



■ INSTRUCTIONAL REVIEW

From “business continuity” to “back to business” for orthopaedic surgeons during the COVID-19 pandemic

**M. H. L. Liow,
K. X. K. Tay,
N. E. M. Yeo,
D. K. J. Tay,
S. K. Goh,
J. S. B. Koh,
T. S. Howe,
A. H. C. Tan**

*Department of
Orthopaedic Surgery,
Singapore General
Hospital, Singapore*

The coronavirus disease 2019 (COVID-19) pandemic has led to unprecedented challenges to healthcare systems worldwide. Orthopaedic departments have adopted business continuity models and guidelines for essential and non-essential surgeries to preserve hospital resources as well as protect patients and staff. These guidelines broadly encompass reduction of ambulatory care with a move towards telemedicine, redeployment of orthopaedic surgeons/residents to the frontline battle against COVID-19, continuation of education and research through web-based means, and cancellation of non-essential elective procedures. However, if containment of COVID-19 community spread is achieved, resumption of elective orthopaedic procedures and transition plans to return to normalcy must be considered for orthopaedic departments. The COVID-19 pandemic also presents a moral dilemma to the orthopaedic surgeon considering elective procedures. What is the best treatment for our patients and how does the fear of COVID-19 influence the risk-benefit discussion during a pandemic? Surgeons must deliberate the fine balance between elective surgery for a patient's wellbeing versus risks to the operating team and utilization of precious hospital resources. Attrition of healthcare workers or Orthopaedic surgeons from restarting elective procedures prematurely or in an unsafe manner may render us ill-equipped to handle the second wave of infections. This highlights the need to develop effective screening protocols or preoperative COVID-19 testing before elective procedures in high-risk, elderly individuals with comorbidities. Alternatively, high-risk individuals should be postponed until the risk of nosocomial COVID-19 infection is minimal. In addition, given the higher mortality and perioperative morbidity of patients with COVID-19 undergoing surgery, the decision to operate must be carefully deliberated. As we ramp-up elective services and get “back to business” as orthopaedic surgeons, we have to be constantly mindful to proceed in a cautious and calibrated fashion, delivering the best care, while maintaining utmost vigilance to prevent the resurgence of COVID-19 during this critical transition period.

Cite this article: *Bone Joint Open* 2020;1-6:222–228.

Keywords: COVID-19, business continuity, transition, normalcy, elective procedures

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has led to unprecedented challenges to healthcare systems worldwide. Orthopaedic departments have adopted business continuity models and guidelines for essential and non-essential surgeries to preserve hospital resources as well as protect patients and staff.^{1–6} These guidelines broadly encompass reduction of ambulatory care with a move towards telemedicine,^{7,8} redeployment of orthopaedic surgeons/residents to the frontline battle against COVID-19,^{9–13} continuation of education and research through web-based means,¹⁴

and cancellation of non-essential elective procedures.

Elective orthopaedic procedures, however, have traditionally accounted for a large proportion of hospital revenues. Private orthopaedic practices are also dependent on elective procedures for financial viability. With existing legislation directing mandatory cancellation of elective procedures, this has adversely affected Orthopaedic practices globally.¹⁵ As several US states begin to ease social distancing measures, Bill Gates has highlighted that implementation of safety measures such as aggressive COVID-19 testing and contact tracing must be in place

Correspondence should be sent to
Ming Han Lincoln Liow; email:
lincoln.liow.m.h@singhealth.
com.sg

doi: 10.1302/2633-1462.16.BJO-
2020-0036.R1

Bone Joint Open 2020;1-6:222–
228.

to prevent a second wave of infections, allowing for a successful reopening of the US economy.¹⁶ As airports began enhanced security screening measures, new measures will have to be instituted for any industry to return to normal activities,¹⁷ or for any orthopaedic department planning to restart elective practice.

In Singapore, enhanced safe-distancing measures known as "circuit-breaker" measures have been instituted since 7 April 2020 to significantly minimize community transmission of COVID-19.¹⁸ Circuit-breaker measures included closure of all non-essential physical workspaces, closure of schools with a move towards home-based learning, closure of all tourist attractions/recreation venues/places of worship, and heightened emphasis on social responsibility mandating the use of reusable masks for all residents when going outdoors. Of note, circuit-breaker measures included the suspension of all elective, non-essential orthopaedic procedures, requiring reorganization of orthopaedic surgery departments.^{19,20} However, if containment of COVID-19 community spread is achieved, circuit-breaker measures will be lifted on 1 June 2020. This will allow the resumption of elective orthopaedic procedures and transition plans must be considered for Orthopaedic departments. Nevertheless, even if community spread appears contained, Orthopaedic departments must continue to maintain a high level of vigilance until a vaccine or effective therapy is available, as second wave outbreaks have been reported in China, South Korea, and Hong Kong with relaxation of social distancing measures.²¹

The COVID-19 pandemic also presents a moral dilemma to the orthopaedic surgeon considering elective procedures.²² What is the best treatment for our patients and how does the fear of COVID-19 influence the risk-benefit discussion during a pandemic?²³ Surgeons must deliberate the fine balance between elective surgery for a patient's wellbeing versus risks to the operating team and utilization of precious hospital resources. Attrition of healthcare workers (HCW) or Orthopaedic surgeons from restarting elective procedures prematurely or in an unsafe manner may render us ill-equipped to handle the second wave of infections. In addition, given the higher mortality and perioperative morbidity of patients with COVID-19 undergoing surgery, the decision to operate must be carefully deliberated.²⁴⁻²⁶ The aim of this article is to provide guidelines for the orthopaedic surgeon's transition back to normalcy during the COVID-19 pandemic.

Manpower considerations and COVID-19 testing for orthopaedic staff. We have previously described our manpower considerations for the COVID-19 pandemic.²⁰ These included ensuring adequate orthopaedic staffing for essential musculoskeletal care through judicious management of leave requests, calibrated deployment of orthopaedic residents/surgeons to augment frontline services while preserving a functional core group, ensuring the

protection of all staff from COVID-19 through geographical manpower segregation and use of appropriate personal protective equipment (PPE).

Surgeons were required to don N95 masks, face-shield, gown, and gloves during ambulatory consults with, or when operating on high-risk patients (COVID-19 suspect or confirmed case). Of note, PAPR is not recommended for use during orthopaedic procedures in our institution as there is currently no convincing evidence that power tools lead to aerosolization of SARS-CoV-2 viral particles from COVID-19 patients.²⁷ Regardless, we would propose the use of N95 masks, face-shield, headcaps, gown and gloves, or PAPR for staff who fail N95 mask fitting during operations on high-risk patients. Further research is required to determine the transmissibility of SARS-CoV-2 in an operating theatre setting. For low-risk, asymptomatic, non-suspected COVID-19 patients who have undergone pre-consult/pre-operative COVID-19 screening, the use of a surgical facemask is mandatory for HCWs and the use of an N95 mask is optional.

With reduced numbers of COVID-19 infections requiring inpatient beds and the gradual return of orthopaedic surgeons/residents from the frontlines, this would allow departments to gradually restart elective care. Without a COVID-19 vaccine or effective therapeutics options,²⁸ manpower segregation using social, geographical or temporal methods into smaller functional teams is advocated to prevent nosocomial COVID-19 spread and ensure clinical care continuity through redundancy. Our department has transitioned from functioning in three distinct geographical locales (inpatient ward, ambulatory care/outpatient clinic, operating theatre) to socially segregated small teams capable of acute and sub-specialty care since 9 March 2020. Social distancing is strictly enforced between members of different teams, preventing cross-infection of COVID-19 between teams, and ensuring business and clinical continuity.

Orthopaedic departments should continue to enforce daily temperature taking and peer monitoring to detect possible COVID-19 infections early. Peer monitoring of respiratory symptoms by consultants and residents within our small team system allows staff to be sent to the staff clinic for assessment and COVID-19 testing whenever necessary. The above-mentioned strategies have been effective as no orthopaedic staff has been diagnosed with COVID-19 to-date. Of note, there have been reports of HCWs with asymptomatic seroconversion, raising questions if all HCWs should undergo COVID-19 tests, such as the severe acute respiratory syndrome (SARS)-CoV-2 infection reverse transcription-polymerase chain reaction (RT-PCR) or antibody test.²⁹ Also, Gilat et al³⁰ have recommended routine testing of all staff before restarting elective procedures.

However, at our institution, routine testing for COVID-19 immunity or seroconversion using antibody

tests in HCWs is not advocated currently. The reasons being: 1) existing antibody tests have varying sensitivities and specificities due to genetic variations of SARS-CoV-2 worldwide, limiting its accuracy;³¹ and 2) antibody response to COVID-19 suggests prior infection but does not indicate immunity and does not provide guidance on whether the staff member is fit or unfit to perform patient care. Currently, antibody testing is mainly used by the Centers for Disease Control and Prevention (CDC) as part of their surveillance efforts to determine prevalence in USA.³¹

Similarly, our institution performs targeted SARS-CoV-2 RT-PCR and chest radiographs in symptomatic patients or HCWs to identify and contain the disease. Routine testing of asymptomatic HCWs using SARS-CoV-2 RT-PCR is controversial: 1) tests kits need to be preserved to identify patients that need intervention; 2) in our institution with a low prevalence of COVID-19 within HCWs, the test will have a low detection rate, thus should only be considered in facilities which have a higher prevalence of HCWs with COVID-19 infection; and 3) a positive result may indicate asymptomatic carrier status, seroconversion, prior infection with viral shedding or false-positive result. However, a positive test may not indicate infectivity but would result in quarantine for the HCW and close contacts at work. Instituting widespread testing may lead to sudden attrition of HCWs which may cripple the already fragile healthcare system.

Of note, senior, male Orthopaedic surgeons aged ≥ 60 years are at high risk of severe disease and death from COVID-19.³²⁻³⁴ However, it is not in the patient's best interest to disallow senior surgeons from operating during this pandemic, as their deep expertise is required. All staff, including senior surgeons, must ensure necessary precautions and don appropriate PPE when performing clinical care. Senior surgeons should consider handing over suspect/confirmed COVID-19 patients to younger attending surgeons to reduce their risk. This will prevent attrition to this valuable group of individuals as we emerge from this pandemic.

Logistical considerations. As travel restrictions are gradually lifted and trade links re-established, there may be a surge of demand for essential items, resulting in a worldwide global supply chain disruption.³⁵ This may affect the supply of PPE,³⁶ anaesthetic drugs such as propofol and anaesthetic circuits, limiting our ability to perform surgeries. Orthopaedic surgeons will need to work closely with anaesthetists to optimize the type of anaesthesia for elective care by preserving essential anaesthetic supplies, as these supplies are also necessary for treating critically ill COVID-19 patients. For example, spinal or regional anaesthesia should be considered for suitable upper or lower limb procedures and general anaesthesia for spine or pelvic surgeries. The added advantage of regional or spinal anaesthesia is the removal of SARS-CoV-2

aerosolization risks during airway intubation. The use of alternative intravenous anaesthetic agents such as thiopentone or etomidate instead of propofol can also be considered. Hospitals should work with vendors to take stock of orthopaedic implant inventories to ensure the sustainability of elective procedures during this ramp-up period.

Ambulatory care/outpatient clinic. Only essential cases requiring essential orthopaedic care were seen during the circuit-breaker period to minimize community spread of COVID-19, such as trauma, oncological, infective, and spine cases with neurological compromise. There is a need to ramp-up ambulatory care attendances in a safe, controlled manner to review patients who were previously postponed. New referrals and follow-up for musculoskeletal degeneration conditions, patient-reported outcome measure (PROM)/quality of life (QoL) assessments of pre- and postoperative patients and assessment of injuries for work injury compensation and legal proceedings are some examples of cases that have been delayed which now require attention.

Prevention of the re-emergence of COVID-19 clusters within the hospital system is paramount. Strict surveillance and screening of patients using contact/travel history, temperature screening, identification of coryzal symptoms, and mandatory use of facemask are essential. Contact tracing by recording a patient's arrival and departure and mandating the use of the national community-driven contact tracing mobile app provides epidemiological benefits, enabling swift containment measures in the event of inadvertent exposures.^{37,38} Personal data is safeguarded in accordance with the Government's data security standards. All data is encrypted and is only accessed by authorized personnel for contact tracing purposes.

High-risk groups i.e. the elderly and those with comorbidities could be seen in separate clinic sessions or could consider telehealth consults to further minimize risk. Notably, the COVID-19 outbreak in the foreign workers dormitories³⁹ in Singapore poses a unique risk to Orthopaedic surgeons who need to assess foreign workers for work injury compensation. Surgeons performing these assessments should don appropriate PPE and perform the assessments in a clinic separate from the main clinic to reduce the potential nosocomial spread of COVID-19.

Although telehealth in orthopaedics has garnered good outcomes, the COVID-19 pandemic resulted in an unexpected necessity to rapidly develop this capability.^{7,40} Our department has instituted telehealth to provide continued access to care for patients while contributing to circuit-breaker efforts by reducing population movement to the hospital. Physicians select suitable patients with stable postoperative conditions or chronic conditions not requiring surgical intervention for virtual consultations. An encrypted video-conferencing application is used to

hold a virtual consult with the patient at a scheduled time, allowing the physician to address any concerns, order tests, provide prescription refills and medical leave which are delivered to patients after the consult. Thus far, good feedback has been garnered from both patient and physician in terms of convenience and effectiveness.

Another advantage of telehealth is its ability to reduce crowding within the clinic by reducing patients and accompanying persons in attendance. Telehealth has also enabled medication home delivery services, online scheduling of specialized musculoskeletal investigations such as magnetic resonance imaging and online bill payment options, reducing queues within the hospital and preventing overcrowding.

It is recommended that institutions develop hospital-specific virtual visit protocols, use of motion-capture and virtual goniometers, as well as remote dynamic testing, will enhance the quality and efficacy of telemedicine.⁷ In addition, as part of Singaporean Governments' value-driven care protocols, mandatory PROM/QoL assessments after common elective procedures such as total knee arthroplasties, total hip arthroplasties, spinal fusion, and hip fracture surgery have been conducted via telehealth during this pandemic. Orthopaedic departments should continue to leverage on telemedicine to enhance efficiency for consults for stable musculoskeletal conditions and physiotherapy.

The above measures are proposed to ensure a safe return include continued vigilance via surveillance, step-wise increase in patient load, identification of vulnerable and high-risk groups for segregated consults, and leveraging technological advances such as telehealth to maximize efficiency of patient consults. These changes, though enacted in response to an unprecedented epidemic, could in some ways revolutionize the practice of orthopaedic ambulatory care in the future.

Operating theatre. Several guidelines on performing essential surgery in COVID-19 patients have been proposed, which highlight overarching principles of clinical urgency, staff protection and preservation of healthcare resources.^{24,41-43} Adherence to these guidelines would minimize risks of occupational exposure to COVID-19, especially when dealing with suspect or confirmed COVID-19 cases. However, with easing of guidelines for non-essential surgeries, such as joint arthroplasties and arthroscopy, there is a possibility that surgeons may operate on asymptomatic COVID-19 patients or patients who may be in the incubation period.⁴⁴ In a small retrospective study, Lei et al⁴⁴ reported an exceedingly high rate of postoperative intensive care (44.1%) and mortality (20.5%) in pre-operatively asymptomatic patients who underwent surgeries during their COVID-19 incubation period. Of note, two out of seven mortalities were patients who underwent hip arthroplasty. This highlights the need for preoperative SARS-CoV-2 RT-PCR testing

before elective procedures, especially in high-risk, elderly individuals with comorbidities (age \geq 75 years, morbid obesity, poorly controlled diabetes, uncontrolled hypertension, chronic obstructive pulmonary disease, obstructive sleep apnoea, chronic heart disease and immunocompromised states). Another alternative would be to postpone high-risk individuals until the risk of nosocomial COVID-19 infection is minimal. These recommendations are per recent guidelines from the International Consensus Group.⁴⁵ However, there are limitations to preoperative testing that must be recognized. The timing of the test should be just before the planned surgery and patients must undergo self-quarantine till the scheduled date of surgery to minimize the risk of contracting COVID-19 during the interim period.

There are conflicting guidelines regarding positive pressure laminar air-flow in operating theatres (OT). The Royal College of Surgeons in Ireland have proposed that positive pressure OTs should not be used and be converted to negative pressure ventilation if possible, however, this would be logistically difficult in most centres.⁴⁶ This recommendation is based on SARS/MERS aerosol transmission studies that reported that increased air pressure can distribute fine particles through the room and via non-sealed doors beyond the OT.⁴⁶ In contrast, The Royal College of Surgeons of England have proposed to maintain positive pressure ventilation within OTs as aerosols generated during aerosol-generating procedures (AGP) would be rapidly diluted by OT ventilation and pose minimal risk when passed out of the OT.⁴⁷

At our institution, we have adopted a similar workflow. High-risk or suspect/confirmed COVID-19 patients undergo operations in a designated COVID-19 OT complex with three rooms equipped with a separate air flow system.⁴⁸ Low-risk, non-suspected COVID-19 patients will undergo surgeries in the main OT complex. For orthopaedic procedures, orthopaedic and nursing staff not involved in the procedure are instructed to leave the theatre during intubation/extubation or aerosol-generating procedures (AGP) by the anaesthetic team. The OT is closed for at least ten minutes after intubation or extubation to allow high-efficiency particulate air filters to remove 99% of particulate air matter, based on the understanding that air change rate in conventional OTs is approximately 25 times per hour.⁴⁹ During orthopaedic procedures, orthopaedic and nursing staff re-enter the operating room in full PPE, further minimizing the risk of contracting the aerosolized virus. Also, with recent evidence suggesting that asymptomatic individuals can spread COVID-19 with high efficiency,⁵⁰⁻⁵² it may be wise to assume patients are COVID-19 positive until proven otherwise and don appropriate PPE upon entering the operating theatre.⁵³

Other considerations include the use of unreamed and uncemented implants to minimize the risk of respiratory

complications and the use of familiar surgical techniques to reduce operative durations.⁴² The use of unreamed and uncemented implants would reduce potential respiratory compromise from fat embolism syndrome secondary to reaming and bone cement implantation syndrome.⁴² It is imperative to ensure the protection of all staff and patients during this transition period and prevent inadvertent COVID-19 nosocomial exposure.

As COVID-19 patients gradually leave the hospital, inpatient bed resources will gradually be returned for elective procedures. Operating theatres that were converted into ICUs will need to be reassigned for elective procedures.⁵⁴ Firstly, surgeons should review postponed patients and prioritize listings for patients most in need. The ramp-up in elective procedures should be done gradually, allowing each surgeon to only list one to two cases per operating list initially. Surgeons must continue to be prudent with allocated OT time to ensure efficiency. More OTs can be progressively opened, and OT hours could be extended to clear the backlog of postponed cases. Dedicated OTs for essential orthopaedic surgery such as trauma, infection, oncological, and urgent spine surgery should be ringfenced.

To ease the expected bed crunch during this recovery period, surgeons should consider converting suitable elective procedures into day surgeries, preserving inpatient resources. Prior to the pandemic, our department has been actively driving endeavours such as Enhanced Recovery After Surgery (ERAS), short-stay surgery, outpatient surgery, and expedited transfers of post-surgery patients to our designated step-down care community hospital. These measures may now prove useful in the management of the bed shortage problem. COVID-19 screening before patient transfers should be performed to prevent inter-healthcare facility spread. Ultimately, the situation will continue to be fluid and surgeons must continue to weigh the benefits of performing surgery with the potential impact on public health. While patients wait for surgery, surgeons should provide information about alternative pain management strategies. Alternative pain management strategies would depend on the condition that is being treated. Patients with hip or knee osteoarthritis can be given intra-articular steroid injections for temporary relief. Braces can be prescribed for patients with ligamentous injuries coupled with a walking aid to prevent instability. Self-directed, web-based, or telephysiotherapy is recommended for pain relief during this period.

Inpatient ward. Our department has adopted a social segregation model that allows inpatient work to be performed by smaller sub-specialty teams. These smaller functional teams consist of three to four attending surgeons, three residents, and two interns, allowing them to go on-call approximately every five days. The team members are not allowed to fraternize with other teams

but can consult other subspecialty teams to coordinate patient care electronically. For non-suspected COVID-19 patients, standard precautions, strict hand hygiene, and face mask usage are mandatory in inpatient areas and appropriate PPE including N95 mask, face-shield or goggles, headcaps, gown, gloves, and shoe-covers must be used when dealing with suspected or confirmed COVID-19 patients. We have found that these measures have prevented nosocomial spread of COVID-19 within our department since early March 2020, with none of our staff contracting COVID-19 to date.

Auxiliary departmental activities. Administrative staff have been segregated temporally and geographically and non-essential staff will continue to work from home. Our department has successfully restarted web-based education rounds with virtual meetings and teleconferencing apps. As social distancing measures remain in place, on-line education will have to continue. Online case-based teaching sessions have been well-received by residents as orthopaedic teaching focuses on the interpretation of radiographs or advanced imaging to determine suitable intervention. Clinical education in the ambulatory care setting and surgical education during emergency/elective orthopaedic procedures can continue within the small segregated teams.

Research activities including animal and human studies have been curtailed and are not allowed unless they are related to COVID-19. Principal investigators for human research studies must provide strong justifications for existing projects as there is a significant risk to trial participants. Human musculoskeletal research during the COVID-19 pandemic recovery period will need to proceed with care. Naturally, the focus of research would be in the areas of COVID-19 vaccines and treatment, where the benefits outweigh the risks.

Conclusion

The need for musculoskeletal care will require us to adapt to a different way of working within a “new norm” as we continue to battle the COVID-19 pandemic through a prolonged period of economic and healthcare uncertainty.⁵⁵ Orthopaedic surgeons have demonstrated resilience and professional dedication in the redeployment to the frontlines, and very soon, we will face more challenges as we stand firm in solidarity with other healthcare professionals in this long-distance race. Most importantly, even as we ramp-up elective services and get “back to business” as orthopaedic surgeons, we have to be constantly mindful to proceed in a cautious and calibrated fashion, delivering the best care during this recovery phase, while maintaining utmost vigilance to prevent the resurgence of COVID-19 during this critical transition period.

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Author information:

- M. H. L. Liow, , DWD (CAW), MRCSEd, MMED (Ortho), FRCSEd (Orth), FAMS, Associate Consultant Orthopaedic Surgeon
- K. X. K. Tay, MBBS, MRCSEd, MMED (Ortho), FRCSEd (Orth), Associate Consultant Orthopaedic Surgeon
- N. E. M. Yeo, MBBS, MRCSEd, MMED (Ortho), FRCSEd (Orth), FAMS, Consultant Orthopaedic Surgeon
- D. K. J. Tay, MBBS, MRCSEd, MMED (Ortho), FRCSEd (Orth), Senior Consultant Orthopaedic Surgeon
- S. K. Goh, , MBBChir (Cantab), MRCSEd, MMED (Ortho), FRCSEd (Orth), FAMS, Senior Consultant Orthopaedic Surgeon
- J. S. B. Koh, MBBS, FRCS (Ed), FRCSEd (Orth), FAMS, Senior Consultant Orthopaedic Surgeon
- T. S. Howe, MBBS, FRCS (Ed), FRCS (G), FRCS (Eng), FAMS, Senior Consultant Orthopaedic Surgeon
- A. H. C. Tan, MBBS, FRCS (G), FRCSEd (Orth), Senior Consultant Orthopaedic Surgeon and Head of Department
Department of Orthopaedic Surgery, Singapore General Hospital, Singapore, Singapore.

Author contributions:

- M. H. L. Liow: Led and conceptualized the study. Performed literature review, Wrote the first draft and revised the manuscript.

- K. X. K. Tay: Edited the manuscript.
- N. E. M. Yeo: Edited the manuscript.
- D. K. J. Tay: Edited the manuscript, Supervision.
- S. K. Goh: Edited the manuscript, Supervision.
- J. S. B. Koh: Edited the manuscript, Supervision.
- T. S. Howe: Edited the manuscript, Supervision.
- A. H. C. Tan: Edited the manuscript, Supervision.

Funding statement:

- This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Acknowledgements:

- The authors wish to thank Dr Ling Moi Ling, Director of Infection Prevention and Epidemiology, Singapore General Hospital, for her inputs related to COVID-19 in this manuscript.

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