THE ORTHOPAEDIC FORUM

Novel Coronavirus and Orthopaedic Surgery

Early Experiences from Singapore

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No sooner had the fireworks, celebrating the dawn of a new decade, faded when health-care systems in China and, later, globally were threatened by the emergence of the 2019 novel coronavirus (COVID-19) epidemic. Medical resources in China and the rest of Asia have been stretched thin in an attempt to contain the spread of what is thought to be a particularly infectious zoonosis. This viral outbreak was first reported in late December 2019 as a cluster outbreak in Wuhan, China, and was linked to a seafood and wholesale wet market[1]. It has now spread to involve countries across multiple continents, stretching as far as the United States[2], Italy[3], and Australia[4]. The World Health Organization (WHO) has since declared this novel coronavirus outbreak a global health emergency, calling for global solidarity and a concerted international effort to stem this burgeoning epidemic. As of March 13, 2020, this coronavirus has infected 145,336 patients and claimed 5,416 lives[5]. These numbers are increasing on a daily basis as screening and diagnostic efforts are being stepped up with heightened vigilance.

This COVID-19 epidemic is not the first infectious disease outbreak to hit Singapore, nor will it be the last. In 2003, our health-care system was abruptly stressed with the emergence of the SARS (severe acute respiratory syndrome) crisis, with 238 infections (including health-care professionals) and 33 deaths. Since then, Singapore has progressively strengthened its ability and resilience in managing further infectious disease outbreaks. Among others, this has included the construction of new purpose-built medical treatment and quarantine facilities at the National Centre for Infectious Diseases in Singapore. Importantly, our lessons from SARS have also culminated in the development and adoption of a systematic outbreak response system, termed DORSCON (Disease Outbreak Response System Condition)[6]. DORSCON is a color-coded framework (green, yellow, orange, and red) depicting various alert levels corresponding to disease severity and spread (Fig. 1). This has served us well during the SARS and H1N1 influenza outbreaks and is currently used in managing the ongoing COVID-19 crisis.

Singapore detected the first confirmed case of COVID-19 infection in a tourist from Wuhan on January 23, 2020. With an increase in the number of infections island-wide and confirmation of early community spread (in patients with no link to previous cases or travel history to China), the Ministry of Health on February 7, 2020, raised the outbreak response to DORSCON Orange status[7]. In coordination with the senior management of the various public hospitals, this triggered a series of outbreak control measures in an attempt to contain the disease spread. Contact tracing measures were ramped up; close contacts of confirmed infections were placed on mandatory 14-day quarantines. Within the health-care setting, health-care workers with pertinent travel histories to the People's Republic of China were placed on a 2-week mandatory leave of absence and were only allowed to return to work if they remained afebrile and asymptomatic. All health-care staff were

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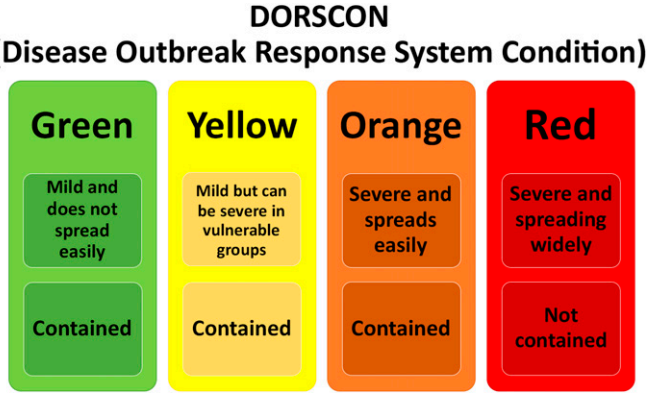

Fig. 1

DORSCON Alert Levels as adopted in Singapore in response to disease outbreaks.

issued thermometers for compulsory, twice-daily temperature screening. Inter-hospital cross-deployments ceased with immediate effect[8]. These measures had served Singapore well in disease containment during the previous SARS epidemic in 2003 and have earned early praise from eminent infectious diseases experts[9].

At first glance, this COVID-19 epidemic and the field of orthopaedic surgery appear completely disparate. Compared with our counterparts in the fields of infectious diseases, emergency, and family medicine, orthopaedic surgeons are not usually considered front-line staff in the fight against a viral pandemic. More adept at fixing fractures and replacing joints, the role of the orthopaedic surgeon in the control of this outbreak may, on the surface, appear to be limited at best. However, as part of the larger health-care ecosystem, orthopaedic surgeons also have a crucial role to play in reining in this pandemic.

How the Practice of Orthopaedic Surgery in Singapore Has Been Affected by This Crisis

Locally, orthopaedic practice has been markedly affected by the emergence of the COVID-19 outbreak. Changes to clinical practice have been largely guided by 3 main, overarching principles: (1) clinical urgency, (2) patient and health-care worker protection, and (3) conservation of health-care resources. Based on these principles, changes to surgical and outpatient care have been accordingly tailored, as will be described later.

Patients requiring urgent or early orthopaedic care will still be attended to at the earliest possible setting, no different from routine workflows. This largely pertains to patients with musculoskeletal trauma and tumors. The musculoskeletal trauma and tumor teams have been allowed to continue operating their surgical lists as scheduled. Other elective surgical cases have been postponed to allow hospitals to free up beds for treatment of patients with confirmed or suspected COVID-19. However, there has to be some balance struck between providing continuity of patient care and containing the COVID-19 spread. Day surgical cases (requiring ≤23 hours of hospital stay) have also been allowed to continue. This largely includes arthroscopies (shoulders, knees, and ankles) and simple day procedures (e.g., soft-tissue surgical procedures and implant removals). These patients with day cases can be discharged expediently (thus reducing their risk for nosocomial COVID-19 infections). Given their relatively short hospital stays, these patients do not pose a major drain on health-care resources. Hospital beds can still be freed up quickly, if required, for emergency admissions.

Elective, non-urgent procedures requiring >23 hours of hospitalization have accordingly been postponed or cancelled. This has predominantly affected knee and hip arthroplasty, spinal deformity corrections, and pediatric elective surgical procedures. Patients undergoing these procedures generally require longer hospital stays (3 to 5 days in the local context), which increases their risk of nosocomial infections. As these cases may be more complex, they may contribute an additional burden to limited health-care resources, which are already being stretched thin in dealing with the ongoing epidemic outbreak. For these reasons, non-urgent elective procedures necessitating a stay of >23 hours have been postponed with immediate effect. We recognize that this may have unintended adverse consequences on patient care, particularly in patients with debilitating pain from degenerative joint or spine conditions. Attending physicians have been advised to see these patients early in their outpatient clinics and, where possible, to consider temporizing pain-alleviating measures in their care. This includes intra-articular corticosteroid injections in patients with osteoarthritis or even nerve root blocks (which can be done as a day case) in patients with radicular back pain.

Although compliance is expected, these guidelines are not set in stone. In extenuating circumstances, written approval for surgical listing can be sought from the Department Chair, Operating Theatre Committee, and lastly, the Chairman of the Medical Board, with each case being evaluated on its own merits and on a case-by-case basis.

Clinical work has also been scaled down to ensure that services can run without putting our personnel and patients at risk. In the outpatient setting, we have encouraged home delivery of refill prescriptions. Clinicians have also been advised to prolong the duration between non-urgent follow-ups to avoid patient overcrowding in hospitals.

The orthopaedic patient demographic group is very varied, with surgeons treating patients at the extremes of ages. Arthroplasty surgeons see an older patient demographic group (often with multiple comorbidities), whereas sports surgeons frequently see younger, more active, and healthier patients. This is of relevance given the still relatively indeterminate pathophysiology of COVID-19 infection. Recent studies have alluded that older patients with medical comorbidities are more adversely affected by COVID-19 infections owing to their diminished functional reserves and weakened immune systems[10-12]. In a *Lancet* publication by Chen et al.[10], half of patients infected by COVID-19 admitted to the Wuhan Jinyintan Hospital had chronic comorbidities (e.g., diabetes and cardiovascular disease). Patients with severe symptoms necessitating intensive care treatment were also found to

be older with more underlying comorbidities[13]. Conflicting reports have also emerged that attribute the severity of symptoms to cytokine storms in immunocompetent individuals. Patients with severe symptoms admitted to the intensive care unit were found to have significantly elevated plasma cytokine levels (e.g., interleukin [IL]-1, IL-10, and tumor necrosis factor alpha [TNF-α]) compared with patients with milder symptoms[14]. In light of this, it is thus imperative for us to be cautious and have a high index of suspicion even when seeing younger and healthier patients in the outpatient setting and to not be lulled into complacency and a false sense of security. All patients attending outpatient clinics are screened for risk factors and have their temperature checked with a thermal scanner. Febrile patients with respiratory tract symptoms, especially those with a positive travel or contact history, will be referred to the emergency department for further evaluation to minimize disease spread. All visitors must register via a visitor management system that limits the number of visitors for each patient at any particular time but can also be used for contact tracing if required. The orthopaedic teams have been advised to wear surgical masks for all patient encounters and to follow strict hand hygiene practices.

Interdepartmental referrals are an inevitability in our line of work. We often receive referrals for inpatients who require orthopaedic consultations and, in turn, refer our own patients for whom non-orthopaedic consults are required. Herein lies the risk of potential disease transmission and spread. In Singapore, when reviewing patients suspected of or diagnosed with COVID-19, whether in the emergency department, the clinic, or the isolation wards, all staff have been instructed that they must wear full personal protective equipment (PPE) and have been taught how to don and remove PPE (surgical caps, goggles, N95 masks, powered air purifying respirators [PAPRs], surgical gowns, and gloves) safely. Strict compliance with hand hygiene has been enforced. Patients suspected of or diagnosed with COVID-19 infections requiring orthopaedic care have been housed in negative-pressure isolation units and will be co-managed together with help from our infectious disease colleagues.

Dedicated orthopaedic contamination teams comprising attending physicians and residents have been established. These teams are responsible for reviewing and operating on suspected or confirmed cases and can be swiftly activated in the case of emergencies. When a subspecialist review is required (e.g., spine), relevant subspecialist attending physicians will be mobilized into and remain part of these contamination teams until they are cleared to return to normal clinical work. Importantly, these teams are kept segregated from the rest of the department to minimize the risk of cross-contamination. We have also segregated into an inpatient team that attends to patients on wards, operates, and provides on-call service, and an outpatient team that runs our specialized orthopaedic outpatient service. These teams do not come into contact with each other and alternate on a weekly basis.

How We Can Rally Together as Individuals and as a Community

The orthopaedic community has banded with their medical and surgical colleagues in the battle against COVID-19. As individuals, we also need to take personal responsibility for our own individual health for the benefit of the community. We should be role models for good hand hygiene and enforce strict compliance to minimize disease spread and not add to the general hysteria that has accompanied this outbreak.

As surgeons, utmost care must be given to patients in the preoperative, intraoperative, and postoperative settings to minimize the risks of nosocomial spread. This means scheduling patients for same-day admissions (on the day of the surgical procedure) as much as possible, compared with preadmissions (1 or 2 days earlier) for elective cases. The risks and benefits of surgical management should be rationalized for each patient. All patients are contacted the day before the surgical procedure and are checked for any respiratory symptoms and any risk factors or recent travel history (within 14 days) that might put them at risk for COVID-19. On arrival to the day surgical unit, patients' temperatures and risk factors are again checked. Non-urgent surgical procedures for elderly, immunocompromised patients should be deferred until an opportune time. Intraoperatively, full PPE including surgical shields and goggles should be donned. Surgical times should be kept short, and operative personnel should be minimized as much as possible. This means keeping surgical teams to minimum numbers.

In the event of further escalation of the alert status (e.g., DORSCON Red), the orthopaedic department would further segregate into self-reliant cells to manage outpatient clinics, wards, and operating theaters on a rotating basis. Hospitals would be in lockdown with no visitors allowed. All elective surgical procedures would be cancelled completely, with only trauma and tumor cases (in the orthopaedic context) allowed to proceed. Further measures such as social distancing at work (between coworkers) and at home (between cohabiting health-care workers) may also need to be implemented.

Although non-urgent clinics and surgical procedures have been postponed until the situation improves, we must ensure that we maintain the quality of care given to our patients. The emergence of such a crisis provides a timely opportunity for us to reflect and evaluate the use of novel technologies in the workplace. This includes the adoption of telemedicine and telerehabilitation initiatives, allowing patients to be reviewed in the comfort of their own homes. Technologies such as wearable sensors[15,16] and videoconferencing[17] tools can be adopted to monitor patient outcomes remotely (e.g., knee range of motion after knee arthroplasty), without subjecting patients to cumbersome hospital visits. In addition to ease of monitoring, technology-assisted rehabilitation (e.g., online educational platforms or game-based therapy) has also been demonstrated to result in significantly improved patient satisfaction, pain, and outcome scores[18-20] compared with conventional therapy.

Technology should also be leveraged for our training needs. With the ongoing COVID-19 crisis, all inter-hospital residency rotations and in-person combined teaching programs have been suspended with immediate effect. With elective surgical procedures cancelled as well, this has ensuing repercussions on orthopaedic training and residents' surgical case logs. Suspending training indefinitely has far-reaching implications and is not sustainable. We have had to think creatively and seek new solutions to maintain quality training, even in these trying times. Teaching programs for residency training can be brought online to various e-learning[21] and videoconferencing[22] platforms. In place of conventional meetings, both faculty and residents can remotely log on to scheduled teaching sessions online using their laptops or handheld devices. This negates the need for in-person contact and minimizes the disruption to teaching schedules and has already commenced at the National University of Singapore and other institutions of higher learning. For procedural specialties such as orthopaedics, the viewing of instructional videos or online webinars can be structured into training programs. This can be followed by faculty-led online discussions to further consolidate resident learning. In addition to domain-specific knowledge and skills, non-cognitive attributes such as teamwork, empathy, courage, and compassion are important qualities that can be demonstrated by every attending physician and can be inculcated in every orthopaedic surgeon in training. During this COVID-19 crisis, orthopaedic residents, together with their counterparts from various other specialties, have been rostered for shifts in the emergency department to assist with the screening of suspected cases. In addition to helping alleviate the manpower crunch in the emergency department, this has provided an opportunity for residents to band, as well as bond, together as a medical community regardless of specialty, to combat this raging viral epidemic. Important lessons in courage, empathy, and teamwork, qualities that are not easily taught through textbooks or even residency rotations, have been learned. Furthermore, this crisis has provided precious lessons for residents in systems-based practice, organization, and leadership. They have learned the importance of rational management of limited resources, to be versatile, and to be able to adapt to an ever-changing, fluid situation. It has also provided an opportunity for residents to revisit their general medical skills (which can sometimes be lost after years of highly specialized orthopaedic training). These are important skill sets for our orthopaedic residents, the health-care leaders of tomorrow.

In addition, although clinical work has been curtailed, research continues. Each institution, following Singapore Ministry of Health guidelines, has instituted workflows for clinical research involving patients that allow research work to continue and, at the same time, ensure the safety of participants and study investigators.

The role of orthopaedic surgeons in mitigating this COVID-19 crisis is certainly not a muted one. We must rally as a community and play our part in overcoming this pandemic. Stay vigilant even when reviewing low-risk elective patients, be champions of good hygiene practices, and be open-minded in the adoption of novel workplace technologies. We can do more than fix fractures. We can fix lives. ■

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