responses to the pandemic must remain fluid. The specific milestones and suggestions included in this report are judgments based on our current understanding, and, as we have seen, this can change rapidly. Importantly, we believe that recovery following the COVID-19 pandemic offers a unique opportunity to disrupt and rebuild the

historical patient and office experiences in a modern post-COVID-19 world.

CONCLUSION

As neurosurgeons, we have always been at the technological forefront of medicine. The recovery from COVID-19 will provide us a unique opportunity to rebuild essentially from zero, with the experience and knowledge to hit the ground running. We believe this is not a time to rest on our laurels as neurosurgeons or do things because we were taught to do them “the same way every time.” Now is a time to innovate, anticipate, and embrace the technologies and advancements that will enable us to safely overcome this period of darkness and isolation. As a department, we are tasked now not to just rebuild neurosurgery, but also to find new ways to expand it. Maintaining excellence is at the core of our training; however, excellence is not an action—it is a habit. Tenacity is not a spontaneous flowering of good character—it is

doing what you were trained to do. It manifests not in those whose training spared them hardship, but rather in those whose training embraced hardship and taught them to deal with it.¹⁸

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Randy S. D'Amico: Conceptualization, Writing - original draft, Writing - review & editing, Visualization, Supervision. **Griffin Baum:** Writing - review & editing. **Yafell Serulle:** Writing - review & editing. **Danilo Silva:** Writing - review & editing. **Michael L. Smith:** Writing - review & editing. **Rebecca A. Wallack:** Writing - original draft, Writing - review & editing, Visualization. **Jason A. Ellis:** Writing - review & editing. **Mitchell Levine:** Writing - review & editing. **Rafael Ortiz:** Writing - review & editing. **John A. Boockvar:** Conceptualization, Writing - review & editing, Supervision. **David J. Langer:** Conceptualization, Writing - original draft, Writing - review & editing, Supervision.

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