Evidence check

24 September 2020

Rapid evidence checks are based on a simplified review method and may not be entirely exhaustive, but aim to provide a balanced assessment of what is already known about a specific problem or issue. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

Cardiopulmonary resuscitation (CPR)

Evidence check question

What is the evidence that cardiopulmonary resuscitation (CPR) is aerosol generating? What is the current advice for CPR in patients with suspected or confirmed COVID-19?

In brief

- Chest compressions, assisted ventilation and advanced airway manoeuvres are all considered potential aerosol generating procedures (AGPs) requiring appropriate PPE, whereas defibrillation can be performed wearing droplet precautions, if the patient's mouth and nose are covered.(1)
- In the context of COVID-19, a systematic review published in April concluded it is unclear whether chest compressions or defibrillation causes aerosol generation or transmission.(2) A July literature review recommended taking a precautionary approach with appropriate personal protective equipment (PPE) to protect healthcare workers based on two pre-peer review simulation studies in COVID-19.(2, 3)
- Guidance from the NSW Clinical Excellence Commission is for the use of airborne (in addition to contact and droplet) precautions when performing chest compressions or airway manipulation on patients with suspected or confirmed COVID-19.(4)
- Many professional bodies, including the Resuscitation Council UK, American Heart Association, Department of Health, Australian College for Emergency Medicine, Australian and New Zealand Committee on Resuscitation, Indian Resuscitation Council and the International liaison committee on resuscitation recommend that full AGP PPE be worn during CPR with known or suspected COVID-19.(1, 5-10) The Resuscitation Council UK recommends if the rhythm is shockable to use a defibrillator prior to chest compressions. Compression-only resuscitation is recommended by multiple sources.(5)
- Paediatric cardiac arrest is commonly precipitated by hypoxemia and effective ventilation is a priority. Advanced Paediatric Life Support Australia and the International Liaison Committee on Resuscitation published good practice statements stating that in out-of-hospital settings, rescuers who are willing, trained and able to do so, consider providing rescue breaths to infants and children in addition to chest compressions.(9,11)

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- Emerging evidence on the use of a plastic barrier drape or novel portable negative pressure isolation device have been suggested to reduce aerosolisation during CPR in simulation studies.(12, 13)

Limitations

The evidence defining AGPs comes largely from low-quality case and cohort studies where the exact mode of transmission is unknown, as aerosol production was not quantified. The search did not identify any study specifically looking at SARS-CoV-2 transmission during chest compressions.

Background

The potential risk for COVID-19 transmission via resuscitation care has led to the development of guidelines by some organisations. A BMJ opinion piece stated that healthcare staff in one region were told not to start chest compressions unless they are wearing full PPE.(14) Little evidence exists on the risks of viral transmission through aerosol and droplet generation from interventions that form part of a resuscitation attempt. A 2012 systematic review examined the risk of respiratory disease transmission by AGPs. It reported non-significant results for an increased risk of transmission. There are however some case reports of disease transmission from compressions.(15) Cardiovascular disease is a risk factor for COVID-19 pneumonia; acute cardiac injury is commonly observed in severe cases and is strongly associated with mortality;(16) survival after cardiac arrest is likely to be low.(17) This review aims to summarise the risk of transmission of disease through CPR, and available relevant guidance for CPR for patients with confirmed or suspected COVID-19.

Methods (Appendix 1)

Google and PubMed were initially searched on 6 April 2020. An updated search was performed on 8 September 2020. Only the latest version of guidelines are included.

Results

Table 1: CPR and aerosol generating procedures

Source	Summary
Peer reviewed sources	
Should chest compressions be considered an aerosol-generating procedure? A literature review in response to recent guidelines on personal protective equipment for patients with suspected COVID-19	• This review, published on 2 July 2020, was designed to investigate if chest compressions are considered AGPs and, more importantly, whether they are a possible risk of transmission of infection to the healthcare worker. • The search found limited evidence from three observational studies with low patient numbers and multiple confounding factors, but they described cases of acute respiratory infection transmission during chest compressions.

Source	Summary
Peer reviewed sources	
Brown, et al. 2020 (2)	• Across the three studies, only 27 healthcare workers delivered chest compressions, of whom six contracted SARS.(18-20) • There have been no studies specifically looking at SARS-CoV-2 transmission during chest compressions. • There is insufficient evidence to suggest that chest compressions are not AGP with a risk of transmission of infection; therefore the authors concluded that level three PPE should be worn when performing chest compressions to SARS-CoV-2 confirmed patients.
Cardiopulmonary resuscitation in COVID-19 patients Chahar, et al. 2020 (21)	This is an overview of special considerations for CPR in patients with suspected or proven COVID-19, published by the Centre of Critical Care and Resuscitation, Cleveland Clinic. • Advance directives should be addressed for all patients with confirmed COVID-19. • Deteriorating patients should be preferentially transferred to negative-pressure rooms to minimise risk of exposure to providers during CPR. • 'Compression-only' (hands-only) CPR should be administered by healthcare workers in appropriate PPE. • A barrier device, cloth, or mask can be placed on the patient's mouth to minimise aerosol generation. • A mechanical compression device (LUCAS device, AutoPulse) should be used as soon as available. • Passive oxygenation should be provided by a non-rebreathing mask covered by a surgical mask. • Use of bag-mask ventilation and rescue breaths is discouraged. • Placement of supraglottic device with a high-efficiency particulate air filter attached is preferred to ventilate the patient while a definitive airway is placed. • The advanced cardiac life support protocol should be followed with early placement of an endotracheal tube • All advanced cardiac life support medications are used in a standard manner • For all recommendations, including CPR for COVID-19 patients in prone position or post-arrest consideration, please click here.
Cardiopulmonary Resuscitation in Intensive Care Unit Patients With Coronavirus Disease 2019 Cheruku, et al. 2020 (22)	In this review, the authors propose a procedure for CPR in the ICU that minimises the number of personnel in the immediate vicinity of the patient and conserves the use of scarce PPE. • Pre-emptive placement of central venous lines in high-risk patients with intravenous tubing extensions that allow for medication delivery from outside patients' rooms is

Source	Summary
Peer reviewed sources	
	recommended. This will allow fast delivery of critical medications and reduce healthcare worker exposure. • Extracorporeal membrane oxygenation should be reserved for patients with few comorbidities and a single failing organ system. • Reliable teleconferencing tools are essential to facilitate communication between providers inside and outside patients' rooms. • The report highlighted the low likelihood of successful resuscitation in high-risk patients may prompt patients to decline CPR.
COVID-19 in cardiac arrest and infection risk to rescuers: A systematic review Couper, et al. 2020 (3)	This systematic review identified 11 studies which provided evidence that chest compressions may generate aerosols, and are associated with transmission of infection to rescuers in some circumstances. Simulation studies demonstrated that the donning of PPE delays the initiation of CPR, and PPE is less effective during chest compressions because of the risk of mask slippage, highlighting the need for careful donning and ongoing monitoring of PPE effectiveness.
Management of adult cardiac arrest in the COVID-19 era: consensus statement from the Australasian College for Emergency Medicine Craig, et al. 2020 (23)	A consensus statement for adult cardiac arrest in the setting of COVID-19 has been produced by the Australasian College for Emergency Medicine on 12 July 2020. The main recommendations are: • in a setting of low community transmission, most cardiac arrests are not due to COVID-19 • early defibrillation saves lives and is not considered an AGP • compression-only CPR is thought to be a low-risk procedure and can be safely initiated with the patient's mouth and nose covered. • all other resuscitative procedures are considered aerosol generating and require the use of airborne PPE • it is important to balance the appropriateness of resuscitation against the risk of infection • methods to reduce nosocomial transmission of COVID-19 include a physical barrier, such as a towel or mask over the patient's mouth and nose, appropriate use of PPE, minimising the staff involved in resuscitation, and use of mechanical chest compression devices when available • if COVID-19 significantly affects hospital resource availability, the ethics of resource allocation must be considered The college identified a summary of the minimum PPE for various resuscitation procedures in low/high/unable to

Source	Summary
Peer reviewed sources	
	assess risk patients COVID-19. Modifications to traditional approaches include a greater emphasis on the safety of healthcare workers and on the use of adequate PPE.
Reducing Aerosol-Related Risk of Transmission in the Era of COVID-19: An Interim Guidance Endorsed by the International Society of Aerosols in Medicine Fink, et al. 2020 (24)	Increased risk of transmission has been associated with AGPs that include CPR. This review provided interim guidance for reducing aerosol-related risk of transmission when managing patients during the pandemic: • during the pandemic all patients should be treated as potentially infected • PPE for aerosol and droplet protection (mask, face shield, gloves and gown) • perform high-risk AGPs in a negative pressure room for COVID-19 patients, if available, or rooms with high air exchange rates, and use additional PPE such as PAPRs • have patients wear a simple mask when possible and between treatments.
Cardiopulmonary resuscitation in COVID-19 patients - To do or not to? Kapoor, et al. 2020 (25)	• Available literature is inadequate to direct clinicians towards keeping low or high threshold for performing CPR in COVID-19 patient in cardiac arrest. • NHS Foundation Trust recommends that COVID-19 patients in cardiac arrest outside ED can be given defibrillator treatment if they have a 'shockable' rhythm. But if this fails, further resuscitation is futile. • If a patient with suspected COVID-19 is in cardiac arrest they should be given cardiac compressions and be ventilated, only if they are in the emergency department. • If CPR is performed, it should be done as safely as possible, reducing the number of healthcare workers, and with all healthcare workers donning full PPE. • More data is needed to comment on whether CPR in COVID-19 patients is likely to benefit the patient or harming the healthcare provider more.
Should COVID-19 patients be taken to an airborne infection isolation room without cardiopulmonary resuscitation? Kobayashi, et al. 2020 (26)	The authors recommended wearing full PPE before performing CPR on-site. If the patient collapsed at the entrance of the hospital, instead of delaying CPR until the patient is transferred to an airborne infection isolation room, they recommend performing passive oxygenation using a bag-mask device attached to a HEPA filter with a tight seal, using two hands to hold the mask.
Resuscitation of the patient with suspected/confirmed COVID-19 when wearing	Simulation trial recommended automated chest compression devices be used for chest compression of patients with suspected or confirmed COVID-19. In the absence of an automated chest compression device, it seems reasonable to

Source	Summary
Peer reviewed sources	
personal protective equipment: A randomized multicenter crossover simulation trial Malysz, et al. 2020 (27)	change the CPR algorithm (in the context of patients with suspected or confirmed COVID-19) by reducing the duration of the CPR cycle from the current 2-min to 1-min cycles due to a statistically significant reduction in the quality of chest compressions among rescuers wearing PPE for aerosol generating procedures.
Paediatric Resuscitation Practices During the Coronavirus Disease 2019 Pandemic Morgan, et al. 2020 (28)	Multi-institutional survey regarding paediatric inpatient resuscitation practices during COVID-19 found that 86% of the emergency departments surveyed (67 institutions) implemented changes to inpatient emergency response. The most common are: • limited number of personnel entering patient rooms • limited resident involvement • new or adapted technology is being used for COVID-19 resuscitations by using enhanced PPE for all COVID-19 resuscitation events • intubating earlier during CPR by utilising video laryngoscopy • pausing chest compressions during laryngoscopy • Leaving patients connected to the ventilator during CPR Responses were varied regarding airway personnel, prone CPR, ventilation strategy during CPR without an airway in place, and extracorporeal CPR.
Barrier Techniques to Reduce Aerosolization During Cardiopulmonary Resuscitation Paroya, et al. 2020 (12)	The authors developed additional modifications to the American Heart Association suggested guidelines for CPR in COVID-19 patients to ensure providers are even further protected from unnecessary aerosolisation. They illustrated a sample protocol for provider safety during advanced cardiovascular life support COVID-19. Protocol modifications are well demonstrated through this video. For the intubated patient, the protocol maintains the patient to the ventilator, in addition to being draped with a plastic barrier over the mouth and nose. For the non-intubated patient, a plastic drape or a non-rebreather mask is used to help reduce aerosolisation during manual chest compressions. This modified protocol allows providers to perform advanced cardiac life support by further minimising exposure risk.
International Liaison Committee on Resuscitation: COVID-19	This review provided a consensus on science and treatment recommendations for CPR in COVID-19 patients and suggested:

Source	Summary
Peer reviewed sources	
consensus on science, treatment recommendations and task force insights Perkins, et al. 2020 (9)	• chest compressions and CPR have the potential to generate aerosols • for lay rescuers to consider compressions and public access defibrillation • lay rescuers who are willing, trained and able to do so, consider providing rescue breaths to infants and children in addition to chest compressions (the risk on the rescuer acquiring COVID-19 is greatly outweighed by improved outcome for infants) • healthcare workers should use PPE for AGP during resuscitation • defibrillation should be considered before donning PPE for AGP in situations where the provider assesses the benefits may exceed the risks.
A Novel Negative Pressure Isolation Device for Aerosol Transmissible COVID-19 Seger, et al 2020 (13)	This paper describes the development and testing of a disposable containment chamber that protects healthcare workers from contact with droplets and dispersed aerosols released by patients during airway management. The device is easily portable, light, completely isolates the patient from the provider, and is easy to deploy and remove. During simulated testing, the device prevented contamination with both droplet and aerosol, allowed ready positioning in the lateral position, and was easily removable to allow unfettered access to the patient airway.
Indian resuscitation council (IRC) suggested guidelines for comprehensive cardiopulmonary life support (CCLS) for suspected or confirmed coronavirus disease (COVID-19) patient Sing, et al. 2020 (10)	The Indian Resuscitation Council issued guidelines relating to resuscitation of patients with suspected or confirmed COVID-19 infection. • CPR is a high-risk activity in a suspected or confirmed COVID-19 patient. • The rescuer must wear appropriate PPE before undertaking any patient care activity, including chest compression. • If available, a mechanical chest compression device should be used in place of manual chest compressions, as it will keep the rescuer away from the patient and thereby decreasing the probability of transmission of infection. • Use of an aerosol containment device can help in reducing the aerosol spill into the environment. • All precautions must be rigorously followed to ensure the safety of healthcare workers in a highly infectious environment of a COVID-19 patient.
Airborne transmission of severe acute respiratory syndrome coronavirus-2	This paper described CPR as a procedure graded by extreme risk of aerosol generation. The study referred to the published case by Christian, et al.(30)

Source	Summary
Peer reviewed sources	
to healthcare workers: a narrative review Wilson, et al. 2020 (29)	
COVID-19 and cardiopulmonary resuscitation: an N95 respirator mask may not be adequate Wong, et al. 2020 (31)	The letter referred to the European Resuscitation Council recommendations for healthcare workers before starting chest compressions. The minimum recommended PPE is a filtering facepiece 3 (FFP3) respirator mask (FFP2 or N95 mask respirator if FFP3 is unavailable), eye and face protection, long-sleeved impermeable gown, and gloves.
Nosocomial transmission of emerging viruses via aerosol-generating medical procedures Judson, et al. 2019 (32)	• Aerosol generating medical procedures (AGMPs) are increasingly being recognised as important sources for nosocomial transmission of emerging viruses. • Healthcare workers are considered to be at risk for nosocomial virus transmission from both small and large droplet aerosols. • AGPs include bronchoscopy, CPR, BiPAP, CPAP, HFOV, tracheal intubation, manual ventilation, surgery, sputum induction, nebuliser treatment, suctioning, laser plume. • Coronaviruses (e.g. SARS, MERS) cause respiratory disease in humans and transmit via aerosols, but it is unknown whether small-droplet or large-droplet aerosols are the modes of transmission.
Risk factors for SARS infection among hospital healthcare workers in Beijing: a case control study. Liu, et al. 2009 (18)	• A retrospective case control study to evaluate possible risk factors for SARS infection among healthcare workers in a Beijing hospital. • The case group comprised 51 infected healthcare workers, and the control group 426 non-infected healthcare workers. • Seven risk factors were associated with a significantly increased odds ratio of SARS infection, including chest compressions, intubation, contact with respiratory secretions or sputum and contact with pathological specimens. • Fifteen healthcare workers in total delivered chest compressions, of whom five contracted SARS. • On multivariate analysis, chest compressions were found to be an important predictor of infection transmission with an odds ratio of 4.52, but given that there was a high correlation between healthcare workers who performed intubation and chest compressions, the relative risk of either procedure in isolation could not be distinguished.
Nosocomial transmission of severe fever with	• A case study of nosocomial transmission of severe fever with thrombocytopenia syndrome in Korea.

Source	Summary
Peer reviewed sources	
thrombocytopenia syndrome in Korea Kim, et al. 2020 (33)	• Overall, 27 healthcare workers had contact with a fatally ill patient with the disease, four of those who were also involved in CPR complained of fever and were diagnosed with the syndrome. It is noted that none of these healthcare workers were wearing PPE during the CPR.
Risk Factors for SARS Transmission from Patients Requiring Intubation: A Multicentre Investigation in Toronto, Canada Raboud, et al. 2010 (20)	• Retrospective cohort study examined routes of SARS transmission to 26 infected healthcare workers out of 697 involved in the care of SARS patients. • It was concluded that transmission was attributable to close airway contact and failure of infection control practices. • A total of nine healthcare workers performed chest compressions, of whom one became infected; four healthcare workers performed defibrillation, with one contracting SARS. • It is unclear whether the same affected healthcare worker involved in defibrillation also participated in chest compressions, and whether they had also been involved in other procedures.
SARS among Critical Care Nurses, Toronto Loeb, et al. 2004 (19)	• This retrospective cohort study reviewed the risk of SARS infection in healthcare workers in critical care. • Eight out of 32 nurses who entered a SARS patient's room were infected during the study period (eleven days). Of the three nurses who performed chest compressions, and two who performed defibrillation, none contracted SARS.
Aerosol Generating Procedures and Risk of Transmission of Acute Respiratory Infections to Healthcare Workers: A Systematic Review Tran, et al. 2012 (15)	• During the severe acute respiratory syndrome (SARS) outbreaks, many frontline healthcare workers had a significantly increased risk of contracting disease. • Although clinical guidelines and protective measures for the management of patients with acute respiratory diseases exists, the magnitude of the risk of acquiring an infectious disease through some patient care procedures is not clearly understood. • Procedures reported to present an increased risk of transmission included tracheal intubation, non-invasive ventilation, tracheotomy and manual ventilation before intubation. • Other intubation associated procedures, endotracheal aspiration, suction of body fluids, bronchoscopy, nebuliser treatment, administration of O_2, high flow O_2, manipulation of O_2 mask or BiPAP mask, defibrillation, chest compressions, insertion of nasogastric tube, and collection of sputum were not significant.
Hospital management of adults with severe acute	Procedures that might promote the generation of aerosols (non-exhaustive list)

Source	Summary
Peer reviewed sources	
respiratory syndrome (SARS) if SARS re-emerges—updated 10 February 2004 Lim, et al. 2004 (34)	• Use of high flow oxygen (>6L/min) • Use of nebulisers • Chest physiotherapy • Continuous positive airways pressure (CPAP) • Non-invasive ventilation (NIV) • Bronchoscopy • Tracheal intubation • Suctioning • Humidification.
Transmission of Infectious Diseases through Mouth-to-Mouth Ventilation: Evidence-Based or Emotion-Based Medicine? Arend, et al. 2000 (35)	Virtually any disease transmissible by secretions or blood may be acquired during basic CPR. Only reports of isolated incidents have been published of tuberculosis, Neisseria meningitidis, Herpes simplex, Helicobacter pylori, Shigella sonnei and Salmonella infantis.
Transmission of Panton-Valentine Leukocidin–Producing Staphylococcus aureus to a Physician during Resuscitation of a Child Chalumeau, et al. 2005 (36)	This paper reports the first case of transmission of Panton-Valentine leukocidin–producing Staphylococcus aureus to a physician during the resuscitation of an infant with fatal pneumonia.
Possible SARS Coronavirus Transmission during Cardiopulmonary Resuscitation Christian, et al. 2004 (30)	This case report describes the apparent transmission of SARS from a patient to healthcare worker during an attempted resuscitation. The healthcare worker was wearing PPE.
Healthcare Worker Infected With Middle East Respiratory Syndrome During Cardiopulmonary Resuscitation in Korea, 2015 Nam, et al. 2017 (37)	This case report describes a healthcare worker who was infected while performing CPR for a MERS patient in an isolation room.
Grey literature	
WHO - Modes of transmission of virus causing COVID-19:	In the context of COVID-19, airborne transmission may be possible in specific circumstances and settings when procedures or support treatments that generate aerosols are

Source	Summary
Peer reviewed sources	
implications for IPC precaution recommendations (38)	performed; i.e. endotracheal intubation, bronchoscopy, open suctioning, administration of nebulised treatment, manual ventilation before intubation, turning the patient to the prone position, disconnecting the patient from the ventilator, non-invasive positive-pressure ventilation, tracheostomy, and CPR.
Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care, WHO (39)	The evidence suggests that performing or being exposed to endotracheal intubation, either by itself or combined with other procedures (e.g. CPR or bronchoscopy), is consistently associated with increased risk of transmission (conditional recommendation, very low to low quality of evidence).
NHS National services Scotland (40)	CPR is not currently stated on the WHO list of AGPs (2014). Nevertheless, CPR can include a number of different procedures, namely intubation, manual ventilation, open suctioning, chest compression and defibrillation. Some of these procedures are identified AGPs. Therefore, CPR involving procedures listed as AGPs should be managed as such (i.e. a potential source of infectious aerosols).
Aerosol-generating procedures in relation to COVID-19 (4)	The NSW Clinical Excellence Commission has recommend that for patients with suspected, probable or confirmed COVID-19, airborne (in addition to contact and droplet) precautions are used when doing cardiac compressions or airway manipulation. If a first responder enters the room using droplet and contact precautions, then oxygen via a mask can be provided to the patient and defibrillation can be performed. It is critical that all health workers who are responders for cardiac arrests have practised the safe, effective and rapid donning of PPE required for contact, droplet and airborne precautions.

Table 2: CPR guidelines for COVID-19

Organisation	Title	Advice
Resuscitation Council UK (5)	Advanced life support for COVID-19 patients	Flow chart including PPE recommendations. When the decision to initiate CPR is made, level 3 PPE is recommended, which includes: • disposable gloves • disposable gown • filtering face piece (FFP3) respirator • disposable eye protection. If shockable, use a defibrillator followed by chest compressions, if not shockable, use chest compressions.

Organisation	Title	Advice
		Defibrillator is classified as level 2 PPE (disposable gloves, disposable apron, fluid resistant surgical mask, disposable eye protection)
Resuscitation Council UK (5)	Resuscitation of COVID-19 patients in hospital	1. Recognise cardiac arrest, do not put face near patient's mouth 2. Defibrillate shockable rhythms if possible 3. Full AGP PPE for anyone in the room, compression only CPR 4. Airway interventions must be carried out by experience personnel 5. Identify and treat any reversal causes before stopping CPR 6. Dispose or clean all equipment that was used during CPR 7. Remove PPE 8. Post resuscitation debrief Infographics with key points were updated on 1 May 2020 and can be found here.
American Heart Association (6)		When caring for patients with known or suspected COVID-19: • aerosol generating procedures e.g. CPR should be performed in airborne infection isolation rooms and personnel should use respiratory protection • Patients with known or suspected COVID-19 should be cared for in a single-person room with the door closed • hand hygiene • PPE. Guidance for emergency medical services and other first responders • Emergency medical dispatchers should question callers and determine the possibility that this call concerns a person who may have signs or symptoms and risk factors for COVID-19 • When COVID-19 is suspected in a patient needing emergency transport, prehospital care providers and healthcare facilities should be notified in advance • Emergency medical services clinician practices should be based on the most up to date COVID-19 clinical recommendations and follow the same precautions regarding aerosol generating procedures and PPE. Emergency medical services clinicians should notify the receiving healthcare facility and keep patient separate from others
Australian government	Information for paramedics and ambulance first	Airborne precautions should be used routinely for all people in the vehicle during high-risk AGPs including:

Organisation	Title	Advice
department of health (41)	responders	• hand hygiene before donning a gown, eye protection, a P2/N95 respirator and gloves • having the driver don a P2/N95 respirator and protective eyewear • after the AGP, removing gloves (perform hand hygiene), eye protection and gown (perform hand hygiene) and P2/N95 respirator (perform hand hygiene) • not touching the front of any item of PPE during removal • disposing used PPE in a clinical waste bag • cleaning ambulance equipment and surfaces with disinfectant wipes by a person wearing clean PPE. If officers don't have sufficient time to adequately apply full airborne precautions they are advised to ensure their own safety by: • using a surgical mask and eye protection as a minimum precaution, or a (fit-checked) P2/N95 respirator and eye protection if available • removing gloves (perform hand hygiene), removing eyewear, gown and mask (perform hand hygiene again) after each episode of care • notifying their employer they had close contact with a suspected or confirmed case of COVID-19 without using appropriate PPE e.g. if COVID-19 was not suspected at the time, and seeking advice from the local public health authority regarding any need to be isolated and monitored for symptoms of the virus.
Australian and New Zealand Committee on Resuscitation (7)	Resuscitation during the COVID-19 pandemic	• The underlying principles for CPR remain the same. • Any resuscitation is better than no attempt. • COVID-19 has changed the risk to rescuers. • Healthcare workers should be provided with appropriate PPE to perform their roles. • Many sudden cardiac arrests occur in the presence of family members and many will be unrelated to COVID-19. • For lay rescuers who are unable or unwilling to do rescue breathing, compression only CPR is acceptable. After any attempts at resuscitation, adhere to current advice about hand washing, cleaning and decontamination.
Australian College for Emergency Medicine (1)	Adult Cardiac Arrest Management	• Healthcare workers should only perform resuscitative interventions when they are protected by appropriate PPE • Healthcare workers must not perform resuscitative interventions if they are not adequately protected by appropriate PPE • Therefore, modifications to the traditional approach to cardiac arrest are needed.

Organisation	Title	Advice
		Individual modifications to cardiac arrest management are provided. The following are some high-level points. • Ideally, all resuscitation should be performed by healthcare workers in PPE suitable for AGPs (may not be the case for first responder who should be wearing at least a surgical mask, eye protection and gloves). • Defibrillation is not considered an aerosol generating procedure and can be performed by responders wearing droplet precautions, as long as the patient's mouth and nose are covered. • Chest compressions, assisted ventilation, and advanced airway manoeuvres are all considered potentially aerosol generating procedures, and should only be performed by responders in airborne PPE. • Until endotracheal intubation has occurred, compression-only CPR is recommended.
International liaison committee on resuscitation (8)	COVID-19 infection risk to rescuers from patients in cardiac arrest	• Suggested that chest compressions and cardiopulmonary resuscitation have the potential to generate aerosols (weak recommendation, very low certainty evidence). • Suggested that in the current COVID-19 pandemic, lay rescuers consider compression-only resuscitation and public-access defibrillation (good practice statement). • Suggested that in the current COVID-19 pandemic, lay rescuers who are willing, trained and able to do so, may wish to deliver rescue breaths to children in addition to chest compressions (good practice statement). • Suggested that in the current COVID-19 pandemic, healthcare professionals should use PPE for AGPs during resuscitation (weak recommendation, very low certainty evidence). • Suggested it may be reasonable for healthcare providers to consider defibrillation before donning aerosol generating PPE in situations where the provider assesses the benefits may exceed the risks (good practice statement).
Medical Journal of Australia (42)	Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group	• Cardiac compressions should not commence until the responsible staff are in aerosol-protective PPE. • Processes must be put in place to ensure appropriate PPE is rapidly allocated to staff at inpatient cardiac arrest calls and pre-hospital sites. • The number of people in the room should be kept to a minimum at all times and no one should be allowed in the room without aerosol protective PPE. • Steps must be taken to protect first responders from exposure to aerosols and droplets during external cardiac compressions.

Organisation	Title	Advice
		• Compression-only CPR is advocated until the airway has been secured with a viral filter in place.
Advanced Paediatric Life Support Australia Statement on Paediatric Resuscitation during the COVID-19 Pandemic (11)	Resuscitation: Hospital Management of Cardiopulmonary Arrest COVID-19	Given the current low prevalence of COVID-19 in Australia, particularly in children, resuscitation of children should be as per usual protocols. Individual state policies should be followed. Treatment recommendations for children in out-of-hospital settings • In contrast to the advice in adults, it is recommended that healthcare workers and lay rescuers who are willing, trained and able to do so, should continue to deliver rescue breaths to children in addition to chest compressions. If rescuers are untrained or unwilling to perform rescue breaths, chest compression only CPR is preferable to no CPR. Treatment recommendations for children in hospital settings • Healthcare workers should use PPE for AGP during CPR in children with confirmed or suspected COVID-19 infection. • Risk associated with AGPs should be minimised by the addition of viral filters on all airway devices, allocating the most experienced clinician to manage airway, recognising that a cuffed endotracheal tube is preferable to a supraglottic airway (LMA or I-Gel) which is preferable to BVM. Infographics are available here.
The Royal Children's Hospital Melbourne Local Guidelines (43)	Resuscitation: Hospital Management of Cardiopulmonary Arrest COVID-19	Key points • CPR should be commenced if cardiac arrest is suspected • Children appear to be less likely to transmit COVID-19 to healthcare worker than adults • CPR may cause aerosolisation of virus; airborne precautions (PPE including N95 mask) must be initiated as soon as possible and management must occur in the highest level of isolation available • CPR should not be delayed for donning of airborne precautions PPE • Decisions on providing airway support in the absence of PPE need to be made with the understanding that there may be a small, but as yet, undefined risk of COVID-19 exposure. • If arrest is anticipated, PPE should be donned in advance. If arrest is unanticipated, initial resuscitation, including airway opening, bag valve mask ventilation and chest compressions, may be provided by a first responder wearing a mask, gloves and eye protection.

Organisation	Title	Advice
		• Staff at increased risk from COVID-19 should consider not working in the resuscitation room.

Appendix

PubMed search terms

PubMed: (("aerosol generat*"[Title/Abstract] OR "airborne infection*"[Title/Abstract] OR "air dispersion"[title/abstract] OR "transmission"[title/abstract]) AND (Cardiopulmonary Resuscitation [MeSH Terms] OR Cardiopulmonary Resuscitation[title/abstract] OR "chest compression*"[title/abstract] OR CPR[title/abstract]))

Google and Twitter search terms

Google: COVID-19 AND CPR, CPR AND Aerosol Generating

Inclusion and exclusion criteria

Inclusion	Exclusion
• All studies investigating whether CPR is an AGP. Evidence from both simulation-based trials and real experiences was included. • Current advice for CPR in patients with suspected or confirmed COVID-19.	• Articles published in a language other than English

References

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Original search 06/04/2020	Updates
15/09/2020	• PubMed search was rerun and identified 19 additional manuscripts relevant to AGPs and CRP management recommendations in suspected or confirmed COVID-19 patients.(2, 3, 9, 10, 12, 13, 18-29, 31, 33) • New relevant PubMed publications are added to Table 1. • The link to the consensus statement made by the Safe Airway Society (under grey literature) is now updated to the full print, instead of the non-peer reviewed pre-print article. • The Clinical Excellence Commission recommendations on Infection Prevention and Control for AGPs in relation to COVID-19 is now included in Table 1. • Advanced Paediatric Life Support Australia Statement and Royal Children's Hospital Melbourne Guidelines on paediatric hospital resuscitation are included in Table 2. • The brief has been updated to reflect new evidence.

Evidence checks are archived a year after the date of publication

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