CONSENSUS GUIDELINES FOR INTERVENTIONAL CARDIOLOGY SERVICES DELIVERY DURING COVID-19 PANDEMIC IN AUSTRALIA AND NEW ZEALAND

on behalf of the Interventional council of CSANZ and COVID-19 Interventional cardiology working group

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EXECUTIVE SUMMARY

The global COVID-19 pandemic poses an unprecedented stress on healthcare systems internationally. These Health system-wide demands call for efficient utilisation of resources at this time in a fair, consistent, ethical and efficient manner would improve our ability to treat patients. Excellent co-operation between hospital units (especially ICU, ED and cardiology) is critical in ensuring optimal patient outcomes. The purpose of this document is to provide practical guidelines for the effective use of interventional cardiology services in Australia and New Zealand. The document will be updated regularly as new evidence and knowledge is gained with time.

Goals:

1. Efficient use of resources (including staff, Personal protection equipment [PPE])
2. Direct interventional cardiology use towards the highest yield use of hospital capacity
3. Minimise adverse patient outcomes
4. Minimise risk to healthcare workers

Considerations

1. Fibrinolysis may be considered (or even preferred) in STEMI reperfusion in hospitals even with catheter laboratories.
2. Postponement of non-urgent procedures to reduce demand on beds, use of PPE, staff and other resources
3. Postpone invasive angiography in “stable” ischaemic heart disease patients
4. Postpone non-urgent TAVI and Mitra-clip™ and all ASD/PFO and LAA closure procedures
5. In health care networks, centralisation of primary angioplasty services may be possible
6. Training of staff in proper PPE donning and doffing is mandatory
7. Fragmentation of staff into teams is desirable and can mitigate risk of exposure and impact on staffing levels to a degree
8. Working closely with ED, ICU and Anaesthetics from planning to processes promotes efficiency and reduces stress in practice

Background: 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 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 infected staff to be off-duty (or worse admitted as patients) will hinder service delivery and in some instances rendering it non-viable.

Internationally[3] , there were 684,652 confirmed COVID-19 cases with Australia having cases with 13 fatalities and New Zealand 283 cases with 1 fatality as of March 29th 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.

	Johns Hopkins Coronavirus Resource Center Map[3]								
	NSW	VIC	QLD	SA	WA	NT	TAS	AUS	NZ
Confirmed	1,791	769	656	299	311	15	62	3980	514
Death	8	4	2	0	2	0	0	16	1
Recovered	4	191	8	6	28	0	5		56

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]. ECG changes can be present (~7% COVID-19 patients[5]) and these can mimic STEMI so this differential diagnosis should be entertained before urgent cardiac catheterisation/angiography/primary 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. Appropriateness of invasive procedures during COVID-19 pandemic.

The decision to perform an interventional cardiology procedure during a pandemic needs to 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/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 ISCHAEMIA trial have excellent long-term outcomes with medical therapy alone. Thus deferral of non-urgent or “stable” ischaemic heart disease patients and possibly PFO closure as suggested by ACC/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. General screening of all patients presenting to the catheter laboratory

All patients presenting for cardiac catheterisation should be screened[7]:

Screening of COVID-19 risk by cardiology trainee/registrar or consultant or catheter laboratory nurse

Verbal communication with patient / patient carer (ward/nurse/doctor) as well as ascertaining 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℃?
- Have they had contact with a confirmed COVID-19 case?
- Has the patient returned from overseas or cruise in the last 14 days?
- Are they coming from an aged care facility/group home?
- Are they a healthcare worker?
- Have they been COVID-19 tested? if yes, when and was it negative?

Some units have created screening tools (See Orange base hospital screening tool) which may include imaging (CXR or CT) and biochemical markers (eg lymphocyte count).

3. Documented patient information risk level (Powerchart /eMR/ history)

LOW EXPOSURE RISK	***HIGH EXPOSURE RISK***	
LOW RISK FEATURES	***INTERMEDIATE RISK FEATURES***	***HIGH RISK FEATURES***
- Listed as droplet/contact precaution - No symptoms or contacts - Negative COVID-19 test - Socially distanced for 2 weeks without symptoms	- Current fever/temperature ≥ 37.5 ^{o}C - Constant non-productive cough - Recent anosmia/hyposmia - 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	- Confirmed COVID-19 - Patient has had contact with confirmed COVID-19 case - CT/CXR suggestive of COVID-19

4. Urgency of invasive cardiac procedure

i) Outpatient / “elective” cases

- 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. This policy conserves resources including staff and importantly PPE use. 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 these patients

- There is no randomised controlled trial evidence (Cochrane review) 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 L main disease on CTCA

- There is no evidence to support the use of early invasive coronary angiography amongst patients with 4th 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"** can 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.

- COVID-19 **"high exposure risk"** 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
  i) symptoms and ECG changes refractory to medical therapy, or
  ii) haemodynamic instability

- When patients are in the ***unknown category*****,** for example, non-English speaking patient and there is an ***urgent clinical need***, it is appropriate to treat as "high exposure risk" of COVID-19.

- Patients who are ***clinically stable*** should be cleared of ongoing COVID-19 infection (asymptomatic and COVID-19 PCR negative) before being considered for invasive coronary angiography

- Patients with severe pneumonia or 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 patient's COVID-19 risk but the accuracy of this has not been demonstrated in practice

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 2 or more STEMI patients is not infrequent. In this situation, it is unlikely that more than 1 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, Nepean Hospital, Eastern Heart Clinic and Zaman et al).

- 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 ½ weight-adjusted TNK-tPA dose with clopidogrel given (n.b.: omit the loading dose and use 75mg daily)[11] as Ticagrelor should not be given at the time of fibrinolysis administration. Enoxaparin should be given at a dose of 30 mg IV bolus (<75 years) and then 1mg/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 ie clear evidence of ongoing severe ischaemia by the presence of

    i) Symptoms and ECG changes refractory to medical (or fibrinolytic) therapy, or

    ii) Haemodynamic instability

    iii) 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 (eg GE V-scan™ and Philips Lumify™).

iv) Structural interventions

a) 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, GA 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 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

Dedicated Catheter Laboratory (see Catheter Laboratory Preparedness Checklist Appendix 1)

The aim is to reduce infection risk to HCW and minimising virus contamination of laboratories. If there is more than 1 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 understanding of the air conditioning system is important as this may expose other parts of the hospital with a single procedure.

Accessory catheter laboratory equipment

It may be pertinent to investigate if accessory catheter laboratory 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 lab possessing already integrated equipment which doesn’t need cleaning such some FFR and OCT systems means these are readily available for procedures. However some systems such as IVUS and rotational atherectomy are mobile 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 and to be cleaned after.

C. VENUE

Ambulance transferred patients should be taken to the Emergency department 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 and can avoid un-screened/non-risk assessed patients directly entering the lab. Pre-catheter lab assessment may be proposed in a **dedicated single “hot” room in a coronary care unit** (when patients 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 negatively pressured but availability is extremely limited. They should be terminally cleaned after use. Alternatively, fibrinolytic therapy may be offered. If patient requires airway management, there is a lowered intubation threshold for “high exposure risk” patients. NIV/CPAP/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.

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/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

Workforce Preparedness (See Catheter laboratory team Preparedness checklist Appendix 2) – 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 (CEC)'s PPE guidelines which are available on its website[13]].

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

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.

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 (2 or even better 3 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 (1.5m) and socially from other teams in a service. Health status of "isolated" teams should be monitored on a daily basis and regular reported to central cardiology management unit as to its availability/health deployability. 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 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 with co-morbidities) from frontline care of COVID-19 patients would be reasonable as they would have a 3-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 immunocompromised and those with chronic health conditions regardless of age.

Minimising the number in-lab staff (scrubbed operators/ nurses/ technicians) and foot traffic in the laboratory

Only essential staff 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 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, it may be necessary to have an additional nurse outside the lab to act as a "clean scout".

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

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.

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 exceeding Intensive care unit 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, team-work, 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[11, 20]:

- Prior intracranial haemorrhage (ICH)
- BP > 180/110
- Severe uncontrolled hypertension (unresponsive to emergency therapy)
- Known structural cerebral vascular lesion
- Known malignant intracranial neoplasm
- Stroke / 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[13]

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

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

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. Transfer to and out of catheter laboratory

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/CCU-Emergency department-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 set 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 (5 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 deemed functional.
- Staff to be in the catheter lab procedure area (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. Anaesthetic/ICU and support staff who are needed in the catheter lab during the procedure should don lead gowns prior to donning PPE before initiating transfer of the patient.

- Need to ensure there will be adequate personnel for physical transfer of patient onto catheter lab bed (registrar/fellow, scrub nurse and minimum of 2 additional personnel who are transferring patient).
- Door between control room and catheter lab should be “closed”
- Patient is not to have any delayed waiting in corridors and will need 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.
- 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 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 of CPR is contemplated.
- Upon completion of the procedure, any additional personnel who needs 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 to 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 (mask and goggles, and last) to be removed outside room.
- Footwear: Encourage the use of washable footwear such as clogs that can be cleaned
- Staff to ensure that they adhere to every step of PPE removal including hand scrub/wash at the end.
- Procedure area and lab to undergo terminal clean (often cleaning commences 30min after procedure) and the time for 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. Practical issues for Catheter Laboratory during 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 ie 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

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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 • Googles • Masks (airborne precautions) • Hand sanitizer • 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 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 pressured room outside of catheter laboratory is preferred prior to procedure	
Ensure each team member is familiar with their individual tasks and who the lead is	
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	