Research Article

Early Experience Managing a High-volume Academic Orthopaedic Department During the Coronavirus Pandemic in New York City

Zachary T. Sharfman, MD, MS†
Jeremy Loloi, MD†
Jonathan Krystal, MD
Eric Fornari, MD
Paul Levin, MD
I. Martin Levy, MD
Neil J. Cobelli, MD
David S. Geller, MD*
Sun Jin Kim, MD*

Abstract

Our orthopaedic surgery department at Montefiore Medical Center and Albert Einstein College of Medicine is located within the Bronx, a borough of New York City, and serves a densely populated urban community. Since the beginning of the novel coronavirus outbreak in New York City, the medical center was forced to rapidly adapt to the projected influx of critically ill patients. The aim of this report is to outline how our large academic orthopaedic surgery department adopted changes and alternative practices in response to the most daunting challenge to public health in our region in over a century. We hope that this report provides insight for others facing similar challenges.

On March 1, 2020, the first case of novel coronavirus (COVID-19) in New York City (NYC) was confirmed. By April 10, 2020, New York reported 161,504 COVID-19 cases and 7,067 COVID-19 related deaths.[1] As the outbreak escalated, state and local governments took steps aimed at meeting the rapidly growing crisis. Policy changes were announced to address the anticipated equipment and staff shortages. On March 7, 2020, the New York Governor issued Executive Order Number 202, declaring a State Disaster Emergency, extending broad emergency measures.[2] On March 10, the national guard was deployed and shortly thereafter, on March 16, both the NYC mayor and the New York State governor issued executive orders postponing all elective surgeries.[3] This was in keeping with the larger effort to proactively manage hospital resources, personnel, and accessibility for the projected influx of critically ill patients.[2] Our tertiary care academic medical system, which includes Montefiore Medical Center and Albert Einstein College of Medicine, is located in the Bronx, a borough of NYC, and serves a densely populated urban community. Since the beginning of the outbreak, the medical center and its staff have cared for thousands of COVID-19 positive patients and tremendous efforts were undertaken to vastly increase hospital capacity beyond the existing 2,059 beds already within our system.

The Department of Orthopaedic Surgery includes 34 attending orthopaedic surgeons, five attending podiatric surgeons, three orthopaedic surgery fellows, 30 orthopaedic surgery residents, 15 podiatric surgery residents, over 50 midlevel providers, and over 150 support staff and managers. The rapidly evolving events related to the pandemic necessitated rapid evaluation and adaptation of departmental human resources,

From the Department of Orthopaedic Surgery, Montefiore Medical Center, Bronx, NY.

Correspondence to Dr. Sharfman: zachsharfman@gmail.com

† Dr. Sharfman and Loloi contributed equally as first authors on this manuscript.

* Dr. Geller and Dr. Kim contributed equally as senior authors on this manuscript.

J Am Acad Orthop Surg 2020;00:1-7

DOI: 10.5435/JAAOS-D-20-00412

operational processes, and professional, academic, and educational commitments. The aim of this report is to outline some of the changes adopted in response to the most daunting challenge to public health in our region in over a century (Figure 1). We hope that this report provides insight for others facing similar challenges.

Establishing Guiding Principles

As the reality of the pandemic became increasingly evident, overarching departmental goals were established. These goals clarified the department's charges and aims over the ensuing weeks and included

(1) to continue to provide high-quality orthopaedic care for our patients,
(2) to limit patient and provider exposure to COVID-19,
(3) to contribute to the larger institutional medical needs, and
(4) to manage and conserve human resources to permit long-term orthopaedic care.

These goals were considered within the context of the department's existing organization and day-to-day operations and used to steer important changes to

(1) departmental communication,
(2) inpatient and emergent orthopaedic care,
(3) outpatient orthopaedic care,
(4) telemedicine,
(5) human resource allocation and utilization,
(6) academic and educational commitments, and
(7) pandemic-specific considerations in orthopaedic care

The following sections will review in greater detail these changes. Supplemental information for each section can be found in the Appendix, Supplemental Digital Content 1, http://links.lww.com/JAAOS/A502.

Departmental Communication

At the outset, the orthopaedic chairman convened a steering committee, comprised key leaders and department managers. A daily conference call was established, whose frequency was adjusted in response to evolving news, policies, or needs. The calls permitted for the distribution of responsibilities in a clear coordinated manner. Decisions regarding policies and processes were vetted and considered in real time. Frequent and clear communication with the entire department played a vital role, serving to quell anxiety, to educate and update, to mitigate misunderstandings, and to ensure the department remained unified and cohesive.

A Google Sheet was created to account for each member of the department. This allowed staff to "sign in" every day and indicate their status, denoted as either "on-service," "available," "unavailable," or "deployed." For example, if an individual became ill, they were deemed "unavailable" until such time that all institutional occupational health requirements were met. Daily e-mails were issued from the Chairman's office providing succinct, relevant, and timely information. Similarly, a residency memo was issued routinely by the program director, providing residency-related updates.

Inpatient and Emergent Orthopaedic Care

The Montefiore Orthopaedic Surgery Department extends across four separate campuses. The residency also staffs an affiliated level one trauma center. In total, the residency provides care in five distinct emergency departments and three inpatient facilities. Orthopaedic inpatient services are staffed by large teams of residents and midlevel providers under the supervision of attending faculty.

Initially, resident staffing was reduced marginally, abandoning service-specific staffing for campus-specific staffing. This reduced workforce was matched with a decreasing inpatient census because elective surgeries declined and eventually ceased entirely. Ultimately, each of the three inpatient services were staffed by a single chief resident during the day shift, whereas a single postgraduate year 4 (PGY-4) resident staffed the overnight shift using a night float schedule. By using a limited number of senior residents under attending supervision, efficient patient care was provided while limiting unnecessary provider exposure. It also made the PGY1, PGY2, and PGY3 residents available for deployment to medical services.

Outpatient Orthopaedic Care

The steering committee considered how to employ schedule changes to the high-volume outpatient faculty practice that spanned multiple campuses. This schedule consisted of five levels, labeled level A to level E, moving in a progressive manner from the least to the most austere (Figure 2). On March 20, the department instituted level A care which consisted of routine inpatient and outpatient care. New surgical case bookings were not permitted, but existing scheduled surgical cases

None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Dr. Sharfman, Dr. Loloi, Dr. Krystal, Dr. Fornari, Dr. Levin, Dr. Levy, Dr. Cobelli, Dr. Geller, and Dr. Kim.

Figure 1

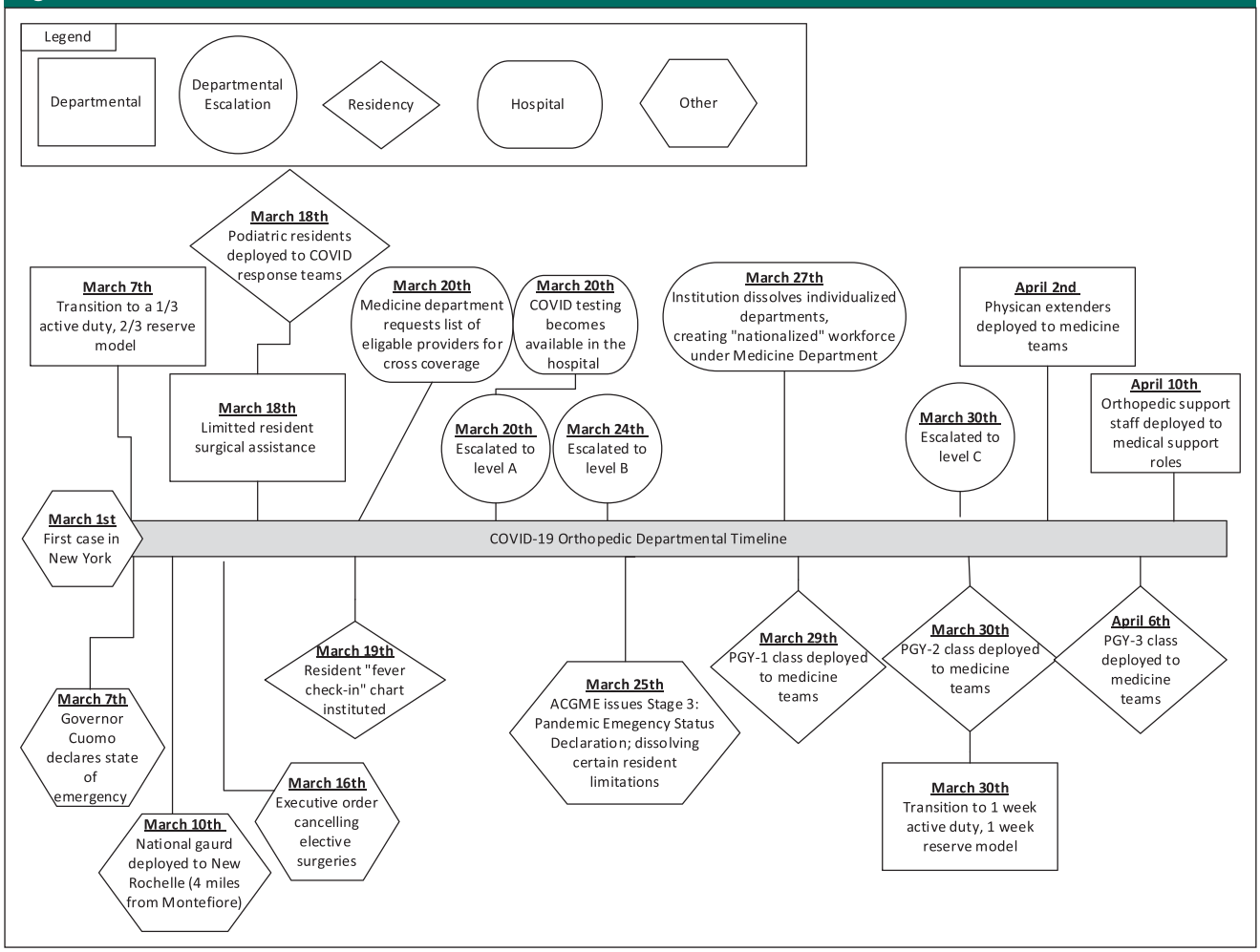

Figure 1 depicts a general timeline starting on March 1, 2020, after the first confirmed case of COVID-19 in New York City. The figure outlines when departmental changes, escalation in response to departmental response level, changes to the residency, and changes to hospital policies were instituted.

were allowed to proceed. Vendors and nonessential personnel were restricted from operating rooms. The departmental response was escalated to level B care on March 24, which called for division-specific clinics, limiting outpatient care to one or two subspecialty-specific sessions per week. This prompted providers to call patients and prioritize who needed an in-person evaluation and who could be managed via telephone or at a later date. Only emergent surgeries were permitted at this point. On March 30, the department escalated to level C care and has remained there during the peak of the pandemic. This further curtailed outpatient access, with only two outpatient office sessions per campus per week. These sessions were designed to provide urgent in-person evaluation for patients who did not merit inpatient admission. Fresh postoperative cases, new fractures, and minor injuries were managed by an "on-service" adult faculty member together with a single midlevel provider. In addition, a single pediatric clinic was staffed by one pediatric orthopaedic surgeon, who also served as the pediatric "on-service" attending. On-service providers were designated to be on-call for the week, coordinating inpatient care with the residents and a single inpatient physician assistant. Two "reserve" subspecialists, one hand surgeon and one spine surgeon, were assigned with covering specialty-related surgical emergencies and providing general support as required. Level D and E escalations, which assumed 50% and 75% of faculty would be unavailable because of illness or reallocation, respectively, were not required even during the peak of the pandemic in New York. These levels of escalation permitted only basic orthopaedic care across the institution and were considered a last-resort option recognized to be, by its very nature, an improvisation at best.

Figure 2

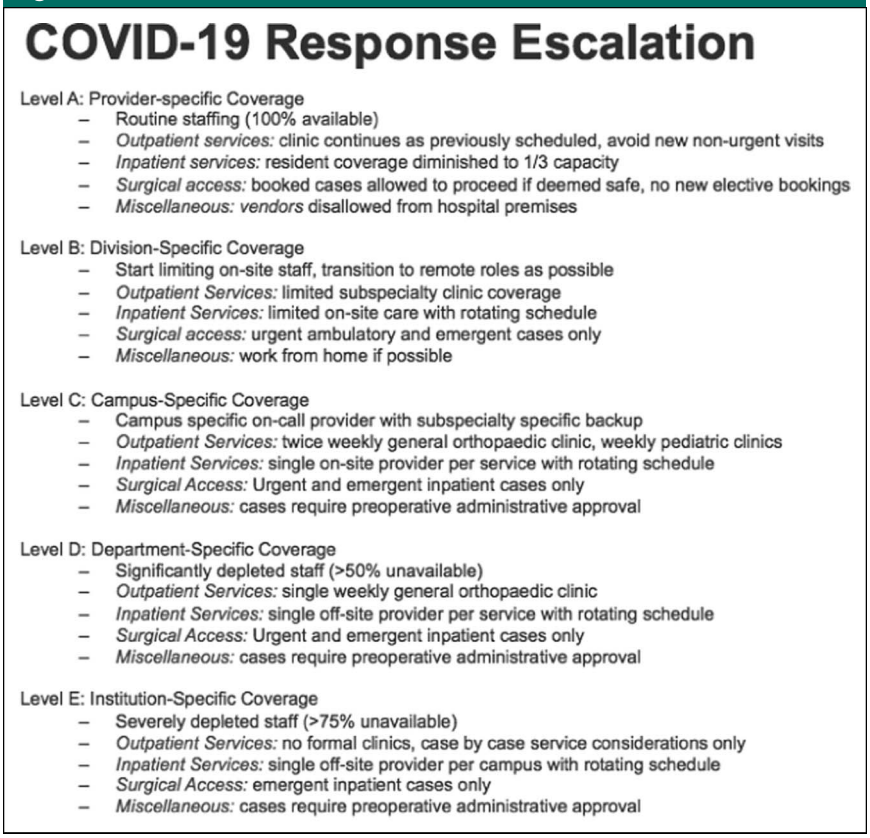

Figure 2 demonstrates the short form COVID-19 response escalation plan instituted by our orthopaedic surgery department.

Planning for these progressive schedule changes required coordination with the call center and the EPIC workflow. For example, levels B and C required new "clinics" to be created within EPIC to permit for scheduling of patients into generalized provider sessions. Care and operations within the physical office space was also modified. At the entrance to each clinical site, a staff member took patient temperatures and screened each patient for relevant symptoms.

Telemedicine

Telemedicine was not being used by the department in any meaningful manner before the COVID-19 pandemic. There was no official institutionally sanctioned platform with which to engage patients, and many of the computers were not equipped with video capabilities. A few weeks into the pandemic, the institution contracted with a third-party vendor, making formal telehealth visits possible. In addition, government policy evolved in a progressive manner, making initially existing patient visits permissible and billable even if only conducted via telephone. Shortly thereafter, new patient visits were permitted as well. Telemedicine required minor changes to scheduling work flow, as well as to documentation and billing. Although minor, these necessitated faculty and provider education.

Human Resource Considerations

Human resource considerations evolved over the course of the outbreak. Initially, the goals were to shield or limit exposure of as many providers and staff as possible, with the expectation that as individuals become ill, protected staff and faculty would be available to take their place.

As the COVID-19 outbreak increased in severity, the institution created a central human resource committee responsible for staffing medical services and newly erected intensive care units. They asked for a list of individuals who could be called on to augment or support the larger medical effort. To this effect, one half of the orthopaedic and podiatric surgeons were made available for medical deployment. Ultimately, only five attending surgeons were deployed to COVID-19 testing services. The PGY1, PGY2, and PGY3 orthopaedic and podiatry residency classes were redeployed to medical services stating on March 18. This included 32 residents, deployed in stages, who assumed the role of internal medicine residents on COVID-19 patient floors (Figure 1).

A total of 11 orthopaedic surgery residents and two podiatric residents contracted a febrile illness during this period that required quarantine and removal from active treatment roles. In addition, six attending surgeons contracted COVID-19. Because testing capabilities remained scarce, not all ill residents underwent testing. In total, seven residents were confirmed COVID-19 positive, whereas the remaining three were presumed positive based on institutional occupational health guidelines. All six of the attending surgeons were confirmed COVID-19 positive. Symptomatic residents were removed from active treatment roles; however, no staffing shortage was realized because both the medicine and orthopaedic departments created large backup teams to prepare for this eventuality.

Regarding returning to work, the hospital's policy allowed for return to active treatment roles after an affected individual was afebrile for 72 hours without antipyretic medications. The

hospital was inundated with the treatment of COVID-19 cases, and exposure was presumed in all providers who entered hospital facilities. As such, providers were not removed from active treatment roles based solely on exposure, unless they became symptomatic. At the peak, five residents were simultaneously sick and required cross coverage. Given the large number of attending surgeons at our institution and limited clinical activities, no coverage was necessary for the attendings recovering from COVID-19. Two midlevel providers also contracted the virus during this period.

Academic and Educational Commitments

Initially, efforts to continue formal didactic session, albeit over Zoom, were made. It quickly became clear that it was not realistic to continue these because shifting priorities dictated deployment of many residents to either medicine or in-house orthopaedic rotations. Given the reduced clinical responsibilities, residents paradoxically found increased time, which was used for independent self-directed didactics. In addition, daily resident educational lectures and question sessions were held via video conference. These sessions were designed to mirror the daily education seminars and the weekly resident education block. As escalating needs demanded, these meetings also transitioned to daily self-study sessions. The Orthobullets PEAK curriculum, already used by the residency, was used to assign daily topics and practice questions. In this way, the existing curriculum was maintained to some degree, despite the extenuating circumstances. Residents were encouraged to use any free time to submit research protocols for IRB review and to work on individual residency research requirements. Regularly scheduled subspecialty research meetings and translational laboratory meetings also continued via video conferencing.

Table 1

Surgical Cases and Deferred Hip Fractures During the 30-Day Pandemic Peak

Surgical cases	
Hip fractures	
CMN	15
Hemiarthroplasty	3
Infection	
I&D implant	4
I&D deep	5
Septic arthritis	3
Necrotizing soft-tissue infection	2
Trauma	
Ankle ORIF	6
Femur ORIF	6
Bilateral femur ORIF	2
Pelvis ORIF	2
Spinal fusion	1
Tibial ORIF	2
Periprosthetic femur ORIF	1
Fasciotomy	1
Tendon repair	1
Implant removal	1
Pediatric	
Elbow CRPP	2
Ankle ORIF	2
I&D deep	1
Oncology	
Femoral resection/reconstruction	2
Open biopsy	1
AKA	1
Total	64
Deferred hip fractures	
Nonsurgical management	3
Transfer to outside facility	2

CMN = cephalomedullary nail, I&D implant = incision and drainage involving orthopaedic implant, I&D deep = deep bony or soft-tissue infections such as osteomyelitis and abscesses, ORIF = open reduction and internal fixation, CRPP = closed reduction percutaneous pinning, AKA = above-knee amputation

Pandemic-specific Considerations in Orthopaedic Care

Perhaps the most common injuries requiring urgent orthopaedic management during the pandemic were hip fractures. Recognizing the survival benefits to early surgical intervention for these patients,[4–6] every effort was made to provide surgery for them, with a few notable exceptions. Nonambulatory patients, who are often offered surgery for pain relief, hygiene, and nursing care, and to facilitate transfers

Table 2

COVID-19 Status and Discharge Status of Surgical Patients During the 30-Day Pandemic Peak

COVID-19 status	
No test	17
Positive	15
Negative	31
Negative preop, positive postop	1
Discharge status	
Skilled nursing facility	29
Home	31
COVID-19 hypoxemic respiratory failure	2
Trauma-related death	2

and out-of-bed mobilization, were reevaluated during this crisis. The potential benefits of surgery for these patients were weighed against the high risk of inpatient exposure to COVID-19. This, coupled with ongoing resource limitations, forced providers to carefully consider whether nonsurgical options were acceptable on a case-by-case basis.

During the 30-day pandemic peak, 31 orthopaedic cases were performed across all Montefiore campuses and 33 cases were performed at our affiliated level one trauma center. All cases were deemed urgent or emergent in nature. This included 18 hip fractures, 20 additional adult fractures, 15 severe infections, four orthopaedic oncology cases, four pediatric fracture cases, one fasciotomy, one digital flexor tendon repair, and one circular frame removal. Surgical intervention was deferred for five hip fracture patients. Three patients received nonsurgical management because they had limited functional capacity at baseline and increased risk for COVID-19-related morbidity and mortality. Two patients with hip fractures were transferred to outside facilities at the height of the pandemic as operating rooms were converted to intensive care units, and it was determined that these individuals would benefit from surgical care that was not possible to provide, given a scarcity of resources and likely exposure (Table 1).

Beyond hip fractures, a number of other orthopaedic injuries that are generally managed surgically were also reevaluated. Specifically, multiple well-aligned midshaft tibial fractures, minimally displaced tibial plateau fractures, stable and unstable ankle fractures, calcaneal fractures, distal radius fractures, and pediatric supracondylar humerus fractures were treated with conservative measures as the fracture patterns were deemed amenable to nonsurgical or delayed surgical care. Considerations of the patient's protective weight-bearing capacity, likelihood of fracture displacement, functional status, and periarticular concerns were carefully evaluated before initiating conservative management. Pathologic fractures caused by either lymphoma or benign entities, which would normally be surgically addressed immediately, were managed conservatively, with plans for delayed surgical intervention as needed. Soft-tissue coverage procedures were temporized with vacuum-assisted wound closure coverage or wet-to-dry dressing changes. Nonemergent injuries that benefit from timely surgical intervention were transferred or referred to local facilities without the same functional limitations we experienced. This included one terrible triad injury, several distal radius and phalangeal fractures, and multiple tendinous and ligamentous injuries. The relevant risks and logistical issues were discussed in depth with each patient and their family, with the aim of arriving at the best informed decision possible, using the shared-decision making model. We maintained meticulous documentation in all cases, particularly when a management strategy differed from our normal clinical institutional preferences.

Although these nonsurgical recommendations fly in the face of routine and familiar orthopaedic surgical care, they were all arrived at after carefully balancing the risks, benefits, and alternatives. Exposure to the inpatient setting, even on a non-COVID-19 ward, often resulted in contraction of the virus. In two instances, this led to fatal consequences for elderly patients with notable preexisting comorbidities who presented with conditions that necessitated surgical intervention. Postoperatively, these patients became symptomatic and were found to have contracted the virus, which ultimately resulted in hypoxemic respiratory failure and death. Thirteen additional patients diagnosed with COVID-19 preoperatively or postoperatively had mild courses of the disease, requiring no more than noninvasive oxygen supplementation. It is difficult to glean insight regarding the postoperative outcomes of patients with COVID-19, given the limited number of cases and variable respiratory outcomes (Table 2). Despite this, the real risk of death secondary to COVID-19 hypoxic respiratory failure, especially in elderly patients and those with multiple comorbidities must be weighed against the proposed benefits of surgery. These concerns

have guided our practice toward conservative management or delayed surgical management of many injuries that we would typically operate on acutely.

COVID-19-positive patients who do undergo surgery, serious consideration of chemical anticoagulation may prove beneficial because there seems to be a hypercoagulability associated with this disease. Our institution has recommended anticoagulation for all adult COVID-19 positive or presumed positive patients not in the intensive care setting with apixaban 2.5 mg twice daily or enoxaparin 40 mg subcutaneous daily with D-dimer levels <3 μg/mL. Therapeutic anticoagulation with apixaban 5 mg twice daily or weight-based enoxaparin is recommended if D-dimer levels are >3 μg/mL. These patients are continued on prophylactic anticoagulation for 3 to 4 weeks after discharge or for 3 months if there is evidence of deep vein thrombosis or pulmonary embolism. Consideration of chemical anticoagulation should be given to COVID-19-positive patients postoperatively. It is also difficult to know which ambulatory cases should receive anticoagulation or when to reopen our clinics and provide elective surgical care. It has been important not to lose perspective and to work within the realities of the institution and the situation as they existed on each given day.

Conclusion

The COVID-19 pandemic has been unlike any regional event in modern history. The lack of effective medical management coupled with its tremendous stress on the healthcare system has required rapid adaptation across all specialties and disciplines. As an academic orthopaedic department in one of the largest training institutions in the country, it has been our charge to evolve with the dynamic and often uncertain medical and political landscape. Having a clear sense of purpose and duty, maintaining open lines of communication, carefully assessing resources and needs, and embracing novel technology, innovative approaches, and collaborative strategies has been essential. Going forward, having emergency response plans in place may prove wise. It is important to recognize that this pandemic has been a daunting challenge for all involved, including patients, their families, and their caregivers alike. Supporting one another both throughout the outbreak and beyond remains paramount to the health and integrity of the larger healthcare system.

References

References printed in **bold type** are those published within the past 5 years.

1. WorldoMeter: Coronavirus April, 10 2020. Available at: https://www.worldometers.info/coronavirus/country/us/. Accessed April 13, 2020.
2. State, N.Y: *No. 202.10: Continuing Temporary Suspension and Modification of Laws Relating to the Disaster Emergency*. 2020. Available at: https://www.governor.ny.gov/news/no-20210-continuing-temporary-suspension-and-modification-laws-relating-disaster-emergency. Accessed April 13, 2020.
3. The city of New York office of the Mayor Emergency Executive Order No. 100, 2020. Available at: https://www1.nyc.gov/assets/home/downloads/pdf/executive-orders/2020/eeo-100.pdf. Accessed April 13, 2020.
4. Donegan DJ, Nicolas Gay A, Baldwin K, Morales EE, Esterhai JL Jr, Mehta S: Use of medical comorbidities to predict complications after hip fracture surgery in the elderly. *J Bone Joint Surg Am* 2010;92:807-813.
5. Librero J, Peiró S, Leutscher E: Timing of surgery for hip fracture and in-hospital mortality: A retrospective population-based cohort study in the Spanish National Health System. *BMC Health Serv Res* 2012;12:15.
6. Khan SK, Kalra S, Khaana A, Thiruvengada MM, Parker MJ: Timing of surgery for hip fractures: A systematic review of 52 published studies involving 291,413 patients. *Injury* 2009;40:692-697.