|  |  |
| --- | --- |
| Question | |
| **Should prehospital critical care vs. advanced life support be used for patients with out-of-hospital cardiac arrest?** | |
| **Population:** | Adults and children with out-of-hospital non-traumatic cardiac arrest. |
| **Intervention:** | Prehospital critical care teams, defined as any provider with clinical competencies beyond that of standard paramedics using advanced life support algorithms and dedicated dispatch to critically ill patients. |
| **Comparison:** | Advanced life support |
| **Main outcomes:** | Survival to hospital discharge; Survival at 30 day; Favourable neurological outcome at hospital discharge; Favourable neurological outcome at 30 days; Survival to hospital admission / return of spontaneous circulation; |
| **Setting:** | Out of hospital cardiac arrest (OHCA) |
| **Perspective:** | Clinical recommendation for treatment |
| **Background:** | The emergency medical service (EMS) system response is a critical element in the pathway of care for OHCA patients.[1,2] The optimal configuration of EMS systems is unclear and varies between countries.[3] Many countries utilise prehospital critical care teams as part of a tiered EMS response.[4–6] These teams are specialists in care of the critically ill patient and have greater exposure to resuscitation than standard EMS teams, potentially offering clinical benefit.[7] These teams have competencies beyond that of standard EMS teams delivering advanced life support. This may include advanced airway management, blood transfusion, central venous access, advanced inotropes/vasopressors, prehospital emergency anaesthesia, sedation/paralysis, invasive monitoring, surgical procedures, and diagnostic ultrasound.[8] They can also facilitate transfer over extended distances, which may allow patients to receive hospital care at a more optimal location. They often attend in addition to a standard team or may attend in isolation dependent on the situation. Understanding the clinical efficacy associated with prehospital critical care teams is important to helping decide how they may be implemented into practice. |
| **Conflict of interests:** | Nil declared. |

# Assessment

|  |  |  |
| --- | --- | --- |
| Problem Is the problem a priority? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know | Improving survival after out-of-hospital cardiac arrest is a priority for healthcare systems and could save thousands of lives worldwide every year. The configuration of emergency medical services varies worldwide and delivering the optimal configuration is a priority. The ILCOR EIT taskforce has prioritised this topic. | Critically appraising the evidence surrounding prehospital critical care teams will allow the clinical efficacy of these teams to be better understood and inform implementation decisions. |
| Desirable Effects How substantial are the desirable anticipated effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ Don't know | The findings of this systematic review and meta-analysis indicate that the anticipated desirable treatment effects are moderate for all outcomes. The effect estimates show that prehospital critical care teams are associated with improved outcomes. The significant odds ratios for benefit range from 1.34 to 1.98. | A moderate desirable effect is beneficial to patients and may improve clinical outcomes. |
| Undesirable Effects How substantial are the undesirable anticipated effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial ● Small ○ Moderate ○ Large ○ Varies ○ Don't know | There is no evidence found by this systematic review of undesirable effects. In meta-analyses of critical outcomes, all effect estimates favoured care with a prehospital critical care team. This review did not detect any adverse or undesirable effects associated with prehospital critical care teams. |  |
| Certainty of evidence What is the overall certainty of the evidence of effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Very low ● Low ○ Moderate ○ High ○ No included studies | The certainty of evidence for each critical outcome was low for adults and very low children. For adults with non-traumatic OHCA, critical outcomes of survival to hospital discharge, survival at 30 days, favourable neurological outcome at 30 days, and survival to hospital admission/return of spontaneous circulation were low certainty of evidence (downgraded for risk of bias). One study examined paediatric patients and the certainty of evidence was very low (downgraded for risk of bias and imprecision). |  |
| Values Is there important uncertainty about or variability in how much people value the main outcomes? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Important uncertainty or variability ○ Possibly important uncertainty or variability ○ Probably no important uncertainty or variability ● No important uncertainty or variability | No study included in this review investigated how much people value the main outcomes. | Previous research has demonstrated the critical importance of survival and favourable neurological outcome. These outcomes are included within the core outcome set for cardiac arrest and this systematic review.[9] |
| Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know | There is low certainty of evidence of moderate desirable effects. There is no evidence to suggest undesirable effects. The outcomes are considered critical and there is no important uncertainty or variability in the value of these outcomes. | Prehospital critical care is likely to incur greater resource costs, an undesirable effect. |
| Resources required How large are the resource requirements (costs)?" | | |
| Judgement | Research evidence | Additional considerations |
| ○ Large costs ● Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ○ Don't know | No studies were included that examined the resource implications and costs of prehospital critical care teams versus advanced life support. | Prehospital critical care teams are established in many EMS systems, as highlighted by this systematic review. However, they treat a minority of OHCA patients. Expanding their services to reach more patients will present resource implications. CCTs typically respond by helicopter or rapid response vehicle, and often carry specialist equipment such as mechanical CPR devices, highlighting the resources required. They must be integrated within established EMS systems and use a dispatch approach that may require specialist personnel within an operations centre, in addition to the CCT clinicians.[10] Expansion of CCTs requires training of specialist clinicians and may draw them away from other healthcare settings and roles. For example, the prehospital physicians responding with CCTs have specialist in-hospital backgrounds in emergency, anaesthesia, or intensive care. There was no evidence from low income settings. Given that CCTs are likely to be costly and present significant training and resource implications, this may not be the most efficient and optimal use of scarce resources. |
| Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Very low ○ Low ○ Moderate ○ High ● No included studies | No studies were included in this review examining this domain. | The certainty of costs is unclear and will vary between healthcare systems. This will be influenced on whether prehospital critical care services are already present within an EMS system, whether they are expanded to reach more patients, or whether they are introduced as a new service provision. |
| Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies | No included studies examined cost-effectiveness. | It is likely that prehospital critical care teams will incur greater monetary costs than advanced life support. One previous study has calculated the prehospital costs in the UK at 2015/2016 costs (prehospital critical care £1711 versus advanced life support £347).[11] This study found that when the costs and outcomes of prehospital, in-hospital, and post discharge phases were included, prehospital advanced life support was cost effective at £11,407/quality-adjusted life year. The clinical efficacy of prehospital critical care was not known and therefore the cost-effectiveness could not be estimated, however the study suggested the minimally economically important difference in survival to hospital discharge would be 3%–5%. This study is UK-specific and generalisability to other healthcare systems is challenging. |
| Equity What would be the impact on health equity? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Reduced ○ Probably reduced ○ Probably no impact ○ Probably increased ○ Increased ○ Varies ● Don't know | No study examined health equity. | It is unclear how prehospital critical care teams impact health inequities and reach disadvantaged groups. The desirable effects associated with prehospital critical care teams have the potential to address health inequities if targeted to groups in need of improvement in access to high quality cardiac arrest care and improvement in outcomes. If an EMS system is optimised to reach these groups then prehospital critical care teams could help address inequities. Conversely, if prehospital critical care teams are not optimally distributed or available to disadvantaged groups in an equitable manner then they could compound health inequities. There is no evidence in included studies to determine this in current practice and is likely to vary between EMS service and region. |
| Acceptability Is the intervention acceptable to key stakeholders? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know | No studies examined acceptability to key stakeholders. | Prehospital critical care teams appears to have moderate desirable effects and no undesirable effects. The associated costs are unclear. Prehospital critical care teams are in use in many developed healthcare systems across the world and this review highlights the high number of patients that are currently receiving this intervention. Given its establishment in contemporary practice, the intervention is likely to be acceptable to key stakeholders. |
| Feasibility Is the intervention feasible to implement? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ● Probably yes ○ Yes **○** Varies **○** Don't know | No included study examined feasibility of implementing prehospital critical care teams. | The intervention is already delivered in many healthcare systems, and hence is feasible in some settings. Expanding these services to reach more patients or introducing this service in some settings will incur a resource costs, which may negatively impact feasibility. Implementation will require availability and training of specialist healthcare professionals, such as prehospital physicians and critical care paramedics. These teams will also require EMS infrastructure to respond effectively. Their presence in many EMS systems demonstrated the feasibility of their implementation, however this is specific to that setting. Their implementation in other settings may be challenging. In summary, the feasibility of implementing prehospital critical care teams is likely to be setting specific. |

# Summary of judgements

|  | **Judgement** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Problem** | No | Probably no | Probably yes | **Yes** |  | Varies | Don't know |
| **Desirable Effects** | Trivial | Small | **Moderate** | Large |  | Varies | Don't know |
| **Undesirable Effects** | Trivial | **Small** | Moderate | Large |  | Varies | Don't know |
| **Certainty of evidence** | Very low | **Low** | Moderate | High |  |  | No included studies |
| **Values** | Important uncertainty or variability | Possibly important uncertainty or variability | Probably no important uncertainty or variability | **No important uncertainty or variability** |  |  |  |
| **Balance of effects** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | **Probably favors the intervention** | Favors the intervention | Varies | Don't know |
| **Resources required** | Large costs | **Moderate costs** | Negligible costs and savings | Moderate savings | Large savings | Varies | Don't know |
| **Certainty of evidence of required resources** | Very low | Low | Moderate | High |  |  | **No included studies** |
| **Cost effectiveness** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | Probably favors the intervention | Favors the intervention | Varies | **No included studies** |
| **Equity** | Reduced | Probably reduced | Probably no impact | Probably increased | Increased | Varies | **Don't know** |
| **Acceptability** | No | Probably no | **Probably yes** | Yes |  | Varies | Don't know |
| **Feasibility** | No | Probably no | Probably yes | Yes |  | Varies | **Don't know** |

# Type of recommendation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Strong recommendation against the intervention | Conditional recommendation against the intervention | Conditional recommendation for either the intervention or the comparison | **Conditional recommendation for the intervention** | Strong recommendation for the intervention |
| ○ | ○ | ○ | **●** | ○ |

# Conclusions

|  |
| --- |
| Recommendation |
| We recommend adults with non-traumatic out-of-hospital cardiac arrest have prehospital critical care teams attend within EMS systems with sufficient resource infrastructure (weak recommendation, low certainty of evidence).  We suggest children with out-of-hospital cardiac arrest have prehospital critical care teams attend within EMS systems with sufficient resource infrastructure (weak recommendation, very low certainty of evidence). |

|  |
| --- |
| Justification |
| * This PICOST was prioritised by the ILCOR EIT taskforce to assess possible improvements in outcomes for out-of-hospital cardiac arrest patients as that is a priority for many healthcare systems. Prehospital critical care was considered as enhanced clinical competencies beyond advanced life support with dedicated EMS teams dispatched to critically ill patients. This was compared to standard advanced life support. * Studies were included from multiple EMS systems across the world, with seven from Japan, three from the UK, and one each from Australia, Iceland, Norway, Poland, and the USA. * Meta-analysis found moderate desirable effects for adult non-traumatic OHCA patients in all critical outcomes (survival, favourable neurological outcome, survival to hospital admission/ROSC) with low certainty of evidence from 14 studies reporting 1,187,100 patients. The ILCOR taskforce has made a recommendation alongside low certainty of evidence for adults with non-traumatic OHCA in light of consistent moderate desirable effects across clinical outcomes in a large number of reported patients and studies from a variety of different health care systems. * There were moderate desirable effects based on very low certainty of evidence for paediatric OHCA patients from one study reporting 1,187 patients. As there was only one study a limited number of patients, the ILCOR task issued a suggestion favouring prehospital critical care teams for paediatric OHCA patients. * The associated resource costs, cost-effectiveness, impact on health equity, and feasibility of implementation were not reported by the included studies. These costs are likely to be healthcare system specific. This systematic review demonstrates that many settings have already implemented prehospital critical care teams and they are treating many OHCA patients in contemporary clinical practice. Expanding prehospital critical care services and implementing these services in other healthcare systems is likely to incur resource, training, and EMS infrastructure costs, and hence may not be universally available. Implementing prehospital critical care teams is likely to be setting specific. |

|  |
| --- |
| Subgroup considerations |
| No subgroup analysis was performed as only one study reported children with out-of-hospital cardiac arrest and the certainty of evidence was very low.  Due to the specialist nature of prehospital critical care teams and the specialist nature of paediatric cardiac arrest subgroup, prehospital critical care teams may offer particular benefit. |

|  |
| --- |
| Implementation considerations |
| Prehospital critical care teams have already been implemented in several healthcare systems, notably Japan, Australia, United Kingdom and other parts of Europe. They currently treat a minority of patients. However, implementing prehospital critical care teams such that more patients have access to this service will present resource implications, and may not be possible in all systems. There is insufficient evidence to understand the resource implications and cost effectiveness as no study investigated that. |

|  |
| --- |
| Monitoring and evaluation |
| Currently there are no randomised controlled trials investigating prehospital critical care teams for out-of-hospital cardiac arrest patients. Observational studies using out-of-hospital cardiac arrest registries have supported most of the evidence gathering in this review.[4–6,12–22] Registries allow monitoring of clinical activity and effectiveness and will be valuable in supporting iterative quality improvement. |

|  |
| --- |
| Research priorities |
| * The evidence on children with out-of-hospital cardiac arrest is based on only one study. More evidence is required to understand if the individualised and enhanced care provided by prehospital critical care teams confers clinical benefit. * Which patient groups would benefit most from prehospital critical care teams in order to optimise emergency medical service systems and target care delivery. * The optimal composition of prehospital critical care teams, their professional background, and training requirements are unknown. This may be EMS system specific. * The enhanced interventions prehospital critical care teams are delivering and what interventions are resulting in the observed desirable effects. * Cost-effectiveness of prehospital critical care teams and implementation costs. This may be EMS system specific. * There is no data from RCTs investigating prehospital critical care teams for OHCA. |

# References

[1] Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the “chain of survival” concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. Circulation 1991;83:1832–47.

[2] Merchant RM, Topjian AA, Panchal AR, Cheng A, Aziz K, Berg KM, et al. Part 1: Executive Summary: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2020;142:S337–57.

[3] Lockey D. International EMS systems. Resuscitation 2003;59:163.

[4] Hatakeyama T, Kiguchi T, Sera T, Nachi S, Ochiai K, Kitamura T, et al. Physician’s presence in pre-hospital setting improves one-month favorable neurological survival after out-of-hospital cardiac arrest: A propensity score matching analysis of the JAAM-OHCA Registry. Resuscitation 2021;167:38–46.

[5] von Vopelius-Feldt J, Morris RW, Benger J. The effect of prehospital critical care on survival following out-of-hospital cardiac arrest: A prospective observational study. Resuscitation 2020;146:178–87.

[6] Bujak K, Nadolny K, Trzeciak P, Gałązkowski R, Ładny JR, Gąsior M. Does the presence of physician-staffed emergency medical services improve the prognosis in out-of-hospital cardiac arrest? A propensity score matching analysis. Polish Heart Journal / Kardiologia Polska 2022;80:685–92.

[7] Bray J, Nehme Z, Nguyen A, Lockey A, Finn J. A systematic review of the impact of emergency medical service practitioner experience and exposure to out of hospital cardiac arrest on patient outcomes. Resuscitation 2020;155:134–42.

[8] von Vopelius-Feldt J, Benger J. Who does what in prehospital critical care? An analysis of competencies of paramedics, critical care paramedics and prehospital physicians. Emerg Med J 2014;31:1009–13.

[9] Haywood K, Whitehead L, Nadkarni VM, Achana F, Beesems S, Böttiger BW, et al. COSCA (Core Outcome Set for Cardiac Arrest) in Adults: An Advisory Statement From the International Liaison Committee on Resuscitation. Circulation 2018;137:e783–801.

[10] Wilmer I, Chalk G, Davies GE, Weaver AE, Lockey DJ. Air ambulance tasking: mechanism of injury, telephone interrogation or ambulance crew assessment? Emerg Med J 2015;32:813–6. https://doi.org/10.1136/emermed-2013-203204.

[11] von Vopelius-Feldt J, Powell J, Benger JR. Cost-effectiveness of advanced life support and prehospital critical care for out-of-hospital cardiac arrest in England: a decision analysis model. BMJ Open 2019;9:e028574–e028574.

[12] Bjornsson HM, Bjornsdottir GG, Olafsdottir H, Mogensen BA, Mogensen B, Thorgeirsson G. Effect of replacing ambulance physicians with paramedics on outcome of resuscitation for prehospital cardiac arrest. European Journal of Emergency Medicine 2021;28:227–32.

[13] Doan TN, Wilson D, Rashford S, Sims L, Bosley E. Epidemiology, management and survival outcomes of adult out-of-hospital traumatic cardiac arrest due to blunt, penetrating or burn injury. Emerg Med J 2022;39:111–7.

[14] Fukuda T, Ohashi-Fukuda N, Kondo Y, Hayashida K, Kukita I. Association of Prehospital Advanced Life Support by Physician With Survival After Out-of-Hospital Cardiac Arrest With Blunt Trauma Following Traffic Collisions: Japanese Registry-Based Study. JAMA Surgery 2018;153:e180674-1.

[15] Goto Y, Maeda T, Nakatsu-Goto Y. Neurological outcomes in patients transported to hospital without a prehospital return of spontaneous circulation after cardiac arrest. Crit Care 2013;17:R274.

[16] Goto Y, Funada A, Goto Y. Impact of prehospital physician-led cardiopulmonary resuscitation on neurologically intact survival after out-of-hospital cardiac arrest: A nationwide population-based observational study. Resuscitation 2019;136:38–46.

[17] Nakajima S, Matsuyama T, Watanabe M, Komukai S, Kandori K, Okada A, et al. Prehospital Physician Presence for Patients With out-of-Hospital Cardiac Arrest Undergoing Extracorporeal Cardiopulmonary Resuscitation: A Multicenter, Retrospective, Nationwide Observational Study in Japan (The JAAM-OHCA registry). Curr Probl Cardiol 2023;48:101600.

[18] Obara T, Yumoto T, Nojima T, Hongo T, Tsukahara K, Matsumoto N, et al. Association of Prehospital Physician Presence During Pediatric Out-of-Hospital Cardiac Arrest With Neurologic Outcomes. Pediatr Crit Care Med 2023;24:e244–52. https://doi.org/10.1097/PCC.0000000000003206.

[19] Olasveengen TM, Lund-Kordahl I, Steen PA, Sunde K. Out-of hospital advanced life support with or without a physician: Effects on quality of CPR and outcome. Resuscitation 2009;80:1248–52.

[20] Pemberton K, Franklin RC, Bosley E, Watt K. Pre-hospital predictors of long-term survival from out-of-hospital cardiac arrest. Australas Emerg Care 2023;26:184–92.

[21] Sato N, Matsuyama T, Akazawa K, Nakazawa K, Hirose Y. Benefits of adding a physician-staffed ambulance to bystander-witnessed out-of-hospital cardiac arrest: A community-based, observational study in Niigata, Japan. BMJ Open 2019;9:e032967.

[22] Yasunaga H, Horiguchi H, Tanabe S, Akahane M, Ogawa T, Koike S, et al. Collaborative effects of bystander-initiated cardiopulmonary resuscitation and prehospital advanced cardiac life support by physicians on survival of out-of-hospital cardiac arrest: a nationwide population-based observational study. Crit Care 2010;14:R199.