COVID-19 and cardiothoracic surgery: A risk-adjusted approach in the context of a global pandemic

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ABSTRACT

In the face of the novel coronavirus pandemic, the impact of COVID-19 infection has disrupted cardiothoracic surgical services globally. A risk-adjusted approach to restructuring the delivery of cardiothoracic surgical services has been proposed in accordance with international guidance to ensure that the surgical standard of care is maintained in the practice of adult and paediatric cardiac surgery, as well as thoracic surgery. The potential influx of COVID-19 patients with cardio-respiratory complications requiring intensive care management and associated surgical procedures falling within the gamut of the thoracic surgeon, is considered. Finally, the protection of healthcare workers, in particular the surgical team exposed to aerosolising procedures, is outlined. SAHeart 2020;17:346-350

INTRODUCTION

Following the initial case of SARS-CoV-2 diagnosed in a South African traveller on 5 March 2020, case numbers have continued to rise with approximately 35 800 cases and 755 deaths reported as of 2 June. The South African national response comprised eight overlapping stages, largely directed by a high-level advisory team, which was tasked with establishing evidence-based policy guidelines.[1]

Repercussions from the rising incidence of COVID-19 on the delivery of cardiac surgical services were noted and reported from Italy.[2] Specifically, it was noted that the exponential rise in COVID-19 cases resulted in a reallocation of ICU resources, with the drastic curtailment of elective cardiac surgery due to lack of ICU beds and a concern of the well documented adverse outcomes in patients developing COVID infections peri-operatively. A modification of the traditional workflow was proposed, with the establishment of a "hub and spoke" model to ensure secure COVID and non-COVID pathways for patients. In addition, nasal swab testing was undertaken on all patients admitted to hospital, and a further thoracic computed tomography (CT) scan was undertaken on all patients admitted for urgent cardiac surgery to facilitate the diagnosis of COVID-19.

In the South African cardiothoracic surgery context, we must be cognisant of a pre-existing inefficient and overwhelmed public health service with long waiting lists, and with a chronic shortage of operating lists and post-operative ICU beds. The location of state cardiac units within a single large regional hospital precludes a "hub and spoke" model of organisation. In contrast, the highly efficient private healthcare sector has numerous cardiac surgical units within the same geographic referral base in urban areas, and yet these units function competitively with profit generation as the primary goal – thereby excluding any form of collaboration to create a "hub and spoke" model. Both private and state cardiac surgical units require restructuring to allow for COVID, non-COVID and Persons Under Investigation (PUI) pathways.

SURGERY FOR ACQUIRED HEART DISEASE

The disruption of adult cardiac surgery programmes has resulted in a risk-adjusted approach to elective and semi-urgent surgery. Procedures that are amenable to catheter-based therapies, such as transcatheter aortic valve implantation (TAVI) and percutaneous coronary interventions (PCI), may be favoured over traditional open-heart surgery due to the shorter

operative, intensive care and overall hospital stay, resulting in a lower risk of exposure to hospital for these patients. In addition, a tiered risk model has been formulated to guide the timing of surgery during incremental levels of COVID-19 in-hospital burden (Table I).[3]

During the peak of the pandemic, these considerations need to be weighed against a dramatically increased surgical mortality in COVID-19 patients. In a recent international multicentre cohort study at 235 hospitals in 24 countries, the outcomes of patients undergoing surgery with SARS-CoV-2 infection confirmed within 7 days before or 30 days after surgery were analysed. Postoperative pulmonary complications occurred in half of patients with perioperative SARS-CoV-2 infection, and were associated with a mortality rate of 24%. The study recommended that the threshold for cardiac surgery during the COVID-19 pandemic be substantially higher than during normal practice, especially in men over the age of 70 years. Consideration should be given to rescheduling non-urgent procedures and promoting non-operative treatment to delay or avoid the need for surgery.[4]

COVID-19 infection has been documented in heart transplant recipients, with the severity of disease ranging from a mild to severe respiratory illness.[5] The effects of COVID-19 in an immunosuppressed population may result in significant morbidity with a mortality rate of up to 25%.[6] Careful consideration should be given to organ transplantation programmes during the peak of the pandemic – weighing up the significant risk of transplantation in a COVID setting against the risk of death on the waiting list. Only high priority listed patients should be transplanted under these conditions.

Guidance documents have also emerged on the safe reintroduction and "ramping up" of surgical services in countries where the peak of the viral infection has passed.[7,8,9]

SURGERY FOR CONGENITAL HEART DISEASE

Guidelines for congenital cardiac surgery during the COVID-19 pandemic include the routine screening of the child as well as the accompanying parents for symptoms of the disease. It is prudent to await the results of a SARS-CoV-2 nasal swab of the patient prior to admission for congenital heart surgery. Although vertical transmission of the disease has not been documented, all infants born to COVID positive mothers should be considered as persons under investigation (PUI) and tested accordingly. The timing of surgical intervention is determined by the clinical condition of the child, the cardiac pathology, and the COVID status of the baby. Where reasonable, it may be appropriate to delay surgery in COVID positive patients until symptoms improve and/or repeat testing at 14 days confirms a negative result.[10]

The guidance document on the risk assessment approach to congenital cardiac surgery is not dissimilar to the standard

TABLE I: Adapted from Adult cardiac surgery during the COVID-19 Pandemic: A Tiered Patient Triage Guidance Statement.[3]

Risk level	Surgery undertaken
Tier 1 0% - 30% inpatient COVID-19 load Mild reduction in operative capacity	All inpatients awaiting surgery (aortic dissection, acute coronary syndromes, acute valvular endocarditis, heart failure) Outpatients at risk (critical aortic stenosis, high-risk coronary artery disease, cardiac tumours) Aortic aneurysms, hypertrophic cardiomyopathy High priority listed heart or lung transplants
Tier 2 30% - 60% inpatient COVID-19 load Moderate reduction in operative capacity	All inpatients awaiting surgery Outpatients with progressive symptomatic coronary artery disease Outpatients with asymptomatic coronary artery disease with impaired systolic function High priority listed transplants
Tier 3 60% - 80% inpatient COVID-19 load Severe reduction in operative capacity	All inpatients who cannot be discharged safely without surgical intervention/correction, including emergency services High priority listed transplants who cannot be discharged from hospital
Tier 4 >80% inpatient COVID-19 load Minimal operative capacity	Only emergency services based on resource availability

guidelines on the surgical treatment of congenital heart disease (Table II).

GENERAL THORACIC SURGERY

International guidance on the risk-adjusted approach to thoracic surgery focuses on intrathoracic malignancies, using a triage system based on the overall burden of COVID-19 disease within the hospital (Table III).[12] The role of non-operative treatment strategies, such as neo-adjuvant chemotherapy, has been suggested as a viable alternative during all phases of the COVID-19 pandemic.

The burden of thoracic surgical disease seen in South Africa is heavily skewed by the high incidence of HIV and co-morbid pulmonary tuberculosis in the population, presenting a unique challenge in the face of a respiratory viral illness such as COVID-19.[1] High risk urgent surgery for the sequelae of inflammatory lung disease, including active tuberculosis and drug resistant tuberculosis, may now be compounded by the presence of coexisting SARS-CoV-2 infection – increasing the surgical morbidity and risk of exposure to the surgical team in view of the aerosol-generating nature of lung resection surgery.

TEACHING AND TRAINING PROGRAMMES

The interruption in the usual clinical workflow, combined with a reduction in surgical volumes and the redistribution of staff within cardiothoracic surgical programmes has disrupted many surgical training programmes. The transition from physical meetings to virtual meetings using online platforms has been made to ensure continuity of teaching through online journal clubs, clinical conferences, surgical audits and academic presentations.

The online platform has facilitated international teaching through online presentations made by the Society of Thoracic Surgeons, the World Society of Paediatric and Congenital Heart Surgery, and the Indian Association of Cardiovascular-Thoracic Surgeons. During the global lockdown, the American Association of Thoracic Surgery 100th annual meeting was converted from a physical meeting in New York in April 2020 to a virtual meeting that took place in late May 2020, ensuring continuity of the international surgical education programme (https://www.aats.org/aatsimis/AATSWeb/Association/Meetings/Annual_Meeting/100th_Annual_Meeting_Virtual/Program_Highlights.aspx).

TABLE II: Adapted from COVID-19: Crisis Management in Congenital Heart Surgery.[11]

	Emergency (24 - 48 hours of diagnosis)	Urgent (Within 1 - 2 weeks)	High priority elective (>2 weeks)
Neonate	Obstructed total anomalous pulmonary venous connection	Transposition of the great arteries with intact ventricular septum	Transposition with ventricular septal defect
Infant	Shunt thrombosis	Ventricular septal defect in cardiac failure Tetralogy of Fallot with hypercyanotic spells	Failure to thrive
Children	Thrombosed prosthetic mechanical valve	Symptomatic valve lesions with cardiac failure	Symptomatic valve lesions with cardiac failure
Adult	Infective endocarditis with cardiogenic or septic shock	Right ventricle to pulmonary artery conduit stenosis, with severe ventricular dysfunction	Valve lesions with worsening cardiac failure

TABLE III: Adapted from the COVID-19 Guidance for Triage of Operations for Thoracic Malignancies: A Consensus Statement from Thoracic Surgery Outcomes Research Network. Ann Thorac Surg 2020.[12]

Phase I	Phase II	Phase III
Few COVID-19 patients in hospital Adequate hospital resources	Many COVID-19 patients Resources limited (ICU beds, ventilators, clinicians, PPE)	Hospital resources are predominantly routed to COVID-19 patients Resources critically limited/exhausted
Surgery restricted to patients who cannot be delayed for 3 months	Surgery restricted to patients who cannot be delayed for days	Surgery restricted to patients who cannot be delayed by hours
Examples: Bronchial carcinoma, oesophageal carcinoma, mediastinal tumours	Examples: Perforated oesophageal carcinoma, bronchial carcinoma resulting in infection/bleeding	Examples: Perforated oesophageal carcinoma, threatened airway, management of surgical complications

Regarding operative training, surgical guidance documents suggest that the most experienced practitioner undertake all urgent surgery on patients with suspected or confirmed COVID-19 infection, in order to decrease the operative time and reduce the viral exposure to the surgical and theatre team.

During the decline in COVID-19 cases volumes, it may be necessary for cardiac surgery training programmes to increase surgical volumes and extend training time in order to "catch up" with the surgical backlog. Academic programmes should maximise the clinical and operative training of surgeons once teaching hospitals are again considered "safe" for the practice of elective surgery. Failure to plan ahead and allocate sufficient resources in this regard may result in substantial surgical waiting lists, with increased morbidity and mortality.[13]

THE PROTECTION OF THE SURGICAL TEAM

Cardiothoracic surgery is well versed in the creation and maintenance of sterile fields and infection control in general. Aggressive infection mitigation strategies in the operating room and surgical recovery have been proposed to reduce the risk to patients and the healthcare team.[14] The principles of improving safety for healthcare workers during the pandemic includes the use of non-operative management where feasible, patient testing within 48 hours prior to surgery, and the avoidance of emergency surgical procedures after hours. Cardiothoracic surgical programmes require clear pathways for the triage of patients based on their COVID-19 status (positive or negative), as well as for patients under investigation (PUI). All staff members over the age of 60 years should not be involved in the care of COVID-19 patients, and surgical units should be divided into at least two teams that are able to function independently of each other in the event of an unexpected exposure to a COVID-19 positive patient, necessitating a period of quarantine.

The nature of cardiothoracic surgery increases the exposure of staff to aerosol-generating procedures (AGPs) and necessitates the use of personal protective equipment (PPE), including an N95 mask, eye protection, gown and gloves in all confirmed or suspected COVID-19 patients. Ongoing donning and doffing training of PPE should be performed on a regular basis for continual refinement of the safety processes.

Guidelines regarding surgical processes include the transfer of patients directly to the operating theatre without stopping in a pre-operative holding area, all relevant precautions taken during airway manipulation (intubation) and electrosurgical use, and the post-procedure aerosol clearance of the operating theatre.

A negative pressure operating room is considered ideal; institutions may however have difficulty in recalibrating existing positive pressure rooms. Alternatively, the operating room may remain positive pressure, but the surrounding rooms maintain a strict negative pressure ventilation system at >-2.5Pa at ≥12 air changes per hour. In addition, the use of video-assisted thoracoscopic surgery has been discouraged due to the risk of aerosolisation and inadvertent lung injury.[14]

The use of fast-tracking protocols has been promoted to reduce post-operative ventilatory requirements, and the early discharge of patients from hospital with online follow-up, where appropriate, is advocated.

THE ROLE OF THE CARDIOTHORACIC SURGEON IN THE CARE OF THE CRITICALLY ILL COVID-19 PATIENT

As noted by our colleagues in Italy, increasing numbers of COVID-19 patients in a healthcare system quickly overwhelm the resources and may result in a shortage of physicians – themselves at risk of contracting the infection.

Cardiothoracic surgeons may therefore find themselves on the frontline in the care of critically ill COVID-19 patients for a number of reasons: familiarity in managing ICU patients, the interpretation of detailed thoracic imaging studies (high resolution CT scans), and the ability to obtain invasive vascular monitoring and access lines. More critically, the thoracic surgeon is entirely comfortable with airway management in these patients – ranging from intubation, bronchoscopy and airway toilet, through to tracheostomy.

In patients with severe hypoxia due to respiratory failure, the institution of extracorporeal membrane oxygenation (ECMO) falls within the gamut of the cardiothoracic surgical and perfusion team. The choice between veno-venous (VV) and veno-arterial (VA) is largely dictated by the presence of associated COVID-19 related myocardial dysfunction.

In a consensus document, the Extracorporeal Life Support Organisation (ELSO) outlined the principles of responsible ECMO use during the COVID-19 pandemic. These include providing extracorporeal life support in established ECMO units, the responsible use of ECMO based on system capacity and resource allocation, and the recommendation that ECMO support be offered preferentially to patients in whom outcomes are favourable with ECMO runs that are relatively short and predictable.

As of 1 June 2020, the ELSO had registered a total of 1 132 patients with suspected or confirmed COVID-19 placed on ECMO, with 253/480 (52%) of patients surviving to discharge. Veno-venous (VV) ECMO was used in approximately 1 033 patients (91%).

CONCLUSION

The role of cardiothoracic surgeons during the COVID-19 pandemic continues to be modified and defined by the ever-changing demands on the healthcare system at large. Our clinical practice during these uncertain times is assisted by guidance documents from professional societies in countries with a high burden of disease, such as the Society of Thoracic Surgeons (STS) in the United States and the European Association for Cardio-Thoracic Surgery (EACTS). Access to this experience ensures that we are able to best deliver quality care to our usual cohort of patients with intrathoracic disease, as well as patients with COVID-19 requiring advanced cardio-thoracic surgical care. During these times, innovative solutions to local problems will be discovered (Smit, et al., in this issue), and in this spirit we shall strive to ensure that "Cardiac" lives will not be lost due to the overwhelming attention placed on saving "COVID" lives.

Conflict of interest: none declared.

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