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Early experience in the COVID-19 pandemic from a vascular surgery unit in a Singapore tertiary hospital

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Singapore has been preparing for further pandemics since the 2003 severe acute respiratory syndrome (SARS) pandemic where Tan Tock Seng Hospital (TTSH), a 1700-bed tertiary hospital in central Singapore, was the epicenter of the battle against SARS. This led to the opening of the National Centre for Infectious Disease (NCID) in September 2019, which is adjacent to TTSH in the same campus. The NCID is a 330-bed, purpose-built facility, consisting of a screening center, isolation and cohort wards, high-level isolation unit, intensive care units (ICUs), radiology suite, imaging facilities, operating rooms, and an independent laboratory.[1] NCID together with TTSH is currently leading the national effort for screening and management of COVID-19 patients in Singapore.

January 23, 2020, marked the day Singapore became one of the first countries outside China to report a case of SARS coronavirus 2 (SARS-CoV-2), which causes the coronavirus disease (COVID-19). By February 6, 2020, Singapore had the highest confirmed number of cases outside China.[2] However, Singapore's sustained multipronged efforts in early detection and containment has led to a control in COVID-19 cases and received acknowledgement by Harvard University[3] and World Health Organisation.[4]

MANPOWER CONSIDERATIONS

As the tertiary hospital linked to NCID, TTSH supplies manpower and resources to staff the NCID in times of pandemic outbreaks. This position is especially pertinent because the NCID caters to 70% of Singapore's COVID-19 screening workload. At the time of this writing, the NCID has screened more than 14,000 people and admitted more than 2000 suspect and confirmed cases. The department of general surgery, of which the vascular surgery service is part, has been deploying up to 25% of our staff in 10-day cycles to the NCID screening center, which also functions as a full-fledged emergency department as some patients may have symptoms of both COVID-19 and a concurrent medical or surgical presentation and diagnosis. Deployed surgeons are required to also manage conditions outside their specialty.

To ensure continuity of an elective and emergency vascular surgery service, we maintain at all times at least two or three vascular surgery consultants within TTSH, and the rest of manpower is deployed to the NCID. Because we anticipate that there is already community transmission of SARS-CoV-2, it is vital to have another vascular surgery consultant on standby in case the on-call vascular surgery consultant develops symptoms of COVID-19 and requires isolation.

Measures to ensure the continuity and viability of our service include suspending all annual leave, overseas travel, and conference leave. This policy was implemented early in February 2020, once it was clear that a pandemic was imminent. Healthcare workers returning from China and subsequently other affected hot spot countries were also put on a mandatory leave of absence of 14 days after their return from return to decrease the risk of imported infection. As the pandemic dragged on, staff were allowed to take 3-day breaks of annual leave but must remain contactable and recallable in the event of a surge in COVID-19 patients or vascular surgery emergencies.

SOCIAL DISTANCING MEASURES

At the start of the outbreak, a mask up policy with a surgical face mask was implemented in clinical areas and then further extended to the entire hospital premises. All nonessential department and unit meetings, including educational plenaries and journal clubs, were suspended in early February 2020 and have not resumed to date. We have also been exploring electronic platforms such as Zoom for large group meetings where face-to-face contact is less important, such as residency teaching, undergraduate teaching, and some administrative department meetings.

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Meetings essential for clinical decision making such as the weekly vascular-radiology multidisciplinary meeting has continued with a mask up policy and attendees sitting 1 m apart with fewer than 10 staff attending this meeting.

Daily ward rounds are now conducted in three separate smaller teamlets, each led by a Consultant comprising two to three junior staff (residents and interns) so as to introduce some segregation among healthcare workers of the same specialty. SARS-CoV-2 positive or suspect patients are usually seen by the consultant alone to decrease exposure to other members of the team.

VASCULAR SURGERY CLINICS

Clinic resources have been decreased by 50%, but a rapid access diabetic foot clinic remains open because we felt diabetic foot patients usually require earlier and more urgent attention. Clinic visits are reviewed and triaged by doctors 2 to 3 weeks before a scheduled visit. Patients with time-sensitive results, needing emergent surgery, or who are symptomatic are booked into clinic slots, whereas those on follow-up for chronic conditions or with nonurgent results have their appointments postponed. Phone consults are not infrequently carried out for nonurgent results to allay the anxiety of patients who are going to have their clinic visits postponed. Provisions are made for patients to refill prescriptions for chronic medications without clinic consultation, with an option for a home delivery service. New referrals are screened by consultants and appointments deferred depending on the acuity of the presenting complaints.

ELECTIVE VASCULAR SURGERY

As the pandemic deepens, we not only have new COVID-19 patients but also a duty of care to our vascular surgery patients, many of whom have life- or limb-threatening conditions. We continue to perform selected elective vascular operations and all listed elective operations are reviewed and triaged by a consultant. For each elective operation performed, we ask ourselves these questions:

1. Is this an essential surgery without which the patient will experience catastrophic morbidity or mortality if denied this procedure?
2. If surgery is denied, will this patient be admitted with a life- or limb-threatening condition that will consume more resources if performed in an emergency setting?
3. Do we have the expertise and resources to perform this surgery taking into consideration that some surgeons may be deployed to manage COVID-19 pandemic patients?

Types of elective operations still currently being carried out include the following:

- Limb salvage surgery (bypass and lower limb angioplasty) for critical limb ischemia.
- Aortic aneurysm surgery (open abdominal aortic aneurysm surgery, conventional and complex endovascular aneurysm repair, including fenestrated and branched grafts).
- Vascular oncology surgery (eg, inferior vena cava leiomyosarcoma) or oncologic surgery requiring vascular reconstruction.
- Major and minor amputations.
- Endovascular salvage of arteriovenous fistula and grafts.
- Creation of arteriovenous fistula (AVF). We have increasingly started to perform most primary radiocephalic and brachiocephalic arteriovenous fistula surgery under local anesthesia during this pandemic. Tertiary arteriovenous access surgery unfortunately still requires anesthesia support for regional or general anesthesia and these cases are triaged according to how urgent the vascular access needs are (eg predialysis patients vs patients on long-term indwelling dialysis catheter).

Because we assume that SARS-CoV-2 is likely to be circulating in the community, patients undergoing essential elective surgery are screened on arrival to the hospital for fever, upper respiratory tract symptoms and contact/travel history. Patients with symptoms will be turned away from surgery and be sent to the emergency department for further investigations.

We have also taken an additional precaution for the surgical team to remain outside the operating theatre while the patient is being intubated or extubated. The anesthesiologists intubate and extubate patients wearing full tier 2 personal protective equipment (PPE) (N95 masks) or powered air-purifying respirator (PAPR) and the surgical team only enters the operating theatre room 3 minutes after the patient has been intubated and stays outside the operating room when extubation is carried out. The air cycling time in our operating rooms in TTSH are between 25 and 30 air cycles per hour; thus, 3 minutes ensures that there has been at least one complete air cycle. This precaution is taken in all patients undergoing elective or emergency surgery, even if they have no symptoms suggestive of COVID-19.

We are also fortunate to have a close working relationship with our interventional radiologists and this has allowed our patients to continue receiving endovascular therapies including limb salvage procedures in a timely fashion, despite their other pandemic duties.

OUR EXPERIENCE WITH COVID-19-POSITIVE AND SUSPECT PATIENTS WITH VASCULAR SURGERY CONDITIONS

We had been involved with COVID-19 suspect and COVID-19-positive patients early in the course of the pandemic. All surgeries for COVID-19 suspect and COVID-19-positive patients are performed in a negative pressure operating room. When operating on COVID-19 suspect and COVID-19-positive patients, we don full tier

2 PPE consisting of N95 mask with goggles for eye protection or PAPR and a waterproof sterile gown, as well as a double layer of sterile gloves. The operation will be consultant led and the surgical team kept lean to minimize exposure of the virus to others. Most operations can be performed in full PPE and N95 masks, but our experience suggests that PAPR may be more ideal for prolonged surgery beyond 3 hours because it is more comfortable for the surgeon, resulting in less fatigue. We have also found that it is rather cumbersome to wear surgical magnifying loupes when operating with tier 2 PPE or PAPR, and vascular surgeons should be aware of this when operating on COVID-19 suspect or COVID-19-positive patients. If the surgery is not urgent and can be delayed for between 24 and 48 hours, then we perform two SARS-CoV-2 polymerase chain reaction tests 24 hours apart and take direction from our infectious disease physicians about the feasibility of de-isolating the patient if both swabs are negative.

A small proportion of COVID-19 patients will have a protracted and difficult ICU stay, requiring prolonged ventilation and inotropic use. This can result in inotropic-related peripheral vasoconstriction and gangrene of the upper and lower limbs. One of our COVID-19-positive patients had peripheral gangrene of all four limbs owing to high-dose noradrenaline and dopamine use. This condition was treated conservatively with daily application of povidone-iodine in an alcohol solution to keep the gangrene dry. The patient eventually succumbed to the sequelae of COVID-19 and passed away.

We were also called to manage a COVID-19 suspect patient with a past medical history of Langerhans cell histiocytosis who was in the ICU with pneumonia and a recent travel history to COVID-19 endemic country. He had bilateral acute lower limb ischemia and a computed tomography aortogram showed an aortic bifurcation saddle embolus and bilateral iliac artery occlusion with the embolic source from a large, 3-cm, free-floating thrombus in the aortic arch just distal to the left subclavian artery. The left lower limb was unsalvageable with mottling and fixed staining up to the groin crease. At the time of surgery, his COVID-19 status was inconclusive and hence surgery was performed in full tier 2 PPE. Right femoral embolectomy was performed and a Valiant Navion low-profile thoracic stent graft (Medtronic, Santa Rosa, Calif) was chosen because his iliac artery diameter measured only 5 to 6 mm. This stent graft was deployed just distal to the left subclavian artery to jail the clot in to prevent further embolic events. A left hip disarticulation was then performed because there was ischemic muscle in the left upper thigh, which would be unsuitable for an above-knee amputation. He was eventually found to be COVID-19 negative and de-isolated. He is currently undergoing intensive rehabilitation.

Some COVID-19-positive patients may eventually require extracorporeal membrane oxygenation (ECMO) late in the course of their disease if they develop acute respiratory distress syndrome or develop pulmonary infiltrates or early fibrosis and their lungs become progressively ineffective for gaseous exchange.[5] Some of the complications of ECMO that a vascular surgeon may be called on to manage include deep vein thrombosis, acute limb ischemia, and groin complications such as bleeding from ECMO access. We have been fortunate not to have encountered any of these problems to date.

FUTURE CONSIDERATIONS

It is becoming clear that the COVID-19 pandemic will be a long and drawn-out war. As we go further into the COVID-19 pandemic, resources in terms of operating room manpower (anesthetists, operating theatre nurse, and technicians), critical care beds, anesthetic drugs, and PPE may start to become scarce owing to disruption of traditional supply chains of such equipment coupled with the possibility of staff being infected requiring quarantine or on sick leave.

SOME CONSIDERATIONS IN TERM OF RESOURCE PRESERVATION INCLUDE:

- Availability of PPE: Further cuts in elective surgery for PPE rationing will mean setting aside such precious life-saving equipment for healthcare workers in frontline, COVID-19-facing patients.
- Availability of operating rooms: Operating rooms may be turned into pandemic ICUs to meet the needs of COVID-19 critically ill patients. The remaining operating rooms may only be running emergency surgery lists, requiring further decreases in elective surgery
- Availability of essential drugs (eg, anesthetic agents): This may again necessitate scaling back of elective surgery, especially complex major operations.
- Increase in need for ICU beds for COVID-19 pandemic patients: This situation will mean that there are fewer anesthesiologists available to run elective operating rooms as well as fewer ICU beds available for postoperative management after major vascular surgeries.
- Availability of surgical manpower: More surgeons may be called away to perform pandemic duties, including staffing screening centers, emergency departments, and ICUs. Some surgeons may unfortunately fall ill and require quarantine or hospital admission.

CONCLUSIONS

Many of the measures described are a result of the lessons learned from the 2003 SARS outbreak and were enforced early in this current pandemic. We have not had any SARS-CoV-2 transmission among surgeons in TTSH yet, and believe the stringent measures applied have helped to achieve this.

Surgical services form an essential component of the healthcare system but as surgeons we need to be versatile and be able to respond to the ever evolving pandemic situation. We need to step forward and take up arms as an emergency physician or intensivist or whatever roles are required of us to help our colleagues and patients through these challenging times.

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