Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Current Practices

The Rapid Response to the COVID-19 Pandemic by the Arthroplasty Divisions at Two Academic Referral Centers

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ABSTRACT

The COVID-19 pandemic has created widespread changes across all of health care. As a result, the impacts on the delivery of orthopedic services have been challenged. To ensure and provide adequate health care resources in terms of hospital capacity and personnel and personal protective equipment, service lines such as adult reconstruction and lower limb arthroplasty have stopped or substantially limited elective surgeries and have been forced to re-engineer care processes for a high volume of patients. Herein, we summarize the similar approaches by two arthroplasty divisions in high-volume academic referral centers in (1) the cessation of elective surgeries, (2) workforce restructuring, (3) phased delivery of outpatient and inpatient care, and (4) educational restructuring.

In December 2019, a novel coronavirus (COVID-19) broke out in Wuhan, Hubei Province, the People's Republic of China. The first reported case in the United States was in Washington State on January 19, 2020. Since that time, the COVID-19 pandemic has affected most of the world and there are currently over 450,000 cases and over 17,000 deaths reported in the United States alone. The unprecedented viral pandemic has motivated rapid societal change, primarily with efforts directed at social distancing to flatten the peak of the pandemic curve, and has also substantially strained health care resources to manage the exponential burden of the disease. Although front-line health care providers involved in the diagnosis and treatment of the respiratory transmitted virus deserve most (all) credit, the pandemic has also created challenges for other medical service lines, including orthopedic surgery. To ensure and provide adequate health care resources, hospital capacity, and personnel and personal protective equipment (PPE), service lines such as adult reconstruction and lower limb arthroplasty have stopped or substantially limited elective surgeries and have been forced to re-engineer care processes for a high volume of patients.

Our adult reconstruction and arthroplasty practices are located within two large quaternary academic referral centers. One serves the entire Intermountain West region, a large geographic area of 7 states and a population area of over 18 million people, and the other serves the entire state of Arkansas, with some referrals from neighboring areas of Oklahoma, Texas, Louisiana, Tennessee, and Missouri and a catchment area of over 3.5 million people. Our arthroplasty services both comprise four high-volume fellowship-trained lower limb arthroplasty surgeons, as well as a combined ten advanced practice clinicians (APCs), seven registered nurses, and multiple other providers including medical assistants (MAs), physical therapists (PTs), administrative assistants, and support staff. In addition, both are educational training centers for orthopedic residents and fellows and have a strong research mission as well. Consistent with our missions, our goal is to serve the clinical needs of the Intermountain West and the state of Arkansas as it relates to simple and complex joint arthroplasty care.

Before the COVID-19 pandemic, both groups performed surgeries at two separate facilities. In Utah, patients who were eligible for same-day-discharge or 23-hour admissions were generally

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scheduled at the University Orthopedic Surgery Center, and patients who required a higher level of care, including complex revisions, were scheduled at the University of Utah Hospital. In Arkansas, primary and complex revision surgeries are performed at the University of Arkansas for Medical Sciences (UAMS) hospital, and primary and simple revision surgeries are also performed at Baptist-Health Conway Medical Center. In 2019, the University of Utah service performed over 2000 hip and knee arthroplasty surgeries including a high rate of revision joint arthroplasty surgery (approximately 25%) combined with over 14,000 clinic visits, whereas the UAMS service performed 1800 joint arthroplasty procedures and completed over 8000 clinical visits. More than 30% of the volume at UAMS included arthroplasty surgeries to treat revision, infections, and/or periprosthetic fractures about the hip and knee. Given these volumes, the changes that have been required in response to the COVID-19 pandemic are unquestionably significant in their impact.

The purpose of this report is to describe the adaptive strategies we have implemented for the care of patients at two academic referral centers in response to the COVID-19 pandemic. Herein, we summarize our centers' similar approaches in (1) the cessation of elective surgeries, (2) workforce restructuring, (3) phased delivery of outpatient and inpatient care, and (4) educational restructuring.

Methods

Temporary Cessation of Elective Surgery

On March 16th (Utah) and 17th (UAMS), our team chose to halt all elective, nonurgent surgeries based on our understanding of the coming COVID-19 pandemic and the need to preserve resources for a potential future surge of patients, including maintaining PPE supply and needed hospital capacity.

First, the University of Utah and UAMS suggested a stop of all nonessential surgeries and clinic visits. The Utah Department of Health then issued a statement on March 23rd, 2020, ordering a hold on all nonessential surgeries from March 25th through April 25th. The Arkansas Department of Health released a similar statement on March 30th. The impetus for the Utah directive was based on the premise of the shared understanding that preservation of health care resources was of utmost importance. Similarly, the academic referral centers were also potential hubs for COVID-19 cases and referrals. To date, this state directive has not been interpreted similarly nor followed by all hospital systems in the state of Utah or Arkansas, in part due to smaller and rural medical centers feeling little impacts in resource restrictions or burden of respiratory cases.

Workforce Restructure

Our first response as a part of the planning for the impending COVID-19 pandemic was to form a platoon of health care provider teams [1]. The previously formalized resident surgeon subspecialty rotations based on broad educational platforms and goals were halted, and resident teams were formed to cover sites of care rather than orthopedic subspecialty services. The sites of care were set up to be covered by the minimum essential staff on a rotating weekly coverage schedule. Residents not currently in the active direct patient care platoons have been assigned work from home and provided enhanced educational assignments (described below in "Educational Restructuring"). At Utah, fellows entered a platoon to alternate with the residents to further mitigate the burden across additional individuals needing to be present at any one time on the inpatient service.

To reduce exposure and prevent the mixing of our workforce, the attending surgeons and the APCs were separated. The APCs were assigned to cover in-person required clinic visits (postop visits, etc.), and the attending surgeons created a rotating weekly coverage schedule to manage the surgical and hospital inpatient care that was deemed needing immediate or urgent care. At both centers, our most senior surgeons serve in leadership roles, and it was felt best to temporarily remove them from direct patient contact as much as possible. Nurses and other clinic staff have moved to a mostly telecommuting model to work from home, wherein they have maintained care coordination and clinical management duties effectively. To date, there are no known confirmed COVID-19 illnesses within our team, a known concern in teams delivering orthopedic or deployed nonorthopedic care [2].

Phased Delivery of Care

To assist in our strategic planning, we created a model for care delivery that aimed to reduce COVID-19–related exposure to our patients, prioritized the health of our care delivery teams, and included the responsible use of our PPE. Strategies to address these questions have been described at other centers as well [3]. Our model has consisted of four care delivery phases.

Phase 1

We implemented a policy to cancel most in-person clinic visits and all nonemergent/urgent surgeries. We defined urgent/emergent surgeries as new fractures; dislocations; tendon, ligament, muscle, joint, or nerve injuries; worsening neurological conditions; infections; and malignant tumors. All other cases, including most adult reconstruction-related surgeries, were deemed nonessential and were canceled and placed into a rescheduling queue. During phase 1, it was not exactly clear how prioritization of canceled cases would be structured.

To clear the operating room (OR) schedule, the Utah group initially set out to delay or reschedule surgeries week by week, with our schedulers, MAs, and APCs calling patients on the upcoming weeks' schedule and informing them that surgery would be postponed. However, as the projected data became clear that the likely duration of the pandemic was going to be prolonged, it became obvious that this strategy was unfair to patients who were being canceled as it created a "leap frog" scheduling scenario: patients being canceled had likely signed up for surgery before the patients the week after, creating confusion and staff chaos. In addition, the short notice we provided to our patients was likely inadequate because of travel, work, and family scheduling. Furthermore, we were giving false hope of surgery to patients not yet canceled. Finally, this approach failed to account for the urgent/complex cases that may have warranted surgery more expediently than other patients because of the potential for ongoing and/or irreversible damage with prolonged delay. In Arkansas, the decision was initially made to reschedule all elective, nonurgent cases until the end of April with the understanding that we would call to reschedule. On April 7, 2020, the decision was made to extend this approach until May 31, 2020.

In anticipation for phase 4 (ramp up/return), described in the section Phase 4, the Utah team has created a ranking list of all patients who are awaiting surgery. Two scoring scales were put into place. The first scale is for complexity (joint destructive/erosive arthritis, loose/failed implants compromising bone stock, stage 2 reimplants awaiting surgery to be able to advance activity/motion/weight bearing/return to work, etc). The second scale is for predicted length of stay to determine who will likely be successful with outpatient surgery based on patient health, independence, and support structure. Each scoring system is created to account for two potential limitations that may exist on the "ramp up/return" phase 4 (see Phase 4).

Phase 2

The messaging to our patients during phase 2 was focused on rescheduling and postponing in-person visits. To continue to provide clinical services to our patients in the setting of the widespread cancellations of nonurgent in-person visits, we quickly ramped up our telehealth and virtual visits by APCs/clinic staff. These virtual visits provided our patients with timely guidance for navigating their home recovery in the setting of the pandemic and helping them with perioperative home care instructions.

Given the focus on in-person visit cancellations and clinic visit rescheduling, our offices experienced a significant increase in patient-generated phone calls. Patients were calling about a variety of concerns including surgery cancellation updates, logistical topics such as booking (or canceling), travel to our medical center, and nonoperative treatment recommendations. In addition to the influx of incoming calls, our staff was also making more outbound calls to coordinate care. Combined, this strained our clinical resources and created unwanted redundancy as staff members were answering similar questions throughout each day and contacting patients frequently to share updates with them.

Given this new challenge, the Utah group looked for a more efficient solution to help keep our patients updated and engaged using systems that we already had available. Before the pandemic, we were using a text-messaging program to coach our patients before and after surgery (StreaMD, Chicago, IL, USA). We adopted a new use of this system that enabled us to send text alerts to all of our patients awaiting surgery. The content included general updates from our office in regard to surgery scheduling, general information about COVID-19 for patients with end-stage arthritis awaiting joint arthroplasty, American Association of Hip and Knee Surgeons sponsored patient education content regarding COVID-19, messages of empathy and encouragement from our staff, and personalized video messages from the attending surgeons.

The final portion of phase 2 revolved around the provision of postop rehabilitation to our patients. Before this pandemic, our PT teams had been using some tools to remotely provide our patients with virtual or video-based therapy services in the efforts of avoiding unnecessary outpatient PT visits. In response to the pandemic, and in an effort to continue to provide therapy and rehabilitation instructions for our postoperative patients and keep them out of outpatient and in-home therapy visits to the extent possible, our PTs increased the use of remote patient rehabilitation via phone, email, and online videos using our pre-existing telerehab systems.

Phase 3

As we await the peak surge of COVID-19, our clinical teams have reached a new state of clinical normalcy and equilibrium and our patient messaging has gone through a shift from “cancellation” to “invitation” as we communicate that we are still open for business—just in a different way. We are no longer canceling or delaying clinic visits, but rather we are shifting to virtual visits and embracing technology to care for our patients remotely to the extent possible. While avoiding unnecessary in-person visits, we still will perform them selectively when needed because of conditions not able to be assessed via telemedicine.

Phase 4

The critical phase of ramp up or return to elective surgery is still on the horizon, but preparations are underway to be ready for a return to normal state. As we have seen the COVID-19 “curve” flattening, the projected surge date is postponed as is our likely return to “normal” timeframe. As patients and surgeons wait, the anxiousness and frustration of both no doubt grow in both prevalence and intensity. The decisions on when to return to more normal elective practice and what criteria to use to implement these plans are still dynamic and may vary from state to state based on the level of COVID-19 impact on our various health care systems.

As we look at returning to normal operating room practices at our academic hospitals and outpatient surgery centers, we will likely be faced with difficult decisions regarding prioritization of patients secondary to limited resources within our system. The most likely limited resource will be that of operating room availability and anesthesia providers along with nursing/support personnel as all surgeons within the system will be trying to work through the large backlog of scheduled cases. The second potential resource restriction will be that of limited PPE. If inadequate PPE exists, cases with short operative times and higher volumes are likely to burn through more PPE than longer/complex cases, where fewer gowns/gloves/masks would be used by default because of less changes throughout the day. In this scenario, the short operative time surgeries may be less appropriate to push into the system during early ramp up of elective surgery, even in healthy and likely outpatient surgical candidates. The third potential resource limitation may come in the way of limited hospital space/capacity in terms of bed availability or nursing capacity. If hospital beds remain the limited resource, longer/complex cases in patients with higher comorbidity burden are less desirable and the healthy patients that can be done efficiently and safely sent home are more likely to be more suitable in this scenario. Finally, the availability of testing screening for providers and patients may be a resource limitation if it remains a limited resource, or perhaps just as likely, a potential variable that allows for an accelerated return to increased clinical care if the resource is readily available. It remains unclear as to the timeline of availability of widespread testing. It is likely that a negative COVID-19 test will be needed in the preoperative preparation phase before surgery.

Our academic institutions have 34 and 28 orthopedic surgeons, respectively, and an additional several hundred other surgeons in each academic health system, all postponing a high volume of surgeries. To date, within our Orthopedic Surgery Departments alone, we have postponed a combination of over 1450 elective cases that will need to be rescheduled across multiple subspecialties. Owing to the aforementioned resource restrictions, either we will all be trying to push through as many relatively young healthy cases all at once or trying to get through the more urgent and often more difficult cases. It is unclear which of these scenarios we will begin with, or if it will be a hybrid of the two. However, we are preparing ourselves to be nimble in this time of transition and quickly adjust our surgical scheduling with the use of the scaling systems described previously in the Phase 1 description. The two scoring systems of surgical complexity, predicted length of stay, and patient age and comorbidities will help us to properly stratify our patients and adapt to whatever ramp up strategy we are faced with in phase 4 of this pandemic. Weighing this with institutional PPE and health care provider availability, our hope is that we will be positioned to efficiently, within our arthroplasty division, as well as within the orthopedic department and across the surgical system, identify those patients most suitable to bring in for surgery as we are allowed to return to the operating room.

Educational Restructuring

Owing to the need to create responsible social distancing, our centers implemented new remote learning opportunities including virtual indication conferences, more frequent didactic and core curriculum, and weekly journal clubs which, quite honestly, allow for a more in-depth learning experience than typical weekly conferences. We have observed early success using Zoom (San Jose, CA) and Cisco Webex (Milpitas, CA) videoconferencing platforms. We

have found these platforms to be ideal for large groups of 30-40 attendees, with application functions such as participant rosters and screen-sharing capabilities that allow for active participation of reading radiographs and answering interactive questions. Through this educational initiative, we have enhanced resident education through these interactive, intimate virtual conversations and have expanded their readings to incorporate classic and modern relevant articles or review chapters in a very short time. Early surveys of the trainees have responded with an overwhelmingly positive assessment of the educational program.

Discussion

As we have moved quickly through this unprecedented period in history, we have taken the time to reflect on some of the key issues and lessons learned to date. As we consider these lessons, we have identified two major themes of learning at our centers: (1) the ethics of caring for the orthopedic patient in the time of a pandemic and (2) the benefit of embracing technology in orthopedic patient care and education that was likely underused in our field before this experience.

Ethics

Each step of this pandemic has brought difficult decisions and ethical dilemmas as we have been tasked with a gatekeeper role in deciding who to operate on and when. What is essential? What is time sensitive? How much delay can individual patients, disease types, or disease severities endure without increasing harm or adding morbidity or mortality? Should we try to continue to get as much volume performed early while the prevalence of disease is low in our hospitals and community on the front end of the curve? Or should we stay strong in our resolve to aid our own hospitals and surrounding health care community planning and preparation by avoiding adding perioperative patient burden to the health care system at a critical time while also using potentially critical resources. And when should we return to operating on elective arthroplasty cases again?

CMS attempted to provide guidance in a public release: "Non-emergent, Elective Medical Services, and Treatment Recommendations." [4] In that attempted guidance, a "tiered framework is recommended to prioritize services and care to those who require emergent or urgent attention to save a life, manage severe disease, or avoid further harms from an underlying condition." The initial early guidance from CMS included example procedures in each tier, and included hip and knee arthroplasty in Tier 2a, which recommended considering postponing surgery for intermediate acuity surgery, a healthy patient with non–life-threatening but potential for future morbidity and mortality. Later revisions of that CMS public statement (last update April 7, 2020) removed reference to particular procedure types and expanded considerations that should help guide decisions of the cessation of surgeries to include the surrounding region, and not just the practice or hospital, given that we are all members of a larger health care delivery system to a population, as opposed to an isolated silo of care within the walls of a single institution. Given the lack of firm guidance, most centers have created written and internally monitored criteria to follow. At our centers, this has included emergent surgeries because of life and limb threat, the potential for significant harm if ongoing delay due to severe joint destruction, bone loss or uncontrollable pain, in addition to fractures, infections, and dislocations.

The ethical struggles we have all experienced internally, as we have significantly restricted care for total hip and knee arthroplasty patients, have been further complicated by the decision of some surrounding hospitals to continue elective surgeries. Owing to the continued expenditure of resources, including PPE that could be mobilized to centers in need, among the other burdens that the care of these patients places on the surrounding health care community and infrastructure, as a referral center, our groups worry about the difficulty in being able to fully offer assistance in the event of complications of the surgical or medical conditions of those patients.

Whether considering offering surgical care in our own facilities, or observing it occur in the surrounding area, it is clear that patients receiving surgery at this time are at risk. They are leaving their houses when officials are recommending the public to "stay safe and stay home." Patients accessing health care facilities for their surgeries and clinical visits are potentially risking exposure during the surgical visits as well as perioperative visits and postoperative and rehabilitative care. The current poorly-understood prevalence of asymptomatic carriers along with the potential inability of current testing to detect cases in the early state of COVID-19 infection can further lead us to falsely believing that we could bring in a "healthy" patient, who in fact may even be a carrier, and risk exposing our health care teams or even risk creating worse outcomes for the patient. Recent studies have suggested that the act of surgery may worsen the outcomes in some patients in the unrecognized incubation period [5]. Even for the healthiest of patients, beyond the potential exposure risk, there is a burden for the perioperative care that is placed in the supporting health care system, which is already taxed with the preparation for and care of COVID-19–related cases. This infrastructure must be protected until we can safely move forward as a unified health care community.

Beyond restricting the offering of elective care to even the healthiest of patients, we have also struggled with even offering expedited care to the most severe orthopedic cases, many of which would be justifiable to offer surgery at this time because of the disease severity and potential for worsening the condition with delay. We have taken a cautious approach in many of these cases as well, as it is these patients with the worst orthopedic conditions who often also have advanced age, severe medical or social comorbidities, and additional risk factors. These are also the patients most likely to require postsurgical stays in inpatient facilities, which could add further risk of exposure [6]. Surgery in many of these patients goes beyond exposure in the operating room, but also extends into the inpatient facilities, outpatient or home health nurse or therapists, skilled nursing facilities, laboratories, imaging centers, and the community through which they must navigate to receive their perioperative care. The decision to operate in these patients exposes them to many risks beyond our standard joint arthroplasty risks, significantly challenging the risk-reward balance.

The decision to operate and when remains a challenging one, but the onus remains on us to be stewards of health for both our own patients and their orthopedic conditions, but also their overall health risk and the risk to the surrounding health care community and population as whole.

Embracing Technology in Orthopedic Patient Care and Education

Our mission and practice of providing care to the large catchment areas of the Intermountain West and State of Arkansas has previously allowed us to experiment with telemedicine and virtual visits. The COVID-19 response, however, has forced us to adopt this strategy overnight and realize the areas where improvements have been made as a result. From a regulatory and policy perspective, the relaxation of unnecessary governmental restrictions on interstate communication with our patients residing in states beyond our license has enabled us to both provide services and, hopefully, be reimbursed for them. Furthermore, previously, the relaxation on

the requirement of Health Information Portability Accountability Act compliant telehealth platforms has created more options to communicate with patients who previously may have had unequal access and understanding of available technologies.

Although virtual health care remains challenging for an arthroplasty practice to be fully reliant on, due to the need for hands on examination for the diagnosis of many conditions including imaging and tests, the COVID-19 response has further shown us that we can potentially challenge our long-standing protocols and reliance on occasionally burdensome care. There is no doubt that many of our treatment interventions and modalities that we typically offer mandate in-person contact (including some rehab care, injection therapy, and surgery). Although many of these interventions are not currently offered because of the needed response, we have been able to use this time to realize there exists some potential over-reliance on routine protocols for burdensome visits, imaging, and studies that may be able to be minimized and, as a result, efficiencies may be added into routine care. Such efficiencies and value may be added by eliminating unnecessary in-person visits that are expensive in both the time and money required of both patients and families. The limited resource of physical clinic space in some practices can be preserved for patients truly needing in-person visits and potentially even expanding capacity as a result. In addition, there can be improved efficiencies realized by virtual visits in having all of the information needed and verified in advance by MAs, as well as eliminating the rooming and room cleaning time, and so forth. Although patients still requiring imaging or in-person visits are accommodated today, as they will be in the future, additional efficiencies, including offering patients the opportunity to receive labs and imaging at remote locations, even at sites outside our own health care networks, are also likely to prove beneficial to both patients and providers moving forward.

Educationally, surveys of the trainees have revealed positive reviews of the improved curriculum, content, and delivery of materials. While no question, some of this has been afforded because of the lower surgical volume during this time, the benefit of remote conferences to allow for clinical care at remote sites, and the increased number of potential attendees, and the improved content will likely be able to be long-lasting changes and improvements with the ongoing use of virtual meeting platforms to supplement the in-person teaching.

Our past underutilization and even undervalue of technology which allows us as providers to communicate and care for our patients and provide education to our trainees remotely is now clearer than ever. In our specialty, and throughout health care, the changes made in response to the COVID-19 pandemic are likely to shape the practice of academic medicine as we go forward.

Conclusion

The COVID-19 pandemic has created widespread changes within our academic health systems and our adult reconstruction and lower limb arthroplasty practices. To manage our clinical and educational responsibilities during this pandemic, we created a model that consisted of four phases of care delivery. We are prioritizing the health and safety of our patients and workforce along with efforts to preserve resources including PPE and hospital capacity by canceling nonessential surgeries, creating a ranking list based on system utilization requirements, and relying on telehealth/virtual visits/patient engagement and educational platforms to keep our patients and trainees informed, educated, and engaged.

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