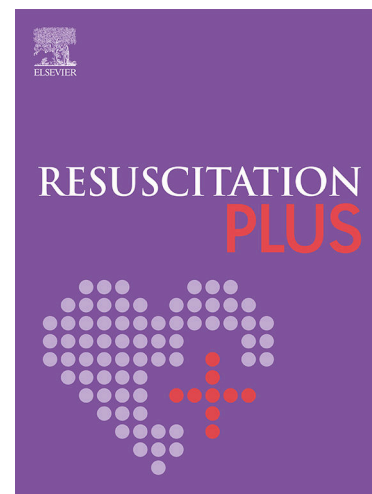


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Potential Harms to Rescuers During Cardiac Arrest Response and Resuscitation: A Scoping Review

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Potential Harms to Rescuers During Cardiac Arrest Response and Resuscitation: A Scoping Review

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Abstract

Background: Rescuer safety during cardiac arrest response and resuscitation is an important consideration that may influence willingness to intervene. This scoping review identifies potential unintentional harms to rescuers responding to cardiac arrest and performing resuscitation.

Methods: This scoping review was reported in accordance with PRISMA-ScR guidelines. We searched EMBASE, Medline, and Cochrane from inception to June 16, 2026, including all human studies reporting physical harms during cardiac arrest response or resuscitation (compressions, ventilation, defibrillation). Two investigators screened studies and extracted data. Synthesis was guided by Joanna Briggs Institute methods, with narrative synthesis by harm category.

Results: Twenty studies were included: sixteen provided direct evidence from cardiac arrest or resuscitation, and four provided indirect evidence from elective cardioversion. Of the direct-evidence studies, nine examined infection transmission during CPR, two evaluated electrical exposure from implantable cardioverter-defibrillators (ICDs) during CPR, two reported physical injuries en route to arrest, and three documented drowning during rescue. Infection transmission rates varied by pathogen but were mitigated by personal protective equipment (PPE). CPR near implantable cardioverter-defibrillators (ICDs) showed potential for higher leakage. In the four indirect-evidence studies, current leakage to rescuers during external shocks delivered for elective cardioversion remained below safe thresholds. One study reported minor injuries from incorrect opening of locked AED cabinets, and another found that injuries en route to patients were rare (<0.7%). Rescue-related drowning fatalities ranged from 0.02 to 0.08 per 100,000 population annually.

Conclusions: This scoping review suggests harms to rescuers during response or resuscitation are rare. Fatal harms have been reported during water rescue. Minor harms include unsafe AED removal, current leakage during ICD shock delivery, performing CPR without appropriate PPE, and minor injuries en route to a cardiac arrest. Indirect evidence from elective cardioversion suggests external defibrillation poses minimal electrical risk.

Introduction

Cardiopulmonary resuscitation (CPR) is a life-saving intervention that requires rescuers to physically engage with patients in cardiac arrest. Rescuer safety is an important consideration that may influence both willingness to intervene and the quality of resuscitation. Understanding the potential harms associated with responding to cardiac arrest and performing resuscitation can inform guidelines, training programs, and safety protocols.

The International Liaison Committee on Resuscitation (ILCOR) Basic Life Support Task Force last addressed rescuer safety in a 2020 scoping review focused on harm to rescuers during CPR [1]. The review identified limited evidence from five experimental studies and one case report, suggesting that performing CPR and the delivery of defibrillator shocks appeared relatively safe. [1]

Since the 2020 review, new evidence has emerged on rescuer safety, particularly regarding infectious disease transmission during the COVID-19 pandemic, on AED acquisition and rescue in aquatic environments. This scoping review aims to identify and characterize potential unintentional physical harms to rescuers during cardiac arrest response, cardiopulmonary resuscitation (CPR) and defibrillation, and patient rescue from hazardous environments.

Methods

This scoping review was conducted using the ILCOR methodological framework and conflict of interest management [2], and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Supplement 1) [3].

This scoping review followed a prespecified PICOST template. [1] (Table 1) Before initiating literature searches, the review was evaluated and approved by a member of the ILCOR scientific advisory committee and registered a priori with ILCOR

Information Sources and Search Strategy

A single information specialist developed the search, with peer-review confirmation. We searched EMBASE, Medline, and Cochrane from inception to June 16, 2026 (Medline search provided in Supplement 2; other databases available from the authors). The search strategy included terms for rescuers (rescuer, single rescuer, savior, deliverer), cardiac arrest (heart arrest, cardiac arrest, cardiovascular arrest, cardiopulmonary arrest, out-of-hospital cardiac arrest, OHCA), resuscitation procedures (cardiopulmonary resuscitation, CPR, basic life support, heart massage, cardiac massage, chest compression, ventilation, defibrillation, electric countershock, automated external defibrillator, AED), and harm outcomes (harm, danger, injury, trauma, damage, adverse effects, safety, hazard, disease transmission, infection). MeSH terms and Embase exploded terms were included.

Eligibility Criteria

Inclusion criteria. We included studies of individuals rescuing adults or children during out-of-hospital or in-hospital cardiac arrest, in which the exposure was responding to a person in cardiac arrest and/or performing resuscitation (ventilations, chest compressions, defibrillation), and in which any unintentional physical harm to the rescuer (e.g., infection, injury, morbidity, death) was reported as an outcome, including the number of cases. Eligible study designs encompassed randomized controlled trials and non-randomized studies, including cohort studies, case-control studies, cross-sectional surveys, case series, and case reports. Studies published in any language were eligible if they had an English abstract. We prespecified studies of defibrillation or cardioversion in patients presumed but not confirmed to be in cardiac arrest or confirmed not to be in cardiac arrest (e.g., elective cardioversion), as indirect evidence; we retained them to inform the electrical-safety question.

Exclusion criteria. We excluded unpublished studies, simulation and manikin studies, animal studies, studies evaluating personal protective equipment as the primary intervention (systematically reviewed by ILCOR in 2020), studies in which rescuer fatigue was the primary outcome, studies of psychological harm (the subject of a separate ILCOR mixed-methods review), intentional injuries, training-related injuries, and harms occurring in extreme environments (mountainous terrain, low gravity, or military deployment).

Selection of Sources of Evidence

Search results were imported into Covidence Software (Veritas Health Innovation, Melbourne, Australia) for screening. Two reviewers (AL, BD) independently screened titles and abstracts for eligibility. Conflicts were adjudicated by a third senior reviewer (LJM). Full-text articles were obtained for potentially relevant studies, and after independent review, final inclusion decisions were made through discussion and consensus.

Data Charting Process and Synthesis

Following the Joanna Briggs Institute structure [4], data charting and synthesis were conducted by one of three reviewers (AL, BD, VD). The extracted data were checked by a reviewer who was not an author of the study. A standardized form captured study design, setting, population, type of harm, sample size, exposure details, and a summary of harm outcomes. Given anticipated variation in study design, populations, and outcomes, a narrative synthesis was performed. After data extraction, we categorized the data into harm subtypes and classified each study as direct evidence (harm occurring during actual cardiac arrest response or resuscitation) or indirect evidence (harm measured during defibrillation or cardioversion in patients not in cardiac arrest). The synthesis was interpreted through discussion among the research team and resuscitation science experts from the ILCOR Basic Life Support Task Force.

Results

Selection of Sources of Evidence

Twenty studies were identified from the search of 2005 articles (Figure 1) and included in this review [5-24]. Sixteen studies provided direct evidence of harm during actual cardiac arrest response or resuscitation, and four studies of hands-on defibrillation during elective cardioversion provided indirect evidence [11, 18, 23, 24]. Among the direct-evidence studies, eleven investigated intra-arrest harm to rescuers, including nine reporting infection transmission [6-10, 13, 15, 17, 21] and two reporting electrical exposure from implantable cardioverter-defibrillators (ICDs) [20, 22]. One study investigated potential harm to the rescuer responding to a cardiac arrest [5], and another examined harm during retrieval of an AED [19]. Three studies examined harms during water rescue [12, 14, 16] (Table 2-5).

Infectious Risks During Resuscitation

Nine studies examined infection transmission risks during CPR, spanning pathogens including COVID-19, SARS, severe fever with thrombocytopenia syndrome (SFTS), and Panton-Valentine Leukocidin-producing *Staphylococcus aureus* [6-10, 13, 15, 17, 21]. Infection rates varied across studies, influenced by pathogen type, PPE use, and specific resuscitation procedures. Studies [6, 15] of SFTS reported notably high infection rates among those performing CPR, with one study finding 57% (4/7) of CPR-involved healthcare workers infected, compared with 15% overall. [15] Two SARS studies [10, 17] identified chest compressions and contact with respiratory secretions as significant risk factors [10], with one reporting an odds ratio of 4.52 (95% CI 1.08–18.81) for chest compressions [17]. Among COVID-19 studies, [7, 8, 13, 21] findings were mixed. One large EMS study [8] attributed a single transmission to a patient encounter involving aerosol-generating procedures out of 1,592 personnel, while a PICU study [7] found that CPR accounted for 9.6% of patient-contact infections, lower than intubation (21%) or non-invasive ventilation (12.2%). One study comparing healthcare workers performing CPR with Level 3 PPE to a non-CPR control group found no significant difference in COVID-19 infection rates (2.5% vs. 5.1%, $p=0.3$) [21]. (Table 2)

Defibrillation-Related Risks

Indirect evidence from elective cardioversion. Four studies examined current leakage to rescuers during hands-on external defibrillation, but all were conducted during elective cardioversion of patients who were not in cardiac arrest, with investigators acting as rescuers under controlled conditions [11, 18, 23, 24]. In accordance with the protocol, these studies were treated as indirect evidence. They tested Class 1 insulating gloves [11], polyethylene medical gloves [18], or polyethylene drapes [23, 24]. In these four studies, researchers delivered 140 shocks at 100J, 200J, and 360J [11, 18, 23, 24]. Current leakage remained below safe thresholds of 1 mA during simulated CPR regardless of insulation method, shock energy, or whether drapes had been stretched by prior CPR. No shocks were perceptible to rescuers in these studies. (Table 3)

Two studies provided direct evidence of electrical risk to rescuers during resuscitation, both involving implantable cardioverter-defibrillators (ICDs) [20, 22]. Implantable cardioverter-defibrillators (ICDs) have a distinct risk profile. One study showed that current leakage from subcutaneous and transvenous ICDs exceeded the 1 mA safe threshold during CPR. [20] Subcutaneous devices produced higher leakage than transvenous devices. This risk was reduced when chest compressions were performed on the side opposite the ICD. [20] A single case report described peripheral nerve injury, with ulnar and median nerve damage confirmed by

nerve conduction studies, in a rescuer who received an ICD shock from a normally functioning ICD while performing chest compressions with hands positioned on the same side of the chest as the implanted device.. The sensory symptoms lasted six months [22]. (Table 3)

Physical Injuries During Response and AED Retrieval

Two surveys examined physical injuries among community responders en route to a patient. In both studies [5, 19], injuries were minor, and only one respondent required hospitalization (ankle fracture) [5]. In one study, injuries were predominantly due to lacerations from breaking glass in locked AED cabinets [19]. Table 4)

Drowning During Aquatic Rescue

Three studies reported fatal drownings during bystander rescue attempts in aquatic environments [12, 14, 16]. Annual rescue-related drowning fatality rates were low in absolute terms, ranging from 0.02 to 0.08 per 100,000 population in studies from Australia and Turkey [14, 16]. Fatal events were concentrated in a consistent demographic: mostly male victims (68–90%), aged 18–44 years (60–69%), most often attempting to rescue a family member [12, 14, 16].(Table 5)

Discussion

Summary of Evidence

This scoping review has summarized the potential physical harms to rescuers during the response to cardiac arrest and during resuscitation. Overall, despite the large number of resuscitations globally, reported injury rates were low and occurred in specific circumstances.

Infection transmission was the most frequently studied harm in this review. In 2020, based on limited evidence, Couper et al. were unable to determine whether chest compressions or defibrillation produce aerosols or pose a risk of COVID-19 transmission to rescuers [25]. In our review, several studies reported significant infection transmission during CPR; however, substantial heterogeneity existed across pathogens, settings, methods for estimating transmission rates, and the use of protective measures. Higher infection rates were consistently observed when PPE was absent or improperly used. Studies with incomplete or suboptimal PPE use reported substantially higher transmission rates [6, 7, 15], whereas studies with systematic PPE protocols reported lower rates. Sample sizes were generally small, and confidence intervals were wide. However, these findings suggest that infection transmission during resuscitation may occur and properly worn PPE during CPR may be preventative.

Our review suggests that defibrillation with external defibrillators poses minimal risk to rescuers when appropriate protective measures are in place. No direct evidence of harm to rescuers from external defibrillation during actual resuscitation was identified. A randomized, blinded simulation study evaluated whether rescuers could detect defibrillation shocks while performing manual chest compressions on a cadaver with various protective barriers. The results showed that nitrile gloves and a neoprene pad prevented perceived detection of defibrillation in 99% of shocks [26]. However, these findings may not reflect real-world conditions, in which lay rescuers

may use nitrile or latex gloves or go bare-handed, making it unclear how this translates into practice. This scoping review suggests that in real-world conditions, there may be minimal risk. Across 140 shocks in four studies, current leakage consistently remained below safe thresholds (<1mA) regardless of energy level or insulation method, and no shocks were perceptible to rescuers.

ICDs present a different risk profile. One study found that current leakage exceeded safe thresholds, but this decreased when chest compressions were performed on the opposite side of the ICD [20] [22]. These findings suggest that rescuers should be aware of the potential for ICD discharge during CPR and, when possible, perform compressions on the opposite side of the device.

Two surveys of community responders reported minor injuries sustained while responding to an OHCA, which rarely require hospitalization. The larger survey suggests these events are rare [5], and in the second, injuries may have occurred because responders did not follow instructions for unlocking AED cabinets [19].

Fatal drowning during attempted bystander rescue, although rare at the population level, was the only fatal harm to rescuers identified in this review. The observed demographic pattern, predominantly males aged 18-44 attempting to rescue family members, mirrors that reported in the broader drowning-prevention literature. These findings support existing water-safety guidance that emphasizes rescue methods that avoid entering the water (e.g., reach, throw, and call for professional assistance) and suggest that resuscitation guidelines, first-aid curricula, and lifesaving training programs should continue to teach and reinforce safe rescue techniques for potential bystanders. Knowledge gaps remain regarding the circumstances that lead bystanders to attempt in-water rescues and the effectiveness of public education in preventing rescuer drowning. Although the current evidence is of low quality and insufficient to warrant a systematic review, the rarity of reported harms may reassure instructors, trainees, and potential rescuers.

Comparison with Previous Reviews

The 2020 ILCOR scoping review on harm to rescuers during CPR identified limited evidence and suggested that performing CPR appears relatively safe [1]. This updated review confirms that suggestion while substantially expanding the evidence base. The inclusion of studies on infection transmission, particularly from the COVID-19 pandemic era, and the addition of evidence on rescue in aquatic environments, provides a more comprehensive picture of the potential harms rescuers may face.

The routine collection of rescuer resuscitation-related injuries in out-of-hospital and in-hospital cardiac arrest registries would provide ongoing surveillance data to inform practice, training, and policy, and provide ongoing assurance for potential rescuers and systems of care.

Limitations

This scoping review has several limitations. Many studies had small sample sizes, and some relied on self-reported outcomes. There was substantial heterogeneity in study design and definitions. We excluded simulation studies because this review focused on harms during actual resuscitation events; consequently, some safety data generated in simulated settings were not captured. The only evidence on hands-on external defibrillation came from elective cardioversion in patients not in cardiac arrest and is therefore indirect; no study measured electrical exposure to rescuers during actual resuscitation. Grey literature was not searched and may contain supplemental data. Additionally, the pre-planned exclusion of psychological harms and fatigue, assigned to separate qualitative reviews or synthesis, means this review does not capture the full burden of harm to rescuers.

Conclusions

Limited observational data suggest that rescue-related risks are rare despite the large number of resuscitations performed globally. The current evidence is insufficient to warrant a systematic review. Harms to rescuers during cardiac arrest response or resuscitation are rare, though they have been reported in specific situations. Training programs and public awareness campaigns may benefit from addressing these specific risks while emphasizing the overall safety of bystander intervention and the critical importance of rapid response to cardiac arrest.

Declarations

Declaration of transparency/disclosure

Given their role as an Associate Editor, Janet Bray, had no involvement in the peer review of this article and had no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to another journal editor.

Conflict of Interest: The ILCOR Continuous Evidence Evaluation process is guided by a rigorous ILCOR Conflict of Interest policy. No Task Force members or authors were recused from discussion due to conflicts of interest. No intellectual conflicts of interest were declared.

Declaration of Interest: Given their role as Associate Editor, Janet Bray had no involvement in the peer-review of this article and has no access to information regarding its peer-review. Full responsibility for the editorial process for this article was delegated to another journal editor.

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References

- [1] Olasveengen TM, Mancini ME, Perkins GD, Avis S, Brooks S, Castrén M, et al. Adult basic life support: 2020 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Circulation*. 2020;142:S41-S91.
- [2] Morley PT, Berg KM, Billi JE, Nolan JP, Montgomery WH, Atkins DL, et al. Methodology and conflict of interest management: 2025 international liaison committee on resuscitation consensus on science with treatment recommendations. *Circulation*. 2025;152:S23-S33.
- [3] Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*. 2018;169:467-73.
- [4] Aromataris E, Munn Z. JBI manual for evidence synthesis: Jbi; 2020.
- [5] Andelius L, Hansen CM, Tofte Gregers MC, Kragh AMR, Køber L, Gislason GH, et al. Risk of physical injury for dispatched citizen responders to out-of-hospital cardiac arrest. *Journal of the American Heart Association*. 2021;10. doi: 10.1161/JAHA.121.021626
- [6] Bae S, Chang HH, Kim SW, Kim Y, Wang E, Kim CK, et al. Nosocomial outbreak of severe fever with thrombocytopenia syndrome among healthcare workers in a single hospital in Daegu,

Korea: Nosocomial SFTS outbreak among healthcare workers. *International Journal of Infectious Diseases*. 2022;119:95-101. doi: <https://dx.doi.org/10.1016/j.ijid.2022.03.048>

[7] Botan E, Uyar E, Ozturk Z, Sevketoglu E, Sari Y, Dursun O, et al. COVID-19 Transmission and Clinical Features in Pediatric Intensive Care Health Care Workers. *Turkish archives of pediatrics*. 2022;57:93-8. doi: <https://dx.doi.org/10.5152/TurkArchPediatri.2022.21205>

[8] Brown A, Schwarcz L, Counts CR, Barnard LM, Yang BY, Emert JM, et al. Risk for Acquiring Coronavirus Disease Illness among Emergency Medical Service Personnel Exposed to Aerosol-Generating Procedures. *Emerging infectious diseases*. 2021;27:2340-8. doi: <https://dx.doi.org/10.3201/eid2709.210363>

[9] Chalumeau M, Bidet P, Lina G, Mokhtari M, Andre M-C, Gendrel D, et al. Transmission of Pantan-Valentine leukocidin-producing *Staphylococcus aureus* to a physician during resuscitation of a child. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America*. 2005;41:e29-30. doi: <https://dx.doi.org/10.1086/431762>

[10] Christian MD, Loutfy M, McDonald LC, Martinez KF, Ofner M, Wong T, et al. Possible SARS coronavirus transmission during cardiopulmonary resuscitation. *Emerging infectious diseases*. 2004;10:287-93. doi: <https://dx.doi.org/10.3201/eid1002.030700>

[11] Deakin CD, Thomsen JE, Lofgren B, Petley GW. Achieving safe hands-on defibrillation using electrical safety gloves--a clinical evaluation. *Resuscitation*. 2015;90:163-7. doi: <https://dx.doi.org/10.1016/j.resuscitation.2014.12.028>

[12] Franklin RC, Peden AE, Brander RW, Leggat PA. Who rescues who? Understanding aquatic rescues in Australia using coronial data and a survey. *Australian and New Zealand journal of public health*. 2019;43:477-83. doi: <https://dx.doi.org/10.1111/1753-6405.12900>

[13] Ghazali DA, Ouersighni A, Gay M, Audebault V, Pavlovsky T, Casalino E. Feedback to Prepare EMS Teams to Manage Infected Patients with COVID-19: A Case Series. *Prehospital and disaster medicine*. 2020;35:451-3. doi: <https://dx.doi.org/10.1017/S1049023X20000783>

[14] Isin A, Turgut A, Peden AE. Descriptive Epidemiology of Rescue-Related Fatal Drowning in Turkey. *International journal of environmental research and public health*. 2021;18. doi: <https://dx.doi.org/10.3390/ijerph18126613>

[15] Kim WY, Choi W, Park S-W, Wang EB, Lee W-J, Jee Y, et al. Nosocomial transmission of severe fever with thrombocytopenia syndrome in Korea. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America*. 2015;60:1681-3. doi: <https://dx.doi.org/10.1093/cid/civ128>

[16] Lawes JC, Rijkse EJT, Brander RW, Franklin RC, Daw S. Dying to help: Fatal bystander rescues in Australian coastal environments. *PloS one*. 2020;15:e0238317. doi: <https://dx.doi.org/10.1371/journal.pone.0238317>

[17] Liu W, Tang F, Fang LQ, De Vlas SJ, Ma HJ, Zhou JP, et al. Risk factors for SARS infection among hospital healthcare workers in Beijing: a case control study. *Tropical Medicine & International Health*. 2009;14:52-9.

[18] Lloyd MS, Heeke B, Walter PF, Langberg JJ. Hands-on defibrillation: an analysis of electrical current flow through rescuers in direct contact with patients during biphasic external defibrillation. *Circulation*. 2008;117:2510-4. doi: <https://dx.doi.org/10.1161/CIRCULATIONAHA.107.763011>

[19] NG Jonathan Shen You , HO Reuben Jia Shun , YU Jae Yong, NG Yih Yng. Factors influencing success and safety of AED retrieval in out of hospital cardiac arrests in Singapore. *The Korean Journal of Emergency Medical Services*. 2022;26:97-111.

[20] Petley GW, Albon B, Banks P, Roberts PR, Deakin CD. Leakage current from transvenous and subcutaneous implantable cardioverter defibrillators (ICDs): A risk to the rescuer? *Resuscitation*. 2019;137:148-53. doi: <https://dx.doi.org/10.1016/j.resuscitation.2019.02.011>

[21] Soni L, Maitra S, Ray BR, Anand RK, Subramaniam R, Baidya DK. Risk of sars-cov-2 infection among health-care providers involved in cardiopulmonary resuscitation in covid-19 patients. *Indian Journal of Critical Care Medicine*. 2021;25:921-3. doi: 10.5005/jp-journals-10071-23924

- [22] Stockwell B, Bellis G, Morton G, Chung K, Merton WL, Andrews N, et al. Electrical injury during "hands on" defibrillation-A potential risk of internal cardioverter defibrillators? *Resuscitation*. 2009;80:832-4. doi: <https://dx.doi.org/10.1016/j.resuscitation.2009.04.010>
- [23] Wight JA, Iravanian S, Haouzi AA, Lloyd MS. Hands-on defibrillation with a safety barrier: An analysis of potential risk to rescuers. *Resuscitation*. 2019;138:110-3. doi: <https://dx.doi.org/10.1016/j.resuscitation.2019.02.043>
- [24] Wight JA, Bigham TE, Hanson PR, Zahid A, Iravanian S, Perkins PE, et al. Hands-on defibrillation with safety drapes: Analysis of compressions and an alternate current pathway. *American Journal of Emergency Medicine*. 2022;52:132-6. doi: 10.1016/j.ajem.2021.11.044
- [25] Couper K, Taylor-Phillips S, Grove A, Freeman K, Osokogu O, Court R, et al. COVID-19 in cardiac arrest and infection risk to rescuers: A systematic review. *Resuscitation*. 2020;151:59-66. doi: <https://dx.doi.org/10.1016/j.resuscitation.2020.04.022>
- [26] Wampler D, Kharod C, Bolleter S, Burkett A, Gabehart C, Manifold C. A randomized control hands-on defibrillation study—barrier use evaluation. *Resuscitation*. 2016;103:37-40.

Table 1. Eligibility Criteria

Population	Individuals rescuing adults or children in out-of-hospital or in-hospital cardiac arrest and/or performing resuscitation.
Exposure	Responding to children or adults in cardiac arrest and/or performing resuscitation (ventilations, compressions, defibrillation) out-of-hospital and in-hospital.
Outcomes	Any reported outcome and the number of cases of unintentional physical harm (e.g., infection, morbidity, death).
Study Design	Randomized controlled trials and non-randomized studies (cohort studies, case-control studies, case series, case reports) were eligible. Studies published in any language were included if an English abstract was available. Data from defibrillation and cardioversion on patients who were either presumed to be in cardiac arrest but not confirmed, or confirmed not to be in cardiac arrest, were used as indirect evidence.
Timeframe	Databases searched from inception to June 16, 2026.
Exclusions	We excluded: unpublished studies, simulation studies, animal studies, studies evaluating personal protective equipment (systematically reviewed in 2020), studies with fatigue as the primary outcome, psychological harm studies (subject of a separate mixed-methods review), intentional injuries, training-related injuries, and harms in extreme environments (mountainous areas, low-gravity, military deployments).

Table 2. Studies reporting infectious risks associated with resuscitation

Category	Primary Author, Year	Design/Setting	Type of Harm	Sample Size/Population	Exposure	Summary of Harm
During CPR (infection)	Bae, 2022 [6]	Case Report, One hospital ICU, South Korea	Severe fever with thrombocytopenia syndrome (STS). PPE: mask and gloves (less than half worn correctly)	59 healthcare workers exposed to one patient; 17 infected	Compared to non-infected HCWs, there was a higher exposure of infected HCW to bag valve mask ventilation (52.9% vs. 13.0%, $p=0.018$) and cardiac massage (35.3% vs. 4.3%, $p=0.034$). Any exposure to body fluids was also much higher in the infected group (76.5% vs 30.4%, $p=0.016$).	Higher proportion infected when doing CPR & BVM
During CPR (infection)	Botan, 2022 [7]	Retrospective Cohort, 16 hospitals PICU, Turkey	COVID-19. PPE: eye protection, N95 Mask, Gloves and Gown (approx. 49% used all PPE)	768 PICU staff; 114 COVID-19 positive healthcare workers. 62 infected through patient contact.	Of the 114, 62 HCWs were infected during patient contact, endotracheal intubation (21%), CPR (9.6%), non-invasive ventilation (12.2%), and other procedures (43.8%). The remaining HCWs were infected due to factors other than patient 45.6%.	Higher proportion of patients infected with airway or ventilation than with CPR
During CPR (infection)	Brown, 2021 [8]	Retrospective cohort study, One EMS, USA	COVID-19. PPE: mask, eye protection, gloves, and gown. Surgical masks considered sufficient for non-AGP, N95 required for AGPs. HEPA filters added to ventilation bags	COVID-19 encounters: 1,592 EMS Personnel, 1,383 incidents attended 3,710 personnel-patient interactions (All encounters 1,592, AGP 567, non-AGP 1,025)	30 EMS Personnel tested positive for COVID-19. 29 of 30 COVID-19 illnesses among EMS providers were not directly attributed to COVID-19 patient encounters. Only 1 case was attributed to a patient encounter involving AGP	Single case of transmission involving aerosol-generating procedures

During CPR (Infection)	Chalumeau, 2005 [9]	Case Report (Hospital in Paris)	Transmission of Pantan-Valentine Leukocidin (PVL)-producing Staphylococcus aureus to a physician. PPE: none	Furunculosis was exhibited by a physician following resuscitation of an infant with fatal pneumonia (infected with PVL-producing S. aureus)	Physician attending on a 4-month-old baby with bronchiolitis who subsequently suffered a cardiac arrest. Resuscitation measures included oral intubation, oxygenation, bag-valve-mask ventilation, and chest compressions in the general ward. S. aureus strains susceptible to methicillin were isolated from samples from 5 other health care workers who had participated in resuscitation along with the physician.	Possible harm through the transmission of pathogens from patient to caregiver (need for personal protection even in situations where benign infections are suspected)
During CPR (infection)	Christian, 2004 [10]	Case Report, One Hospital, Canada	SARS. PPE: two gowns, two sets of gloves, goggles, a full-face shield (with the exception of RN1 and RN2), shoe covers, hair cover, and NIOSH-approved N95 disposable respirators that were not fit-tested	9 healthcare workers involved in the resuscitation of 1 SARS patient	1 confirmed SARS-CoV infection (positive serology), 1 probable case, 1 symptomatic but not meeting case definition	Three cases of potential transmission from exposure of 9 HCWs
During CPR (infection)	Ghazali, 2020 [13]	Four Case series, EMS, France	COVID-19. Case #1 PPE: glasses and surgical mask worn by physician, no PPE worn by Nurse or EMS. Cases #2-4 PPE: not reported	Case #1: CPR and Intubation, 2 of 4 HCWs positive for COVID-19. Case #2: non-invasive ventilation and oxygen administered, 1 of 4 HCWs infected. Case #3: patient intubated with a difficult airway, 1 of 4 HCWs infected. Case #4: patient administered oxygen, no EMS infected, one ED nurse infected on arrival.	This was a case series with only 1 of 4 cases receiving CPR; in that case, 2 of the 4 EMS personnel became infected.	Four respiratory cases, one with CPR 50% infection, three other cases involving aerosol-generating procedures 25% infection
During CPR (infection)	Kim, 2015 [15]	Case Report, One Hospital, South Korea	Severe fever with thrombocytopenia syndrome (STS). PPE: None of the HCWs used a face shield or goggles. 9	27 healthcare workers were exposed to 1 STS patient. 7 were involved in CPR.	Infection rate 15% (4/27) overall, 57% (4/7) among those involved in CPR.	Higher proportion of infected when doing CPR

			HCWs wore a surgical mask, 5 wore gloves, and 3 wore a surgical mask and gloves.			
During CPR (Infection)	Liu, 2009 [17]	Retrospective case control study (in Armed Forces Hospital- Beijing, China)	SARS infection. PPE: Two kinds of personal protective equipment were studied, face protection and body protection. Six categories of most often used masks were identified from the participating staff: disposable mask, surgical mask, 12-layer cotton surgical mask, 16-layer cotton surgical mask, N95, and higher-level protective respirator.	477 completed questionnaires. 51 from infected staff and 426 from uninfected controls. Case group: HCWs diagnosed as probable SARS cases admitted between March and May 2003. Controls: eligible uninfected HCWs who worked in the same hospital and had self-reported exposure to SARS patients between March and May 2003.	Performing chest compression (or intubation, which is highly correlated), contact with respiratory secretion, and emergency care experience were considered risk factors for acquiring SARS infection. Contact: chest compressions (OR 4.52), 95% CI (1.08-18.81), P value 0.031. Contact: respiratory secretions (OR 3.27), 95% CI (1.41-7.57), and P value 0.006. Contact: intubation Contact: chest compression-correlation coefficient 0.201 and P value <0.001	Exposure to high-risk procedures (chest compression) and contact with respiratory secretions are significant risk factors for SARS infection among HCWs
During CPR (infection)	Soni, 2021[21]	Retrospective Cross-sectional Survey, designated area of New Delhi, India	COVID-19. PPE: Level 3 (not further described). Noted that 3% of HCWs had a breach of PPE during CPR	393 healthcare providers working in COVID-19 designated areas (197 CPR group, 196 control group)	15/393 were infected. 5/197 (2.53%) in the CPR group vs 10/196 (5.10%) in the control group developed COVID-19, p value: 0.3	No significant difference in proportion of infected doing CPR vs. no-CPR

Table 3. Studies reporting risks associated with electrical exposure, including defibrillation during resuscitation

Category	Primary Author, Year	Design/Setting	Type of Harm	Sample Size/Population	Exposure	Summary of Harm
During CPR (Shock) (Indirect)	Deakin, 2015 [11]	Prospective, Clinical testing, In-Hospital, UK	Hands-on defibrillation using Class 1 electrical insulating gloves	49 patients undergoing elective cardioversion, 67 shocks analyzed with rescuer's hands placed firmly on the midpoint of the patient's sternum. Pads in Anterior-Lateral position.	The rescuers perceived zero out of 67 shocks. All leakage from shocks reaching the rescuer, irrespective of energy (150J, 200J, or 360J), were well below the safe threshold of 1 mA; the highest recorded was 38 micro Amp (0.038 mA).	No harm
During CPR (Shock) (Indirect)	Lloyd, 2008 [18]	Prospective clinical testing in a hospital in the USA	Safety of hands-on defibrillation (leakage voltage and current to rescuers while compressing the chest of patients receiving external biphasic shock). Provider wearing polyethylene medical gloves.	43 Patients undergoing elective cardioversion for persistent atrial fibrillation or flutter, and those undergoing invasive electrophysiology studies who were likely to need external cardioversion or defibrillation during the procedure. Self-adhesive pads placed in the anterior-posterior position. 1-4 HCWs (all co-investigators acted as mock rescuers) wearing polyethylene medical gloves simulated manual chest compressions on the patient, standing on the patient's right side. The rescuer's palm was placed adjacent to the anterior shocking electrode. Rescuer-Patient-Circuit established. The electrode placed in the patient's posterior left shoulder served as the "voltage source," and the electrode on the rescuer's anterior thigh served as the "load".	43 hands-on shocks in 39 patients. 4 shocks at 100J, 27 at 200J, and 8 at 360J. None of the 43 hands-on shocks were perceptible to the rescuers. 7 of 43 hands-on shocks did not produce sufficient leakage current to trigger the oscilloscope. 36 hands-on shocks were analysed using oscilloscope measurements. The duration of the defibrillation shocks was 15 ms. Voltage between the rescuer's hand and the return pathway on the thigh was 5.8 +/-5.8 V (range 0.280 to 14.1 V). Leakage current through the rescuer simulating compressions was 283 +/- 140 micro Amp (range 18.9 to 907 micro Amp). Mean leakage energy was 24 ± 12 µJ (range 0.07 to 95 µJ), which was below the safe threshold of 1 mA).	No harm.
During CPR (Shock)	Petley, 2019 [20]	Prospective, Clinical testing, In-Hospital, UK	Hands-on defibrillation comparing Implantable cardioverter-defibrillators (ICD), Transvenous (T-ICD), and Subcutaneous (S-ICD). A measurement	25 patients (13 T-ICD, 12 S-ICD) underwent ICD testing with a measurement device placed on the patient's chest to determine the current leakage a rescuer may	measured current leakage for S-ICD devices was found to be significantly higher than current from T-ICDs (Median RMS 135 mA (range 90.7-- 164.0 mA) vs	Potential for harm.

(indirect)			device on chest replicating potential shock through hands if they were pressed against chest.	experience if their hands were pressed against the chest.	31 mA. Both were in excess of the safe threshold of 1 mA.	
During CPR (Shock) (direct)	Stockwell, 2009 [22]	Case Report (Hospital in the UK)	Nerve injury (ulnar & median nerve) to a rescuer by a shock delivered from an ICD during chest compressions. Rescuer wearing latex-free Nitrile gloves.	The rescuer experienced a shock during cardiac compressions in a patient with end-stage hypertrophic cardiomyopathy with an entirely normally functioning ICD in situ.	PEA cardiac arrest followed by VF, for which the ICD discharged spontaneously. New, persistent paraesthesiae in the left little finger, half the ring finger, and over the distal palm about 30-60 min later. Transient mild sensory loss affecting the left index and middle fingers experienced for a day. 10 days post injury, demonstrated small sensory nerve action potentials from the left little finger (ulnar), middle finger, and index fingers (median) indicating peripheral nerve damage. Symptoms persisted for 6 months.	Potential for harm
During CPR (Shock) (indirect)	Wight, 2019 [23]	Prospective, Clinical testing, In-Hospital, USA	Hands-on defibrillation using polyethylene drapes, where current leakage measurement was conducted with a device on the patient's chest on the drape, with a subset of cases with rescuers bare hands in place on the drape.	33 patients undergoing elective cardioversion, 23 shocks (18 shocks 200J, 5 shocks 360J). A measurement device on the patient's chest to measure leakage. Pads in Anterior-Posterior position.	All leakage was below the International Electrotechnical Commission (IEC) safe threshold of 3.5 mA RMS and 5.0 mA peak. 0 out of 10 shocks (8 at 200J and 2 at 360J) were perceived by a hands-on rescuer.	No harm
During CPR (Shock) (indirect)	Wight, 2022 [24]	Prospective, Clinical testing, In-Hospital, USA	Hands-on defibrillation using polyethylene drapes. No rescuer touching patient, measurement device on chest on top of the drape replicating potential shock through hands.	20 patients undergoing elective cardioversion; 20 shocks delivered at 200J. Two types of measurement devices: one on the patient's chest to measure leakage at the chest, and one simulating the potential current transferred to a rescuer's body. Pads in Anterior-Posterior position.	Used a drape that had been stretched by 30 minutes of CPR on a mannequin, and the same drape was used for all 20 shocks. All leakage measured by both devices was below the IEC safe threshold of 3.5 mA RMS and 5.0 mA peak.	No harm

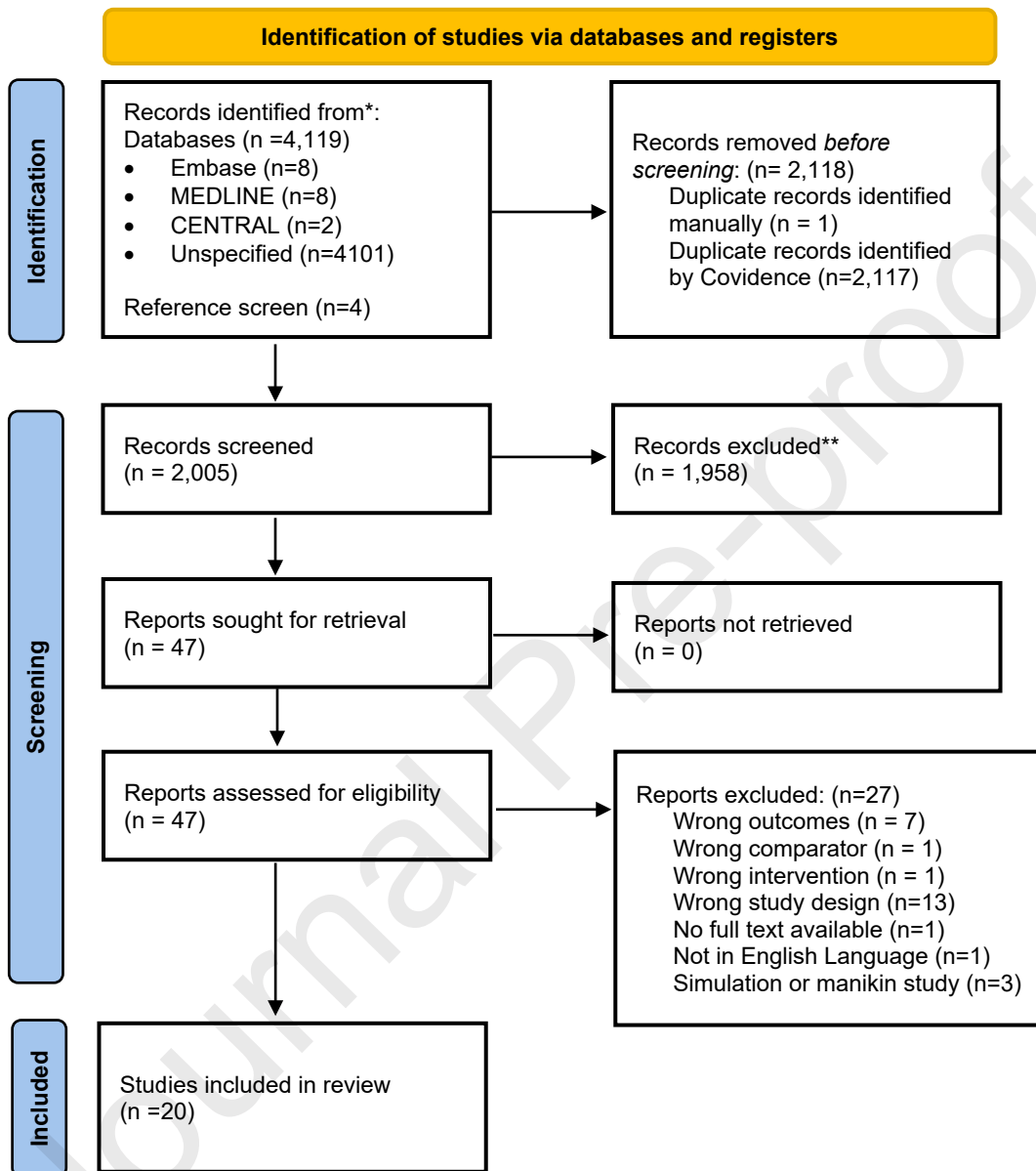
Table 4. Studies reporting physical risks associated with attempted resuscitation

Category	Primary Author, Year	Design/Setting	Type of Harm	Sample Size/Population	Exposure	Summary of Harm
En-route to arrest (fractures)	Andelius, 2021 [5]	Retrospective survey of responders, Real-world community setting, Denmark	Physical traumatic injury	1665 suspected OHCA to which 9574 citizen responders either accepted or accepted and then declined the alert and received the survey.	Of the 7,334 citizen responders who answered questions about injuries, 99.3% reported no injury, while 0.3% felt at risk and 0.4% experienced some degree of injury. Only one responder with an injury required hospital treatment (an ankle fracture), while the remaining 25 responders with minor injuries did not require medical care.	Low rate of traumatic injury en route to OHCA
En-route to arrest (cuts while retrieving AED)	Ng, 2022 [19]	Retrospective survey of responders, Real-world community setting, Singapore	Physical traumatic injury	88 participants who responded to an OHCA in the past 12 months, 45 attempted to retrieve an AED	24 (53%) of the 45 responders who attempted to retrieve an AED were injured from breaking glass in locked cabinets. No responder required treatment at a clinical or hospital for their injuries, suggesting injuries were minor.	Harm from breaking glass in locked cabinets

Table 5. Studies reporting risks associated with water exposure, including resuscitation of a drowning victim

Category	Primary Author, Year	Design/Setting	Type of Harm	Sample Size/Population	Exposure	Summary of Harm
En-route to arrest (drowning)	Franklin, 2019 [12]	Retrospective cohort study of Royal Life Saving National Fatal Drowning Database, Australia	Drowning	51 rescue-related fatal drowning cases in 10 years reported in the Royal Life Saving National Fatal Drowning Database - Bystander-attempted rescues confirmed through coronial inquiry (2006 - 2015)	45 people drowned while attempting to rescue a person in an aquatic environment between 2006 and 2015. 6 people drowned in the rescue of animals. The majority of rescue-related drowning deaths were family members (51%), male (82%), aged between 18 and 44 (60%).	Evidence for harm
En-route to arrest (drowning)	Işın, 2021 [14]	Retrospective analysis of media reports, Turkey	Drowning	237 rescue-related fatal drowning cases in 5 years reported in the media attributed to bystander attempted rescues (2015 - 2019)	237 people drowned while trying to attempt rescue of a person in an aquatic environment over a 5-year period between 2015 and 2019. Annual mortality rates attributed to bystander rescuer drowning ranged from 0.04 to 0.08 per 100,000. The majority of rescue related drowning deaths were male (90%), aged between 15 - 44 (69%)	Evidence for harm
En-route to arrest (drowning)	Lawes, 2020 [16]	Retrospective cohort study of Surf Life Saving Coastal Fatality Database, Australia	Drowning	67 rescue-related fatal drowning cases in 15 years from Surf Life Saving Coastal Fatality Database - Bystander-attempted rescues confirmed through coronial inquiry (2004-2019)	67 people drowned while trying to attempt rescue of a person in an aquatic environment over a 5-year period between 2004 and 2019. A crude fatality rate attributed to bystander rescuer drowning of 0.02 deaths per 100,000 population. The majority of deaths were family members (69%), male (68%), aged between 18-44 (69%)	Evidence for harm

Figure 1 2020 PRISMA Flow Diagram of Hierarchical Review of Search Output



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Declarations

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