



# Timeline and Procedures on Restarting Non-Emergent Arthroplasty Care in the US Epicenter of the COVID-19 Pandemic

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## Introduction

A novel coronavirus disease (COVID-19) was identified in several patients living in Wuhan, China, and first reported in December 2019 [35]. By early June 2020, the disease had been diagnosed in 6.6 million people and 388,000 deaths had been reported in 215 countries. Mortality rates were high in some European countries; in Italy, the rapid growth of COVID-19 cases led to shortages of hospital beds, ventilators, and personal protective equipment (PPE) [2].

The USA has had the highest number of confirmed cases—nearly 6 million by late August 2020 [15]. The first US case was reported in January 2020 [12], and the first case in New York State on March 1, 2020 [32]. As of May 24, 2020, New York State had the highest number of confirmed cases in the nation (374,085) and deaths (24,079) [15]. The state had more confirmed cases than many countries, and within New York State, New York City and its nearby counties of Westchester, Suffolk, and Nassau had 80% of all confirmed COVID-19 cases in the state [15].

The experience in other countries, coupled with predictions that COVID-19 could overwhelm local healthcare resources, led to a halt in all elective surgery. On

March 7, 2020, the Governor of New York State, Andrew Cuomo, declared a state of emergency after 89 cases were confirmed in the state and after predictions indicated that the hospital capacity for beds, ICU beds, and ventilators would be insufficient to cope with the demand of people affected by COVID-19. Hospital for Special Surgery (HSS) suspended all elective outpatient visits and surgeries in mid-March 2020, a decision that had last been taken after the terrorist attack on September 11, 2001. Our hospital's decision was soon followed by an executive order by the governor stopping all non-essential medical and surgical care in hospitals, clinics, surgical centers, and outpatient offices statewide.

During March, April, and May, HSS, which had been primarily devoted to elective treatment of orthopedic and rheumatologic conditions, underwent a substantial transformation and admitted COVID-19 patients and others affected by non-orthopedic conditions and emergent orthopedic conditions. Non-critical COVID-19 patients were attended to in a devoted medical unit, whereas critical COVID-19 patients received care in operating rooms that had been transformed to an intensive care unit (ICU).

Included from the start was planning for the return to normal operations after the emergency was resolved. This review narrates the steps taken by the Adult Reconstruction and Joint Replacement (ARJR) service to frame and organize the return to non-emergent orthopedic surgery. Our hope is that others can benefit from our experience while dealing with this pandemic or other situations that require similar, drastic measures.

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## Brainstorming the Return to Non-Emergent Surgery

After cancelling all elective surgery, the ARJR service was divided into three groups of attending surgeons and trainees. The groups functioned as autonomous cells to take care of orthopedic emergencies in our own patients

and those from nearby and affiliated institutions that were fully devoted to the care of COVID-19 patients. Each group would see emergencies and operate on a rotating schedule [6, 27].

Two weeks after halting elective care, a group of four attending arthroplasty surgeons (FB, SH, MF, AGDV) were tasked with brainstorming ideas about returning to non-emergent arthroplasty care, while substantial efforts were being made to expedite a telehealth program that would allow patients to have access to limited, non-emergent medical advice.

Meeting virtually twice a week, we worked on a model that would focus on re-initiating non-urgent outpatient and inpatient care related to arthroplasty focusing our efforts on seven areas that would cover most of our patient interactions: (1) the timing to re-start non-emergent arthroplasty surgery; (2) COVID-19 screening and testing; (3) the office visit and ancillary testing; (4) pre-surgical screening (PSS); (5) the operating room; (6) the hospital stay; and (7) recovery after discharge. We conceived a plan that would minimize the risk of both health care workers (HCW) and patients of contracting COVID-19.

Our plan relied on the need to adapt to a very dynamic situation. In a short period of time, the medical community gained knowledge on this new pathogen and its resulting disease. Our group organized weekly conference calls with colleagues in China, Singapore, and South Korea, areas that had experienced an earlier increase in the number of cases and had put into practice different containment strategies [19, 20]. Their experience, and that of colleagues in European countries that also experienced a high number of cases like Italy and Spain, proved to be very useful.

### The Timing to Return to Non-Emergent Care

The daily monitoring of the number of new COVID-19 cases, the number of new hospital admissions, the number of admissions to the ICU, the number of hospital discharges, and deaths associated with COVID-19 in New York State proved to be crucial to timing the re-start of non-emergent surgery. Guided by the governor, New York State institutions were directed to develop step-by-step protocols for re-opening, including the following guidelines for non-emergent surgery:

1. New infections: In accordance with Centers for Disease Control and Prevention guidelines, health care facilities considering re-opening should have had at least 14 days of decline in total net hospitalizations and deaths on a 3-day rolling average. Regions with few COVID-19 cases could not exceed 15 net new total hospitalizations or five new deaths on a 3-day rolling average. In addition, the region must have had fewer than two new COVID-19 patients admitted per 100,000 residents per day.
2. Health care capacity: Every region must have had the health care capacity to handle a potential resurgence in cases. Hospitals in the region were required to reserve at least 30% of their hospital and ICU beds

and to stockpile at least 90 days of personal protective equipment (PPE).

3. Testing: Facilities were ordered to implement testing regimens that prioritized symptomatic individuals and those who had come into contact with them and to conduct frequent tests of frontline and essential workers. Each region had to have the capacity to conduct 30 diagnostic tests for every 1000 residents per month.
4. Contact tracing: Regions had to ensure a baseline of 30 contact tracers for every 100,000 residents, with additional tracers based on the projected number of cases in the region.
5. Isolation: Facilities had to present plans to have rooms available for patients testing positive for COVID-19 and who could self-isolate as part of the re-opening process.

These requirements were overseen by the state government. The number of cases nationwide and particularly in New York State, coupled with the lack of pharmacologic treatment or prevention, made officials, hospitals, and the public realize that life would not be the same until an effective treatment or vaccine were available. The expression “return to new normal” was coined.

While the state government guided the timing to return to elective surgeries, by May 2020, hospitals started to ease criteria for emergency medical visits and surgeries. At HSS beginning in early May 2020, guidelines from the American College of Surgeons [30] and the Centers for Medicare and Medicaid Services [7] for medical care including surgery were offered first to emergent, followed by urgent, and then priority cases (Table 1).

Because the outcome of elective surgery in patients who develop COVID-19 is unclear, strict safety guidelines were established not authorizing urgent and priority procedures in patients at increased risk for COVID-19 complications. In a case series describing four patients in the first weeks of the COVID-19 outbreak who underwent elective cholecystectomy, hernia repair, gastric bypass, and hysterectomy, peri-operative complications were significant [1]. Three of the four patients died from complications typical of rapid progression of COVID-19. Similarly, Li et al., in reporting a death rate of 20.6% in 34 patients operated on electively during the COVID-19 outbreak, suggested that surgery may exacerbate and accelerate disease progression [18].

HSS established safety criteria for the careful selection of patients who would be eligible for urgent and priority surgery. These criteria were modified and eased during the “return to new normal” (Table 2). The ultimate goal was to select patients who were at low risk for procedure-related complications, would require short hospitalizations, and had a low risk of death should they contract COVID-19 post-operatively [10].

### Screening and Testing for COVID-19

Clinical screening was implemented for all patients coming to our hospital, which included measuring body temperature and asking a series of questions assessing for fever, dry

**Table 1** Classification of essential and elective surgeries

Category	General description	Arthroplasty surgery
Essential	Need for immediate care. Delay can be life-threatening or result in long term functional disability.	THA for hip fracture, peri-prosthetic fracture, prosthetic joint infection, catastrophic mechanical failure of implant, manipulation under anesthesia, evacuation of hematoma.
Emergent	Condition that if left untreated can result in sub-optimal outcome, aggravation of underlying medical condition, or chronic opioid dependence.	Pending peri-prosthetic fracture, some prosthetic joint infection, recurrent dislocation, advanced osteonecrosis with collapse and bone loss, rapidly progressive OA, some reimplantation.
Urgent	Condition that if left untreated will result in sub-optimal outcome for a variety of medical or socioeconomic factors	Some primary and revision arthroplasty, some revisions and reimplantation.
Priority	Procedure that will improve patient's function. There is no time constraint on its optimal outcome. Low-risk patients only.	Elective primary and revision arthroplasty. Single stage bilateral arthroplasty.
Low risk	Procedure that will improve patient's function. There is no time constraint on its optimal outcome. Low-risk patients only.	Elective arthroplasty.
All patients		

**Table 2** Risk stratification for patients undergoing surgery

Number	
1	COVID-19 negative
2	Age < 70 years (later expanded to age < 60 at the end of May 2020)
3	ASA class 1 or 2
4	Body mass index < 40
5	Non-smoker
6	Low risk for complex pain management challenges
7	Opioid use < 6 months
8	No history of substance use disorder, including active/current licit or illicit substance abuse
9	No intrathecal pump
10	No history of or current buprenorphine use
11	No history of coronary artery disease, heart failure, valvular heart disease, pulmonary disease, immunosuppressive disease or therapy
12	Diabetes: none or HbA1c < 7 (later expanded to < 8 at the end of May 2020)
13	Chronic kidney disease class 1–2
14	Expected hospitalization ≤ 48h
15	Not expected to need inpatient pain consult
16	Not expected to need blood transfusion
17	Independent functional status pre-operatively
18	Expected discharge to home (e.g., RAPT ≥ 9)
19	Ability to participate in remote/tele-rehabilitation

RAPT Risk Assessment and Prediction Tool, ASA American Society of Anesthesiologists

cough, sore throat, anosmia, tiredness, continuous rash, and gastrointestinal symptoms [16] experienced in the prior 2 weeks. Other institutions implemented a full physical evaluation for all patients [28, 29]. By the time hydroxychloroquine was being evaluated as a preventive and potentially therapeutic agent, some institutions inquired about the history of receiving prophylactic medication against COVID-19 [5].

One cornerstone in the effort to control the disease and return to safe elective surgery is accurate, rapid testing. At the beginning of the pandemic, testing was recommended only for patients with symptoms compatible with COVID-19. However, as the hospital began the return to new normal, all patients requiring admission were tested. All patients undergoing emergent, urgent, priority, or elective surgery underwent testing within 24 h of admission. This included those without symptoms of COVID-19, as asymptomatic contacts may transmit the disease during the incubation period [26]. Only COVID-19-negative patients could undergo urgent, priority, and elective surgery [16].

The most common recommendation for testing is a reverse transcriptase polymerase chain reaction (RT-PCR) test via nasopharyngeal swab, which is considered highly specific for SARS-CoV-2 [8, 36], but several studies had reported a significant false-negative rate [31, 34] with this test. Our hospital procured the equipment and reagents to perform in-house testing in hopes of reducing the false-negative incidence.

In addition to the PCR test, our protocol included testing for SARS-CoV-2 antibodies that would have indicated prior exposure or resolved infection. This information is essential to identify patients who had COVID-19 and who might be at an increased risk for complications post-operatively. A new

serology test by Roche administered 14 days after COVID-19 PCR confirmation reported a specificity of 99.8% and a sensitivity of 100% [25]. Our early experience with overflow transfers to our hospital from other institutions for treatment of orthopedic injuries suggested that some asymptomatic patients without a history of COVID-19 presented with hypoxemia or even infiltrates on screening chest radiographs. As a result, the pre-operative screening process for elective surgery during this period mandated a screening chest X-ray and assessment of oxygenation using pulse oximetry. Pulmonary computed tomography (CT) had been recommended by some authors for screening [13, 14, 33] due to the possibility of a false-negative RT-PCR test; however, we relied on pulse oximetry and chest radiographs.

### **The Office Environment for Urgent and Non-Urgent Office Visits**

Immediately after the shutdown in mid-March 2020, telehealth was implemented. Online training was made available, and over 210 physicians were trained. The telemedicine platform went live in 4 weeks. An additional 135 rehabilitation specialists (physical, occupational, speech, and performance therapists) were trained in 3 weeks. Prior to the pandemic, physical therapists held on average 20 telehealth visits per week as part of post-operative monitoring. During the pandemic, we reached over 1000 visits per day between physicians and therapists. Telerehabilitation with patients who had undergone arthroplasty in the weeks prior to the shutdown proved very useful. In our area, total knee replacement patients rely heavily on in-person physical therapy services after discharge. Telemedicine allowed us to conduct routine post-operative checks that we would otherwise have conducted in person.

From mid-March to early June 2020, outpatient clinics to assess and treat patients with emergencies related to arthroplasty continued to function. These clinics were available in the main campus in Manhattan and in satellite locations in White Plains, Uniondale, and Stamford, areas less affected by COVID-19 and where COVID-19-negative patients could feel more comfortable receiving essential care.

In addition to the outpatient emergency clinic, beginning in mid-May 2020, a limited office schedule was implemented at the main campus and the satellites to provide care to patients with urgent and priority conditions (Table 2). Surgeons saw no more than three patients per hour (24 patients in an 8-h period). This limited the number of staff coming in to work, maintained social distancing, and allowed for cleaning of exam rooms between patients. Each surgeon saw patients once a week in a predetermined location and was encouraged to use the satellite offices.

We implemented a strict clinical screening for all patients at our facilities. Face masks and hand sanitizing was provided, and no visitors were allowed. An appointment was required, no walk-ins were allowed, and questionnaires on COVID-19 symptoms were completed for all appointments.

Our elective outpatient clinics remained closed until early June 2020, re-opening on a similar limited schedule

of days and number of daily appointments. During these phases, our office staff worked remotely. In order to obtain valuable information that would shorten the face-to-face time in the office, we strongly encouraged physicians to perform telehealth visits on new patients prior to their in-person visit. We predict that in the future, telehealth for routine follow-ups and patients coming from long distances will be a routine part of our practices.

In addition, we facilitate the office visit by pre-scheduling any needed X-rays, magnetic resonance imaging (MRI), and testing. Patients requiring imaging before their visit were given an appointment and asked to wait until they received a text message to enter the building and the radiology suite. Patients requiring an X-ray, MRI, or special procedure without an office visit were placed on a list and contacted by radiology for a scheduled visit at times when the facilities were less busy.

### **Prioritizing Patients for Non-Urgent Surgery and the Selection Criteria**

In prioritizing patients for non-emergency arthroplasty, and in view of the backlog generated by the halt in non-urgent surgery, patients were assessed for the severity of their symptoms, disability, and radiographic findings. Surgeons were asked to create priority lists for their practices using a five-level scale (Table 1). Such priority rating systems are routinely used in national health care systems [3, 9]. In May 2020, essential surgeries could proceed, providing the hospital had adequate resources and protocols in place for them to be performed safely.

The second set of criteria was based on individual risk factors (Table 2). COVID-19 posed substantial additional risk to older patients with comorbidities such as coronary artery disease, chronic obstructive pulmonary disease, or uncontrolled diabetes [11]. Medical safety guidelines were developed, and patients were risk stratified [21, 22]. The totality of the patient's medical condition and need for surgery were individualized. Guidelines were helpful for decision-making. Additional considerations included social and rehabilitation factors. Patients who required inpatient rehabilitation and prolonged hospitalization were deemed inappropriate for the early phase of non-emergent surgery. It was important to document the appropriateness for surgery and to obtain informed consent for procedures during this period. We established a surgical oversight committee to review case selection and documentation for our surgical cases.

### **The Patient's Journey While Preparing for Arthroplasty**

Our goal was to streamline the process of PSS and offer patients the possibility of completing tasks online rather than in the hospital. The idea was to shorten the time required for PSS. The one-and-a-half-hour, in-person, pre-operative education class for patients undergoing THA and TKA was converted to online education modules patients took before their PSS visit. Likewise, in a pre-operative telerehabilitation



visit, the most important pre- and post-operative exercises and precautions were discussed, while preparing patients for a post-operative therapy plan that would include telerehabilitation and/or in-person therapy. In-person discharge planning with a social worker was replaced by a pre-operative discharge planning call, during which a case manager would confirm the plan, eliminating unnecessary delays in discharge after surgery.

PSS was performed either at the main institution or at the satellites. Satellites had previously been utilized for pre-operative testing rarely. In order to leverage the benefits of the satellite offices, hospitalists assigned clinic days at the satellites facilitated the pre-operative evaluations. All patients had antibody (IgG) testing for SARS-CoV-2 within a week of surgery. If the antibody test was positive, surgery was scheduled for the last case of the day.

Anesthesiologists were encouraged to call patients the day before surgery, to shorten the face-to-face dialog prior to surgery. This ensured that questions could be answered prior to coming into the hospital and maximized professional distancing.

In order to further minimize waiting times, pre-operative radiographs, MRIs, or CT scans were scheduled along with other exams required for PSS. Patients who had only a telehealth visit before scheduling surgery would also see their surgeon on PSS day for a complete physical exam, evaluation of radiographs, and discussion of questions not covered via telehealth. Designed to minimize face-to-face contact, many of these changes have streamlined the patient experience and are expected to continue in the post-pandemic period.

### The Surgeries and the Operative Environment

As our region began to move beyond the crisis, indications for non-urgent arthroplasty were expanded. Our hospital took a thoughtful and staged approach, while complying with local and federal guidelines. In early May 2020, urgent and priority arthroplasties in patients who had been waiting almost 2 months were progressively allowed. These included a limited number of patients with advanced joint disease and concomitant bone loss, those with grossly loose implants and pending peri-prosthetic fractures, those who had undergone removal of an infected joint replacement and required reimplantation, and those with poorly controlled pain (Table 1).

As the hospital started to expand surgical indications, the surgical schedule remained substantially reduced. This allowed safe distancing for the protection of patients and HCWs and gave the team time to comply with in-hospital security measures and testing. All patients and staff were screened daily upon entry and were required to wear PPE. Social distancing was maintained between patients; in order to do so, schedules were modified to accommodate the additional space and staff requirements. All patients underwent PCR swab testing upon admission and prior to surgery [2, 11, 23]. The turnaround time for COVID-19 PCR testing was 60 min and was incorporated into the

workflow. Facilities that cannot do rapid testing should try to have testing performed as close to surgery as possible.

New operating room (OR) safety protocols were developed for universal use of PPE and proper waiting times. Rigorous adherence to these newer safety protocols should take priority over efficiency in the early expansion of surgical indications.

Careful consideration was taken to create the appropriate operating room airflow and sterile environment. The International Consensus Group (ICM) recommended a normal positive-pressure room modality to decrease efflux such as in-room air filters or negative-pressure antechambers [24]. The European Knee Society [11] and ICM [24] also recommend air flow with a minimum of 20 air changes per hour. At our institution, air circulation is via laminar flow with high-efficiency particulate air (HEPA) changed 20 times per hour through the ceiling, coming down on the patient from above and then being drawn out of the room through two exhaust vents on opposite sides of the room. The majority of arthroplasty surgery at our hospital was and is performed with neuraxial anesthesia. For potentially aerosolizing procedures (intubation or extubation, for example), indispensable OR personnel remained in the room utilizing PPE that include N95 masks and goggles, and the OR doors were kept closed for 20 min to allow for complete air turnover, thereby protecting the hallways. In addition, portable HEPA filters have been installed at the head of each operating table to immediately filter air coming from the patient.

### The Post-Operative Hospital Stay

Patients undergoing arthroplasty who required a short hospitalization or same-day discharge were preferred in the early phases. This was carefully discussed with the patients, and the conditions for an early, safe discharge were optimized. Ambulatory arthroplasty has been a growing trend in the USA for several years. Advocates have emphasized the safety of outpatient procedures and the avoidance of inpatient risks [4]. In the era of COVID-19, same-day or short-stay surgery is especially appealing. In spite of hospitals' extensive efforts to minimize COVID-19 risks to patients, other patients and/or HCW potentially transmit the virus in spite of testing negative for COVID-19 [17]. Patients at home are likely to have fewer personal interactions, limiting the exposure risk. During this period all hospital rooms were single occupancy. During early phases of return to normal, no visitors or visiting hours were allowed for adult patients.

In conclusion, the COVID-19 crisis had a major impact on elective surgeries including arthroplasty. As our hospital emerged from the crisis, we made adaptive responses in care that we implemented on the basis of understanding the spread of COVID-19 in our area; our patients' characteristics, social and living conditions; and their priorities in undergoing different kinds of surgery. We leveraged pre-crisis structures and procedures and created others to allow the progressive return to non-urgent arthroplasty.

## Compliance with Ethical Standards

**Conflict of Interest:** Alejandro Gonzalez Della Valle, MD, reports no conflicts of interest. Friedrich Boettner, MD, reports grants and personal fees from Smith & Nephew and personal fees from OrthoDevelopment, Depuy, and Medtronic, outside the submitted work. Mathias Bostrom, MD, reports grants and personal fees from Smith & Nephew, grants from Ines Mandl Research Foundation, outside the submitted work. Mark Figgie, MD, reports board membership, consulting fees, royalties, and stock ownership from Wishbone, stock ownership from Insight, HS2, and Mekanika, and royalties and consulting fees from Lima, outside the submitted work. Steven Haas, MD, reports grants, personal fees, and royalties from Smith & Nephew, personal fees from OrthAlign and Heraeus, and ownership interest in OpLogix, outside the submitted work. David Mayman, MD, reports personal fees and royalties from Smith & Nephew, royalties and stock options from Orthoalign, and investment in Wishbone, InSight, and Cymedica, outside the submitted work. Douglas Padgett, MD, reports personal fees from DJO global and stock or stock options from PSI LLC, Tangen, and Orthophor, outside the submitted work.

**Human/Animal Rights:** N/A

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