



**American
Red Cross**

Scientific Advisory Council

American Red Cross Scientific Advisory Council

Scientific Review

Infection Risk in First Aid and CPR

Questions to be Addressed:

Among adults and children who are performing first aid or CPR on another individual, what is the risk of contracting an infectious disease when using standard personal protective equipment and hand hygiene compared with when not using personal protective equipment and hand hygiene?

Introduction/Overview:

When interacting with another individual there is a perceived risk of contracting an infectious disease through either direct contact or an airborne route. Providing first aid or CPR brings individuals into closer contact, potentially spreading germs through direct contact, the respiratory route or through body fluids which are of concern for transmission of infectious disease. These concerns have prompted the use of personal protective equipment such as gloves and breathing barrier devices, including CPR masks and face shields, when rendering care. The emergence of COVID-19 has brought these concerns into the forefront, with the concern of the transmission of COVID-19 through contact or rescue breathing, resulting in recommendations for compression-only CPR. Concern for disease transmission could result in a decrease in number of persons who receive first aid or CPR in the community, resulting in an unintended increase in morbidity and mortality. This question evaluates the risk of transmission of infectious diseases during the performance of first aid or CPR

Search Strategy and Literature Search Performed

Review Process and Literature Search of Evidence Since Last Approval Performed

Key Words Used

The initial search was completed using the combined question of training or performing first aid or CPR. After the review was complete, the SR was translated into two separate SRs, performing FA and CPR and training in FA and CPR, to simplify the recommendations. A repeat search separating out these questions was not performed.

Inclusion Criteria (time period, type of articles and journals, language, methodology)

1. Search strategy (full record of search)

Medline (Ovid)

Search date: 24/03/2020

Database: Ovid MEDLINE(R) ALL <1946 to March 23, 2020>

Search Strategy:

-
- 1 exp cardiopulmonary resuscitation/ (17618)
 - 2 heart arrest/ (28725)
 - 3 out-of-hospital cardiac arrest/ (4046)
 - 4 electric countershock/ (14654)
 - 5 defibrillators/ (1774)
 - 6 (cardiopulmonary resuscitation or defibrillat* or CPR or chest compression* or ((cardiac or cardiopulmonary) adj arrest)).ti,ab,kf. (70049)
 - 7 1 or 2 or 3 or 4 or 5 or 6 (91442)
 - 8 exp Health personnel/ (505028)
 - 9 exp police/ (5056)
 - 10 exp firefighters/ (1000)
 - 11 (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherap* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist* or bystander* or police* or firefighter* or layperson* or laypeople or public).ti,ab,kf. (1497414)
 - 12 8 or 9 or 10 or 11 (1743878)
 - 13 cadaver/ (40334)
 - 14 manikins/ (4981)
 - 15 (cadaver* or manikin* or mannequin*).ti,ab,kf. (63603)
 - 16 13 or 14 or 15 (80361)
 - 17 12 or 16 (1819209)
 - 18 occupational exposure/ (53787)
 - 19 air microbiology/ (7553)
 - 20 infectious disease transmission/ (9010)
 - 21 infection control/ (23324)
 - 22 exp cross infection/ (58476)
 - 23 Disease Outbreaks/ (78245)
 - 24 Aerosols/ (29986)
 - 25 ((aerosol* or cough* or droplet* or infection* or infectious or disease*) adj3 (generat* or induc* or stimulat* or produc* or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)).ti,ab,kf. (437175)
 - 26 cross infection.ti,ab,kf. (2969)
 - 27 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 (642342)
 - 28 17 and 27 (91209)
 - 29 Infectious Disease Transmission, Patient-to-Professional/ (3835)
 - 30 28 or 29 (93257)

31 7 and 30 (184)
 32 human influenza/ (48279)
 33 exp Influenza A virus/ (42980)
 34 SARS virus/ (2899)
 35 Severe Acute Respiratory Syndrome/ (4470)
 36 exp coronavirus/ (11425)
 37 exp Coronavirus Infections/ (9723)
 38 Middle East Respiratory Syndrome Coronavirus/ (968)
 39 exp tuberculosis/ (190319)
 40 exp pneumonia/ (90583)
 41 (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or MERS or avian flu or swine flu or rhinovirus or acute respiratory infection*).ti,ab,kf. (450916)
 42 (((corona* or corono*) adj1 (virus* or viral* or virinae*)) or coronavirus* or coronavirus* or coronavirinae* or Coronavirus* or Coronavirus* or Wuhan* or Hubei* or Huanan or "2019-nCoV" or 2019nCoV or nCoV2019 or "nCoV-2019" or "COVID-19" or COVID19 or "CORVID-19" or CORVID19 or "WN-CoV" or WNCov or "HCoV-19" or HCoV19 or CoV or "2019 novel*" or Ncov or "n-cov" or "SARS-CoV-2" or "SARSCoV-2" or "SARSCoV2" or "SARS-CoV2" or SARSCov19 or "SARS-Cov19" or "SARSCov-19" or "SARS-Cov-19" or Ncovor or Ncorona* or Ncorono* or NcovWuhan* or NcovHubei* or NcovChina* or NcovChinese*).ti,ab,kf. (17835)
 43 Rhinovirus/ (3680)
 44 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 (544638)
 45 7 and 17 and 44 (141)
 46 31 or 45 (307)

Embase (Ovid)

Search date: 24/03/2020

Database: Embase Classic+Embase <1947 to 2020 Week 12>

Search Strategy:

 1 *resuscitation/ (56156)
 2 *heart arrest/ (26461)
 3 *cardiopulmonary arrest/ (1142)
 4 *out of hospital cardiac arrest/ (5817)
 5 *defibrillation/ (4586)
 6 exp *external defibrillator/ (706)
 7 (cardiopulmonary resuscitation or defibrillat* or CPR or chest compression* or ((cardiac or cardiopulmonary) adj arrest)).ti,ab,kw. (112209)
 8 1 or 2 or 3 or 4 or 5 or 6 or 7 (154423)
 9 exp *health care personnel/ (518538)
 10 exp *police/ (3765)
 11 *fire fighter/ (1532)

12 (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherap* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist* or bystander* or police* or firefighter* or layperson* or laypeople or public).ti,ab,kw. (1968709)

13 9 or 10 or 11 or 12 (2263394)

14 *cadaver/ (5746)

15 exp *manikin/ (382)

16 (cadaver* or manikin* or mannequin*).ti,ab,kw. (84125)

17 14 or 15 or 16 (86517)

18 13 or 17 (2343670)

19 *airborne infection/ (795)

20 *hospital infection/ (19842)

21 *virus transmission/ (12660)

22 *bacterial transmission/ (2301)

23 *disease transmission/ (9518)

24 *aerosol/ (24924)

25 ((aerosol* or cough* or droplet* or infection* or infectious or disease*) adj3 (generat* or induc* or stimulat* or produc* or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)).ti,ab,kw. (588510)

26 19 or 20 or 21 or 22 or 23 or 24 or 25 (644165)

27 18 and 26 (88591)

28 8 and 27 (240)

29 exp *influenza virus/ (16773)

30 exp *influenza/ (51692)

31 *parainfluenza virus infection/ (258)

32 *severe acute respiratory syndrome/ (4499)

33 exp *coronavirus/ (6085)

34 exp *Coronavirus Infection/ (6335)

35 *Middle East respiratory syndrome/ (536)

36 *tuberculosis/ (88342)

37 *lung tuberculosis/ (50737)

38 *drug resistant tuberculosis/ (1185)

39 *streptococcus pneumoniae/ (15862)

40 *pneumonia/ (49217)

41 *respiratory syncytial pneumovirus/ (6459)

42 (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or MERS or avian flu or swine flu or rhinovirus or acute respiratory infection*).ti,ab,kw. (565099)

43 (((corona* or corono*) adj1 (virus* or viral* or virinae*)) or coronavirus* or coronavirus* or coronavirinae* or Coronavirus* or Coronavirus* or Wuhan* or Hubei* or Huanan or "2019-

nCoV" or 2019nCoV or nCoV2019 or "nCoV-2019" or "COVID-19" or COVID19 or "CORVID-19" or CORVID19 or "WN-CoV" or WNCov or "HCoV-19" or HCoV19 or CoV or "2019 novel*" or Ncov or "n-cov" or "SARS-CoV-2" or "SARSCoV-2" or "SARSCoV2" or "SARS-CoV2" or SARSCov19 or "SARS-Cov19" or "SARSCov-19" or "SARS-Cov-19" or Ncovor or Ncorona* or Ncorono* or NcovWuhan* or NcovHubei* or NcovChina* or NcovChinese*).ti,ab,kw. (20813)

44 *rhinovirus/ (2144)

45 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 (639389)

46 8 and 18 and 45 (357)

47 28 or 46 (568)

48 limit 47 to (conference abstract or conference paper or "conference review") (294)

49 47 not 48 (274)

Cochrane Central Register of Controlled Trials (Cochrane Library via Wiley)

Search date: 25/03/2020

ID	Search Hits
#1	[mh "cardiopulmonary resuscitation"] 1019
#2	[mh ^"heart arrest"] 1053
#3	[mh ^"out-of-hospital cardiac arrest"] 364
#4	[mh ^"electric countershock"] 858
#5	[mh ^defibrillators] 81
#6	("cardiopulmonary resuscitation" or defibrillat* or CPR or (chest next compression*) or ((cardiac or cardiopulmonary) next arrest)):ti,ab,kw 8632
#7	#1 or #2 or #3 or #4 or #5 or #6 9168
#8	[mh "health personnel"] 8364
#9	[mh police] 65
#10	[mh firefighters] 37
#11	((("health care" next worker*) or (healthcare next worker*) or ("health care" next provider*) or (healthcare next provider*) or physiotherap* or dentist* or nurse* or doctor* or physician* or "health personnel" or "medical personnel" or "hospital personnel" or (hospital next worker*) or staff or (healthcare next professional*) or ("health care" next professional*) or (care next giver*) or caregiver* or paramedic* or therapist* or bystander* or police* or firefighter* or layperson* or laypeople or public):ti,ab,kw 137610
#12	#8 or #9 or #10 or #11 138631
#13	[mh ^cadaver] 580
#14	[mh ^manikins] 839
#15	(cadaver* or manikin* or mannequin*):ti,ab,kw 4097
#16	#13 or #14 or #15 4097
#17	#12 or #16 141620
#18	[mh ^"occupational exposure"] 502

#19 [mh ^"air microbiology"] 65
 #20 [mh ^"infectious disease transmission"] 106
 #21 [mh ^"infection control"] 523
 #22 [mh "cross infection"] 1241
 #23 [mh ^"disease outbreaks"] 192
 #24 [mh ^aerosols] 2039
 #25 ((aerosol* or cough* or droplet* or infection* or infectious or disease*) near/3 (generat* or induc* or stimulat* or produc* or creat* or (respirable next range*) or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)):ti,ab,kw 103502
 #26 "cross infection":ti,ab,kw 1218
 #27 #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 106205
 #28 #17 and #27 11540
 #29 [mh ^"Infectious Disease Transmission, Patient-to-Professional"] 59
 #30 #28 or #29 11559
 #31 #7 and #30 72
 #32 [mh ^"human influenza"] 2595
 #33 [mh "Influenza A virus"] 836
 #34 [mh ^"SARS virus"] 9
 #35 [mh ^"Severe Acute Respiratory Syndrome"] 33
 #36 [mh coronavirus] 11
 #37 [mh "Coronavirus Infections"] 12
 #38 [mh ^"Middle East Respiratory Syndrome Coronavirus"] 1
 #39 [mh tuberculosis] 557
 #40 [mh pneumonia] 3428
 #41 (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or "severe acute respiratory syndrome" or SARS or MERS or "avian flu" or "swine flu" or rhinovirus or ("acute respiratory" next infection*)):ti,ab,kw 29310
 #42 (((corona* or corono*) near/1 (virus* or viral* or virinae*)) or coronavirus* or coronavirus* or coronavirinae* or Coronavirus* or Coronavirus* or Wuhan* or Hubei* or Huanan or "2019-nCoV" or 2019nCoV or nCoV2019 or "nCoV-2019" or "COVID-19" or COVID19 or "CORVID-19" or CORVID19 or "WN-CoV" or WNCov or "HCoV-19" or HCoV19 or CoV or "2019 novel*" or Ncov or "n-cov" or "SARS-CoV-2" or "SARSCoV-2" or "SARSCoV2" or "SARS-CoV2" or SARSCov19 or "SARS-Cov19" or "SARSCov-19" or "SARS-Cov-19" or Ncovor or Ncorona* or Ncorono* or NcovWuhan* or NcovHubei* or NcovChina* or NcovChinese*):ti,ab,kw 412
 #43 [mh ^Rhinovirus] 144
 #44 #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 29660
 #45 #7 and #17 and #44 39
 #46 #31 or #45 106

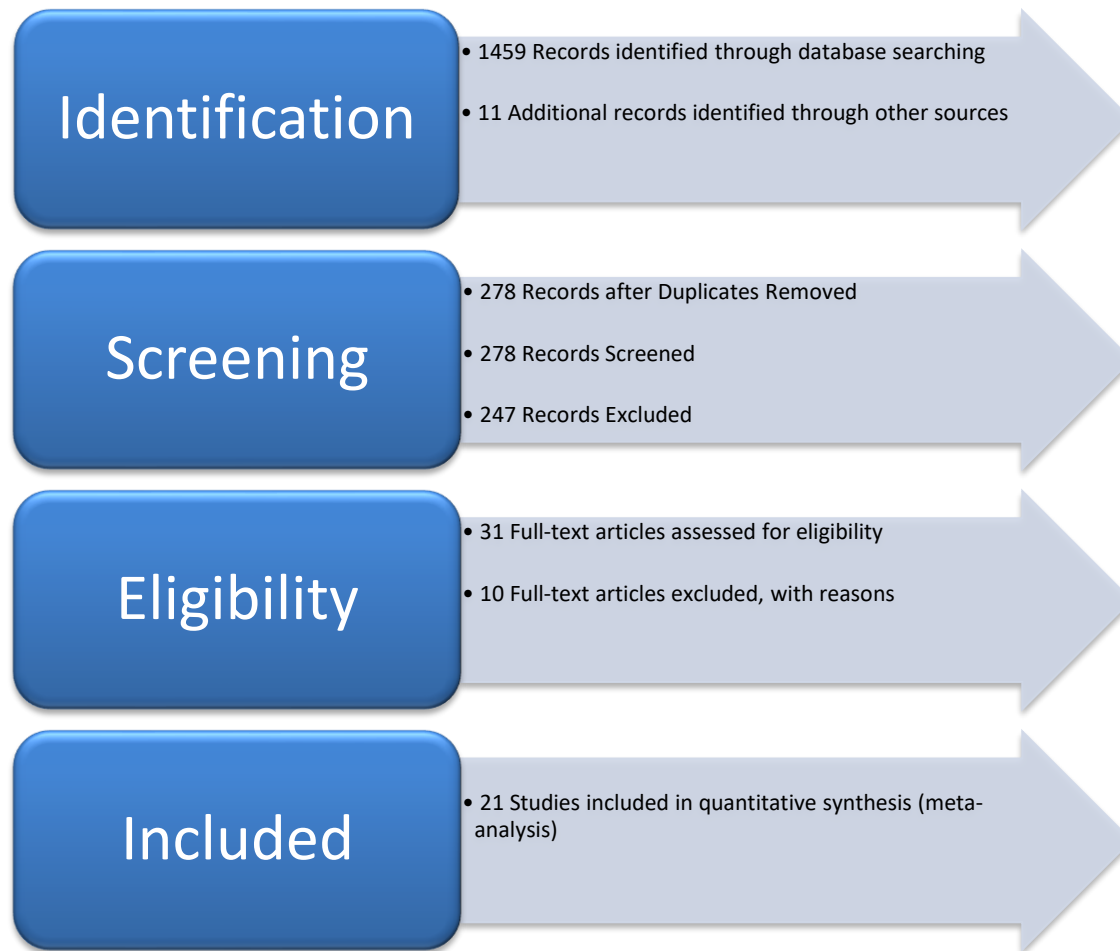
Trials: 105

2. Full details of the study eligibility criteria

	Include	Exclude
Question one	Population - Individuals in any setting Exposure - Delivery of: 1) Chest compressions 2) Defibrillation 3) CPR (all CPR-interventions that include chest compressions) Delivery may be by human or mechanical chest compression device to patient or cadaver. Outcome - Aerosol generation (reported to be associated with exposure) May be described as presence or absence or quantitatively (e.g. count per metre-cubed) Study design Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, case reports/series, cadaver studies) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols)	Animals Computer models Manikin studies Non-primary research-reviews, editorials etc Guidelines Non-English language
Question two	Population - Individuals in any setting Exposure - Delivery of: 1) Chest compressions 2) Defibrillation 3) CPR (all CPR-interventions that include chest compressions) Delivery may be by human or mechanical chest compression device to patient. Outcome - Transmission of any viral or bacterial or fungal infection- must be reported transmission or reports of no transmission (in studies with comparator group). Study design	Animals Computer models Manikin studies Non-primary research-reviews, editorials etc Guidelines Non-English language

	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, case reports/ series).	
Question three	Population - Individuals delivering chest compressions and/or defibrillation and/ or CPR in any setting Intervention - Wearing of personal protective equipment Comparator - Wearing any alternative system of personal protective equipment or no personal protective equipment Includes wearing normal clothing/ no PPE Outcome - Infection with the same organism as patient (can be any infection) PPE effectiveness- example mask slippage, areas of exposure Quality of CPR- chest compression depth, chest compression rate, no-flow time, flow-time, time to key interventions (start CPR, defibrillation) Study design Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) cadaver studies, simulation studies.	Animals Computer models Non-primary research-reviews, editorials etc Guidelines Non-English language Studies of hazmat suits Studies without a control group

Databases Searched and Additional Methods Used (references of articles, texts, contact with authors, etc.)



Scientific Foundation:

In this review 21 articles were identified regarding the transmission of infectious disease while providing CPR or first aid or during training. Fourteen studies were observational (10 case reports, 2 case series, 1 retrospective cohort, 1 case-control) and 7 were review articles. The observational studies were of low to very low certainty and, therefore make it difficult to estimate the true risk of contracting an infectious disease while providing first aid or CPR.

CPR

Eight case reports document transmission of infectious disease to the rescuer during resuscitation (Ahmad 1990, Chalumeau 2005, Finkelhor 1980, Heilman 1965, Hendricks 1980, Nam 2017, Todd 1980, Valenzuela 1990). These infections include *Salmonella infantis*, *Staphylococcus aureus*, cutaneous tuberculosis, *Herpes simplex* type 1, MERS-CoV, *Shigella sonnei*, and *Strep pyogenes*. However, in most of these cases the rescuer was not using personal protective equipment (PPE), including either gloves or a barrier device for rescue breathing.

One case series documented 23 health care workers who were exposed to a SARS-CoV-2 (COVID-19) positive patient largely without PPE (none wore masks, only 10/23 wore gloves during the entire resuscitation) during a cardiac arrest and noted that none of these individuals contracted the virus during this resuscitation (Ingason, 2021). In a second case series (Christian 2004) evaluating the transmission of SARS-CoV, three of nine healthcare workers who participated in resuscitation of a patient with SARS-CoV later experienced viral symptoms suggestive of SARS-CoV. Only five of the nine agreed to convalescent serum testing. Three of these workers who agreed to testing experienced viral symptoms, of whom one was indeterminate as above and, one was positive. These three providers were wearing gowns, gloves, safety glasses, face shields, shoe covers, hair covers and N95 respirators at the time of the resuscitation. The positive provider was involved in IV insertion, ECG lead placement and medication administration during the resuscitation (Christian 2004).

In one retrospective cohort study (Ran 2020), 72 health care workers with respiratory symptoms were followed for diagnosis of COVID-19. Thirty-three of these workers were classified as high risk based on their job location and 39 persons were classified as general risk based on their job location. The high-risk group had a 2.13 RR of developing COVID-19 compared with the general risk group. “Unqualified hand washing” (undefined in document), suboptimal hand hygiene and “improper PPE” (undefined in document) were associated with an increased risk of contracting COVID-19 with RR of 2.64 (95% CI =1.04-6.71), 3.10 (95% CI = 1.43-6.73), and 2.43 (95% CI – 1.34-4.39), respectively. One case-control study (Liu 2009) evaluated 51 SARS infected healthcare workers (compared with 426 uninfected controls) who had self-reported exposure to SARS patients found that chest compressions were significantly associated with high risk for infection (providing chest compressions: OR 4.52 (95% CI = 1.08–18.81 p= 0.031). However, in multivariate analysis it was not possible to distinguish between chest compressions and intubation. Wearing protective goggles and gloves were found to reduce the risk of infection (p values 0.046 and 0.011, respectively, raw data not given). Not wearing a mask was found to be a risk for contracting SARS (p = 0.002).

Seven review articles were identified that were applicable to this review (Brown 2020, Couper 2020, Jackson 2020, Mejicano 1998, Sun 1995, Tran 2021). A literature review conducted by Brown et al in 2020 evaluated the literature regarding chest compressions as an aerosolizing procedure. (Brown 2020). The studies included that calculated an odds ratio of contracting respiratory illness from performing chest compressions varied from 0.4 – 4.5. Ultimately the authors concluded that there was a paucity of data, all are observational and of low certainty. Further experimental studies are needed to determine if chest compressions are truly aerosolizing and in the absence of evidence they would recommend considering chest compressions an aerosolizing procedure.

A rapid systematic review (SR) conducted in response to COVID-19 evaluated procedures that could be considered aerosolizing (Jackson 2020). One-hundred twenty-eight documents were identified including peer-reviewed journal articles, pre-prints, conference proceedings and grey literature from a variety of sources such as healthcare organizations, agencies, and government departments. These documents were reviewed to generate a panel consensus on whether the procedure was considered aerosolizing. A 90% or greater agreement was required to state there was “very strong consensus” that the specific procedure was aerosol-generating and an 80% or greater agreement was required to state there was “strong consensus” that the procedure was aerosol generating. Intubation and extubation procedures and manual ventilation were deemed a very high risk. “Strong” or “Very Strong” procedures applicable to first aid or CPR were: cardiopulmonary resuscitation, non-invasive ventilation, high-flow oxygen therapy, nebulized or aerosol therapy, and coughing. A large limitation is that the SR primarily used secondary sources, did not review the primary literature, and seemed to arbitrarily define “very strong” and “strong” consensus.

Mejicano et al (Mejicano 1998) summarized the literature on the available data on the likelihood of transmission of infectious organisms during CPR. This study was a narrative review in which the MEDLINE database and related bibliographies were searched from 1965 to 1998 to identify articles pertaining to the risk of acquiring an infectious disease through CPR or CPR training. Twelve articles were identified for infectious disease transmitted through CPR. Twelve observational studies, comprised of 15 persons, were identified that reported the transmission of an infectious disease during CPR. These studies are also identified in this Red Cross review. No studies were identified regarding cases of transmission from training courses. The authors concluded that the risk of acquiring an infectious disease during CPR or CPR training is low.

Tran et al (Tran 2012) performed a systematic review on the risk of transmission of acute respiratory infections in healthcare workers exposed to patients undergoing aerosolizing procedures. Results were inconclusive. Pooled estimates of the risk of transmission during chest compressions in two cohort studies were not statistically significant. (Raboud 2010, Loeb 2004) However one case control study found that chest compressions were a risk factor for transmission of SARS. (Liu 2009) Similarly the risk of transmission of aerosolized infections during defibrillation was not found to be statistically significant. (Raboud 2010, Loeb 2004)

Couper 2020 performed a systematic review sponsored by ILCOR to examine the risk of transmission of infection during chest compressions, defibrillation and CPR. Eleven studies were found for inclusion. They did not find any direct evidence that chest compressions or

defibrillation did, or did not, generate aerosols. Two case reports were found in which a healthcare worker contracted an infection from a patient receiving CPR. However, in both cases patients received prolonged resuscitation likely incorporating ventilations. The researchers also did not find any direct evidence that chest compressions or defibrillation are, or are not, associated with transmission of aerosolized infection. Indirect evidence was found from 8 studies. In two cohort studies, no statistically significant association was found between healthcare workers exposed to chest compression or defibrillation and transmission of SARS. (Loeb 2004, Raboud 2010) In one case-control study a multivariate analysis suggested that exposure increased odds of probable SARS infection (OR 4.52, 95% CI 1.08-18.81). (Liu 2009) In five case reports there are reported transmission of infectious disease. PPE varied across the case reports. Studies were confounded by airway procedures in conjunction with chest compressions and defibrillation.

First Aid

Limited literature is available regarding the risk of transmission of infectious disease when providing first aid. Only two case reports were identified in this review. Both case reports document apparent transmission of HIV when rescuers were bitten on the fingers while trying to prevent airway obstruction during a seizure in an HIV positive patient (Andreo 2004, Vidmar 1996).

Only one systematic review was identified that was pertinent to the transmission of infectious diseases in first aid. In 2018 Cresswell et al published a systematic review of the risk of HIV transmission through biting or spitting. This review included 13 case reports. There were no reported cases of HIV transmission related to spitting, but nine cases were identified following a bite. The majority of these occurred during an intentional bite from the infected individual. Two of these cases occurred when untrained first-aiders placed their fingers in the mouth of someone having a seizure. These two case reports are also included in this Red Cross review.

Summary

While the risk of contracting an infectious disease while performing first aid or CPR appears to be low, the true incidence is not known. Studies are observational in nature, substantially limiting the ability to draw conclusions from this data. Multiple case reports document that there is a risk of contracting an infectious disease during resuscitation and first aid. However, in two limited case series of a total of 32 health care providers involved in resuscitation of two SARS-CoV-2 positive patients only one tested positive for SARS-CoV-2 (Christian 2004, Ingason 2021). In the first of these case series health care providers were wearing full PPE, including gowns, N95 masks, eye protection and gloves and only two of the 9 individuals exposed had documented evidence SARS-CoV-2 transmission (Christian 2004). In the second study, where minimal PPE was worn (no masks were worn and only 10/23 wore gloves the entire resuscitation), no documented transmission of SARS-CoV-2 took place (Ingason 2021). A retrospective cohort study (Ran 2020) with 72 health care workers demonstrated that suboptimal hand hygiene and improper PPE were associated with an increased risk of contracting COVID-19 with RR of 3.10 (95% CI = 1.43-6.73) and 2.43 (95% CI = 1.34-4.39), respectively. A case-control study (Lui 2009) found that chest compressions were significantly associated with high

risk developing for SARS infection (OR 4.52 95%CI = 1.08–18.81 p= 0.031). Wearing protective goggles and gloves were all found to reduce the risk of infection (p values = 0.046, 0.011, respectively, raw data not given). In addition, not wearing a multiple layer mask was found to be a risk for contracting SARS (p = 0.002).

A recent study investigating a cohort of 1067 patients from January 1 – April 15, 2020, less than 10 percent of EMS responses for out-of-hospital cardiac arrest (OHCA) tested positive for COVID-19. Only one of these persons was in a public place when OHCA occurred (Sayre 2020). IN this study, the vast majority of persons with suspected COVID-19 were either at home or in a nursing home when cardiac arrest occurred (Sayre 2020). With the available data, the risk of contracting COVID-19 while performing hands-only CPR, particularly if wearing PPE, in a community setting appears minimal.

No studies regarding the transmission of COVID-19 during CPR were found for the pediatric population. In young children, cardiac arrest is more often precipitated by a respiratory insult than in adults (Shimoda-Sakano 2020). Therefore, children may benefit from rescue breath/ventilation during cardiac arrest more so than the adult population (Maconochie 2017). Parents and caregivers may be more aware of their child’s past medical history and may be more willing to provide rescue breaths to their children in the event of a cardiac arrest than in the general population.

Current practices for prevention of infectious disease transmission are listed in the Appendix but in general providers are instructed to follow “standard precautions” including avoiding contact with blood and other body fluids, using protective CPR breathing barriers, using disposable gloves and washing hands after rendering care.

With the lack of more definitive evidence, current practices utilizing PPE, including gloves, barrier device and avoiding contact with bodily fluids when giving first aid and CPR appears appropriate. If COVID-19 infection is suspected, compression-only CPR is an option to try to limit the spread of infection and wearing a multi-layered mask, protective goggles and gloves while giving compressions is preferable.

Overview of Recommendation:

Providers should avoid contact with body fluids and utilize PPE, including gloves, and a breathing barrier device when giving first aid and CPR. If COVID-19 infection is suspected, compression-only CPR is an option to try to limit the spread of infection and wearing a multi-layered (at least two layers) mask, protective goggles and gloves while giving compressions is preferable. No studies were available evaluating the transmission of COVID-19 in the pediatric population. Providers should consider the potential added benefit of respiratory support when caring for this population.

Specific Recommendations and Strength

Standards:

- None

Guidelines:

- Providers should avoid contact with bodily fluids and utilize PPE, including disposable gloves and a breathing barrier device when giving first aid and CPR.
- After providing first aid or CPR the providers should wash their hands with soap and water as soon as possible. Hand sanitizer can be used until soap and water is available.

Options:

- If COVID-19 infection is suspected, compression-only CPR is an option to try to limit the spread of infection. Wearing a multi-layered mask, eye protection and gloves while giving compression-only CPR is preferable.

Knowledge Gaps and Future Research

There is very limited data available to determine the risk of contracting an infectious disease either with, or without, personal protective equipment when rendering first aid or CPR. Further research needs to be conducted in determining the risk of spreading both respiratory and blood borne pathogens.

Implications for American Red Cross Programs

Current Red Cross programs recommend limiting exposure to bodily fluids and utilizing disposable gloves, breathing barriers and hand washing to lower the risk of infectious disease transmission (Appendix - Red Cross Instructors Manual, Red Cross Training Manual). These recommendations are in line with the current science and do not need updating with approval of this document.

Summary of Key Articles/Literature Found and Level of Evidence/Bibliography:

Table 1. Summary of findings

Study (reference)	Study design	Certainty of Evidence	Population	Outcome(s)	Intervention	Comparison	Results
Ahmad 1990	Case Report	Very low	n=1, female, unknown age	Contracted disease during CPR	A case report of a female physician of unknown age who contracted <i>Salmonella infantis</i> from a patient after performing mouth to mouth resuscitation without a barrier. The patient had a 5 day history of a diarrheal illness resulting in death and the need for CPR. Samples from the patient and doctor revealed the same strain of Salmonella. The physician reportedly washed her hands after the encounter and had no other contact with the patient.	NA	Developed <i>Salmonella infantis</i> after performing mouth to mouth resuscitation on a person with a <i>Salmonella infantis</i> infection
Andreo 2004	Case Report	Very low	n=1, 59 yo female	Contracted disease during FA for seizure	A case report of a 59 year old female who contracted HIV from her 31 year old son after he bit her on the hand during a seizure. It is not reported why the mother was bitten during then seizure, but it appears to be though performing FA. Genetics were similar in the strains of the mother and son. The mother had no other apparent source of HIV exposure per the report.	NA	Developed HIV after being bit on the hand by an HIV positive person.

Brown 2020	Review Article		Systematic search n=8 articles, 1 SR, 2 retrospective cohort, 2 simulation, 1 case control, 1 cross-sectional, 1 case study	Contracted a disease transmitted by aerosol while performing chest compressions	NA	NA	Review article evaluating the literature regarding chest compressions as aerosolizing procedure. A literature review was performed of multiple databases using a standard search string and the literature included was described in a narrative fashion. Many of the studies included in this article were also identified in this current search. The reviewers concluded there was a paucity of data, all are observational, and of low certainty. The studies included that calculated the odds ratio of contracting respiratory illness from performing chest compressions varied from 0.4 – 4.5. A systematic review by Trans et al including this review gave a weighted pooled odds ratio of 1.4. Limitations include that many of the individuals that performed chest compressions also performed other procedures during resuscitation. Ultimately the authors concluded that further experimental studies are needed to determine if chest compressions are truly aerosolizing and in the absence of evidence they would recommend considering chest compressions an
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							aerosolizing procedure. con.
Chalumeau 2005	Case Report	Very low	n=1, male unknown age	Contracted disease during CPR	A case report of a physician who contracted <i>Staphylococcus aureus</i> from a 4 month old boy who needed resuscitation and intubation for a <i>Staphylococcus aureus</i> pneumonia. The physician who took part in the resuscitation and performed the intubation without protective equipment develop numerous furuncles of the fingers and face. The physician had a genetically similar strain of staph Aureus identified from surveillance samples.	NA	Developed <i>Staphylococcus aureus</i> of the skin from participating in a of a child with <i>Staphylococcus aureus</i> pneumonia.
Christian 2004	Case Series	Very low	n = 9 healthcare workers present during resuscitation of a patient with SARS-CoV.	Contracted SARS-CoV from resuscitation	A case series of 9 healthcare workers who participated in resuscitation of a patient with SARS-CoV with cardiac arrest. Three providers performed chest compressions for up to 15 minutes each. Two providers performed bag valve mask ventilation for between 5 and 15 minutes each. One provider performing chest compressions experienced viral symptoms but had a negative COVID-19 screen by RT-PCR. No other provider performing the above procedures experienced symptoms. Convalescent serum testing was indeterminant. However, a total of 3 of the 9 providers in the	NA	Three 3 of 9 providers developed viral symptoms suggestive of SARS-CoV . However (of the five that participated in convalescent serum testing) one was indeterminate as above and one was positive.

					room experienced viral symptoms suggestive of SARS-CoV. Five of the 9 agreed to convalescent serum testing, one was indeterminate as above and one was positive. The positive provider was involved in IV insertion, ECG lead placement and medication administration during the resuscitation.		
Couper 2020	Systematic Review		n = 11 articles, 2 cohort, 1 case control, 5 case reports, 3 manikin randomized control trials.	Risk of generating aerosols from chest compressions, defibrillation or CPR or transmission of infection through any of the above procedures.	None.		No direct evidence was found that chest compressions or defibrillation did / did not generate aerosols. Two case reports were found in which a healthcare worker contracted an infection from a patient receiving CPR. However in both cases patients received prolonged resuscitation likely incorporating ventilations. The researchers also did not find any direct evidence that chest compressions or defibrillation are / are not associated with transmission of aerosolized infection. Indirect evidence was found from 8 studies. In two cohort studies, no statistically significant association was found between healthcare workers exposed to chest compression or defibrillation and transmission of SARS. (Loeb 2004, Raboud 2010) In one case-control study a

							multivariate analysis suggested that exposure increased odds of probable SARS infection (OR 4.52, 95% CI 1.08-18.81). (Liu 2009) In five case reports there are reported transmission of infectious disease. PPE varied across the case reports. Studies were confounded by airway procedures in conjunction with chest compressions and defibrillation.
Cresswell 2018	Review article		Systematic literature search n = 13 articles, 2 case series, 11 case reports.	Contracted HIV through biting or spitting.	NA	NA	A systematic review evaluating the literature regarding the transmission of HIV through biting or spitting. There were no reported cases of HIV transmission related to spitting and nine cases identified following a bite, in which the majority occurred between family (six of nine), in fights involving serious wounds (three of nine), or to untrained first-aiders placing fingers in the mouth of someone having a seizure (two of nine). Only four cases were classified as highly plausible or confirmed transmission. The two related to first aid are also included in this review.

Finkelhor 1980	Case Report	Very low	n=1, 26 yo male	Contracted disease during CPR	A case report of a 26 year old male who contracted HSV after performing mouth to mouth ventilations on a 55 year old patient with no barrier device. He noticed abrasions on his lip after the resuscitation. Cultures from the patients mouth revealed she also had herpes simplex.	NA	Developed HSV after performing mouth to mouth ventilations
Heilman 1965	Case Report	Very low	n=1, 25 yo male	Contracted disease during CPR	A case report of a 25 year old male who contracted cutaneous tuberculosis after performing mouth to mouth resuscitation, without a barrier device, on a female with active pulmonary TB. The ppd of the male was negative prior to this and was positive 6 months after the resuscitation. 8 weeks after the resuscitation when person noted pustules on the nasolabial fold that developed into indurated ulcers that were positive for acid fast bacillus.	NA	Developed cutaneous tuberculosis after performing mouth to mouth resuscitation.
Hendricks 1980	Case Report	Very low	n=1, 27 yo male	Contracted disease during CPR	A case report of a 27 year old male who developed herpes simplex type 1 of the skin, along with fever and lymphadenopathy, after performing mouth to mouth resuscitation without a barrier device on a 51 year old woman. She developed respiratory arrest while infected with herpes simplex type 1 that was cultured from lung tissue. The male who contracted HSV had no prior history of HSV.	NA	Developed herpes simplex type 1 after performing mouth to mouth resuscitation.

Ingason 2021	Case Series	Very low	n = 23 healthcare providers who participated in resuscitation of a SARS-CoV patient who had cardiac arrest.	Transmission of SARS-CoV-2	Case series of a male in his thirties with SARS-CoV-2 who went into cardiac arrest and received advanced life support including intubation. None of the 23 healthcare professionals who participated the resuscitation developed COVID-19. During the exposure, none of the participants reported use of a mask and only two participants used protective clothes (9%). Ten participants reported using gloves during all patient contact (43%), while eight (35%) used gloves for some tasks requiring patient contact.	NA	No provider tested positive for SARS-CoV-2 for the 14 day monitoring period following exposure to a SARS-CoV positive person during resuscitation
Jackson 2020	Review Article		Systematic review, 128 documents included. Academic journals (n=31), supranational agencies (n=7), government agencies (n=72) and professional associations (n=17). (1 seems unaccounted for)	A rapid systematic review conducted in response to COVID-19 . A systematic review was performed using multiple databases based on PRISMA reporting methods. Potential procedures were divided into groups. Articles deemed eligible for inclusion were peer-reviewed journal articles, pre-prints, conference	NA	NA	One-hundred twenty eight documents were identified including peer-reviewed journal articles, pre-prints, conference proceedings and grey literature from a variety of sources such as healthcare organizations, agencies and government departments. These documents were reviewed regarding consensus on whether or not the procedure was considered aerosolizing. Intubation and extubation and manual ventilation were deemed

				proceedings and grey literature from a variety of sources such as healthcare organisations, agencies and government departments. 90% or greater agreement on a procedure group as aerosol-generating or possibly aerosol-generating as very strong consensus, and 80% or greater agreement as strong consensus.			a very high risk procedure. High consensus procedures (>80%) applicable to first aid or CPR were: cardiopulmonary resuscitation, non-invasive ventilation, high-flow oxygen therapy, nebulized or aerosol therapy, and coughing.
Liu, 2009	Case Control	Low	n = 51 SARS infected healthcare workers who had self-reported exposure to SARS patients. 426 uninfected healthcare workers from the same hospital with self-reported exposure to SARS patients were used as controls.	Contracted SARS from exposure to hospitalized SARS patients.	Demographic data (age, gender and ethnic group), personal medical history, coexisting conditions, work unit and ward, job description, SARS-related work behaviours, protection measures and training activities. Logistic regression was performed to estimate odds ratios (ORs) and their 95% confidence intervals (CI). Univariate analyses were conducted to determine the effect of each variable separately. A multivariate logistic regression was fitted using a	426 uninfected healthcare workers from the same hospital with self-reported exposure to SARS patients were used as controls.	Chest compressions were significantly associated with high risk for SARS infection. Contact: chest compression 15/477 OR 4.52 1.08–18.81 p= 0.031. However in multivariate analysis it was not possible to distinguish between chest compressions and intubation. Not wearing a mask was found to be a risk for contracting SARS.

					stepwise-forward procedure with all variables that were marginally significant ($P < 0.10$) in the univariate analyses as candidates for selection.		
Mejicano 1998	Review article		Narrative review in which the MEDLINE database and related bibliographies were searched from 1965 to 1998 to identify articles pertaining to the risk of acquiring and infectious disease through CPR or CPR training. n = 12 articles identified for infectious organisms transmitted through CPR. All observational in nature.	Documented transmission of infectious disease through either CPR or CPR training.			Twelve observational studies, comprised of 15 persons, were identified that reported the transmission of infectious disease during CPR. These studies are also identified in this Red Cross review. No studies were identified regarding cases of transmission from training courses. The authors concluded that the risk of acquiring an infectious disease during CPR or CPR training is low.
Nam 2017	Case Report	Very low	n = 1, 39 year old female healthcare worker exposed to MERS-CoV while performing CPR	Contracted disease during CPR	A case report of a 39 year old female who contracted MERS-CoV from being splashed with body fluid in the process of performing CPR on a MERS-CoV positive hospitalized individual. While the person was wearing personal protective equipment, she had her goggles slide down during the resuscitation and also wiped off her mask and goggles with a contaminated gloved hand.	NA	Developed MERS-CoV after performing CPR on a MERS-CoV positive person.
Ran 2020	Retrospective Cohort	Low	N = 72 health care worker with	Diagnosis of COVID-19	33 persons were in the high risk job group	39 persons were in the	The high risk group had a 2.13 RR of developing

			respiratory symptoms were classified as high risk or general risk groups based on their job location. The outcome of interest with diagnosis of COVID-19			general risk job groups	COVID-19 compared with the general risk group. Unqualified hand washing (undefined what this means), suboptimal hand hygiene and improper PPE (undefined what this means) were associated with an increased risk of contracting COVID-19 with RR of 2.64 (95% CI = 1.04-6.71), 3.10 (95% CI = 1.43-6.73), and 2.43 (95% CI = 1.34-4.39), respectively.
Sun 1995	Review article		A narrative review discussing the risk of acquiring HIV from salivary exchange through resuscitation training and mouth to mouth resuscitation.	Transmission of HIV through contact with saliva from persons infected with HIV.	NA	NA	A narrative review that includes case reports and scientific research on the HIV transmission through human bites from HIV infected persons, the possibility of transmission through oral/genital contact, the effect of saliva on the viability of HIV and effect presence of HIV in saliva, and the possibility of transmitting HIV through CPR manikins and mouth to mouth resuscitation. The authors concluded that the risk of transmission of HIV and other infectious diseases by saliva during CPR training practice is extremely low, however it is necessary to perform decontamination after contact with each CPR trainee. Mouth-to-mouth resuscitation should be carried out with a barrier device.
Todd 1980	Case Report	Very low	n = 1 Healthcare worker exposed to	Contracted disease during CPR	A case report of a male of unknown age who	NA	Developed <i>Shigella sonnei</i> infection after

			<i>Shigella sonnei</i> after performing mouth to mouth ventilations		developed <i>Shigella sonnei</i> after performing mouth to mouth ventilations without a barrier on a 3 year old child who died with a <i>Shigella sonnei</i> infection.		performing mouth to mouth ventilations in a infected person.
Tran 2012	Systematic Review		Systematic review from 01/01/1990 to 22/10/2010 that included 10 studies, 5 case control and 5 retrospective cohort studies.	Risk of Acute Respiratory Infection (ARI) transmission in healthcare providers exposed to patients undergoing aerosol generating procedures compared to those caring for patients not undergoing aerosol generating procedures.	NA	NA	Pooled estimates of the risk of transmission during chest compressions in two cohort studies were not statistically significant. (Raboud 2010, Loeb 2004) However one case control study found that chest compressions were a risk factor for transmission of SARS. (Liu 2009) Similarly the risk of transmission of aerosolized infections during defibrillation was not found to be statistically significant. (Raboud 2010, Loeb 2004).
Valenzuela 1990	Case Report	Very low	n= 1 worker exposed to <i>Strep pyogenes</i> while performing bag-valve-mask ventilation	Contracted disease during CPR	A case report of a 30 year old male whose hand's were contaminated with sputum while performing bag-valve-mask ventilation on a child during resuscitation. The individual sustained a small abrasion to the hand during clean-up. He subsequently developed a fever, vomiting and diarrhea and had to be hospitalized for cellulitis and "toxic shock syndrome" due to <i>Strep pyogenes</i> . Serologically similar <i>S pyogenes</i> was isolated from the child who received the initial resuscitation.	NA	Developed cellulitis and "toxic shock syndrome" due to <i>Strep pyogenes</i> after exposure to contaminated sputum during resuscitation.

Vidmar 1996	Case Report	Very low	n = 1 male exposed to HIV while performing first aid on an individual during a seizure	Contracted disease during FA for seizure	A case report of a 53 year old male who contracted HIV after he was bitten on the fingers by an HIV positive individual during a seizure. The individual placed his fingers in the person's mouth to try to prevent airway obstruction. The bite resulted in a shallow wound on the finger without visible bleeding, there was blood in the mouth of the individual having the seizure. The bitten person washed his hands about half an hour after the injury. The person was HIV negative the day of the bite but developed fatigue, headache and sore throat 33 days after the bite and was subsequently found to be HIV positive. There were no other known exposures.	NA	Contracted HIV after human bite for an HIV positive person.
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Level of Evidence	Definitions (See manuscript for full details)
Level 1a	<u>Experimental and Population based studies</u> - population based, randomized prospective studies or meta-analyses of multiple higher evidence studies with substantial effects
Level 1b	<u>Smaller Experimental and Epidemiological studies</u> - Large non-population based epidemiological studies or randomized prospective studies with smaller or less significant effects
Level 2a	<u>Prospective Observational Analytical</u> - Controlled, non-randomized, cohort studies
Level 2b	<u>Retrospective/Historical Observational Analytical</u> - non-randomized, cohort or case-control studies
Level 3a	<u>Large Descriptive studies</u> – Cross-section, Ecological, Case series, Case reports
Level 3b	<u>Small Descriptive studies</u> – Cross-section, Ecological, Case series, Case reports
Level 4	<u>Animal studies or mechanical model studies</u>
Level 5	<u>Peer-reviewed Articles</u> - state of the art articles, review articles, organizational statements or guidelines, editorials, or consensus statements

Level 6	<u>Non-peer reviewed published opinions</u> - such as textbook statements, official organizational publications, guidelines and policy statements which are not peer reviewed and consensus statements
Level 7	<u>Rational conjecture</u> (common sense); common practices accepted before evidence-based guidelines
Level 1-6E	<u>Extrapolations</u> from existing data collected for other purposes, theoretical analyses which is on-point with question being asked. Modifier E applied because extrapolated but ranked based on type of study.

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Appendix

[American Red Cross First Aid/CPR/AED Instructor's Manual 2019](#)

[American Red Cross First Aid/CPR/AED Participant's Manual 2016](#)

[American Red Cross Scientific Advisory Committee COVID-19 and Resuscitation-ANSWERS](#)

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