Question CS+2022.08#120 [Version 3.1]

What guidance is available for healthcare workers on the provision of CPR for patients with confirmed or suspected COVID-19 in hospital settings, focussing primarily on the evidence relating to CPR as an aerosol-generating procedure?

What guidance is available for healthcare workers on the provision of CPR for patients with confirmed or suspected COVID-19 in hospital settings, focussing primarily on the evidence relating to CPR as an aerosol-generating procedure?

Main Points

1. Updated American Heart Association (AHA)(2022) guidance recommends that all health care personnel should wear a respirator (eg, N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection when performing AGPs or in a setting where AGPs are regularly performed.
2. Vaccination against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) offers significant protection to health care providers, including those involved in resuscitation of patients with suspected or confirmed COVID-19.
3. ILCOR advise that national, regional and local resuscitation councils should consider the values and preferences of their local communities, prevalence of disease, uptake of vaccination, availability of PPE, training needs of their workforce, and infrastructure and resources to provide ongoing care for patients resuscitated after cardiac arrest.

[***NB* Guidance in relation to the use of PPE on initiation and during CPR cited in some of the articles contained within this Summary of Evidence has been superseded by the updated American Heart Association (AHA) guidance[5] which recommends that all health care personnel should wear a respirator (eg, N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection when performing AGPs or in a setting where AGPs are regularly performed.]**

Please refer to the Health Library Ireland Levels of Evidence Table used to grade the levels of evidence included below. Inclusion criteria: Settings of relevance include acute hospitals, community assessment hubs and intermediate care facilities. Exclusion criteria: None. Please note that individual studies may not have been critically appraised and that designation at a certain level of evidence is not a final determination of the quality of a given study.

Evidence Summary

Giving CPR poses a high risk to healthcare workers in the context of COVID-19 due to the aerosol-generating procedures (AGPs) involved,[9,10,13] the close proximity of multiple healthcare workers and the patient, and the need to work quickly.[9] British guidelines advise that no chest compressions (CC) or airway procedures should be started without full AGP PPE. Updated American Heart Association (AHA) guidance[5] recommends that all health care personnel should wear a respirator (eg, N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection when performing AGPs or in a setting where AGPs are regularly performed. This includes donning appropriate PPE (including respirator) before performing the components of resuscitation that are aerosol generating, which include but are not limited to: chest compressions, defibrillation, bag-mask ventilation, intubation and positive-pressure ventilation. Hsu et al[12] assert that rapid initiation of chest compressions is critical for successful resuscitation and, in light of the low incidence of documented transmission to health care personnel to date, is likely low risk to the compressor. Citing the revised AHA guidance, UpToDate and others[22,24,29] point out that vaccination offers significant protection to health care personnel.

The Australian National COVID-19 Clinical Evidence Taskforce set out the following preferred PPE for CPR of adults with COVID-19 in healthcare settings: contact, droplet and airborne gown, particle filter respirator, eye protection, gloves, visor, head and neck protection as per local guidelines.[6]

In a systematic review of the transmission of infection during aerosol generating procedures in critical care, Chan et al[1] found that endotracheal intubation (OR, 6.69, 95% CI, 3.81-11.72; p < 0.001), noninvasive ventilation (OR, 3.65; 95% CI, 1.86-7.19; p < 0.001), and administration of nebulized medications (OR, 10.03; 95% CI, 1.98-50.69; p = 0.005) were found to increase the odds of healthcare workers contracting SARS-CoV- 1 or SARS-CoV- 2. The use of N95 masks (OR, 0.11; 95% CI, 0.03-0.39; p < 0.001), gowns (OR, 0.59; 95% CI, 0.48-0.73; p < 0.001), and gloves (OR, 0.39; 95% CI, 0.29-0.53; p < 0.001) were found to be significantly protective of healthcare workers from contracting SARS-CoV- 1 or SARS-CoV- 2.[1]

Cui et al[2] observed that in pooled results from simulation-based studies of the influence of personal protective equipment (PPE) on the quality of chest compressions showed no statistically significant difference between the rate or the

depth of chest compressions (CC) performed by medical personnel with and without PPE. Subgroup analyses showed that use of PPE was associated with reduced rate of chest compressions in studies before COVID-19, but not in studies after COVID-19; and that PPE was not associated with significantly reduced depth of chest compressions in studies before or after COVID-19. However, Sahu et al reported a significant decrease in CC rate (SMD: -0.28, 95%CI: -0.47 to -0.10) and CC depth (SMD: -0.26, 95%CI: -0.44 to -0.07) in the PPE arm as compared to the no-PPE arm of their meta-analysis with the conclusion that use of PPE compromises the quality of CC during CPR significantly. Banfai et al[8] found that the effectiveness of CC (depth and rate) was non-inferior when wearing a cloth mask compared to wearing a surgical mask. However, the authors report that the effectiveness of CC decreased significantly in both groups during the two-minute chest-compression-only CPR session, and did not reach the appropriate chest compression depth range recommended by the European Resuscitation Council. Bua et al[11] report that in a manikin model, using PPE delayed neonatal resuscitation procedures with potential clinical impact; and that healthcare workers reported limitations and discomfort when wearing PPE. Chojecka et al[26] point out the potential need to introduce changes to CPR algorithms (eg, more frequent changes of chest compression providers, broader use of mechanical CPR devices) as well as improvements in the assessment of transmission risk and PPE guidelines in order to secure patients' chances of survival.

In respect of paediatric and neonatal resuscitation, Morgan et al[15] state that all CPR events should be considered AGPs: appropriate PPE (including N95 respirators or an equivalent) should be donned prior to resuscitation, and high-efficiency particulate air (HEPA) filters should be utilized. Any personnel without appropriate PPE should be immediately excused by providers wearing appropriate PPE. The authors also caution that delayed or withheld CPR increases the risk to patients for poor clinical outcomes, and that children and neonates with suspected or confirmed COVID-19 should receive prompt, high-quality CPR in accordance with evidence-based guidelines.

The New Zealand Resuscitation Council[16] recommend that an age limit for resuscitation is not recommended, but co-morbidities, futility and patient wishes should be considered on a case-by-case basis.

Hsu et al[3] identified a limited number of observational studies and case reports comparing prone versus supine CPR and/or defibrillation. The authors conclude that prone CPR may be a reasonable option if immediate supination is difficult or poses unacceptable risks to the patient.

The International Liaison Committee on Resuscitation (ILCOR) recognizes that the impact of COVID-19 will vary across regions and countries, and that in applying treatment recommendations to their local context, regional and national resuscitation councils should consider the values and preferences of their local

communities, prevalence of disease, uptake of vaccination, availability of PPE, training needs of their workforce, and infrastructure and resources to provide ongoing care for patients resuscitated after cardiac arrest.[24]

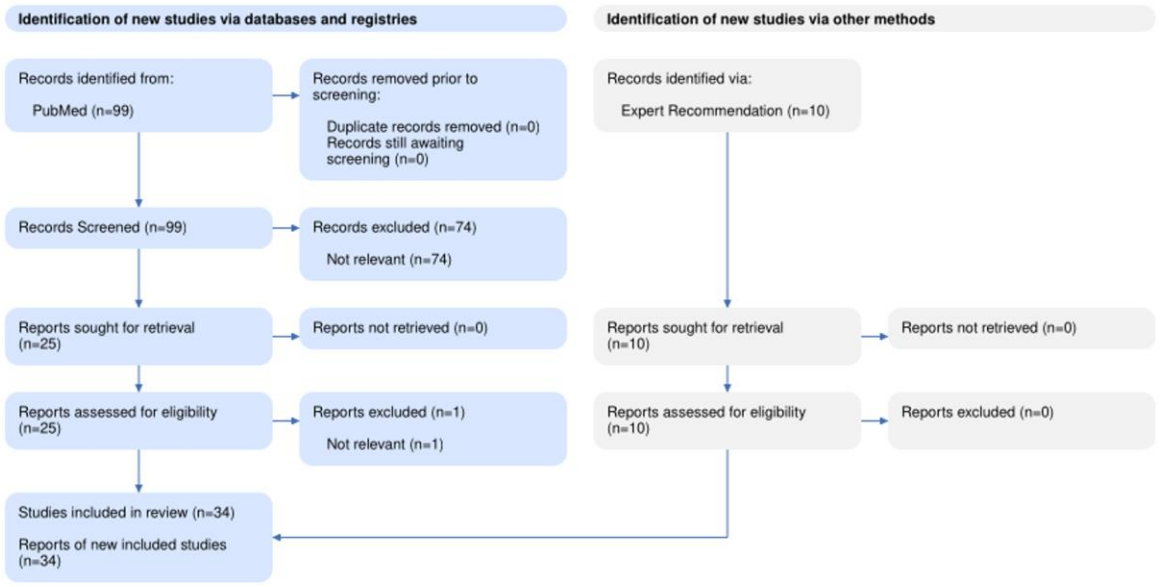
PICO(T)

PICO(T) elements used as a basis for the systematic literature search.

P	COVID-19
I	CARDIOPULMONARY RESUSCITATION (CPR)
C	-
O	AEROSOL GENERATION, EXPOSURE TO SARS-CoV-2 INFECTION
(T)	JANUARY 2020-JULY 2022

PRISMA Flow-Diagram

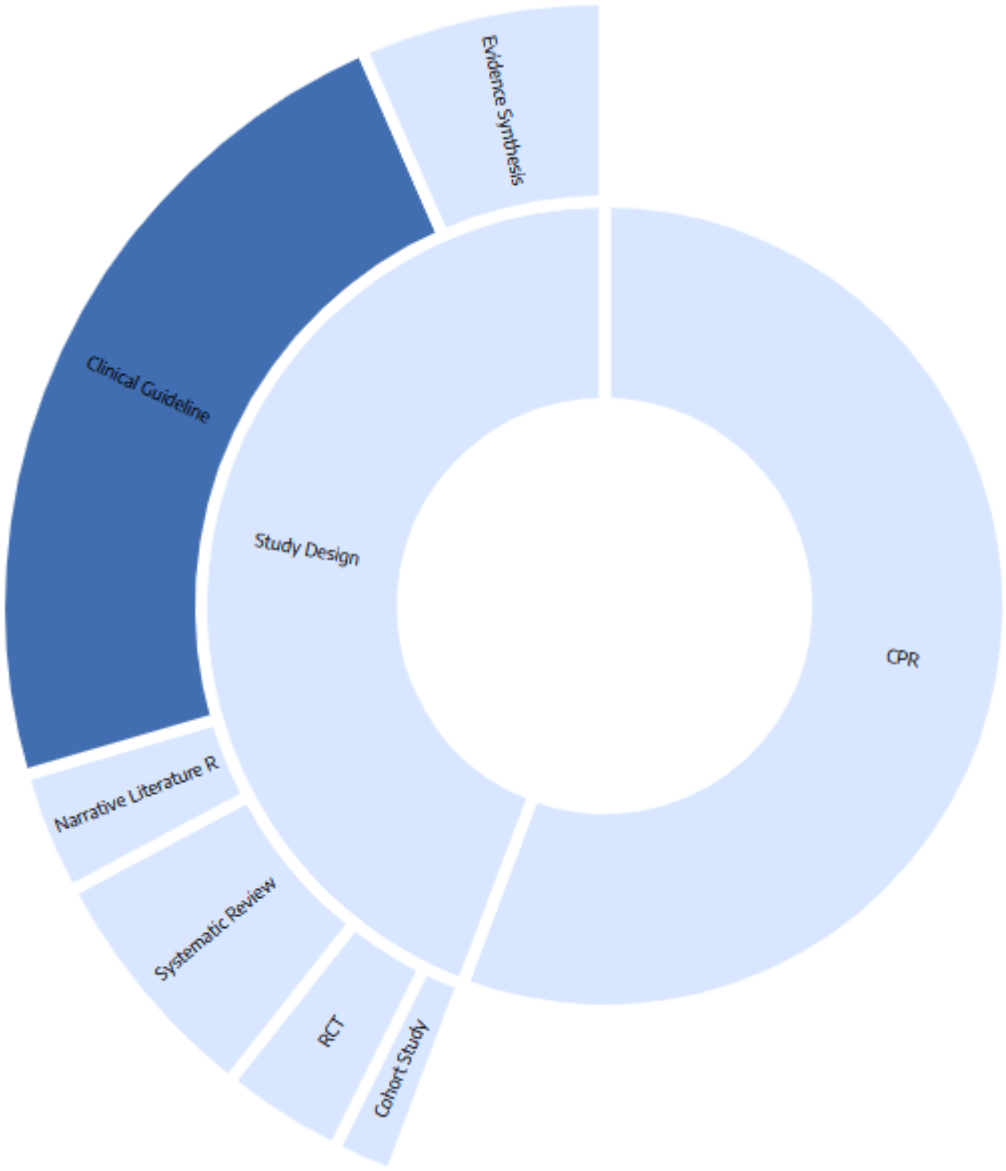
A PRISMA flow-diagram of the systematic literature search.



Sunburst Diagram

An interactive 'sunburst diagram' or visual map of the studies included in the evidence summary. Click on the link or image below to view.

https://nested-knowledge.com/nest/qualitative/2648



Studies Included

Studies included for consideration in the evidence summary.

1 Chan V.W.-S. et al. Transmission of Severe Acute Respiratory Syndrome Coronavirus 1 and Severe Acute Respiratory Syndrome Coronavirus 2 During Aerosol-Generating Procedures in Critical Care: A Systematic Review and Meta-Analysis of Observational Studies. Critical Care Medicine. 2021. //10.1097/ccm.0000000000004965[1] https://pubmed.ncbi.nlm.nih.gov/33749225/	Seventeen studies out of 2,676 yielded records were included for meta-analyses. Endotracheal intubation (odds ratio, 6.69, 95% CI, 3.81-11.72; p < 0.001), noninvasive ventilation (odds ratio, 3.65; 95% CI, 1.86-7.19; p < 0.001), and administration of nebulized medications (odds ratio, 10.03; 95% CI, 1.98-50.69; p = 0.005) were found to increase the odds of healthcare workers contracting SARS-CoV- 1 or SARS-CoV- 2. The use of N95 masks (odds ratio, 0.11; 95% CI, 0.03-0.39; p < 0.001), gowns (odds ratio, 0.59; 95% CI, 0.48-0.73; p < 0.001), and gloves (odds ratio, 0.39; 95% CI, 0.29-0.53; p < 0.001) were found to be significantly protective of healthcare workers from contracting SARS-CoV- 1 or SARS-CoV- 2. Conclusion(s): Specific aerosol-generating procedures are high risk for the transmission of SARS-CoV- 1 or SARS-CoV- 2 from patients to healthcare workers. Personal protective equipment reduce the odds of infection.
1 Cui et al. Influence of Personal Protective Equipment on the Quality of Chest Compressions: A Meta-Analysis of Randomized Controlled Trials. Frontiers in medicine. 2021. 10.3389/fmed.2021.733724[2] https://pubmed.ncbi.nlm.nih.gov/34901055/	Results: Six simulation-based RCTs were included. Overall, pooled results showed that there was no statistically significant difference between the rate [mean difference (MD): -1.70 time/min, 95% confidence interval (CI): -5.77 to 2.36, P = 0.41, I2 = 80%] or the depth [MD: -1.84 mm, 95% CI: -3.93 to 0.24, P = 0.11, I2 = 73%] of chest compressions performed by medical personnel with and without PPE. Subgroup analyses showed that use of PPE was associated with reduced rate of chest compressions in studies before COVID-19 (MD: -7.02 time/min, 95% CI: -10.46 to -3.57, P < 0.001), but not in studies after COVID-19 (MD: 0.14 time/min, 95% CI: -5.77 to 2.36, P = 0.95). In addition, PPE was not associated with

	significantly reduced depth of chest compressions in studies before (MD: -3.34 mm, 95% CI: -10.29 to -3.62, P = 0.35) or after (MD: -0.97 mm, 95% CI: -2.62 to 0.68, P = 0.25) COVID-19. No significant difference was found between parallel-group and crossover RCTs (P for subgroup difference both > 0.05). Conclusions: Evidence from simulation-based RCTs showed that use of PPE was not associated with reduced rate or depth of chest compressions in CPR.
1 Hsu et al. Cardiopulmonary resuscitation and defibrillation for cardiac arrest when patients are in the prone position: A systematic review. Resuscitation plus. 2021. 10.1016/j.resplu.2021.100186[3] https://pubmed.ncbi.nlm.nih.gov/34934996/	Aim: To perform a systematic review of cardiopulmonary resuscitation (CPR) and/or defibrillation in the prone position compared to turning the patient supine prior to starting CPR and/or defibrillation. Results: The systematic review identified 29 case reports (32 individual cases), two prospective observational studies, and two simulation studies. The observational studies enrolled 17 patients who were declared dead in the supine position and reported higher mean systolic blood pressure from CPR in prone position (72 mmHg vs 48 mmHg, p < 0.005; 79 ± 20 mmHg vs 55 ± 20 mmHg, p = 0.028). One simulation study reported a faster time to defibrillation in the prone position. Return of spontaneous circulation, survival to discharge or 30 days were reported in adult and paediatric case reports. Critical risk of bias limited our ability to perform pooled analyses. Conclusions: We identified a limited number of observational studies and case reports comparing prone versus supine CPR and/or defibrillation. Prone CPR may be a reasonable option if immediate supination is difficult or poses unacceptable risks to the patient.
1 Sahu A.K. et al. Impact of personal protective equipment on the effectiveness of chest compression - A systematic	Five simulation-based studies were finally included in this systematic review. A significant decrease in CC rate (SMD: -0.28, 95%CI: -0.47 to -0.10) and CC depth (SMD: -0.26, 95%CI: -0.44 to -0.07) were observed in the PPE arm as

review and meta-analysis. American Journal of Emergency Medicine. 2021. 10.1016/j.ajem.2020.09.058[4] https://pubmed.ncbi.nlm.nih.gov/33046289/	compared to the no-PPE arm. The difference in CC rate was more prominently seen in adult CPR than in paediatric CPR. Without PPE, the proportion of adequate CC rate delivered was 0.74, which reduced significantly to 0.60 after use of PPE (p - 0.035). Similarly, the proportion of adequate CC depth was significantly lesser (p - 0.001) in PPE arm (0.55), as compared to that of the no-PPE arm (0.78). Conclusion(s): The use of PPE compromises the quality of CC during CPR significantly, and newer ways to deliver chest compression has to be investigated.
2 Atkins et al. American Heart Association 2022 Interim Guidance to Health Care Providers for Basic and Advanced Cardiac Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19: From the Emergency Cardiovascular Care Committee and Get With The Guidelines-Resuscitation Adult and Pediatric Task Forces of the American Heart Association in Collaboration With the American Academy of Pediatrics, American Association for Respiratory Care, the Society of Critical Care Anesthesiologists, and American Society of Anesthesiologists. Circ Cardiovasc Qual Outcomes. 2022. PMID: 35072519 | 10.1161/circoutcomes.122.008900[5] https://pubmed.ncbi.nlm.nih.gov/35072519/	The changes in the interim guidance are focused on these 3 tenets: Incorporating the most recent Center for Disease Control and Prevention (CDC) and World Health Organization guidance: All health care providers should wear a respirator (eg, N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection, when performing aerosol-generating procedures (AGPs) or in a setting where AGPs are regularly performed. The definition of suspected cases should be consistent with the most current definitions from relevant public health officials as well as local standards and protocols. This includes donning appropriate PPE (including respirator) before performing the components of resuscitation that are aerosol generating, which include but are not limited to: chest compressions, defibrillation, bag-mask ventilation, intubation and positive-pressure ventilation. In the event, initial responders are not already wearing appropriate PPE, they should immediately don it and then begin CPR. As PPE recommendations change, health care providers should continue to follow the most-up-to-date recommendations from the World Health Organization, CDC, and regional health authorities and local institutions. Reinforce

	resuscitation best practices: Cardiac arrest survival rates have decreased dramatically during the COVID-19 pandemic. Out-of-hospital cardiac arrest survival in 2020 also declined in regions/time frames that did and did not have significant COVID infection rates. The reasons for this decline are both unclear and complex. Cardiac arrest survival is dependent on early initiation of CPR and we continue to recommend chest compressions as soon as is safely possible. We believe patients with confirmed or suspected COVID-19 should receive the best resuscitative efforts possible and we are committed to both the training of health care providers, and rigorous evaluation of the evidence to ensure our CPR and First Aid guidelines support best practices. Ensure adequate PPE supply: At this time, all health care providers should be following appropriate precautions and should have access to PPE in all clinical settings, regardless of the potential of encountering resuscitation events. Effective use of PPE is critical for the safety of health care providers performing resuscitations. Health care organizations should continue to secure appropriate PPE as available, ensure training regarding appropriate application and use of PPE, reinforce effective use of PPE, and create systems so that health care providers have immediate access to appropriate PPE when emergency care is required.
2 Australian National COVID-19 Clinical Evidence Taskforce (Australia). Cardiopulmonary resuscitation of adults with Covid-19 in healthcare settings. 2021[6] https://covid19evidence.net.au/wp-content/uploads/FLOWCHART-	The Australian National Covid-19 Clinical Evidence Taskforce set out the following in their guideline: PPE Recommendations for First Responders: PREFERRED: Contact, droplet and airborne gown, particle filter respirator, eye protection, gloves, visor, head and neck protection as per local guidelines. At a MINIMUM: Contact and droplet gown, surgical mask, eye protection, gloves, visor, head and neck protection as per local guidelines and ICEG guidance. ONGOING RESUSCITATION:

CPR-IN-HOSPITAL.pdf?=220606-215932	REQUIRED: Contact, droplet and airborne gown, P2/N95 respirator, eye protection, gloves, visor, head and neck protection as per local guidelines and ICEG guidance.
2 Australian National COVID-19 Clinical Evidence Taskforce (Australia). Preparedness for cardiopulmonary resuscitation during the Covid-19 pandemic. 2021[7] https://covid19evidence.net.au/wp-content/uploads/FLOWCHART-PREPARDENESS-FOR-CPR.pdf?=220604-40524	This flowchart outlines overarching principles that apply to cardiopulmonary resuscitation (CPR) for adults with confirmed COVID-19.
2 Banfai B. et al. How effective are chest compressions when wearing mask? A randomised simulation study among first-year health care students during the COVID-19 pandemic. BMC Emergency Medicine. 2022. 10.1186/s12873-022-00636-2[8] https://bmcemergmed.biomedcentral.com/articles/10.1186/s12873-022-00636-2	The study aimed to evaluate and compare the effectiveness of chest compressions and the level of fatigue while wearing two different types of mask (surgical vs. cloth). Participants were randomised into two groups: surgical mask group (n = 108) and cloth mask group (n = 108). The effectiveness (depth and rate) of chest compressions was measured within a 2-min continuous chest-compression-only CPR session. Conclusion: The effectiveness of chest compressions (depth and rate) was non-inferior when wearing cloth mask compared to wearing surgical mask. However, the effectiveness of chest compressions decreased significantly in both groups during the 2-min chest-compression-only CPR session and did not reach the appropriate chest compression depth range recommended by the ERC.
2 BMJ Best Practice. Management of coexisting conditions in the context of COVID-19 . 2022[9]	Giving CPR poses a high risk to healthcare workers in the context of COVID-19 due to the aerosol-generating procedures, close proximity of multiple healthcare workers and the patient, and the need to work quickly. If cardiac arrest is recognised (patient is

https://bestpractice.bmj.com/topics/en-us/3000190	unresponsive and breathing abnormally), UK and international (ILCOR) guidelines advise looking for breathing, but advise against opening the airway or listening/feeling for breathing by placing the face close to the patient's mouth. In acute hospital settings, UK guidelines advise that full Aerosol Generating Procedure (AGP) Personal Protective Equipment (PPE) must be worn by all members of the resuscitation team before entering the room; no chest compressions or airway procedures should be started without full AGP PPE. The number of staff in the room should be restricted, and airway interventions should be done by experienced staff, minimising aerosolisation risk. Updated US guidelines* advise that chest compressions or defibrillation should not be delayed for provider PPE, but that initial resuscitation personnel should be relieved by providers wearing appropriate PPE as soon as possible. If the patient cannot be placed supine, cardiopulmonary resuscitation may be provided in the prone position, particularly if the patient has advanced airway and circulatory support. Brazilian guidelines recommend beginning continuous chest compressions to deliver CPR to adults. The patient’s oral cavity should be sealed with a cloth or a mask providing low flow (6-10 litres/minute) oxygen before starting chest compressions; the seal should be kept in place until an invasive airway is secured. Bag-valve-mask or bag-valve tube ventilation should be avoided if possible; if it is needed, two rescuers should provide ventilation (to allow a two-handed seal around the mask) and an oropharyngeal airway should be used. A HEPA filter should be placed between the mask and bag. If the patient is prone at the time of cardiac arrest and does not have an invasive airway, they should be repositioned supine. If the patient is intubated, chest compressions should be delivered while prone. Resuscitation of

	children should ideally be with chest compressions and use of a bag-valve-mask apparatus with a HEPA filter until a definitive airway is established. **[* Updated American Heart Association (AHA) guidance[5] which supersedes the guidance cited in this article recommends that all health care personnel should wear a respirator (eg, N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection when performing AGPs or in a setting where AGPs are regularly performed.]**
2 Brangan K. et al. Updated AHA Basic and Advanced Cardiac Life Support guidance with COVID-19 considerations. Nursing. 2022. 10.1097/01.nurse.0000820020.00324.b0[10] https://pubmed.ncbi.nlm.nih.gov/35196279/	The data regarding which procedures are aerosol generating are conflicting and continue to develop. CPR is considered to be an aerosol-generating procedure (AGP). AGPs include but are not limited to chest compressions, defibrillation, bag-valve-mask (BVM) ventilation, intubation, and positive pressure ventilation, as well as any breaks in respiratory circuits. The updated guidance emphasizes fully protecting HCWs who perform resuscitation. HCWs should wear a respirator, such as an N95 mask, along with other PPE (gown, gloves, and eye protection) when performing AGPs on patients with suspected or confirmed COVID-19 infection. In the event initial responders are not already wearing appropriate PPE, they should immediately don it and then begin CPR.
2 Bua B. et al. Impact of personal protective equipment on neonatal resuscitation procedures. Journal of Maternal-Fetal and Neonatal Medicine. 2021.	Objective: We aimed to compare the timing of neonatal resuscitation procedures with or without PPE for prevention of SARS-CoV-2 transmission in a manikin model. Methods: A randomized controlled crossover (AB/BA) trial of resuscitation with or without PPE in a neonatal resuscitation scenario. Forty-eight participants were divided in 12 consultant-nurse teams and 12 resident-nurse teams. The

10.1080/14767058.2021.1962370[11] https://pubmed.ncbi.nlm.nih.gov/34489350/	primary outcome measure was the time of positive pressure ventilation (PPV) initiation. The secondary outcome measures were: duration of tracheal intubation procedure, time of initiation of chest compressions, correct use of PPE, and discomfort/limitations using PPE. Results: There were significant differences in timing of PPV initiation (consultant-nurse teams: mean difference 6.0 seconds, 95% confidence interval, CI 1.1-10.9; resident- nurse teams: mean difference 11.0 s, 95% CI 1.9-20.0), duration of tracheal intubation (consultant-nurse teams: mean difference 22.0 s, 95% CI 7.0-36.9; resident-nurse teams: mean difference 9.1 s, 95% CI 0.1-18.1) and chest compressions (consultant- nurse teams: mean difference 32.3 s, 95% CI 14.4-50.1; resident-nurse teams: mean difference 9.1 s, 95% CI 0.1-18.1). PPE was associated with visual limitations (43/48 participants), discomfort in movements (42/48), limitations in communication (32/48) and thermal discomfort (29/48). Discussion: In our trial, the use of PPE increased the time of PPV initiation, the duration of tracheal intubation procedure and the initiation of chest compressions. In the simulation, all participants wore PPE (with some breaches of the dressing protocol) and more than half reported some PPE-related limitations or discomfort. The strengths of the study include the use of a high-fidelity manikin and the video recording, the participation of both inexperienced and experienced healthcare providers, and the cross-over design. However, the simulation using a manikin implied that the procedures were performed under safe and secure conditions in a lower stress environment, although the trial simulated the exposure to a highly contagious neonate. Conclusions: In a manikin model, using PPE delayed neonatal resuscitation procedures with potential clinical impact. Healthcare workers

	reported limitations and discomfort when wearing PPE.
2 Hsu A. et al. 2021 Interim Guidance to Health Care Providers for Basic and Advanced Cardiac Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19. Circulation. Cardiovascular quality and outcomes. 2021. 10.1161/circoutcomes.121.008396[12] https://pubmed.ncbi.nlm.nih.gov/34641719/	This updated interim guidance sets out the following recommendations: Reduce Provider Risk Rationale Frontline health care providers are at significant risk for contracting respiratory illnesses due to frequent contact with symptomatic patients. Adequate PPE including N-95 masks or positive air pressure respirators, especially during aerosol generating procedures (AGPs), can reduce the risk of coronavirus transmission. Provider risk may vary based on individual (age/ethnicity/comorbidities/vaccination status) and system factors. Health care organizations may need to consider redoubling efforts to maintain a sufficient supply of PPE for AGPs if vaccination of their staff is incomplete as only full vaccination of health care providers ensures an extremely low rate of infection. Even as immunity to SARS-CoV-2 is achieved with health care provider vaccination, it is reasonable for health care providers to continue taking appropriate precautions against COVID-19 and its variants since CPR includes AGPs and vaccination rates of health care providers remain below 100%. On the other hand, the risk to the patient by withholding or delaying the response for cardiac arrest is extremely high compared with the much lower risk that the resuscitation provider will contract COVID-19 and develop serious illness. This risk is particularly low in the vaccinated or unvaccinated provider who provides care while wearing appropriate PPE for AGPs. Although the effectiveness of available vaccines has been demonstrated against the wild-type SARS-CoV-2 and variants of concern, breakthrough infections, which are usually not life threatening, may still occur. Boosters addressing emerging variants of concern may be required. Reduce Provider

Exposure and Provide Timely Care Rationale
The data regarding which procedures are aerosol generating are conflicting and continue to develop. Some components of CPR are suspected to be aerosol generating. SARS-CoV-2 is transmitted primarily by respiratory droplets and aerosols, with little transmission by fomites. Rapid initiation of chest compressions is critical for successful resuscitation and, in light of the low incidence of documented transmission to health care providers to date, is likely low risk to the compressor. In witnessed sudden arrests of patients with suspected or confirmed COVID-19, chest compressions should not be delayed. Chest compressions can be performed initially by a chest compressor with or without a surgical mask until relieved by responders with appropriate PPE for AGPs. Although data continue to develop, in light of the low incidence of documented transmission to health care providers to date, chest compressions should not be delayed for retrieval and application of a mask or face covering for either the patient or provider. Masks may be considered for providers once compressions have started and before the arrival of responders with appropriate PPE for AGPs*. Unless there are active efforts to maintain an open airway, it is typically occluded in the unconscious patient with minimal air movement during chest compressions. The case definitions of suspected and confirmed COVID-19 have changed over time. For communities and facilities with a higher prevalence of COVID-19 and lower immunization rates, the continuous use of an N-95 respirator and eye protection should be considered when the patient's COVID-19 status is unknown and resuscitation involves AGP interventions to which compressors and other personnel will be exposed. Provided there is sufficient PPE,

additional compressors may be required due to increased fatigue or potential for N-95 respirator slippage resulting from compressions. The application of mechanical compression devices can reduce the number of health care providers required for compressions; however, these devices may not be appropriate or available for morbidly obese adults, infants, children, and small adolescents or for all clinical scenarios. Training and regular practice in the use and rapid application of mechanical compressions devices is required to minimize the early no-flow time and to ensure proper application and utilization of the device. Although the clinical use of mechanical devices has not demonstrated improvement in outcome compared with manual CPR, it may reduce the number of additional staff who are needed to participate in the resuscitation event. As not every resuscitation space has negative pressure ventilation, closing the door may help limit contamination of adjacent indoor spaces. In out-of-hospital cardiac arrest, taking measures to better ventilate a confined space such as opening windows or doors may reduce the local concentration of aerosols for health care providers if this does not risk contamination of other spaces in the adjacent vicinity. In addition, some health care organizations may have continued shortages in PPE supply, low vaccination rates among staff, and personnel limitations; this guidance needs to be adapted to local protocols with consideration of current COVID-19 disease burden and resource availability. In-Hospital Cardiac Arrest Crowd control for effective direction of resuscitation by the minimum number of people required is advised. Closing the door to the resuscitation area, when possible, may minimize airborne contamination of adjacent indoor space. Health care personnel should continue to wear appropriate PPE for clinical care including

masks, eye protection, and gloves as recommended by the Centers for Disease Control and Prevention. The standard 2020 AHA guidelines for CPR and ECC should apply to those patients who are known to be COVID-19 negative.

[* Updated American Heart Association (AHA) guidance[5] which supersedes the guidance cited in this article recommends that all health care personnel should wear a respirator (eg, N95) along with other PPE (gown, gloves, and eye protection) for patients with suspected or confirmed COVID-19 infection when performing AGPs or in a setting where AGPs are regularly performed.]

2 ILCOR. ILCOR COVID-19 infection risk to rescuers from patients in cardiac arrest (search updated 14th June 2022). 2021[13] https://costr.ilcor.org/document/covid-19-infection-risk-to-rescuers-from-patients-in-cardiac-arrest	We suggest that chest compressions and cardiopulmonary resuscitation have the potential to generate aerosols (weak recommendation, very low certainty evidence). We suggest that in the current COVID-19 pandemic lay rescuers consider compressions and public-access defibrillation (good practice statement). We suggest that in the current COVID-19 pandemic, lay rescuers who are willing, trained and able to do so, consider providing rescue breaths to infants and children in addition to chest compressions (good practice statement). We suggest that in the current COVID-19 pandemic, healthcare professionals should use personal protective equipment for aerosol generating procedures during resuscitation (weak recommendation, very low certainty evidence). We suggest it may be reasonable for healthcare providers to consider defibrillation before donning personal protective equipment for aerosol generating procedures in situations where the provider assesses the benefits may exceed the risks (good practice statement).
2 Latsios G. et al. CardioPulmonary Resuscitation in patients with suspected or confirmed Covid-19. A consensus of the Working group on CardioPulmonary Resuscitation of the Hellenic Society of Cardiology. Hellenic Journal of Cardiology. 2021. 10.1016/j.hjc.2020.09.010[14] https://pubmed.ncbi.nlm.nih.gov/32949726/	Includes recommendations for performing CPR and/or defibrillation in an out-of-hospital environment, and for CPR from health professionals in a hospital setting and other organized health structures.

2 Morgan R.W. et al. Guidance for Cardiopulmonary Resuscitation of Children With Suspected or Confirmed COVID-19. Pediatrics. 2022. 10.1542/peds.2021-056043[15] https://pubmed.ncbi.nlm.nih.gov/35818123/	Due to the importance of ventilation during pediatric and neonatal resuscitation, oxygenation and ventilation should be prioritized. All CPR events should therefore be considered aerosol-generating procedures (AGPs). Thus, personal protective equipment (PPE) appropriate for AGPs (including N95 respirators or an equivalent) should be donned prior to resuscitation and high-efficiency particulate air (HEPA) filters should be utilized. Any personnel without appropriate PPE should be immediately excused by providers wearing appropriate PPE. Neonatal resuscitation guidance is unchanged from standard algorithms except for specific attention to infection prevention and control. In summary, healthcare personnel should continue to reduce the risk of SARS-CoV-2 transmission through vaccination and use of appropriate PPE during pediatric resuscitations. Healthcare organizations should ensure the availability and appropriate use of PPE. As delays or withheld CPR increases the risk to patients for poor clinical outcomes, children and neonates with suspected or confirmed COVID-19 should receive prompt, high-quality CPR in accordance with evidence-based guidelines.
2 New Zealand Resuscitation Council. Resuscitation of those with Covid-19 in Healthcare Settings . 2021[16] https://www.resus.org.nz/healthcare-resources/course-administration/statements/	Resuscitation of those with COVID-19 in health care settings: Summary of Recommendations All workers in health and disability roles and settings should be vaccinated against COVID-19 as required by The COVID-19 Public Health Response (Vaccinations) Order 2021. Ensure early conversations and decision making regarding goals of care and resuscitation plans. An age limit for resuscitation is not recommended, but co-morbidities, futility and patient wishes should be considered for each patient. Those with COVID-19 like symptoms, who are at risk of acute deterioration or cardiac arrest, should be identified as soon as possible. Management steps should include prevention

of cardiac arrest and avoidance of resuscitation without Personal Protective Equipment (PPE). Anyone who is known or suspected of having COVID-19 should be cared for by those wearing PPE as outlined in the NZ Ministry of Health Infection Prevention and Control (MoH IPC) requirements. All clinicians should wear contact and airborne precaution PPE before entering the room of a COVID-19 positive patient. This includes a P2/N95 particulate respirator mask, eye protection, a long sleeve fluid resistant gown and gloves. Those who are required to wear a P2/N95 particulate respirator mask should have undertaken the requisite fit testing and be trained in fit checking. Patients without COVID-19 infection, who have an in-hospital cardiac arrest (IHCA), have a much better chance of survival if standard resuscitation procedures are followed (early CPR, early defibrillation, good quality CPR, good teamwork). The standard NZ Resuscitation Council Advanced Life Support algorithm and guideline should be used. Resuscitation Management Wearing contact and airborne precaution PPE, assess the collapsed person for response and normal breathing, without placing ear and cheek close to the person's mouth and nose. If unresponsive and normal breathing is absent, call for help. If a defibrillator is immediately available do not delay early defibrillation of shockable rhythms. Shocks may be delivered prior to starting chest compressions. Good quality chest compressions should be commenced. If an oxygen mask is on the person's face, leave this in place until help arrives. Consider covering this with a surgical mask. If a view of the mouth and nose is obscured, regularly check the patient's airway for vomit or secretions. Restrict the number of rescuers in the room with the collapsed person. A gatekeeper should be allocated to do this. Ventilations with a bag-mask device should be

performed by two rescuers where possible – one rescuer using two hands to hold the mask and ensure a tight mask seal, and the second rescuer alternating between doing compressions and squeezing the bag. An appropriate heat and moisture exchanging (HME) viral filter must be connected to any positive pressure oxygen delivery device, as close to the patient as possible. Ensure that all connections are secure. Prolonged bag-mask ventilation should be avoided. A supraglottic airway (SGA) should be considered if an experienced person is available to insert it. For ventilation with a bag-mask or supraglottic airway, pause chest compressions for ventilation using a 30:2 compression to ventilation ratio in adults and a 15:2 ratio in infants and children. A tracheal tube may be less likely to generate additional respiratory particles than a supraglottic airway or bag-mask ventilation. Airway and ventilation interventions should be performed by the most skilled provider to ensure a high first attempt insertion success rate, and minimize aerosol generation. Consider methods that enable providers to remain further from the patient's mouth, such as video laryngoscopy. Ensure an adequate cuff pressure to prevent leaks. Mechanical CPR devices may be useful to reduce the number of health care workers present during resuscitation. They should only be used when staff are adequately trained in their use. Apply the NZ Resuscitation Council Advanced Life Support algorithm throughout the resuscitation. When no reversible cause of cardiac arrest can be identified and treated, the appropriateness of ongoing resuscitation and the termination of resuscitation should be considered. Clean or dispose of equipment as required by MoH IPC measures. Remove all PPE safely to avoid self-contamination and thoroughly wash hands. All clinicians involved in the resuscitation should have their names

	and contact details recorded to facilitate appropriate MoH IPC follow up if needed. MoH IPC requirements for the management of deceased patients must be adhered to. Post resuscitation debrief is encouraged.
2 Perkins G.D. et al. European Resuscitation Council Guidelines 2021: Executive summary. Resuscitation. 2021. 10.1016/j.resuscitation.2021.02.003[17] https://pubmed.ncbi.nlm.nih.gov/33773824/	The ERC guidelines were based on the ILCOR systematic review on COVID-19 and CPR and corresponding CoSTR. Since publication of these reviews, the search strategies have been re-run and a further four articles identified. None of the new articles contained information sufficient to change the previous treatment recommendations. The ERC COVID-19 guidelines promote the continuation of resuscitation attempts for both out-of-hospital and in-hospital cardiac arrest, whilst seeking to reduce the risk to the person(s) providing treatment. The COVID-19 guidelines focus specifically on patients with suspected or confirmed COVID-19. If there is uncertainty about the presence of COVID-19, those providing treatment should undertake a dynamic risk assessment which may consider current COVID-19 prevalence, the patient's presentation (eg, history of COVID-19 contact, COVID-19 symptoms), likelihood that treatment will be effective, availability of personal protective equipment (PPE) and personal risks for those providing treatment. The COVID-19 guidelines will be kept under continuous review and updated on-line as new evidence emerges. The main ERC Guidelines address resuscitation of those who are low risk or confirmed negative for COVID-19.
2 Resuscitation Council UK. Statement: Updates to RCUK COVID-19 Guidance in April 2022. 2022[18] https://www.resus.org.uk/sites/default/files/2022-	We continue to recommend the use of FFP3 masks or respirators during aerosol generating procedures associated with resuscitation when treating a patient with suspected or confirmed COVID-19. The donning of other aspects of AGP PPE should not lead to a delay in patient treatment. Clinicians will be used to the concept

04/First%20Aid%20Settings%20COVID%20statement%20April%202022.pdf	of individualised risk/ benefit assessments. In the context of resuscitation, we suggest consideration is given to the risks from the patient, virus, procedures undertaken, practitioner susceptibility and environment/setting.
2 Tiwari L. et al. IAP ALS Update on Resuscitation Guidelines During COVID-19 Pandemic. Indian Journal of Pediatrics. 2021. 10.1007/s12098-020-03483-w[19] https://pubmed.ncbi.nlm.nih.gov/32980943/	The authors outlined the following recommendations for CPR as related to Covid-19: HCW should don full personal protective equipment (PPE) while handling In Hospital Cardiac Arrest (IHCA) in COVID area. Follow IAP Basic Life Support algorithm. In non-COVID critical area, HCWs should preferably use full PPE or at least double gloves, eye gear and N 95 respirator for IHCA. Severe acute respiratory infection (SARI) or influenza like illness (ILI) cases, pending laboratory confirmation should be managed as potentially COVID-19 cases. Shield patient's mouth and nose with aerosol plastic drape or surgical mask before starting chest compressions if airway is not secure. Do not give mouth-to-mouth or mouth-to-mask ventilation. Use compressions- only CPR until the victim's airway is secured CPR is highly aerosol generating procedure though spread of aerosol can be limited by use of shields (like face mask) on airway of the victim. In view of pandemic status of COVID-19, any victim of sudden cardiac arrest even in out of hospital setting is likely to be a source of infection. While providing CPR in Out of Hospital Cardiac Arrest (OHCA) surgical mask or other airway shield may not be available. One may use home-made face mask or piece of cloth to shield the airway of the victim in such scenario.
2 UpToDate. Adult basic life support (BLS) for health care providers. 2022[20]	Systems and procedures should be in place to minimize any time delays in providing life-saving interventions. Tasks and modifications for clinicians emphasized in the COVID 19-related guidelines include the following: Don personal protective equipment (PPE) according

https://www.uptodate.com/contents/adult-basic-life-support-bls-for-health-care-providers	to local guidelines and availability before beginning CPR. Minimize the number of clinicians performing resuscitation; use a negative-pressure room whenever possible; keep the door to the resuscitation room closed if possible. May use a mechanical device, if resources and expertise are available, to perform chest compressions on adults and on adolescents who meet minimum height and weight requirements. Use a high-efficiency particulate air (HEPA) filter for bag-mask ventilation (BMV) and mechanical ventilation. Emphasize early intubation performed by the provider most likely to achieve first-pass success; use video laryngoscopy if resources and expertise available; stop chest compressions while intubation is performed (ideally, this should be performed during the two-minute rhythm check as quickly as possible to minimize no-flow time). Use a supraglottic airway (or bag-valve-mask with tight seal, two-person thenar technique) if intubation is delayed; avoid excessive ventilation rate or pressure (ie, avoid hyperventilation and squeeze the bag gently). Avoid prolonged resuscitation efforts: consider the extremely high mortality of adult COVID-19 patients in cardiac arrest and consider lapses in infection control and associated risks during high-stress medical emergencies.
2 UpToDate. COVID-19: Arrhythmias and conduction system disease. 2022[21] https://www.uptodate.com/contents/covid-19-arrhythmias-and-conduction-system-disease	Any personnel caring for a patient with suspected or confirmed COVID-19 should wear the appropriate PPE before entering the room: gown, gloves, eye protection, and a respirator (eg, an N95 respirator). If supply of respirators is limited, the United States Centers for Disease Control and Prevention acknowledges that facemasks are an acceptable alternative (in addition to contact precautions and eye protection), but respirators should be worn during aerosol-generating procedures, which includes intubation. The appropriate PPE

should all be donned prior to interacting with the patient, even if this leads to a delay in the provision of resuscitative care. The number of people involved in the resuscitation should be kept to a minimum. This typically includes a team leader, anesthesiologist to manage the airway (if the patient is not already intubated), recorder/scribe, and persons to perform chest compressions, defibrillation, and administration of medications (often, these participants can rotate to allow for periods of rest after performing chest compressions). In COVID-19 patients who are not yet intubated at the time of cardiac arrest, early intubation should be performed by the provider most likely to achieve success on the first pass, utilizing all readily available technology (eg, video laryngoscopy) to optimize first-pass success. Chest compression can be stopped during intubation, and intubation (with a cuffed endotracheal tube) can be performed prior to the standard two minutes of chest compressions and early defibrillation as a means of controlling the potential spread of airborne droplets. If available, mechanical chest compression device may be used in place of manual compressions for adults and adolescents who meet minimum height and weight requirements. For a critically ill patient who is already intubated and in the prone position at the time of arrest, CPR may be attempted with the patient prone by performing compressions of usual depth (ie, 5 to 6 cm) with the hands between the scapulae (over the T4-T7 vertebral bodies). Defibrillation may be performed with the pads in the anterior-posterior position. The patient should be turned to the supine position for resuscitation only if able to do so without equipment disconnections that may lead to aerosolization of viral particles.

2	UpToDate. Advanced cardiac life support (ACLS) in adults . 2022[22] https://www.uptodate.com/contents/advanced-cardiac-life-support-acls-in-adults	See Section: RESUSCITATION OF PATIENTS WITH COVID-19 Interim guidance for the performance of cardiopulmonary resuscitation (CPR) in patients with suspected or confirmed coronavirus disease 2019 (COVID-19)-related illness was first published by the American Heart Association (AHA) in 2020 and updated in 2021. Original and updated guidance emphasizes several key points: Vaccination against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) offers significant protection to health care providers, including those involved in resuscitation of patients with suspected or confirmed COVID-19. Don personal protective equipment (PPE) according to local guidelines and availability. Providers must follow local guidelines for use of PPE to protect against SARS-CoV-2 infection. We prefer rescuers use an N95 mask or its equivalent and eye protection because of the risk of aerosolization of virus from chest compressions, positive-pressure ventilation, and intubation. Because providers with surgical or procedural masks may initiate chest compressions, these providers should be relieved as soon as possible by personnel with higher-level PPE. Airway management, including bag-valve-mask (BVM) ventilation, should be delayed until all providers have donned appropriate PPE. Minimize the number of clinicians performing resuscitation; use a negative-pressure room whenever possible; keep the door to the resuscitation room closed if possible. May use a mechanical device, if resources and expertise are available, to perform chest compressions on adults and on adolescents who meet minimum height and weight requirements. Use a high-efficiency particulate air (HEPA) filter for BVM and mechanical ventilation as soon as it is available. A single responder can perform defibrillation or initiate chest compressions while a patient is prone. Provided the patient is intubated, chest

	compressions can be accomplished by pushing on the chest wall behind the heart with the hands centered over the T7–T10 vertebral bodies. This approach is likely to be less effective than chest compressions in a supine patient with a compression board in place. We recommend patients be repositioned in a supine position and placed on a compression board as soon as sufficient personnel with appropriate PPE are available.
2 Wyckoff et al. 2021 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Neonatal Life Support; Education, Implementation, and Teams; First Aid Task Forces; and the COVID-19 Working Group. Circulation. 2022. 10.1161/cir.0000000000001017[23] https://pubmed.ncbi.nlm.nih.gov/34813356/	The fifth annual summary of the International Liaison Committee on Resuscitation International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations addresses the most recently published resuscitation evidence reviewed by International Liaison Committee on Resuscitation task force science experts. Topics covered by systematic reviews in this summary include … cardiopulmonary resuscitation in the prone patient [and] coronavirus disease 2019 infection risk to rescuers from patients in cardiac arrest.
2 Wyckoff et al. 2021 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Neonatal Life Support; Education, Implementation, and Teams; First Aid Task	The following are recommendations from ILCOR: We suggest that chest compressions and CPR have the potential to generate aerosols (weak recommendation, very low–certainty evidence). We suggest that in the current COVID-19 pandemic, lay rescuers consider chest compressions and public-access defibrillation (good practice statement). We suggest that in the current COVID-19 pandemic, lay rescuers who are willing, trained, and able to do so consider providing rescue breaths to children in addition to chest compressions (good practice statement). We

Forces; and the COVID-19 Working Group. Resuscitation. 2021. 10.1016/j.resuscitation.2021.10.040[24] https://pubmed.ncbi.nlm.nih.gov/34933747/	suggest that in the current COVID-19 pandemic, health care professionals use PPE for aerosol-generating procedures during resuscitation (weak recommendation, very low–certainty evidence). We suggest that it may be reasonable for health care providers to consider defibrillation before donning aerosol-generating PPE in situations in which the provider assesses that the benefits may exceed the risks (good practice statement). International organizations identify CPR (chest compressions and ventilation) as an aerosol-generating procedure such that transmission of COVID-19 is assumed to be possible if a rescuer delivers CPR to an individual with COVID-19 infection. CPR is a complex intervention with several components, including ventilation, defibrillation, chest compressions, and drug administration. The benefits of these interventions to the patient vary, as does the likely associated risk of infection transmission to the rescuer. A key consideration in developing treatment recommendations is the importance of rescuer safety. During chest compressions, aerosol generation is plausible because chest compressions generate passive ventilation associated with small tidal volumes. Furthermore, the person performing chest compressions is in physical contact with the patient and in close proximity to the airway. We did not identify evidence that defibrillation either does or does not generate aerosols. If it occurs, the duration of an aerosol-generating process would be brief. In developing these treatment recommendations, the COVID-19 working group sought to carefully balance the benefit of early treatment with chest compressions and defibrillation (before donning PPE) with the potential harm to the rescuer, their colleagues, and the wider community if the rescuer were to be infected with COVID19. We note that the vaccination status of the rescuer, patient, and the wider

	community may influence the potential for harm. ILCOR recognizes that the impact of COVID-19 will vary across regions and countries. In applying these treatment recommendations to their local context, regional and national resuscitation councils should consider the values and preferences of their local communities, prevalence of disease, uptake of vaccination, availability of PPE, training needs of their workforce, and infrastructure and resources to provide ongoing care for patients resuscitated after cardiac arrest.
4 McCann-Pineo M. et al. Factors Influencing Use of Personal Protective Equipment among Emergency Medical Services Responders during the COVID-19 Pandemic: A Retrospective Chart Review. Western Journal of Emergency Medicine. 2022. 10.5811/westjem.2022.2.55217[25] https://pubmed.ncbi.nlm.nih.gov/35679488/	In this study our objective was to identify factors that influenced PPE use by EMS responders during the coronavirus disease 2019 (COVID-19) pandemic. Methods: We conducted a retrospective chart review among all EMS encounters across an EMS agency affiliated with a large New York health system from March 16–June 30, 2020. Results: We identified 28,693 eligible EMS encounters during the study period; 54.2% of patients were male, the median patient age was 58 years, and 66.9% of patients had at least one chronic medical condition. The use of PPE was documented in 92.8% of encounters, with full PPE used in 17.8% of these encounters. Full PPE utilization, relative to partial, was most strongly influenced by dispatch codes indicative of "breathing problems" (odds ratio [OR] 4.89; 95% confidence interval [CI]: 4.40, 5.46) and "cardiac/respiratory arrest" (OR 3.82; 95% CI: 2.99, 4.88), in addition to a patient's positive screening for COVID-19 on 9-1-1 dispatch (OR 3.97; 95% CI: 3.66, 4.32).Conclusion: Emergency medical services responders more frequently used full PPE for calls with dispatch codes indicative of respiratory distress or cardiac arrest.

6 Chavez S. et al. Clinical update on COVID-19 for the emergency clinician: Airway and resuscitation. American Journal of Emergency Medicine. 2022. 10.1016/j.ajem.2022.05.011[26] https://pubmed.ncbi.nlm.nih.gov/35636042/	This review presents a concise update of the resuscitation strategies and airway management techniques in patients with COVID-19 for emergency medicine clinicians. Patients with COVID-19 and septic shock should be resuscitated with buffered/balanced crystalloids. If hypotension is present despite intravenous fluids, vasopressors including norepinephrine should be initiated. Stress dose steroids are recommended for patients with severe or refractory septic shock. Airway management is the mainstay of initial resuscitation in patients with COVID-19. Patients with COVID-19 and ARDS should be managed similarly to those ARDS patients without COVID-19. Clinicians should not delay intubation if indicated. In patients who are more clinically stable, physicians can consider a step-wise approach as patients' oxygenation needs escalate. High-flow nasal cannula (HFNC) and non-invasive positive pressure ventilation (NIPPV) are recommended over elective intubation. Prone positioning, even in awake patients, has been shown to lower intubation rates and improve oxygenation. Strategies consistent with ARDSnet can be implemented in this patient population, with a goal tidal volume of 4-8 mL/kg of predicted body weight and targeted plateau pressures <30 cm H2O. Limited data support the use of neuromuscular blocking agents (NBMA), recruitment maneuvers, inhaled pulmonary vasodilators, and extracorporeal membrane oxygenation (ECMO).
6 Chojecka D. et al. How to maintain safety and maximize the efficacy of cardiopulmonary resuscitation in COVID-19 patients: Insights from the recent guidelines. Journal of	Prior to the SARS-CoV-2 pandemic, there had already been concern about the negative impact of PPE on the overall performance of healthcare workers and specifically on CPR quality. It was debated that the use of respirators and whole-body gowning interferes with numerous physiological functions of the wearer, as well as psychological and social aspects of work,

Clinical Medicine. 2021. 10.3390/jcm10235667[27] https://pubmed.ncbi.nlm.nih.gov/34884368/	leading to decreased task performance. PPE was also shown to worsen the quality of chest compressions provided by anesthesia residents in a randomized crossover simulation study. These considerations reappeared quickly as the COVID-19 crisis in healthcare escalated. In 2020, several studies showed that wearing PPE significantly compromised the quality of chest compressions and increased the fatigue of healthcare workers performing CPR. These findings were confirmed by a systematic review and meta-analysis of publications up to 6th June 2020. Notably, a more recent triple-crossover simulation trial demonstrated that the use of FFP2 masks by emergency medical technicians did not influence the depth of chest compressions provided during 12-min BLS scenarios, although it did increase subjective physical exhaustion among participants. The authors of the study debated that the ability to provide high-standard chest compressions achieved during emergency medicine training cannot be easily altered by external factors such as wearing PPE. In another recent simulation, a randomized crossover trial by Rauch et al. showed no significant difference between two-minute sequences of chest compressions performed with PPE (including a FFP3 mask) and without PPE in terms of several quality indicators: ie, depth, rate, release and number of effective compressions. Interestingly, participants of the study also reported increased subjective fatigue ($p < 0.001$) and decreased subjective performance ($p = 0.031$) while wearing PPE, which was not reflected by the objective measurements of chest compression quality. This questions the ability of healthcare providers to accurately self-assess the quality of their performance. Nonetheless, the findings suggestive of the negative impact of full PPE on CPR quality remain a concern. They support the need to introduce changes to CPR algorithms (eg, more

	frequent changes of chest compression providers, broader use of mechanical CPR devices) as well as improvements in the assessment of transmission risk and PPE guidelines in order to secure patients' chances of survival. Perhaps further high-fidelity simulation trials will ensure more understanding of this issue.
6 Jafari D. et al. Changing resuscitation strategies during a pandemic: lessons from the consecutive surges in New York and global challenges. Current Opinion in Critical Care. 2021. 10.1097/mcc.0000000000000895[28] https://pubmed.ncbi.nlm.nih.gov/34581299/	Performing cardiopulmonary resuscitation (CPR) on COVID-19 patients requires the clinicians to adopt infection mitigation strategies such as full personal protective equipment, mechanical chest compression devices, and restricting the number of people present during the resuscitation. The time of intubation is a subject of ongoing research and clinicians should use their best judgment for each patient. Clinicians should prepare for CPR in prone position. Particular attention should be given to the psychological well-being of the staff. Point of care ultrasound has proved to be an invaluable diagnostic tool in assessing ventricular dysfunction and parenchymal lung disease. Although novel therapies to supplant the function of diseased lungs have shown promise in select patients the evidence is still being collected. The end-of-life discussions have been negatively impacted by prognostic uncertainty as well as barriers to in person meetings with families.
Brady W.J. et al. Clinical update on COVID-19 for the emergency clinician: Cardiac arrest in the out-of-hospital and in-hospital settings. American Journal of Emergency Medicine. 2022. 10.1016/j.ajem.2022.04.031[29] https://pubmed.ncbi.nlm.nih.gov/35561501/	While many interventions, including chest compressions, are aerosol-generating procedures, the risk of contagion to healthcare personnel is low, assuming appropriate personal protective equipment is used; vaccination with boosting provides further protection against contagion for the healthcare personnel involved in cardiac arrest resuscitation.

ERC Courses : Resuscitation practices during the COVID-19 pandemic Lesson 3 protect yourself . 2022[30] https://cosy.erc.edu/en/online-course-preview/356a192b7913b04c54574d18c28d46e6395428ab/index#/	There is a high risk of viral transmission during all airway procedures including tracheal intubation, inserting a supraglottic airway, performing BMV, non-invasive ventilation, a tracheostomy, disconnecting the ventilatory circuit, in-line suctioning or using an oro- or nasopharyngeal airway. These procedures demand that all providers who are present in the room wear airborne-precaution PPE. Limit aerosol spread by inserting a viral filter (heat and moisture exchanger (HME) filter or high-efficiency particulate absorbing (HEPA) filter) between the patient's airway and breathing circuit, and an additional filter on the expiratory limb of a ventilator; clamp the tube and stop the ventilator before disconnecting; use a neuromuscular blocking drug to prevent coughing; and use closed suction systems. Airway interventions must be performed by the most competent provider available. Protocols should be in place for emergency and elective intubation of all patients potentially having COVID-19, both adults and children. Ideally, dedicated teams should be pre-defined and specific intubation trolleys (with adequate PPE, including face shields for staff involved) made available beforehand. Cuffed tracheal tubes are advised and providers should take care to inflate to a sufficient cuff pressure (before the first insufflation). Competent providers should consider, if available, the use of videolaryngoscopy instead of direct laryngoscopy, in view of both operator safety and improved visualisation. In the setting of CPR, providers should pause chest compressions during an intubation attempt.
Fragkou P.C. et al. Transmission of Infections during Cardiopulmonary Resuscitation.	CPR can bear potential risks not only for the patient but also for the rescuer. Among those risks, transmission of an infectious agent has been one of the most compelling triggers of reluctance to perform CPR among providers. The concern for transmission of an infection

Clinical Microbiology Reviews. 2021. 10.1128/cmr.00018-21[31] https://pubmed.ncbi.nlm.nih.gov/34319149/	from the resuscitated subject may impede prompt initiation and implementation of CPR, compromising survival rates and neurological outcomes of the patients. Infections during CPR can be potentially acquired through airborne, droplet, contact, or hematogenous transmission. However, only a few cases of infection transmission have been actually reported globally. In this review, we present the available epidemiological findings on transmission of different pathogens during CPR and data on reluctance of health care workers to perform CPR. We also outline the levels of personal protective equipment and other protective measures according to potential infectious hazards that providers are potentially exposed to during CPR and summarize current guidelines on protection of CPR providers from international societies and stakeholders.
Okoye O.G. Implementing trauma resuscitation protocol in COVID 19 Era: Our modifications at the national trauma centre, Abuja, Nigeria. Nigerian journal of clinical practice. 2021. 10.4103/njcp.njcp_352_20[32] https://pubmed.ncbi.nlm.nih.gov/33473041/	Outlines measures to adjust local trauma resuscitation protocols at the national trauma centre, Abuja, Nigeria, in the context of the COVID-1 pandemic in order to ensure the safety of the trauma team and trauma patients.
Raju K. et al. Effectiveness of "resuscitation Cover All" in minimizing COVID-19 transmission to health-care workers during cardiopulmonary resuscitation. Journal of Global Infectious	The authors aimed to determine the effectiveness of their novel 'Resuscitation Cover All'(RCA) in reducing the exposure of HCW to simulated respiratory particles and its feasibility during cardio pulmonary resuscitation (CPR). This was a pilot simulation-based study. Five CPR simulation sessions were performed in Standard and RCA protocols, individually. Exposures through contact, droplets, and aerosols were simulated

Diseases. 2022. 10.4103/jgid.jgid_182_21[33] https://pubmed.ncbi.nlm.nih.gov/35418727/	using a standardized volume of liquid detergent. Under Wood's lamp illumination, exposures of participants were compared between the protocols. Rate and depth of chest compressions, time taken to intubate, interruptions in CPR, and first-pass success were analyzed. Result(s): Overall mean exposure in standard protocol was 4950.4 +/- 1461.6 (95% confidence interval [CI]:3135.7-6765.2) sq.pixels and RCA protocol was 2203.6 +/- 1499.0 (95%CI: 342.4-4064.9) sq.pixels (P = 0.019). In standard, chest compressor had the highest exposure of 3066.6 +/- 1419.2 (95%CI: 2051.3-4081.9) sq.pixels followed by defibrillator assistant 1166.4 +/- 767.4 (95%CI: 617.4-1715.4) sq.pixels. Chest compressor of RCA had reduced exposure compared to that of standard (P < 0.001). Hands were the most frequently exposed body part. Airway manager of RCA had no exposure over head and neck in any session. No significant difference in CPR performance metrics was observed. Conclusion(s): This pilot simulation-based study shows that the novel RCA device could minimize the exposure of HCW to simulated respiratory particles during CPR. Also, it might not alter the high-quality CPR performance metrics. We need more real-life evidence.
Wong M.-F. et al. Leg-heel chest compression as an alternative for medical professionals in times of COVID-19. American Journal of Emergency Medicine. 2022. 10.1016/j.ajem.2022.02.026[34] https://pubmed.ncbi.nlm.nih.gov/35219559/	20 medical professionals performed standard manual chest compression followed by leg-heel chest compression after a brief instruction on a manikin. We compared percentage of correct chest compression position, percentage of full chest recoil, percentage of correct compression depth, average compression depth, percentage of correct compression rate and average compression rate between both methods. In a second approach, potential aerosol spread during chest compression was visualized. Results: Our data indicate no credible difference between manual and leg-heel compression. The distance to potential

aerosol spread could have been increased by leg-heel method. Conclusion: Under special circumstances such as the COVID-19-pandemic, leg-heel chest compression may be an effective alternative without previous training compared to manual chest compression while markedly increasing the distance to the patient.

Contributors

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Search Strategy

Ovid Embase

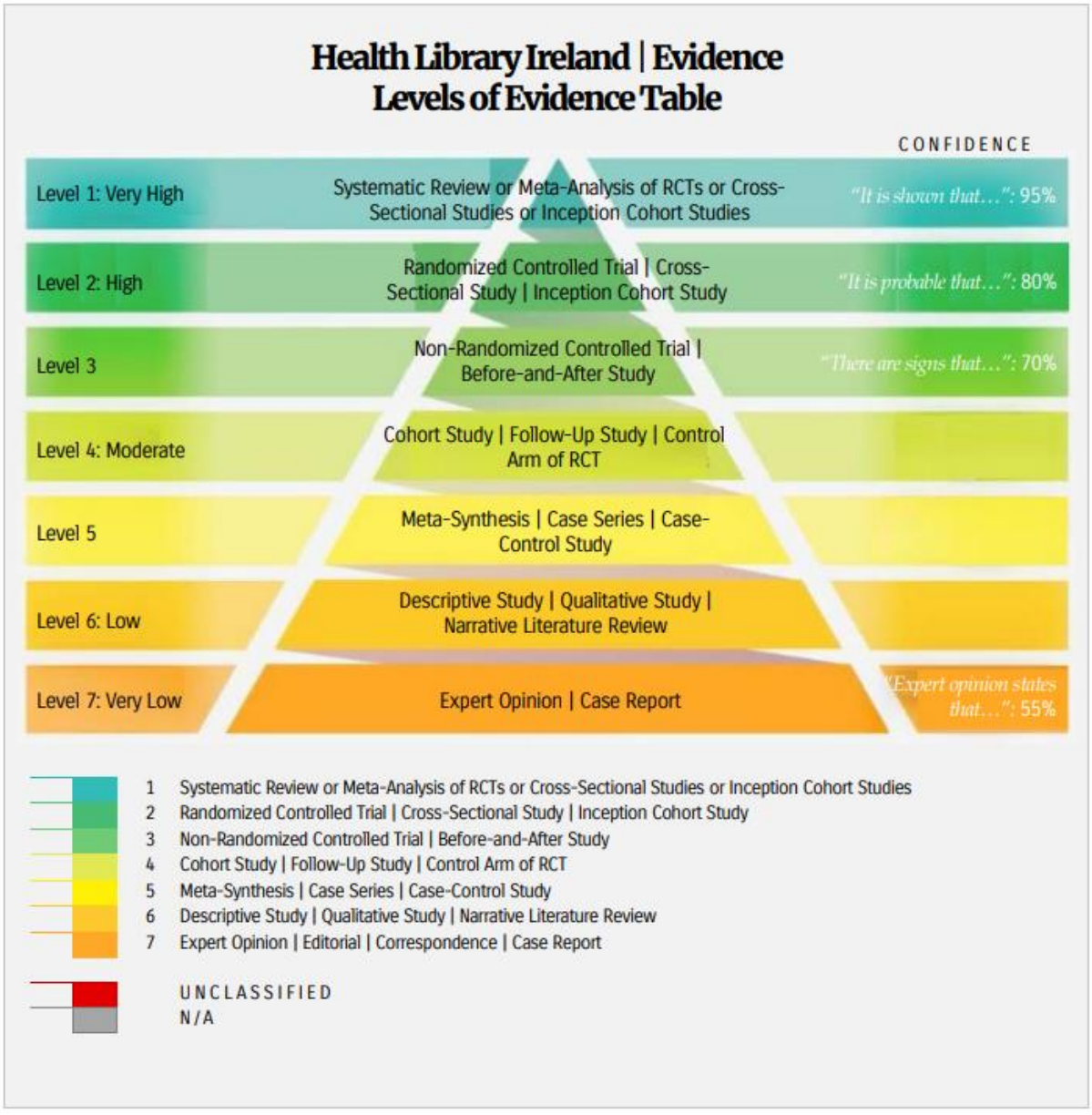
The following Ovid Embase search strategy was used: Embase <1974 to 2022 August 03> 1 exp coronavirus disease 2019/ 247365 2 (Covid or Covid-19 or "Covid 19" or "SARS Cov-2" or Coronavirus or "2019 novel coronavirus" or "2019 nCov Disease").ab,ti. 304425 3 1 or 2 326002 4 exp resuscitation/ 124222 5 (CPR or "cardio-pulmonary resuscitation" or "cardiopulmonary resuscitation" or "chest compressions").ab,ti. 39773 6 (resuscitation or resus or resuscitate or "automated external defribrillator").ab,ti. 90569 7 4 or 5 or 6 160260 8 3 and 7 2182 9 8 and 2021:2022.(sa_year). 1411 10 "systematic review"/ 362294 11 meta analysis/ 252710 12 ("systematic review" or "meta analysis " or meta-analysis or "umbrella review" or "literature review").ab,ti. 553684 13 10 or 11 or 12 687769 14 9 and 1365 15 exp practice guideline/ 655269 16 ("practice guideline" or guideline or guidance or protocol or recommendation).ab,ti. 940691 17 15 or 16 1449060 18 9 and 17 207

Ebsco Medline

The following Ebsco Medline search strategy was used: S1 (MH "Cardiopulmonary Resuscitation+") 21,126 S2 CPR OR RESUSCITATION OR RESUS* OR CARDIO-PULMONARY RESUSCITATION OR CARDIOPULMONARY RESUSCITATION OR CHEST COMPRESSIONS OR AUTOMATED EXTERNAL DEFRIBRILLATOR OR CARDIAC ARREST OR ADVANCED CARDIAC LIFE SUPPORT OR CARDIO PULMONARY RESUSCITATION OR RESUSCITATE 135,123 S3 (S1 OR S2) 135,123 S4 (MH "COVID-19") 171,178 S5 COVID-19 OR coronavirus OR "corona virus" OR (Wuhan N2 virus) OR (("2019-nCoV" or "2019 ncov")) OR "severe acute respiratory syndrome coronavirus 2" OR (("2019" and (new or novel) and coronavirus)) 285,812 S6 (S4 OR S5) 285,812 S7 (S3 AND S6) 1,610 S8 MH "Systematic Review" OR MH "Meta Analysis" OR PT "Meta-Analysis" OR TI systematic* N1 (review* OR overview*) OR AB systematic* N1 (review* OR overview*) OR TI "meta analys*" OR TI "meta analyz*" OR AB "meta analys*" OR AB "meta analyz* OR TI literature N2 (review* OR overview*) OR AB literature N2 (review* OR overview*) 704,605 S9 (S7 AND S8) 96 S10 (Limited by date of publication Date of Publication: 20210101-20221231) 75

Levels of Evidence

The following schema was used to grade the levels of evidence included:



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