

Appendix A6 COVID-1 EtD Table

COVID-19 infection risk to rescuers from patients in cardiac arrest

Overarching research question: In individuals undertaking chest compressions/ defibrillation/ CPR (population), does the wearing of approved personal protective equipment for aerosol generating procedures (Intervention) compared with not wearing personal protective equipment or another system of personal protective equipment (Comparator) affect infection transmission risk from COVID-19 (population)?

Research question one

In individuals in any setting (population), is delivery of 1) chest compressions, 2) defibrillation or 3) cardiopulmonary resuscitation (exposures) associated with aerosol generation (outcome)?

Research question two

In individuals in any setting wearing any/ no personal protective equipment (population), is delivery of 1) chest compressions, 2) defibrillation or 3) cardiopulmonary resuscitation (exposures) associated with transmission of infection (outcome)?

Research question three

In individuals delivering chest compressions and/or defibrillation and/ or CPR in any setting (population), does wearing of personal protective equipment (intervention) compared with wearing any alternative system of personal protective equipment or no personal protective equipment (comparator) affect infection with the same organism as the patient, personal protective equipment effectiveness, or quality of CPR (outcomes)?

ASSESSMENT

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input checked="" type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know 	<p>Internationally, COVID-19 infection has caused extremely high morbidity and mortality. Despite important developments, including vaccination and identification of effective treatments, COVID-19 continues to be an important risk to health across many regions.</p> <p>Outside of the COVID-19 pandemic, each year over 1 million people sustain an out of hospital cardiac arrest around the world. CPR and defibrillation provide these people with the only chance of survival.[1]</p> <p>There is good evidence that tracheal intubation and bag-mask ventilation are aerosol generating and may create risk to the unprotected rescuer. At present, the evidence surrounding the aerosol generating potential of chest compressions and defibrillation is uncertain. Given that these are the most time-critical interventions in cardiac arrest, the international resuscitation community has</p>	

	<p>highlighted uncertainty as to the optimum approach in cardiac arrest patients with confirmed or suspected COVID-19.</p> <p>For healthcare professionals, one approach is to don personal protective equipment prior to any resuscitation attempt. This may reduce the risk of transmission to the rescuer, but will delay treatment whilst the rescuer dons personal protective equipment. Cardiac arrest is a time-sensitive condition, where delays to treatment reduce the likelihood of a good patient outcome.</p> <p>An alternative approach is to commence chest compressions and defibrillation prior to or without donning personal protective equipment. On arrival of subsequent team members wearing personal protective equipment, the initial rescuer can depart whilst protected team members continue resuscitation including the commencement of ventilation if deferred. This approach minimises the delay to key treatments, but may expose rescuers to the risk of infection through aerosol generation.</p> <p>There is additional uncertainty for resuscitation by bystanders and in the context of dispatcher-assisted compression only CPR, and the advice that should be given to members of the public by the dispatcher. Cardiac arrests often occur in the home, and the rate of such events will likely increase due to isolation strategies being implemented by Governments across the world. As such, individuals that deliver dispatcher-assisted compression only CPR have likely already been exposed to the infection, and delivery of compression-only CPR may not cause additional exposure/ harm.</p> <p>During pediatric cardiac arrest, bystander rescuers are frequently those who routinely care for the child. In that case, the risk of the rescuer newly acquiring COVID-19 through provision of rescue breaths is greatly outweighed by improved outcome for children in asphyxial arrest who receive ventilations.</p>	
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Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <input type="radio"/> Trivial <input type="radio"/> Small <input type="radio"/> Moderate <input type="radio"/> Large <input type="radio"/> Varies <input checked="" type="radio"/> Don't know 	<p>From a patient perspective, the immediate initiation of chest compressions and defibrillation provides the highest likelihood of a good outcome. For children, who are more likely to sustain a cardiac arrest due to asphyxia, there is addition benefit from the provision of ventilation.</p> <p>Personal protective equipment (PPE) may reduce the risk of viral transmission during resuscitation.</p> <p>Reducing infection in laypersons and healthcare professionals decreases the risk of further propagating infection and which may preserve health system workforce capacity at a time of increased demand.</p>	

Undesirable Effects
How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
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<ul style="list-style-type: none"> ○ Large ○ Moderate ○ Small ○ Trivial ○ Varies ● Don't know 	<p>Delaying or withholding chest compressions, defibrillation and in children ventilation leads to worse outcomes</p> <p>Some case reports and observational studies at high risk of bias suggested an association between cardiopulmonary resuscitation with aerosol generation and transmission of infection even in individuals wearing personal protective equipment. However, it was not possible in any study to isolate the potential aerosol generation and transmission during chest compressions and defibrillation with aerosol generation and transmission during cardiopulmonary resuscitation that incorporated airway manoeuvres.</p> <p>The donning of personal protective equipment, particularly by a resuscitation team is time-consuming, and delays treatment.</p> <p>Where personal protective equipment is worn, we identified that mask slippage during chest compression delivery may limit its effectiveness.</p> <p>This risk to the healthcare worker may be reduced through successful vaccination programmes. However, there is ongoing uncertainty as to the efficacy of some vaccines in the context of new strains of COVID-19.</p>	
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Certainty of evidence
 What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> ● Very low ○ Low ○ Moderate ○ High ○ No included studies 	<p>Across all three research questions, evidence certainty in relation to critical outcomes was assessed as very low.</p>	

Values
 Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> ● Important uncertainty or variability ○ Possibly important uncertainty or variability ○ Probably no important uncertainty or variability ○ No important uncertainty or variability 	<p>There is important uncertainty amongst the wider community as to the balance between optimising the likelihood of survival for an individual against the risk to an individual of being infected with COVID-19. Individual values may influence this decision- for example, a relative in the context of bystander CPR may be more willing</p>	

Balance of effects
Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention Favors the intervention ● Varies ○ Don't know 	<p>At present, the evidence does not demonstrate a definitive risk of aerosol generation associated with chest compression delivery and defibrillation. However, we did not identify any evidence that these key interventions do not generate aerosols.</p> <p>The risks versus benefit ratio may vary depending on the circumstances of the cardiac arrest and those providing resuscitation.</p> <p>Defibrillation within the first few minutes of cardiac arrest may achieve a sustained return of spontaneous circulation, with less risk than initiating chest compressions and ventilations for a patients in a non-shockable rhythm</p> <p>A risk benefit analysis may favour a layperson performing chest compressions on a witnessed cardiac arrest amongst a household member without PPE, more than a bystander performing compressions and ventilations on a stranger with an unwitnessed cardiac arrest.</p> <p>Healthcare professionals would have greater access to PPE, would likely be trained in its use, and may be able to don PPE before arriving at the patient’s side, thus minimizing delays to commencing or continuing resuscitation.</p>	

Resources required
How large are the resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> ○ Large costs ○ Moderate costs○ Negligible costs and savings ○ Moderate savings ○ Large savings ● Varies ○ Don't know 	<p>The assumption is that all healthcare professionals will be required to don personal protective equipment at some stage during the care of the patient requiring resuscitation from cardiac arrest. This question relates to the timing of donning personal protective equipment, such that no additional resources are required.</p> <p>The question about rescuers in settings where personal protective equipment is not usually available is different. In these settings there are substantial potential logistic issues related to cost, distribution, training and availability of PPE resource for laypersons.</p>	

Certainty of evidence of required resources
What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
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<ul style="list-style-type: none"> <input type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input checked="" type="radio"/> High <input type="radio"/> No included studies 	<p>As stated above, for healthcare professionals there may be no additional resources are required.</p> <p>For laypersons, there would be likely substantial additional costs to provide and train large numbers of people in the use of aerosol generating PPE.</p> <p>No studies were identified that specifically addressed resource requirements.</p>	
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Cost effectiveness
Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <input type="radio"/> Favors the comparison <input type="radio"/> Probably favors the comparison <input type="radio"/> Does not favor either the intervention or the comparison <input type="radio"/> Probably favors the intervention <input type="radio"/> Favors the intervention <input type="radio"/> Varies <input checked="" type="radio"/> No included studies 	<p>We did not identify any cost-effectiveness studies.</p>	

Equity
What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <input type="radio"/> Reduced <input type="radio"/> Probably reduced <input type="radio"/> Probably no impact <input type="radio"/> Probably increased <input type="radio"/> Increased <input type="radio"/> Varies <input checked="" type="radio"/> Don't know 	<p>A delay in delivering chest compressions and defibrillation to individuals in cardiac arrest may disadvantage patients in cardiac arrest.</p> <p>However, it may provide benefits to the wider community by limiting potential infection transmission, particularly to healthcare professionals.</p>	

Acceptability
Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input type="radio"/> Yes <input checked="" type="radio"/> Varies <input type="radio"/> Don't know	The wearing of personal protective equipment by healthcare staff is accepted by stakeholders. For laypersons, the resuscitation provider to balance the benefits and risks.	

Feasibility
Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input type="radio"/> Yes <input checked="" type="radio"/> Varies <input type="radio"/> Don't know	The use of PPE to protect healthcare professionals from COVID-19 is routine in many parts of the world. The provision of appropriate PPE and training in their use to large numbers of laypersons is unlikely to be feasible.	

SUMMARY OF JUDGEMENTS

PROBLEM	JUDGEMENT						
	No	Probably no	Probably yes	Yes		Varies	Don't know
DESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	Don't know
UNDESIRABLE EFFECTS	Large	Moderate	Small	Trivial		Varies	Don't know
CERTAINTY OF EVIDENCE	Very low	Low	Moderate	High			No included studies
VALUES	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	Don't know
RESOURCES REQUIRED	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies	Don't know
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES	Very low	Low	Moderate	High			No included studies

JUDGEMENT							
COST EFFECTIVENESS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	No included studies
EQUITY	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies	Don't know
ACCEPTABILITY	No	Probably no	Probably yes	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	Probably yes	Yes		Varies	Don't know

TYPE OF RECOMMENDATION

Strong recommendation against the intervention ○	Conditional recommendation against the intervention ○	Conditional recommendation for either the intervention or the comparison ○	Conditional recommendation for the intervention ●	Strong recommendation for the intervention ○
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CONCLUSIONS

Recommendation

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 compression only resuscitation 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, may wish to deliver rescue breaths to 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 aerosol generating personal protective equipment in situations where the provider assesses the benefits may exceed the risks (good practice statement)

Justification

- *This topic was prioritized by ILCOR based on ongoing international clinical uncertainty regarding the optimum approach regarding the initiation of chest compressions and defibrillation in known or suspected COVID-19 patients.*
- *ILCOR seeks to provide evidence-based recommendations for implementation by regional and national resuscitation councils. The practical implementation of these recommendations will require regional and national resuscitation councils to consider the values and preferences of their local communities, the prevalence of disease, uptake of vaccination, availability of PPE, training needs of their workforce and infrastructure/resources to provide ongoing care for patients resuscitated from cardiac arrest.*
- *The WHO describe two modes for transmission of COVID-19 droplet transmission and airborne transmission. WHO reports COVID-19 is primarily transmitted through droplets from either direct contact with the patient or indirectly through contact with surrounding environment. Airborne transmission is also possible during aerosol generating procedures. <https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions>*
- *WHO list cardiopulmonary resuscitation as an aerosol generating procedure. <https://apps.who.int/iris/rest/bitstreams/1319378/retrieve-of-sars-cov-2-implications-for-infection-prevention-precautions> Cardiopulmonary resuscitation is a complex intervention with several components e.g. ventilation, defibrillation, chest compression, drug administration. The risks and benefits of these procedures vary and were the focus for this review by the International Liaison Committee on Resuscitation.*
- *This CoSTR complements other guidelines which describe the personal protective equipment that should be worn for aerosol generating procedures. <https://apps.who.int/iris/rest/bitstreams/1319378/retrieve-of-sars-cov-2-implications-for-infection-prevention-precautions> ; <https://www.sccm.org/getattachment/Disaster/SSC-COVID19-Critical-Care-Guidelines.pdf?lang=en-US>; https://journals.lww.com/ccmjournal/Abstract/9000/Surviving_Sepsis_Campaign_Guidelines_on_the.95371.aspx*
- *In the context of chest compressions, aerosol generation is plausible as chest compressions do generate passive ventilation associated with small tidal volumes.[2] It also has parallels with chest physiotherapy techniques which are associated with aerosol generation, although in that context the intent is often to induce coughing and aerosol generation.[3] 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 generates aerosols. If it occurs the duration of an aerosol generating process would be brief. Furthermore, the use of adhesive pads, when available, means that defibrillation can be delivered without direct contact between the defibrillator operator and patient.*
- *We acknowledge the risks of confounding as none of the identified studies were able to separate risks related to individual components of a resuscitation attempt (compressions, ventilations, defibrillation) from the resuscitation attempt as a whole. We further note the indirectness of evidence as only some included studies reported data on COVID-19 which may have a different transmissibility risk to other infections.*

- *Outside of the COVID-19 pandemic, each year over 1 million people sustain an out of hospital cardiac arrest around the world. CPR and defibrillation provide these people with the only chance of survival.[1]*
- *In making recommendations, there is a need to carefully balance the benefit of early treatment with chest compressions and defibrillation (prior to donning personal protective equipment) with the potential harm to the rescuer, their colleagues and the wider community if the rescuer were to be infected with COVID-19.*
- *In suggesting that lay rescuers consider compression only CPR and public access defibrillation, the writing group noted that the majority of out of hospital cardiac arrests occur in the home where those providing resuscitation are likely to have been in contact with the person requiring resuscitation; that accessibility to personal protective equipment for aerosol generating procedures is likely to be limited; there may be significant harm from delaying potentially lifesaving treatment if resuscitation is deferred until arrival of personnel with suitable personal protective equipment.*
- *In suggesting that lay rescuers who are willing, trained and able to do so, may wish to consider rescue breaths in addition to chest compressions, the writing group considered that bystander rescuers are frequently those who routinely care for the child. In that case, the risk of the rescuer newly acquiring COVID-19 through provision of rescue breaths is greatly outweighed by improved outcome for children in asphyxial arrest who receive ventilations.*
- *In suggesting that healthcare professionals should use personal protective equipment for aerosol generating procedures we considered that healthcare professionals would have greater access to PPE, would likely be trained in its use, and may be able to don PPE before arriving at the patient's side, thus minimizing delays to commencing or continuing resuscitation.*
- *Given the potential for defibrillation within the first few minutes of cardiac arrest to achieve a sustained return of spontaneous circulation and uncertainty of the likelihood of defibrillation generating an aerosol, we suggest healthcare providers consider the risks versus benefits of attempting defibrillation prior to donning personal protective equipment for aerosol generating procedures.*
- *The time taken for a team to don personal protective equipment may be up to 5-minutes, although individuals may don equipment in around one-minute.[4, 5] However, once donned we identified evidence that there is a risk of mask slippage during chest compression delivery rendering the protective equipment less effective.*
- *Feedback received during the initial public commenting provided highlighted the challenges of balancing the risks to those providing resuscitation with the potential benefits for the patient requiring resuscitation. ILCOR seeks to provide evidence based recommendations for implementation by regional and national resuscitation councils. The practical implementation of these recommendations will require regional and national resuscitation councils to consider the values and preferences of their local communities, the prevalence of disease, availability of PPE, training needs of their workforce and infrastructure / resources to provide on-going care for patients resuscitated from cardiac arrest.*
- *During search updates, we identified one new study eligible for research question one[6], two new studies eligible for research question two [7, 8]_ and two new studies relevant to research question three [9, 10]. We reviewed treatment recommendations in the context of these new data, taking in to account study findings and overall contribution to certainty of evidence. Based on this assessment, we determined that these new data did not support a change to current treatment recommendations.*

Subgroup considerations

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Implementation considerations

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Monitoring and evaluation

Research priorities

No identified study assessed the potential for aerosol generation through delivery of chest compressions and/or defibrillation without associated airway maneuvers.

We encourage further research relating to the risks and benefits of resuscitation interventions in the context of the current COVID-19 pandemic.

Further research should explore the effects of strategies to mitigate the risk of viral transmission during chest compression and defibrillation e.g. use of a surgical mask, oxygen mask, cloth applied to the patients mouth and nose.

- [2] Deakin CD, O'Neill JF, Tabor T. Does compression-only cardiopulmonary resuscitation generate adequate passive ventilation during cardiac arrest? *Resuscitation*. 2007;75:53-9.
- [3] Simonds AK, Hanak A, Chatwin M, Morrell M, Hall A, Parker KH, et al. Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections. *Health technology assessment (Winchester, England)*. 2010;14:131-72.
- [4] Watson L, Sault W, Gwyn R, Verbeek PR. The "delay effect" of donning a gown during cardiopulmonary resuscitation in a simulation model. *CJEM*. 2008;10:333-8.
- [5] Abrahamson SD, Canzian S, Brunet F. Using simulation for training and to change protocol during the outbreak of severe acute respiratory syndrome. *Crit Care*. 2006;10:R3.
- [6] Ott M, Milazzo A, Liebau S, Jaki C, Schilling T, Krohn A, et al. Exploration of strategies to reduce aerosol-spread during chest compressions: A simulation and cadaver model. *Resuscitation*. 2020;152:192-8.
- [7] Ran L, Chen X, Wang Y, Wu W, Zhang L, Tan X. Risk Factors of Healthcare Workers With Coronavirus Disease 2019: A Retrospective Cohort Study in a Designated Hospital of Wuhan in China. *Clin Infect Dis*. 2020;71:2218-21.
- [8] El-Boghdadly K, Wong DJN, Owen R, Neuman MD, Pocock S, Carlisle JB, et al. Risks to healthcare workers following tracheal intubation of patients with COVID-19: a prospective international multicentre cohort study. *Anaesthesia*. 2020;75:1437-47.
- [9] Tian Y, Tu X, Zhou X, Yu J, Luo S, Ma L, et al. Wearing a N95 mask increases rescuer's fatigue and decreases chest compression quality in simulated cardiopulmonary resuscitation. *Am J Emerg Med*. 2020.
- [10] Serin S, Caglar B. The Effect of Different Personal Protective Equipment Masks on Health Care Workers' Cardiopulmonary Resuscitation Performance During the Covid-19 Pandemic. *J Emerg Med*. 2020.