



POSITION STATEMENT ON THE MANAGEMENT OF CARDIAC ELECTROPHYSIOLOGY AND CARDIAC IMPLANTABLE ELECTRONIC DEVICES IN AUSTRALIA DURING THE COVID-19 PANDEMIC: A LIVING DOCUMENT

from the Heart Rhythm Council COVID-19 Pandemic working group, Cardiac Society of Australia and New Zealand.

Version 2, 9th April, 2020

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The recommendations of this document are current as of April 9th, 2020 and will be reviewed again, as necessary.

UPDATES IN VERSION 2

- Recommendations for mandatory training in PPE, screening of patients into “low” or “high exposure risk” to COVID-19 to guide use of PPE by staff during electrophysiology (EP) and cardiac implantable electronic devices (CIED) interventions and in-person interactions with patients (Domain 1, Points 1, 2).
- Further detailed recommendations on set up of allied health staff and practical considerations for lab setup and management (Domain 1).
- Recommendation that routine CIED check pre-and post-surgery is not needed unless there is ECG evidence of unexpected device malfunction whilst the patient is monitored (Domain 2, point 6).
- Recommendation that for end-of-life management of patients who have CIEDs be such that a magnet be placed over the defibrillator where possible, rather than using the programmer (Domain 2, point 9).
- Recommendation for triaging ambulatory investigations by a cardiologist or electrophysiologist (Domain 3, point 1).
- Expansion of the definition of “urgent” elective EP and CIED procedural indications to include: (i) lead revision for lead malfunction in a pacemaker dependent patient or defibrillator patient receiving inappropriate therapy; (ii) defibrillator implants for the secondary prevention of sudden death (and associated electrophysiology study, if needed, for clarification); (iii) catheter ablation of supraventricular arrhythmias causing hemodynamic deterioration and/or heart failure that is uncontrolled by antiarrhythmic drugs, rate control, and/or cardioversion, and/or anti-failure medications or if the arrhythmia results in repeated emergency department visits and/or hospitalisations; (iv) catheter ablation for Wolff-Parkinson-White syndrome associated with cardiac arrest or pre-excited AF associated with R-R intervals shorter than 250 msec (Domain 4).
- Classification of “semi-urgent” elective EP and CIED procedural indications where clinical judgement and collaboration with health care teams required before proceeding: (i) primary prevention defibrillator implants in patients at high risk of life threatening ventricular arrhythmias; (ii) cardiac resynchronization therapy (de-novo or upgrades); (iii) ventricular tachycardia ablation for medically refractory, recurrent ventricular tachycardia; (iv) CIED generator replacement for ERI battery status that is not urgent or emergent; (v) ablation of arrhythmias thought to be contributing to cardiomyopathy (Domain 4).
- More detailed classification of elective EP and CIED procedures that could be considered as “non-urgent (Domain 4).
- Addition of Domain 6, with recommendations for EP and CIED implications for children and adults with congenital heart disease.

EXECUTIVE SUMMARY

The COVID-19 pandemic poses a significant stress on health resources in Australia. The Heart Rhythm Council of the Cardiac Society of Australia and New Zealand aims to provide a framework for efficient resource utilisation balanced with competing risks of appropriately treating patients with cardiac arrhythmias. This document provides practical recommendations for the electrophysiology (EP) and Cardiac Implantable Electronic Devices (CIED) services in Australia. The document will be updated regularly as new evidence and knowledge is gained with time.

Goals

1. Ensure that critical resources are used efficiently namely staff, personal protection equipment (PPE).
2. Provide guidance for the appropriate use of EP and CIED services during the pandemic.
3. Minimise adverse patient outcomes during the pandemic period where resources are limited.
4. Minimise exposure of patients and health care workers.

Key Considerations

1. Mandatory training of staff on use of PPE.
2. Tailoring of the current document to local demand for EP and CIED services, local outbreak patterns, local hospital recommendations, hospital PPE supply chain, and hospital contingency plans and/or crisis capacity status.
3. Encourage patient specific risk assessment and sound clinical judgment, weighing the risk vs. benefits of delaying intervention versus risk of patient and staff infection with COVID-19, and use of precious PPE resources.
4. Realignment of the delivery of EP and CIED services with switch to telehealth and remote monitoring, where feasible.
5. Division of physician and allied health into separate teams, with minimal in-person interaction between team members.
6. Where feasible, segregation of labs and equipment for use in patients with suspected or confirmed COVID-19.
7. Temporary deferment of non-critical ambulatory monitoring services to minimise direct patient contact.
8. Rapid completion of inpatient EP and CIED procedures which cannot be deferred for 1-3 months.
9. Temporary deferment of non-urgent elective EP and CIED procedures.
10. Outpatient procedures limited to only those deemed urgent, or deemed, “semi-urgent” where risk of prolonged deferment are unacceptably high;
11. Individual patient screening for COVID-19 exposure risk as per local hospital recommendations, and appropriate use of PPE.

INTRODUCTION

On December 19, an outbreak of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) marked the beginning of a pandemic that has had a major impact on health care systems around the world. SARS-Cov-2 also known as COVID-19 causes a pneumonic respiratory illness, with the potential for severe cardiovascular damage. Its high infectivity rate has led to rapid escalation of affected cases around the world. It demonstrates a higher mortality rate amongst patients with pre-existing illness, in particular, those with cardiovascular disease. This has prompted a rapid evaluation of routine cardiac electrophysiology (EP) and Cardiac Implantable Electronic Devices (CIED) services within Australia. Major international societies (Heart Rhythm Society, British Heart Rhythm Society), have emergently released guidelines as live documents for the provision of such services.¹

In response to this pandemic, the Cardiac Society of Australia and New Zealand (CSANZ) Board has summoned the Heart Rhythm Council to rapidly produce a live document to provide guidance to its members for the practice of EP and CIED services in Australia. This live document takes into account published grey papers from international societies, and advice from key opinion leaders within Australia and overseas, with frequent updates to adapt to the evolving pandemic and its impact on the Australian health system. The guidelines provide a framework for implementing services during the pandemic. It is noted that the practice of EP and CIED management in Australia is varied amongst public and private hospitals, regional and remote areas, and in outreach clinics. **The application of these recommendations will therefore need to be tailored to local models of service delivery.**

In response to the CSANZ board request, the Chair of the Heart Rhythm Council has summoned the formation of the **Heart Rhythm Council COVID-19 Pandemic working group**. The group will be formed by the authors listed in this document whose responsibility will be to contribute to the original source document and provide frequent updates in six domains (authors working on each domain listed at end of the document):

1. Implementing a Framework for altered services.
2. Monitoring and follow up of patients with CIED.
3. Ambulatory monitoring.
4. EP and CIED procedural considerations.
5. Arrhythmic implications of COVID-19.
6. EP and CIED implications for children and adults with congenital heart disease.

DOMAIN 1: IMPLEMENTING A FRAMEWORK FOR ALTERED SERVICES

The COVID-19 pandemic requires rapid re-evaluation of EP and CIED services, as outlined below.

1. We recommend mandatory training of all staff involved in EP and CIED services in proper donning and doffing of PPE.
2. We recommend general screening of all patients scheduled to undergo an intervention or in-person interaction with staff delivering EP and CIED services. We recommend adherence to local hospital protocols for such screening methods. Patients could be divided into low, intermediate and high risk patients as per the CSANZ consensus guidelines for interventional cardiology services. ([CSANZ Consensus Guidelines for Interventional Cardiology Services Delivery During COVID-19 Pandemic in Australia and New Zealand 29 March 2020](#))
 - a. Each network, hospital or local health district has developed such screening tools, and should be followed.
 - b. “Low exposure risk” patients could be brought to the catheter laboratory with staff observing appropriate PPE during procedure performance (may be routine care in this case) and cleaning procedures applied as per usual practice.
 - c. “High exposure risk” patients should have EP and CIED procedures deferred until complete resolution of their illness, unless there is a compelling indication that an urgent procedure would alter their short-term prognosis.
 - d. When patients are in the unknown category, for example, non-English speaking patients and there is an urgent clinical need, it is appropriate to treat as “high exposure risk” of COVID-19.
3. We strongly recommend that all physicians involved with the provision of services related to EP and CIED management ***hold a forum within their network, hospital, practice, or local health district to discuss and tailor these guidelines to their local models of service delivery***, with frequent visitation of updates.
4. Each of the networks should work closely with their hospital or network’s established COVID-19 Taskforce group ideally comprising of one or more of: cardiology department heads, EP leads, CIED program heads, infectious disease specialists, population health physicians, emergency department physicians, intensive care physicians, nurses and allied health staff, industry partners and hospital administration ***to formulate a plan for ongoing management of EP and CIED procedures and clinics, using these guidelines as a reference***. The group should meet at weekly intervals to ensure maintenance of appropriateness criteria, urgency and alignment of practices with the local outbreak response phase.
5. We recognise that such infrastructure may not exist in private practices, but advise that a framework be established within one or more partners within the group, and the host hospital where consultation and procedures are performed. Where not possible or practical, such as in the ***instance of solo practitioners, we advise that the group could adhere to the majority of these recommendations, as far as practically feasible***.
6. ***Tele-conferencing is recommended*** to avoid cross infection of the leadership group.
7. We recommend ***nomination of a group leader*** within the network who will coordinate and implement the action plan and an assistant lead who should monitor national and global trends closely, and adapt, where feasible, to local and national recommendations.
8. We recommend ***nomination of a triaging lead physician*** (1 EP, 1 CIED program) who works with a triage nurse or allied health staff member to review clinical need and urgency of elective procedures.
9. We recommend that ***non-urgent elective cardiac electrophysiology and CIED implant procedures*** be deferred to preserve resources for urgent cases and allow catheterisation labs time to prepare for the use of PPE. We ***suggest inpatient procedures be performed as quickly as possible if they cannot be deferred for a minimum of 1-3 months***.

10. We suggest that *all outpatient consultations should be altered to telephone or teleconference* as soon as possible to reduce in-person interaction of vulnerable patients and/or vulnerable physicians. If feasible, outpatient services should remain to support general practices and emergency department (ED) referrals.
11. *Electronic medical records* of arrhythmia patients will need to be available in a format to be shared rapidly with ED physicians, intensive care physicians, general practitioners, and the rural medical workforce.
12. We suggest *weekly or fortnightly review of upcoming schedule of clinics and procedures* with the aim of identifying patients that:
 - a. can be safely rescheduled for a follow up or a procedure after 1-3 months;
 - b. can be invited to a virtual visit via teleconference;
 - c. must be seen face-to-face;

Setup of allied health staff

The EP and CIED programs are extensively supported by allied health staff. The following guidelines could be used as a framework for their management during the COVID-19 pandemic period:

1. We suggest that allied health staff responsible for EP and CIED services could be divided into “lab based” vs “clinical based” teams using a rotational roster, whereby teams are not in physical contact with each other. These teams should be kept separate at all times, either via rostered location or rostered times with:
 - a. Clinical based teams performing, where feasible, duties from a site remote to areas exposed to direct patient contact.
 - b. Lab based teams performing duties that involve direct patient contact.
 - c. Teams should be designed to best conserve skill and leadership, and have sufficient competence to perform in-person and remote CIED interrogations, independently of the other teams, in the event that there is a necessity to isolate one team.
2. Potential tasks/activities for a clinical based team(s) could include:
 - a. To support scheduled outpatient CIED clinics via teleconferencing, if feasible. These clinics will provide continuing patient education and support. It further aims to avoid unnecessary hospitalisations and in-person visits, thereby reducing the burden on the hospital system and reducing infection risk for patients and staff. Patients with remote monitoring should have downloads scheduled to synchronise with their originally scheduled face to face appointment. Ideally, these remote clinics will occur in a location distant to areas exposed to direct patient contact. Where feasible, additional support from information technology services should be provided with special ‘virtual private network’ (VPN) access to allow staff access to patient e-records and clinical databases to ensure optimal patient care.
 - b. We recommend regular rostering in remote monitoring as much as practically feasible to address CIED alerts in a timely manner. Alerts should be triaged and addressed via patient telecommunication with the aim to avoid in office visits to hospitals, clinics and practices. We strongly discourage in-person device interrogations, which should only be performed in discussion with the cardiac electrophysiology team, if it has the capacity to change the patients’ management.
 - c. In addition to remote monitoring, we would encourage the “clinical based” team to work on quality improvement projects during the reduced elective case workload period. This could include tasks such as designing and improving departmental protocols, competency assessments and development of educational resources. This will have a positive long-term impact on patient care after re-establishment of normal routines as the pandemic subsides.

Furthermore, we recommend the continuation of all local educational programs to promote departmental skillset diversity across the allied health team. This is particularly pertinent in the event that a significant proportion of staff become infected or require prolonged isolation.

3. The lab based team(s) would be responsible for running and supporting EP, CIED inpatient procedures and elective procedures. One or more nominated members could be designated as “clean” members who should not perform any duties with COVID-19 positive or COVID-19 pending patients. This will allow preservation of staff to provide case coverage, if other members are affected.

Practical considerations for lab maintenance

1. Where feasible, a single lab should be designated as a COVID-19 lab.
2. Where feasible, the following recommendations could be applied to the EP/CIED implant lab:
 - a. Move all unnecessary EP equipment and cables out of the lab and into a designated storage area/on a trolley which can be accessed, if needed for a procedure. Remove all unnecessary items out of the control room such as spare cables, folders, storage discs, papers, posters etc.
 - b. Created individual ECG dot packets to be taken in per case.
 - c. Cleaning of main contact areas in the control room on a regular basis and/or between patients when necessary including but not limited to keyboards, mouse, phone, screens, door handles, light switches etc., using cleaning solutions known to be active against COVID-19, as per local hospital protocol.

DOMAIN 2: MONITORING AND FOLLOW UP OF PATIENTS WITH CIED

Management of patients requiring follow up for device therapy during the COVID-19 pandemic needs to address a number of specific challenges. Namely:

- a. Frequent presence of high-risk comorbid conditions including advanced age.
- b. Direct physical contact required for in-person device checks.
- c. High risk of significant adverse impact of delayed or missed review appointments in selected patients.

Remote monitoring is a powerful tool for the management of patients with implanted devices.

Although COVID-19 is spread primarily through respiratory droplets and close contact with an infected person, the virus may also be spread by contact with contaminated surfaces. Each of the networks should consult with their hospital's infection control or COVID-19 task force regarding recommended cleaning. Practices operating out of private consulting rooms should follow the guidelines of their nearest academic hospital who have an established infection control service.

The aim of these recommendations is to reduce patient, personnel and programmer exposure to COVID-19. Due to the possibility of rising community transmission of COVID-19, asymptomatic carriage and asymptomatic incubation period and post illness viral shedding, **it is feasible that in the near future, every patient will be perceived as equivalent risk of transmitting COVID-19.** These guidelines may change rapidly, in line with rising community prevalence.

In patients with CIED:

1. We suggest that *remote monitoring be utilised as much as practically feasible, to avoid in office visits to hospitals, clinics and practices.*
 - a. For patients who are not currently enrolled in remote monitoring, *new enrolment should be considered.*
 - b. During the pandemic period, we recommend that all patients undergoing new device implantation, wherever possible, be provided with remote monitoring devices. For patients already enrolled in remote monitoring and have active ongoing conditions, drug therapies, or planned interventions, or follow up after catheter ablation interventions that require in-person evaluation, *we recommend that the treating physician replace routine office visits with a remote visit (video calling or telephone follow-up).* Several billing codes have been released by the Federal Government to help facilitate this arrangement. <http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/news>
2. We suggest *deferring routine in-hospital and in-person device interrogations in stable patients*, with chronic indications for device therapy, and sufficient battery longevity (>9 months).
 - a. When there is a need to confirm whether therapies (anti-tachycardia pacing/shock) have been delivered in patients with implanted cardiac defibrillators, remote monitoring and/or manual transmissions are preferred. For each patient that has experienced defibrillator therapy, the treating physician should undertake an individualised risk assessment and then decide how best to manage their patient. Options might include telehealth review, in-person clinic review or rarely, hospital admission;
 - b. In patients with implanted cardiac devices with suspected lead malfunction or battery issues, the treating physician should undertake an individualised risk assessment before deciding how best to manage their patient. Options might include, telehealth review, in-person clinic review or rarely, hospital admission;

- c. During in-person device checks *we encourage the use of wireless communication technology by CIED allied staff to maintain a safe distance (>1.5 metres)*. In addition, we encourage limitation of the number of people present during the device check (i.e. only patient, clinician and CIED allied health staff). To minimise the duration of contact for a device check, we suggest device data is downloaded, saved and reviewed away from the patient.
 - d. Where feasible, remote monitoring / remote interrogation (manual transmissions) should be used for routine follow up of stable patients.
3. Where feasible, the immediate post implant follow-up should be done remotely where possible with scar review via photo, or live audio-visual technology.
4. In patients with magnetic resonance imaging (MRI)-conditional devices requiring urgent MRI scanning we recommend use of automatic reprogramming functions where available.
5. Perioperative reprogramming of CIEDs is only necessary for:^{2, 3}
 - a. Surgery within 15 cm radius of the CIED (generator) where a magnet cannot be applied;
 - b. Procedures above the iliac crest, and where patient positioning would prevent easy securing of a magnet if required (in pacing dependent patients, those with significant baseline bradycardia or to deactivate anti-tachycardia therapies in Implantable Cardioverter Defibrillators (ICDs);
 - c. Pacing dependent ICD patients for procedures above the iliac crest;
6. A routine CIED check following surgery is not required. A CIED check is only required following surgery if there is ECG evidence of unexpected device malfunction whilst the patient is monitored.
7. For patients in whom in-hospital or ambulatory in-person interrogation is absolutely critical or necessary, we recommend screening for symptoms or history of exposure to COVID-19. We recommend categorising patients as per CSANZ interventional guidelines prior to the interrogation procedure (Low, Intermediate and high risk) and utilising PPE as per the local hospital protocol. Wherever possible, in-person device interrogation should be delayed until the patient is deemed no longer infectious by the appropriate treating team, according to local or national protocols.
 - a. We recommend that each department should quarantine a single set of programmers for in-person evaluation of all patients during the pandemic. These programmers should be stored in a separate area. The programmer is to be cleaned with disinfectants approved by hospital protocols to have activity against COVID-19 before and after each interrogation and at the beginning and the end of the day. Consider covering the programmer interrogation wand with a transesophageal probe cover, sterile wand sleeve or simply a plastic bag to prevent it from touching the patient and the surrounding area. This would need to be changed between patients.
 - b. Whilst individual hospitals will have their own protocols, we recommend that staff involved in care of patients with implanted devices wear surgical scrubs (or similar garments) which are laundered daily, and dedicated shoes which are not worn outside the clinical setting.
8. Where necessary, ED and hospital wards should have access to on demand device monitoring systems that are available (e.g. Medtronic Carelink Express and Abbott Merlin on Demand). Where indicated, device monitoring for patients attending ED should be performed using available on-demand systems. In all other situations, the patient's cardiologist or the on-call cardiologist should be contacted. We recommend that device company representatives are not to be contacted first line.
9. In the event of end-of-life management of a patient with terminal disease with or due to COVID-19 and an ICD in situ, consider asking the treating team to secure a clinical magnet to the skin over the ICD where possible, rather than using the programmer. ICD deactivation cannot be performed remotely. We recommend that company representatives minimise their presence in device implants and clinics, to minimise travel between multiple centres, with high risk of potential exposure and transmission. If deemed necessary for a procedure, we

recommend that each centre have a designated representative, where feasible, to assist with implants. The number of personnel during an implant should be minimised.

10. Each device company has released its own working guidelines for the COVID-19 pandemic which will be complementary to this document. These working guidelines can be obtained from the company representative responsible for each region. We will endeavour to work in concert with device companies to deliver a consistent message to physicians.

DOMAIN 3: AMBULATORY MONITORING

Ambulatory monitoring is of variable diagnostic yield, and may be avoided during the COVID-19 pandemic.

1. We *advise avoiding the routine use of ambulatory Holter monitors or exercise stress tests* (which involve direct patient interaction), for the screening, surveillance, ongoing management and/or follow up of patients with suspected or confirmed cardiac arrhythmias.
 - a. Ambulatory monitoring should be delayed for 1-3 months, or until such time the pandemic has passed unless the ambulatory ECG monitoring is expected to pick up a finding that may result in change of management or prevent ED presentation.
 - b. All inpatient and outpatient Holter requests should be triaged by either an electrophysiologist or a cardiologist and necessary information should be sought from referral team or GP to ensure patients are triaged appropriately.
 - c. When clinically essential, ambulatory monitors that can be mailed out to patients (e.g Heartbug, Ziopatch) should be considered.
 - d. In low risk patients (e.g. those with undiagnosed, infrequent palpitations and a structurally normal heart), smartphone or smartwatch acquired ECGs (medical grade quality) may be considered (e.g. AliveCor Kardia). Although small studies and anecdotal reports suggest that these may be useful, large scale randomised controlled data is lacking. The use of heart rate monitors (e.g. Fitbit, Garmin watch) are unlikely to be useful in this setting, and is discouraged.
2. In the rare instance that ambulatory Holter monitoring and/or stress testing is the **ONLY** option for investigation of a patient, advice listed in Item 7 of Domain 1 should be followed. Equipment must undergo a thorough clean before and after each use using hospital approved disinfectants that are active against COVID-19. For handling those Holters, department/practices should have a working policy. While Holter monitors can be shipped, and returned through post but issues related to damage and loss should be considered.

DOMAIN 4: ELECTROPHYSIOLOGY AND CIED PROCEDURAL CONSIDERATIONS

As noted in Domain 1, the practice of EP and CIED in Australia is variable amongst local health districts, and in regional and remote areas. These guidelines are not mandated, but intend to provide a framework for rationalising outpatient procedures. We encourage that members use these recommendations and tailor them to **local demands for EP and CIED services, models of service delivery, local outbreak patterns, local hospital recommendations, PPE supply chain, and contingency and/or crisis capacity status for each hospital**. Individualised risk assessment for each patient and sound clinical judgment is encouraged, weighing the risk/benefits of delaying intervention versus risk of patient and staff infection with COVID-19, and use of precious PPE resources.

As of March, 25th 2020, Australian Prime minister Scott Morrison has cancelled all (public and private) non-urgent surgical procedures regardless of COVID-19 risk. Given the potential for rapid dissemination of COVID-19 throughout the health system, *we recommend delaying non-urgent elective electrophysiology and CIED procedures* until the COVID-19 crisis has ended. The rationale for this is to conserve critical PPE stock in the pandemic period. Furthermore, an elective procedure in an unsuspected COVID-19 positive patient carries the potential infectivity of physicians, nursing, anaesthetic and allied health staff and fellow inpatients for rapid transmission of COVID-19.

The recommendations in this document are intended to apply to outpatient procedures. Inpatients procedures required to facilitate discharge and/or to avoid emergency department/hospital readmissions should be performed as quickly as possible, if they are deemed urgent. If inpatient procedures are not deemed urgent or critically necessary and can be deferred for a minimum of 1-3 months, early discharge is recommended. More frequent telehealth follow up (e.g. weekly or monthly) may be needed to ensure that clinical stability is maintained in such patients, so as to avoid emergency department presentations and hospital readmissions.

The definition of what constitutes an elective/non-urgent case is based on a patient-specific risk assessment. The rationale for delaying elective/non-urgent case procedures should be discussed with the patient and documented in the medical record. Discussion amongst local peers is recommended in borderline cases, in the current pandemic era. Where possible, same day discharges, are encouraged. Factors not directly relating to the individual patient, such as PPE/other equipment or allied health staff availability and the ability of the hospital to manage non COVID-19 patients at a particular point in time may also affect the decision-making process of whether to proceed to an elective procedure.

In line with major societal recommendations, especially those from the Heart Rhythm Society COVID-19 Task Force,¹ expert opinion and direct communication with key opinion leaders around the world, the expert writing committee agreed the **following could be considered as urgent elective procedures:**

1. Pacemaker insertion for those with asystolic pauses or advanced AV block.
2. Lead revision for lead malfunction in a pacemaker dependent patient or defibrillator patient receiving inappropriate therapy.
3. Defibrillator implants for the secondary prevention of sudden death (and associated electrophysiology study, if needed, for clarification).
4. Pacemaker generator replacement for pacing dependent patients who are at elective replacement indicator (ERI) or at device end of life (EOL).
5. Defibrillator generator replacements in those with previous appropriate defibrillator therapies who are at EOL.
6. Catheter ablation of supraventricular arrhythmias causing hemodynamic deterioration and/or heart failure that is uncontrolled by antiarrhythmic drugs, rate control, and/or cardioversion,

and/or anti-failure medications or if the arrhythmia results in repeated emergency department visits and/or hospitalisations.

7. Catheter ablation for Wolff-Parkinson-White syndrome associated with cardiac arrest or pre-excited AF associated with R-R intervals shorter than 250msecs.
8. Catheter ablation for medically-refractory, ventricular arrhythmia storm on a case-by-case basis as determined by the consensus of experts at the specialist centre for the management of ventricular arrhythmias.*
9. Transvenous lead extraction on a case-by-case basis as determined by the consensus of experts at the specialist accredited centres, taking into account the relative risks of an invasive vs semi-invasive or conservative approach, the resource use implications and ancillary support teams (e.g. cardiac surgical backup, anaesthesia, ICU) required to carry out such a procedure.

**Ventricular arrhythmia storm include sustained monomorphic VT or PVC induced VF. Storm defined as sustained VT lasting >12 hours or ≥ 3 episodes of VT within 24 hours. Decisions regarding ablation of ventricular arrhythmia storm need to be taken in the context of the patient's overall mortality risk, the personnel and equipment burden on the health care system during such procedures, and the risk of managing potential complications of the procedure. Procedures on patients that may require a significant period in ICU should be avoided.*

The writing committee acknowledges that there are many other procedures that are considered “semi-urgent”, and that clinical judgement of the EP physician, in partnership with the patient and the associated health care teams be exercised in whether to perform these procedures or delay them for 1-3 months. Examples of such procedures, in agreement with Heart Rhythm Society COVID-19 Task Force committee guidelines¹ are:

1. Primary prevention defibrillator implants in patients at high risk of life threatening ventricular arrhythmias.
2. Cardiac resynchronization therapy (de-novo or upgrades).
3. VT ablation for medically refractory, recurrent ventricular tachycardia.
4. CIED generator replacement for ERI battery status that is not urgent or emergent.
5. Ablation of arrhythmias thought to be contributing to cardiomyopathy.

The writing committee considers the following as non-urgent procedures, which could be delayed till the pandemic subsides. Examples of such procedures, in agreement with Heart Rhythm Society COVID-19 Task Force committee guidelines¹ are:

1. Premature ventricular complex (PVC) ablation.
2. Supraventricular tachycardia (SVT) ablation not meeting criteria listed in “urgent elective procedures”.
3. Atrial arrhythmia ablation in stable patients without heart failure, not at significant risk of getting hospitalised by delaying the procedure or at high risk for procedure related complications due to comorbidities.
4. EP testing to evaluate stable tachyarrhythmias or bradycardia.
5. Primary prevention defibrillator implants that are not semi-urgent.
6. CIED upgrades.
7. Pacemaker implant for sinus node dysfunction, Mobitz I AV block, other stable non-high degree AV block, or tachy-brady syndrome in mildly symptomatic patients.
8. CIED generator replacements in patients with >6 weeks of battery remaining;
9. Extraction of non-infected devices/leads, unless device function is dependent on lead extraction and re-implant.

10. Left atrial appendage closure.
11. Implantable loop recorder implants.
12. Tilt-table testing.

Further considerations

1. We consider CIED implants to be at least moderate risk of transmission to staff. We recommend categorising patients as per CSANZ interventional guidelines prior to the procedure (low, Intermediate and high risk) and utilising PPE as per local hospital protocol with all staff involved suiting up prior to procedure commencement and de-robing in the procedure room post procedure. We advise only the minimum number of staff to be present and where feasible, two separate operating teams to avoid loss of device facility if one team is infected.
2. We also advise case-by-case clinical judgement regarding clinical futility when proceeding with a device implant on a COVID-19 patient.
3. Where indicated and possible we advise against temporising and advocate a permanent device implantation.

DOMAIN 5: ARRHYTHMIC IMPLICATIONS OF COVID-19

The intention of this domain is to provide an updated information source on the arrhythmic implications of COVID-19.

Summary

Palpitations and chest tightness are uncommon but recognised presenting symptoms of SARS-CoV-2 (COVID-19) infection. Increasing age and the presence of multiple medical comorbidities are associated with more severe infection and increased mortality. Many of these patients will suffer from arrhythmias. In at least one series arrhythmias were reported in 16.7% of hospitalised patients and were more common in those patients managed in the intensive care unit. Myocardial injury with raised troponin levels may be identified in hospitalised patients and is a marker of increased mortality. Atrial and or ventricular arrhythmias may be due to exacerbation of pre-existing arrhythmias with underlying cardiovascular disease in the setting of acute respiratory infection, or due primarily to myocarditis, hypoxaemia, inflammation, inotropes, and/or side effects of specific anti-viral therapies (commonly QT prolongation). Details on arrhythmias unique to SARS-CoV-2 infection are lacking. Heart rhythm specialists may be asked to assist in the management of arrhythmias or in the monitoring of empirical drug therapy regimens.

Arrhythmias in COVID-19 patients

Whilst the most common presenting clinical symptoms of SARS-CoV-2 infection are fever, cough and respiratory symptoms, some patients in China first presented with palpitations and chest tightness.⁴ The reports of arrhythmias with SARS-CoV-2 infection are limited but arrhythmias do appear to occur commonly in hospitalised patients. Whilst most patients have a mild infection 10-20% may develop severe infection and a proportion of these will require management in an intensive care unit.⁵

In Influenza infection, cardiovascular complications include myocarditis, acute myocardial infarction (plaque rupture secondary to viral inflammation) and exacerbation of heart failure. Previous coronavirus infections have also been associated with cardiovascular complications. The risk of adverse outcomes and the severity of adverse outcomes are increased by pre-existing cardiovascular disease. SARS has previously been associated with hypotension, tachycardia, bradycardia, atrial and ventricular arrhythmias.⁶ ECG changes and a troponin rise may indicate myocarditis. Myocarditis may recover with supportive therapy and arrhythmias may be transient.

With SARS-CoV-2 older age and the presence of underlying medical conditions appears to increase complications and mortality.⁷ The Italian experience shows that of all deaths, only 1.2% occurred in patients with no co-morbidities and 48.6% of deceased patients had three or more co-morbidities (COVID-19 Surveillance group). This may relate to reduced immunity and it has been noted that the SARS-CoV-2 virus binds to alveolar and myocardial cells via the ACE2 receptor.⁸ Myocardial injury with troponin rise may be seen in up to 17% of hospitalised patients⁹ and is a risk factor for mortality. The mechanisms of cardiac injury include myocarditis, hypoxaemia, and cytokine storm. Myocarditis may be associated with ECG changes and arrhythmias but detailed observations on arrhythmias specific to SARS-CoV-2 are limited.

The large series published from the Wuhan infection epicentre in China by Wang and colleagues shows illustrative data of the severity of SARS-CoV-2.¹⁰ In this series, the complications included acute cardiac injury 7.2%, shock 8.7%, arrhythmias 16.7% and overall 26% of hospitalised patients required ICU care. Details on specific arrhythmias were not provided but were more common in ICU than non-ICU patients. Other smaller studies have demonstrated similar observations with the development of cardiomyopathy in 1/3rd of patients admitted to ICU.⁵

A separate single-centre retrospective analysis also from Wuhan demonstrates correlation between underlying cardiovascular disease (CVD) and myocardial injury with increased mortality and malignant arrhythmias. One third of the patients (35.3%) had previous CVD, and 52 (27.8%) patients experienced an acute myocardial injury. Troponin T (TnT) elevation likely represents myocardial injury from either myocarditis, infarction with plaque rupture or diffuse ischaemia from hypoxia. Mortality among patients with CVD and elevated TnT levels was 69.44% (25 of 36), compared to 7.62% (8 of 105) among patients without CVD and acute myocardial injury. Patients with CVD were more prone to TnT elevation (54.5% vs 13.2%), and patients with elevated TnT had more frequent malignant arrhythmias. The overall incidence of ventricular tachycardia (VT) or ventricular fibrillation (VF) in this cohort of sick patients with frequent underlying CVD (and a total mortality of 23%) was 5.9%. VT/VF was much more likely in the group with elevated TnT (17.3% vs 1.5%). Events of asystole were not described.¹¹ These preliminary reports suggest greater incidence of malignant arrhythmias among COVID-19 patients compared to SARS (2003).

Potential drug therapies for SARS-CoV-2 may exacerbate cardiac arrhythmias. Hydroxychloroquine has been touted as a possible agent which might reduce the severity of or prevent infection.¹² Hydroxychloroquine (Plaquenil) is a chloroquine derivative and like all the related drugs in this group may cause QRS widening and QT prolongation. However, it is safer to use than chloroquine. Cases of torsades de pointes secondary to this drug are published. The half-life of the drug is very long, and the risk is related to either over dosage acutely or high dose long term usage. Hydroxychloroquine is being used in combination with the antimicrobial azithromycin in clinical trials and shown to reduce viral load.¹³ This drug has anti-inflammatory effects. This antibiotic may cause Long QT and Torsade de Pointes. Case reports exist for potentiation of long QT in patients with hypokalaemia and co-administration of other QT prolonging drugs eg chloroquine.¹⁴

A recent article from Mayo clinic suggested that the risk of drug-induced Torsade de Points (DI-TdP) and/or sudden cardiac death (DI-SCD) can be mitigated with some precautions. Baseline ECG and individual patient assessment for additional risk factors for QTc prolongation is indicated. Congenital (or inherent tendency for drug induced QTc prolongation), modifiable or non-modifiable QTc risk factors ought to be taken into consideration. Taking into consideration COVID-19's pandemic nature, the small proportion of patients at risk of DI-TdP/DI-SCD represents a significant number of individuals who may experience a life-threatening adverse effect, if these medications are accepted for post-exposure prescription.¹⁵ Rigorous investigation of modifiable risk factors for QTc prolongation and consecutive ECG is mandatory in such patients.

No doubt other therapies are being assessed and include Interferon-alpha and the specific anti-viral Remdesivir.¹⁰ The cardiovascular side effects of the latter are currently unknown.

DOMAIN 6: EP AND CIED IMPLICATIONS FOR CHILDREN AND ADULTS WITH CONGENITAL HEART DISEASE

COVID-19 Infection in children

Children in general tend to have less severe disease than adults, and seem to present much less to hospital. Of 72,314 cases reported by the Chinese Centre for Disease Control, less than 1% were under 10 years of age, 60% were male. Of 171 confirmed cases collected in one study, 3 required ICU and there was one death at aged 10 months. Median age of infected children was 6.7 years. Two thirds had some evidence of pneumonia and 16% were asymptomatic.¹⁶ In a series from 10 hospitals from the Hubai province published March 24, only 25 confirmed paediatric cases were identified.¹⁷ Abdominal symptoms, are not uncommon.¹⁸ There was no proven vertical transmission to the foetus among nine pregnant women with COVID 19, but symptomatic newborns as young as day 2 have been reported, some with typical features of respiratory distress syndrome (RDS) on chest X Ray, but with favourable outcome so far.¹⁸

Cardiac effects in children

Although tachycardia was documented in 40%, no cardiac effects have been described in children as of March 26 2020, aside from an elevated troponin in one 55-day old infant.¹⁹ (However, there is no systematic review is available and myocarditis has been reported in young adults with severe RDS.

Post-operative, and adults with congenital heart disease

Data are not available on outcomes of COVID-19 in this group. Known risk factors in adults will apply; such as older age, hypertension and diabetes.⁹ Intuitively *we would expect those with reduce ventricular function, pulmonary hypertension and Fontan circulation, to tolerate to pulmonary manifestations of disease less well.* One of the deceased patients in the above study had congenital heart disease.

Patients with Channelopathies

Before starting a treatment in COVID-19 affected patients with QT prolonging or experimental drugs, an individual risk vs benefit analysis should be made and an electrophysiologist should be involved. Adrenaline in CPVT should be avoided even in resuscitation.

Implications of the pandemic to immediate management of arrhythmia in children and adults with CHD (congenital heart disease).

The implications are generally the same as for adult non-CHD patients, and we endorse the above carefully considered statements presented by this council.

The biggest burden of this pandemic will be on the adult population, but we have many shared resources, and interdisciplinary collaboration in this instance may largely be for the paediatric services to make space for the huge onslaught of very sick adult patients.

We also have a responsibility to provide ongoing paediatric cardiac services, since there is no back-up if all become sick. There is a single small team for a whole State, so there is a priority to protect the whole medical and surgical team so that vulnerable yet treatable infants in particular don't die as a consequence of lack of a service at all. Minimising exposure of this team to COVID-19 is thus a major imperative.

We summarise our position below, in essence, this is the same as for older/non-CHD patients, with some minor additions.

We recommend the following indications for EP/ablation in children during the pandemic:

1. Cardiac arrest in association with pre-excited AF;
2. Arrhythmia causing need for ECMO and unresponsive to medical management;
3. Incessant arrhythmia with severe ventricular dysfunction and failed medical management (where the balance of risks favours ablation rather than protracted inpatient medical management (eg tachyopathy due to EAT, PJRT or VT).

We recommend the following indications for EPS/ablation for ACHD patients during the pandemic:

These are the same as for the general adult population with the possible addition of

1. Cardiac arrest secondary to atrial flutter in RV dependent circulation;
2. VT Storm, particularly in Tetralogy/Rastelli subgroup.

We recommend the following indications for pacing/defibrillation during the pandemic:

1. Congenital complete heart block– newborn with heart rate less than 55bpm, or at all ages with syncope;
2. Syncope due to slow heart rate /intermittent AV block;
3. Post-operative complete heart block;
4. Pacemaker dependent and pacemaker at EOL;
5. Secondary prevention defibrillator implant;
6. Replacement of defibrillator device at EOL for high risk patients.
7. Removal of infected devices
8. Insertion of loop recorder in known channelopathy/cardiomyopathy only

Outpatient consults

New patients

1. New patients should at first be offered virtual/telehealth outpatients review. Note that often a good enough ECG can be obtained from the GP or referring hospital, and AliveCor can be ordered on-line.
2. Those who may need to be seen in person during lock-down **after** the virtual consult, are those where:
 - a. the history leads to an impression that *a life-threatening condition seems likely (eg CPVT/LQTS/HCM);*
 - b. truly arrhythmic sounding syncope, syncope with palpitations, exercise triggered syncope, particularly if there is a malignant family history;
 - c. syncope with newly diagnosed WPW (not with documented pre-excited AF) diagnosed on ECG by a paediatric colleague can usually be initially managed with an antiarrhythmic such as flecainide/Sotalol remotely or at referring hospital and review when the pandemic shut-downs have finished.

Some of these new patients can be dealt with remotely except that they need ECG, echocardiography and an exercise test. These tests, if they cannot wait, can sometimes be done by another colleague/allied health and not necessarily reviewed face to face by an EP.

Medications can usually be started remotely.

An exercise test can potentially be deferred by banning exercise in the meantime.

Follow up patients

1. As per the adult follow up guidelines, each week's clinic list should be reviewed and patients should be deferred when safe to do so. Those who do need to be seen *should first have telehealth review, and seen only where treatment cannot safely be optimised remotely.*
2. Some cases may require echocardiography, *but this does not necessarily require the consultant to see the patient during that visit.*
3. Cases where telehealth +/- in person review should occur include:
 - a. known cardiac inherited disease with syncope;
 - b. known congenital heart disease with syncope (e.g. post Rastelli, TOF)
 - c. Patients requiring pacemaker/ICD follow up, as per adult guidelines. It is generally safe to delay or skip one planned pacemaker or ICD check in patients with or without remote monitoring if they are not pacemaker dependent and had stable battery and lead measurements in the last checks.

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Domain 5: Arrhythmic implications of COVID-19

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Domain 6: EP and CIED implications for children and adults with congenital heart disease

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