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CONSENSUS STATEMENT

Consensus Guidelines for International Cardiology Services Delivery During COVID-19 Pandemic in Australia and New Zealand☆

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Background

The coronavirus disease (COVID-19) pandemic is rapidly progressing worldwide and the impact on societies is constantly evolving. This consensus document highlights the clinical challenges and seeks to guide Australian and New Zealand cardiology units in their decisions as to how best reconfigure interventional cardiac services during this difficult time. There is no ''one-size fits all'' recommendation and each unit may be faced with unique challenges. It is possible if the worst-case scenario occurs that little or no service provision is possible.

Main Challenge

COVID-19 appears to be more virulent than other common respiratory tract viral infections such as H1N1/ influenza. Bringing a confirmed or suspected COVID-19 patient to the cardiac catheterisation laboratory will expose all laboratory staff to the risk of infection and disable laboratory use for a prolonged period of time for terminal cleaning.

Ideally, all patients undergoing urgent cardiac catheterisation in the absence of a negative COVID-19 test should be treated as potentially infected, as in Italy [1]. Internationally, a shortage of personal protective equipment (PPE) has contributed to frontline health care workers (HCW) infections and death [2]. In Australia, our available PPE appears to be in short supply. Therefore, the indication and urgency of interventional cardiac procedures needs to be balanced against the risks. The potential need for exposed staff to be ''self-quarantined'' or for infected staff to be off-duty (or worse admitted as patients) will hinder service delivery and, in some instances, will render it non-viable.

Internationally [3], there were 684,652 confirmed COVID-19 cases, with Australia having 1791 cases with 13 fatalities and New Zealand 283 cases with one fatality as of 29 March 2020. Modelling suggests a doubling time of approximately every 3 days and potentially resulting in many thousands of infections within weeks despite ''social distancing'' and ''lockdown'' measures which can take 3–6 weeks to show an impact.

Clinical judgement and consensus amongst treating physicians in a cardiology unit/hospital facility based on current evidence and service delivery capability should apply in every case.

Cardiac Manifestations of COVID-19 Infection

Myocarditis, cardiomyopathy, cardiogenic shock, myocardial injury and arrhythmia are reported with COVID-19 infection [4,5]. Electrocardiographic changes can be present (~7% COVID-19 patients [5]) and these can mimic ST segment elevation myocardial infarction (STEMI), so this differential diagnosis should be entertained before urgent cardiac catheterisation/angiography/primary percutaneous coronary intervention (PCI) or thrombolysis is considered. However, coronary angiography may be necessary to help differentiate STEMI from myocarditis or stress cardiomyopathy.

General Considerations

A. Patients

1. **Consider appropriateness of invasive procedures during COVID-19 pandemic.**
   The decision to perform an interventional cardiology procedure during a pandemic must be carefully balanced between the risks of viral exposure to staff and unnecessary utilisation of precious resources. It is important to assess the clinical urgency of a procedure and this should be a joint decision between the cardiologist, other clinicians, and the patient. At-risk cardiac outpatients presenting to a catheter laboratory may be exposed to the possibility of COVID-19 infection, especially if hospital admission is required post-procedure and, as the pandemic progresses, this will increase the proximity to an infected in-patient population. ''Stable'' patients, such as those studied in the International Study of Comparative Effectiveness with Medical and Invasive Approaches (ISCHEMIA) trial, have excellent long-term outcomes with medical therapy alone. Thus, deferral of non-urgent or ''stable'' ischaemic heart disease patients and possibly patent foramen ovale (PFO) closure, as suggested by the American College of Cardiology (ACC) Intervention Council/Society of Cardiovascular Angiography and Intervention (SCAI) [6], will conserve resources such as PPE, including N95 masks, gloves and gowns. CT coronary angiography (CTCA) should be considered as an alternative to invasive angiography in patients with stable symptoms or positive functional testing.
2. **Conduct general screening of all patients presenting to the catheter laboratory**
   All patients presenting for cardiac catheterisation should be screened for COVID-19 risk [7], by cardiology trainee/registrar or consultant or catheter laboratory nurse.
   Screening should be via verbal communication with patient / patient carer (ward/nurse/doctor) as well as ascertaining relevant information from patient file or history:
   - Are they a confirmed COVID-19 case?
   - Does patient have a cough, sore throat, runny nose, recent anosmia?
   - Does the patient currently have a temperature >37.5 °C?
   - Have they had contact with a confirmed COVID-19 case?
   - Has the patient returned from overseas or a cruise in the last 14 days?
   - Are they coming from an aged care facility or group home?
   - Are they a health care worker?
   - Have they been COVID-19 tested? If yes, when, and was the test negative?

Some units have created screening tools (See Orange Base Hospital, NSW, screening tool, personal communication, Dr Ruth Arnold, head of cardiology, Orange Base Hospital, Orange, NSW) which may include imaging (CXR or CT) and biochemical markers (eg lymphocyte count).

Table 1 Exposure risk related to patient risk features.

LOW EXPOSURE RISK	*HIGH EXPOSURE RISK*	
LOW RISK FEATURES	*INTERMEDIATE RISK FEATURES*	*HIGH RISK FEATURES*
Listed as droplet/contact precaution	- Current fever/temperature $\geq$ 37.5 ^{o}C	Confirmed COVID-19
No symptoms or contacts	- Constant non-productive cough	Patient has had contact with confirmed COVID-19 case
Negative COVID-19 test	- Recent anosmia/hyposmia	- CT/CXR suggestive of COVID-19
Socially distanced for 2 weeks without symptoms	- Documented recent international travel/cruise or close contact with someone who has recently travelled	
	- Flu like symptoms in HCW	
	- Non English-speaking patient with urgent need, where no history is possible	
	- High likelihood of requiring NIV/CPAP/BiPAP or high flow oxygen in suspect patient	
	- Lymphopaenia	

Abbreviations: BiPAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure; HCW, health care worker; NIV, non-invasive.

3. **Document patient information risk level**
   Patient risk level can be documented using Powerchart, electronic medical record, (eMR) or by formal written history-taking.
   Table 1 shows how patient risk features relates to exposure risk to others.
4. **Assess the urgency of an invasive cardiac procedure**
   i) Outpatient or ''elective'' cases
   - As of 25 March 2020, Australian Prime minister Scott Morrison had cancelled all (public and private) non-urgent surgical procedures, regardless of COVID-19 risk. This policy conserves resources including staff and, importantly, PPE.
   - Outpatients having unstable symptoms or considered high-risk for events or hospital admission maybe considered ''urgent'' and treated after agreement between local hospital administration and cardiology units.

   ii) Acute coronary syndrome: NSTEMI/Unstable angina
   - There are many considerations regarding whether a catheter procedure should be performed or how rapidly it is done for patients with non-ST elevation myocardial infarction (NSTEMI) or unstable angina.
   - According to a Cochrane review, there is no randomised controlled trial evidence that an early invasive approach reduces death or non-fatal myocardial infarction in this setting [8]. However, there is a reduction in recurrent MI and angina and re-hospitalisation which is important in unstable patients.
   - Invasive management may facilitate early discharge especially in those with medical therapy refractory angina or high-risk anatomy such as left main coronary artery disease on CTCA.
   - There is no evidence to support the use of early invasive coronary angiography amongst patients with fourth Universal definition [9] Type II myocardial infarction, acute myocardial injury with troponin elevation without significant delta, but clinical decision on a case-by-case basis should be made. Echocardiography may be a useful tool in this context.
   - COVID-19 **''Low Exposure Risk''** patients can be brought to the catheter laboratory with staff observing appropriate PPE during procedure performance (routine care in this case), and cleaning procedures applied as per usual practice.
   - COVID-19 **''High Exposure Risk''** patients should only be brought into the catheter laboratory if there is a strong indication that urgent cardiac catheterisation would alter their short-term prognosis, ie clear evidence of ongoing severe ischaemia by the presence of

   a) symptoms and ECG changes refractory to medical therapy, or
   b) haemodynamic instability.
   - When patients are in the ***unknown category* of risk,** for example, a non-English speaking patient, and there is an ***urgent clinical need***, it is appropriate to treat as a ''High Exposure Risk'' of COVID-19.
   - Patients who are ***clinically stable*** should be cleared of ongoing COVID-19 infection (asymptomatic and

COVID-19 polymerase chain reaction [PCR] negative) before being considered for invasive coronary angiography
- Patients with severe pneumonia or acute respiratory distress syndrome (ARDS) should **not** be brought to the catheter laboratory as multi-disciplinary management discussions are likely necessary (eg escalation to intubation or haemodynamic support, risk/benefits/indications for invasive angiography/PCI or decision to palliate).
- The possibility of myocarditis should always be considered and possibly excluded using CTCA where possible.
- Point-of-care COVID-19 testing when available may reduce time required to stratify a patient's COVID-19 risk but the accuracy of this testing has not been demonstrated in practice at time of writing.

iii) Acute coronary syndrome: STEMI
- Patients with ''Low Exposure Risk'' of COVID-19 can be brought to the catheter lab with appropriate PPE and cleaning procedures applied as per usual practice
- In units where staffing levels are compromised, and primary PCI cannot be offered (including lack of PPE) then fibrinolysis may be appropriate if patients are lysis-eligible
- In busy primary PCI units, simultaneous presentations of two or more STEMI patients is not infrequent. In this situation, it is unlikely that more than one patient will receive primary PCI (time delay with PPE, terminal cleaning time, avoid contamination of a ''clean Lab'', lowered staffing levels), then fibrinolysis would be an option
- Fibrinolytic agents should be made available where patients are likely to be treated (eg emergency departments, coronary care units, catheter laboratories)
- Cardiologists should re-familiarise themselves with the indications and contraindications of fibrinolytic agents they are using (commonly TNK-tPA single bolus weight-adjusted dosing)
- Fibrinolytic therapy could be considered in lytic-eligible patients with ''High exposure'' risk of COVID-19 as suggested by Sichuan Provincial people's hospital flow chart [10] (see also protocols from: Cairns Hospital, personal communication, Dr Greg Starmer, director of cardiology, Cairns Hospital, Cairns, Qld; Nepean Hospital, personal communication, Dr Hisham Hallani, Director of Cardiology, Nepean Hospital; Eastern Heart Clinic, personal communication, Dr Nigel Jepson, Eastern Heart Clinic, NSW; and, Zaman et al. (preprint published on line [3 April 2020] at www.mja.com.au)
- Lengthy treatment delay in delivering cardiac catheterisation is likely to arise due to the need for proper infection control procedures and PPE need (time donning PPE, terminal cleaning between procedures; see Practical Considerations below).
- Indicated fibrinolytic treatment should be delivered within key performance targets (30 min ''Door-to-Needle'' or ''Door-to-Lysis'' time).
- If fibrinolysis is used for STEMI, patients aged ≥ 75 years should receive half weight-adjusted TNK-tPA dose with the antiplatelet agent clopidogrel given (N.B.: omit the loading dose and use 75 mg daily) [11], as ticagrelor should not be given at the time of fibrinolysis administration. The low molecular weight heparin enoxaparin should be given at a dose of 30 mg IV bolus (<75 years) and then 1 mg/kg SCI BD except for patients ≥ 75 years where enoxaparin is given at 0.75 mg/kg SCI BD with no IV bolus [11]
- ''High Exposure Risk'' COVID-19 patients should only be brought into the catheter laboratory if there is a strong indication that urgent cardiac catheterisation would alter their short-term prognosis i.e. clear evidence of ongoing severe ischaemia, by the presence of:

a) Symptoms and ECG changes refractory to medical (or fibrinolytic) therapy, or
b) Haemodynamic instability, or
c) Large STEMI e.g. left main/anterior territory or inferior territory with hypotension or ischaemic arrhythmia.
   - Patients with severe pneumonia or ARDS should not be brought to the catheter laboratory, and multi-disciplinary management discussions are likely necessary (eg escalation to intubation or haemodynamic support, risk/benefits of invasive angiography/PCI or decision to palliate).
   - The possibility of myocarditis should be considered and possibly excluded using CTCA where possible.
   - Echocardiography is also useful and hand-held devices may be advantageous because of their ease-of-use and simpler cleaning (e.g. GE V-scan™ and Philips Lumify™).

iv) Structural interventions

a) **Transcatheter aortic valve implantation (TAVI) -** the patient group in question can be very elderly and are already vulnerable to death from infections. The overall value and clinical urgency of TAVI would require joint decision making between Heart team/TAVI implanter/referring cardiologist/patient and the host institution. TAVI offers shortened hospital stays and reduced morbidity compared to surgical aortic valve replacement (SAVR). Compared to SAVR, TAVI may reduce demand for ICU and anaesthetic services during a pandemic. If TAVI is performed, pre-procedural screening and COVID-19 PCR may aid in reducing risk to staff. Although a significant proportion of TAVI are done under conscious sedation, general anaesthesia and intubation is a consideration, especially to mitigate viral spread in the event of unforeseen intubation or CPR requirement.
b) **Mitral Clip –** unstable patients could be considered for mitral valve repair for mitral regurgitation via a mitral

clip, if resources allow; lower risk patients should be postponed

c) **PFO and ASD closures –** postponement recommended
d) **LAA closure –** postponement recommended
e) Other – postpone unless urgent in-hospital indication

B. Equipment

1. **Dedicated Catheter Laboratory**
The aim during the COVID-19 pandemic is to reduce infection risk to health care workers (HCW) and minimise virus contamination of laboratories. If there is more than one laboratory available in a cardiology unit, then one should be made a dedicated COVID-19 laboratory, so that the others are ''clean''. This does not guarantee that the ''clean lab'' will not be contaminated at any time but serves to minimise risk and maximise patient flow (especially for ''low exposure risk'' patients) in the catheter laboratory. If time permits, explore with hospital engineering if the laboratories can be made ''negatively pressured'', and an understanding of the air conditioning system is important as this may expose other parts of the hospital with a single procedure.
Appendix 1 outlines a Catheter Laboratory Preparedness Checklist.
2. **Accessory Catheter Laboratory Equipment**
It may be pertinent to investigate if accessory catheter laboratory (cath lab) equipment is easy to clean post-treatment of a ''high exposure risk'' patient. Such equipment should not be left in the catheter laboratory and kept in a ''clean'' area. It is especially important to understand what is being cleaned during a ''terminal cleaning process'' and the time required before the lab can be re-used. All equipment in the lab during a case needs cleaning, and covers may be useful.
Cath labs possessing already integrated equipment which does not need cleaning, such some fractional flow reserve (FFR) and optical coherence tomography (OCT) systems means these are readily available for procedures. However, some systems such as intravascular ultrasound (IVUS) and rotational atherectomy are mobile and may not be made available if cleaning is not possible. This may potentially hinder treatment options. Portable iSTAT machines may be placed in the laboratory to be used during an urgent procedure, to be cleaned after.

C. Venue

1. **Controllable Entry Point**
Ambulance-transferred patients should be taken to the ED, especially if clinically unstable as, there are usually limited medical staff supervising wards. This may be the single most controllable entry point to any hospital to minimise staff infection risk, avoiding un-screened/non-risk assessed patients directly entering the lab.
2. **Dedicated ''Hot'' Room**
Pre-catheter lab assessment may be proposed in a **dedicated single ''hot'' room in a coronary care unit** (when patient numbers demands increase) for transferred patients. Depending on the choice of reperfusion therapy (Lysis or Primary PCI), risk-assessment, imaging (CXR), transthoracic echocardiography, intubation may be done prior to transfer to the catheter laboratory. Such a ''Hot room'' should preferably be a negatively pressure room but availability is extremely limited. They should be terminally cleaned after use. Alternatively, fibrinolytic therapy may be offered.
If the patient requires airway management, there is a lowered intubation threshold for ''high exposure risk'' patients. Non-invasive ventilation (NIV), continuous positive airway pressure (CPAP), bilevel positive airway pressure (BiPAP) and high flow oxygen all increase aerosolised viral spread. If patients are borderline (eg 6L Hudson mask or may need NIV/CPAP/BiPAP) then intubation should be performed by a dedicated anaesthetic team donning PPE.
3. **Centralised Services**
Units which are within a State health care network or district should have early discussions regarding service availability across their areas. It may be prudent to limit one centre to be receiving urgent primary PCI for each district/network, as in Italy [1]. This may be co-ordinated with conversion of smaller networked centres to fibrinolysis-first strategy despite the presence of a catheter laboratory on-site. Appropriate discussion and notification to the ambulance or paramedic service should occur if reperfusion strategies change within a network/district. This may have the advantage of minimising infection risk to staff in network referral centres and, also, somewhat mitigate risk of declining staffing levels as they may be a back-up team. The latter would require cross-credentialling of cardiologist privileges across health networks/districts. Notably this is already the ''pharmaco-invasive'' reperfusion strategy practiced in regional Australian and New Zealand centres.

D. Staff

1. **Workforce Preparedness**
All laboratory staff should be trained in the appropriate donning and doffing of PPE (see Spanish Society of Cardiology COVID-19 guidelines [12], for Donning and Doffing PPE flow chart diagrams).
All staff should also be made aware of the lab locations where PPE is kept for security and efficiency reasons. Online PPE education is usually available through the hospital system (for example, NSW Health is proactively communicating the Clinical Excellence Commission's PPE guidelines which are available on its website [13]).
Appendix 2 outlines a Catheter laboratory team Preparedness checklist.
2. **PPE Inventory Management**
The catheter laboratory Nursing Unit Manager and Director should both be active in managing the supply of PPE to staff, as this is essential equipment to allow procedures to be undertaken. Systems such as h-trak can

aid this process and an active inventory management approach is encouraged.

It is likely that when PPE is not available then procedures may be cancelled or alternative therapies (such as fibrinolysis for STEMI) instituted.

3. **Simulation Training**

Regular simulations in the catheter laboratory with the entire team managing a COVID-19 patient should be performed as this will identify issues early and serve to increase ''team preparedness''. ''Practice runs'' with full PPE for the team can be performed on low-risk patients but this will expend PPE supply.

Clinical nurse educators and consultants should take a major role in this preparation since this can alleviate staff stress and anxiety. However, ''procedural stress'' will always occur during a case.

4. **Staffing Levels**

Primary PCI is a resource-intensive procedure and efficiency depends significantly on the systems of care. This relies on the availability of adequate staff, expertise, equipment and, now especially, PPE. In area health services, districts or networks, it is preferable to fragment the unit into a number of teams (two or, even better, three or more). Teams would include, either in part or whole, junior medical staff, cardiology advance trainees, fellows, consultants, nursing staff, radiographers and cardiac technologists.

Each team should remain physically separate both during working hours (1.5 m) and socially from other teams in a service. Health status of ''isolated'' teams should be monitored on a daily basis, and its availability/health ''deployability'' regularly reported to the central cardiology management unit.

Fragmentation into separate teams mitigates the risk of interruption to essential service delivery due to the enforced absence of medical and/or nursing staff with specialised skills as the result of either exposure to or infection with COVID-19. They can work on a rotating basis in shifts. Discontinuity of ward patient care is a disadvantage, but the strategy serves to better ensure medical staff availability. However, it may not be possible to do this in very small cardiology departments. Agreement from hospital Human Resources and executive administration would be required.

It has also been suggested that sequestering ''at risk'' staff (>65 years of age, and with co-morbidities) from frontline care of COVID-19 patients would be reasonable as they would have a three-fold mortality [14], if infected. This would depend on the age of the workforce and the impact on staffing levels to deliver services. Other ''at risk'' staff include the immunocompromised and those with chronic health conditions, regardless of age.

5. **Minimising the Number of In-Lab Staff and Foot Traffic**

Only essential staff (scrubbed operators) necessary for the performance of the procedure should be within the laboratory, with all the doors closed. There should be an adequate microphone system for communication between the proceduralist and the cardiac technologist/radiographer/nurse supporting the case in the control room. It may be good practice to have a ''clean'' scout nurse outside the laboratory to obtain consumables and pass them into the laboratory.

In 'closed' laboratories, geographically within an operating theatre environment, ''foot traffic'' is generally minimised. ''Open laboratories'' are prone to unnecessary people passing through which increases infection risk. Notifications should be made to reduce unnecessary ''foot traffic'' within the cardiac catheterisation laboratory for non-essential staff members. However, despite reducing in-lab staffing levels, again, it may be necessary to have an additional nurse outside the lab to act as a ''clean scout''.

6. **Staff Mental Health**

The lack of PPE resulting in COVID-19 infection (and subsequent mortality risk) as well as wearing PPE results in increased anxiety in catheter laboratory staff members [15]. Experience from China during COVID-19 describes intense psychological stress in treating physicians resulting in increased anxiety and poor sleep [16]. In a study at a tertiary infectious disease hospital in China during COVID-19 there was a high incidence (~25%) of anxiety and post-traumatic stress in medical staff during their peak surge and it is worse in female staff, especially nurses [17,18]. Deliberate absenteeism may result from heightened stress in a pandemic leading to healthcare worker social isolation and low staffing levels.

Clear and updated information regarding pandemics may aid in reducing concern [19]. Institutions should have strategies to mitigate stress and anxiety in frontline staff during pandemics [19]. Staff should be made aware of what services are available within their respective institutions.

7. **Staff Physical Health**

Medical and nursing staff are dedicated and usually prefer working despite minor illness. This can be highly problematic during the COVID-19 pandemic, as minor symptoms should not be ignored, and early reporting will help identify infected individuals with COVID-19 testing. Enhanced vigilance of all members of working staff aids early identification of possible infection.

8. **Frontline Physicians in Difficult Times**

The COVID-19 pandemic has the potential to overwhelm an entire country's health care infrastructure to manage critically ill patients and exceed ICU capacities. Frontline medical staff providing essential emergency services at personal risk are working under extreme stress.

There is no doubt that excellent catheter laboratory team preparation, teamwork, communication, mutual trust, regular updates, feedback, and leadership is desirable for the best outcomes. Pre-planning, communication, and collegiality between multidisciplinary units within the hospital improves the ability to deliver optimal patient care.

Practical Considerations

1. **Contraindications to Fibrinolytic Therapy**
   Fibrinolytic therapy is contraindicated in the following circumstances [11,20]:
   - Prior intracranial haemorrhage (ICH)
   - Blood Pressure >180/110 mmHg
   - Severe uncontrolled hypertension (unresponsive to emergency therapy)
   - Known structural cerebral vascular lesion
   - Known malignant intracranial neoplasm
   - Stroke or transient ischaemic attack (TIA) within 12 months
   - Suspected aortic dissection
   - Active bleeding or bleeding diathesis (excluding menses)
   - Significant closed head trauma or facial trauma within 3 months
   - Intracranial or intraspinal surgery within 2 months
2. **Levels of PPE**
   There are three levels of PPE providing standard care, droplet precautions and airborne precautions, respectively [13]:

A.	Standard care:	handwashing and gloves
B.	Droplet precautions:	gown, gloves, facemask, eye goggles
C.	Airborne precautions:	As above, plus N95 mask

The level of PPE to be used directly corresponds to the exposure risk, which is determined by the patient's level of risk (Table 2).

3. **Lowered Intubation Threshold**
   Patients who are at risk of creating aerosolised pathogens, ie requiring oral/nasal suctioning (nausea/vomiting), use of nebulisers, use of NIV/CPAP/BiPAP/high flow oxygen, should be intubated (by a PPE-trained dedicated anaesthetic team) prior to catheter laboratory transfer
   Early intubation, sedation and possible paralysis should be considered for patients who are thought to require high flow oxygen supplementation approaching intubation or those who have difficulty lying still.
4. **Before Patient Transfer to Cath Lab**
   Prior to transfer, cardiology registrar/trainee in charge of transfer and proceduralist will be responsible for determining the urgency and COVID-19 risk of the patient. Transfer protocols (especially between Cardiology ward/coronary care unit (CCU)-ED-ICU and the catheter lab) should be prepared, so that risk is mitigated, and patient flow is improved.
   Patients with no or "Low Exposure Risk" of COVID-19 can be managed as per usual care.
   Patients with "High Exposure Risk" of COVID-19 will need extra considerations and these steps should be adhered to despite urgency of case and time delay:
   - Dedicated laboratory will be locked and sealed for cleaning for a prolonged period after the procedure.
   - Cleaning staff should also be informed and trained regarding their protection.
   - Staff to ensure that complete sets of level C PPE are available for primary operator, scrub nurse (may be omitted), scout nurse and registrar/fellow (may be omitted). Additional PPE to be ready in case additional personnel are needed in the room (five sets total). Hand sanitisers to be made ready just outside the procedure room for PPE removal. Two additional hazard bins for PPE (one just inside and one just outside procedure room doors) to be made ready.
   - All staff listed above, together with radiographer and technician, will have to ready and available in catheter lab, start-up has been performed, and catheter lab deemed functional.
   - Staff to be in the catheter lab procedure area (ie, operator, registrar/fellow, scrub nurse and scout nurse to don PPE, lead gown). Operator and scrub nurse to scrub and gown. Scout nurse and registrar/fellow to remain unscrubbed in PPE.
   - Technician and radiographer to remain in control room with surgical mask and gloves throughout.
   - Everyone is to be ready and waiting in room prior to transfer of patient.
   - Ready access to equipment (catheters, guides, wires, balloons etc.) should be made simple and means of conveyance to in-lab operators planned to minimise risk of infection.
5. **Patient Transfer and Additional Equipment**
   Anaesthetic/ICU and support staff who are needed in the catheter lab during the procedure should don lead gowns *prior* to donning PPE and *before* initiating transfer of the patient.
   Other important considerations are to ensure that:
   - There will be adequate personnel for physical transfer of patient onto catheter lab bed (registrar/fellow, scrub nurse and minimum of two additional personnel who are transferring patient).
   - The Door between control room and catheter lab should be "closed".
   - The Patient is not to have any delayed waiting in corridors and will have direct transfer into the catheter lab procedure room from their origin (should have transfer protocols organised).
   - Ideally, all personnel in PPE who transferred the patient should stay in the catheter lab throughout procedure. Otherwise, they will have to remove PPE in lab prior to exit from lab through main doors (and not control room), with hand sanitisers used outside the procedure room, and re-don PPE prior to returning to collect patient at the end of the procedure.
   - All non-essential equipment (balloons, wires, catheter, stents) should be stored outside the procedure room, preferably in cabinets.

Table 2 Level of Personal Protective Equipment (PPE) required.

LOW EXPOSURE RISK	HIGH EXPOSURE RISK	
Low risk features	Intermediate risk	High Risk
Level B PPE	**Level C PPE**	

- Additional equipment required from outside the procedure area should be obtained by technician or radiographer and be passed via slightly opened control room door, with no contact between personnel.
- If a medical emergency team (MET) call is activated, staff in control room to ensure only essential MET call staff enter room and that all MET call staff don PPE prior to entering the procedure room via main door (not via the control room).
- Automatic chest compression devices such as LUCAS II are preferred, if CPR is contemplated.
- Upon completion of the procedure, any additional personnel who need to come into the procedure room to help with patient transfer/transport will need to don full PPE.
- All scrubbed staff to stay in room until patient transferred out of room directly to destination.
- Staff then remove surgical scrub and PPE as per protocol, one person at a time (take time to do this properly) inside procedure room, until last step when the mask and goggles are to be removed outside room.
- The use of washable footwear, such as clogs, that can be cleaned is encouraged.
- Staff adhere to every step of PPE removal, including hand scrub/wash at the end.
- The Procedure area and lab to undergo terminal clean (often cleaning commences 30 min after procedure) and have the time needed before lab re-use, as per infection control recommendations in various centres. Procedure area of lab to be sealed until after terminal clean. If equipment needed urgently from the room, PPE will have to be donned to enter.

6. **Key Practical Issues for Catheter Laboratory**

In summary, during the COVID-19 pandemic:

- Only essential staff or personnel to be allowed access into the catheter laboratory
- Clinical discussions between medical staff should be performed via phone, if possible
- Social distancing to be adhered to by everyone
- Limit the amount of contact between groups of staff, if possible, i.e. nursing/medical teams to be segregated (difficult in practice)
- Limit the amount of different staff that have contact with each individual patient
- Limit wait times for patients in catheter laboratory corridor
- Accept patients only when ready in catheter laboratory after team has donned PPE.

Conflicts of Interest

SL: Consulting fees and Research grants Abbott, Consulting fees Bioexcel, Bayer, Pfizer and Boehringer Ingleheim, Proctorship fees Bioexcel and Boston Scientific, Advisory Board Medtronic and Abbott. ASY: none. AS: Proctor, advisory board, research grants from Edwards Lifesciences, Medtronic, Boston Scientific, Astra Zeneca. SS:none. AMcC: none. DC: none. LG:none; SEl-J: None. MS:none. RT: none. HH: none. PB: none. AW: Proctorship fees Medtronic and Abbott, Advisory board Medtronic. Research grant support Medtronic, Abbott and Edwards Lifesciences. GS: none. RB:Advisory board Medtronic and Edwards Lifesciences, Proctorship fees Medtronic. DYL:None. CPJ: none. RB: none. DWMM: Consultant for Medtronic, Abbott, Edwards. Proctor for Abbott and Medtronic, Research grants Medtronic. Rajaratnum R: none. JKF: Research Grant Boehringer Ingleheim. LK: None.

Appendix A. APPENDIX 1. Catheter laboratory COVID Preparedness checklist

CATHETER LABORATORY COVID-19 PREPAREDNESS CHECKLIST

TASK

If available, appoint a dedicated COVID Laboratory

Check Catheter Laboratory is in working order

Check all doors for breaks and that they can fully close

Check appropriate signage is placed on door of entry points

- Control room door
- Main entrance door

Ensure dedicated PPE trolley is set up outside of main door to procedure room:

- Gloves
- Gowns
- Goggles
- Masks (airborne precautions)
- Hand sanitiser
- Hazard bins

Ensure adequate PPE supply

Check with engineers regarding feasibility of converting to negative-pressure (reversing fans) and direction of air flow (avoid conducting to other parts of hospital)

Ensure microphone in control room is in good working order when doors closed

Ensure lighting in-lab can be adjusted from control room (not always possible)

Check location of scrub sinks (can affect PPE donning sequence) – (note: some are inside the laboratory)

Check proposed passage of a patient to-from catheter laboratory from Ward/ED/ICU

Organise a transfer protocol and agreement with other units

Remove accessory equipment from dedicated lab to avoid contamination (eg portable IVUS machine)

Waste Bin and Doffing station at main door of procedure lab

Check with Terminal Cleaning to understand what is cleaned and time this takes. Liaise with Infection Control to see if this is adequate

Understand time needed before lab can be re-used after terminal cleaning

Check Lab Consumables location and efficiency of delivery to in-lab staff

Investigate use of covers for equipment in lab (eg Anaesthetic machine)

Display important information in easy view
eg PPE donning sequence/flow chart
eg PPE doffing diagrams
eg Important phone numbers – Dedicated COVID intubation team number etc
Ensure Lucas II/automatic CPR device is in-lab
Minimise foot traffic in laboratory
Minimise non-urgent procedural volumes

Appendix B. APPENDIX 2. Catheter laboratory Team Preparedness checklist

CATHETER LABORATORY TEAM PREPAREDNESS CHECKLIST
TASK

Ensure that all staff is aware of PPE location
Ensure Catheter Laboratory Team is trained in Donning/Doffing PPE
Check with dedicated COVID Anaesthetic intubation team that they will bring their ''essential equipment'' pack to lab when they are called
Ensure all staff understands that elective intubation prior to catheter lab is the preferred option in ''high exposure risk'' patient with high oxygen requirement
If required, elective intubation in dedicated negative pressure room outside of catheter laboratory is preferred prior to procedure
Ensure each team member is familiar with their individual tasks and who is the lead
Ensure team is aware of support is available if counselling is required
Ensure entire in-lab team assists in patient care prior to leaving lab (eg transfers etc) as PPE is removed
Ensure team is familiar with any transfer protocols
Ensure team is aware of any service limitations compared to normal
Ensure appropriate recommended footwear or footwear protection is used
Ensure team is aware of time needed for terminal cleaning and when the lab can be re-used
Encourage team members to report physical symptoms however minor and they need assessment for isolation or COVID-19 testing before allowed back to duties
Run simulation of patient managed through the lab
Run a trial on a ''low-risk exposure'' non-urgent patient with full PPE

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