Interventional procedure overview of VA ECMO for extracorporeal cardiopulmonary resuscitation (ECPR) in adults in refractory cardiac arrest

Contents

Table 1 Abbreviations

Abbreviation	Definition
95% CI	95% confidence interval
ACS	Acute coronary syndrome
CA	Cardiac arrest
CCPR	Conventional cardiopulmonary resuscitation
CPC	Cerebral performance category
CPR	cardiopulmonary resuscitation
CV	Cardiovascular
ECMO	Extracorporeal membrane oxygenation
ECPR	Extracorporeal cardiopulmonary resuscitation
IHCA	In-hospital cardiac arrest
ITT	Intention to treat
MGOS	Modified Glasgow Outcome Scale
mRS	Modified Rankin scale
OHCA	Out-of-hospital cardiac arrest
OR	Odds ratio
PEA	Pulseless electrical activity
PSM	Propensity-score matched
RCT	Randomised controlled trial
ROSC	Return of spontaneous circulation
RR	Relative risk
VA	Venoarterial
VF	Ventricular fibrillation
VT	Ventricular tachycardia

The condition, current treatments, unmet need and procedure

Information about the procedure, condition, current practice and unmet need is available in section 2 and 3 of NICE's interventional procedures consultation document on VA ECMO for extracorporeal cardiopulmonary resuscitation (ECPR) in adults in refractory cardiac arrest

Outcome measures

The main outcomes include survival and survival with favourable neurological outcome. The measures used are detailed in the following paragraphs.

Cerebral performance category (CPC)

The Glasgow-Pittsburgh cerebral performance category (CPC) assessment tool is a 5-category measure used to assess neurological outcome. Categories 1 (good cerebral performance: conscious, alert, capable of normal life) and 2 (moderate cerebral disability: conscious, alert, sufficient cerebral function for activities of daily life) are considered to show a good neurological outcome. Categories 3 (severe cerebral disability), 4 (coma/vegetative state) and 5 (certified brain death) are considered a poor neurological outcome.

Modified Rankin scale (mRS)

The modified Rankin scale (mRS) assessment tool grades functional recovery on a 7-category scale from 0 (no symptoms), to 6 (dead). A score of 0 to 3 is considered a good neurological outcome, and a score 4 or 5 as a poor neurological outcome.

Modified Glasgow Outcome Scale (MGOS)

The modified Glasgow Outcome Scale (MGOS) assessment tool grades functional recovery on a 5-category scale from 1 (dead), to 5 (good recovery). A score of 4 or 5 is considered a good neurological outcome, and a score 1 to 3 as a poor neurological outcome.

Evidence summary

Population and studies description

This interventional procedure overview is focused on VA ECMO use in ECPR for in hospital cardiac arrest (IHCA) and out of hospital cardiac arrest (OHCA). Two additional overviews have been developed focusing on VA ECMO in acute heart failure and postcardiotomy cardiogenic shock.

This overview is based on approximately 129,000 people from 8 systematic reviews (Low 2023, Low 2024, Zhong 2024, Gomes 2023, Cheema 2023, Kiyohara 2023, Scquizzato 2023, Pagura 2024), 1 long-term RCT follow-up study (Rob 2024), 1 retrospective registry study (Inoue 2022), and 1 single-centre retrospective PSM study (Shih 2024). This a rapid review of the literature, and a flow chart of the complete selection process is shown in figure 1. This overview presents 11 studies as the key evidence in table 2 and table 3, and lists 31 other relevant studies in appendix B, table 5.

All 8 systematic reviews (Low 2023, Low 2024, Zhong 2024, Gomes 2023, Cheema 2023, Kiyohara 2023, Scquizzato 2023, Pagura 2024), included the same 3 RCTs; ARREST (USA, 2020), Prague OHCA (Czech Republic, 2022), and INCEPTION (Netherlands, 2023). Of these systematic reviews, 3 included a fourth pilot RCT: EROCA (USA 2021) (Cheema 2023, Kiyohara 2023, Scquizzato 2023).

OHCA and IHCA studies

The selected key evidence includes 3 publications reporting on 2 systematic reviews and meta-analyses comparing ECPR and CCPR in people with IHCA and people with OHCA from studies done in Asia, Europe and North America (Low 2023, Low 2024, Zhong 2024). All other key evidence included people with OHCA only.

The systematic review and meta-analyses by Low (2023), included 11 studies (3 RCTs and 8 PSMs) reporting on adults with OHCA or IHCA. This was updated in the publication by Low (2024) to include a further 2 PSM studies. Overall, both Low et al. publications report on 14,048 adults, of whom 6,336 had ECPR. Of the studies included in the review, 8 (3 RCTs and 5 PSMs) included people with OHCA, 4 PSM studies included people with IHCA, and 1 PSM included people with OHCA and IHCA. All RCTs were noted to be either at 'low risk' or 'some concerns' for bias, while all PSMs were noted to be of 'high quality'. Across the included studies, the mean age ranged from 55 to 73 years and 77% were male. The most common cause of cardiac arrest was acute coronary syndrome (33 to 77%), and of those treated with ECPR, 57% had an initial shockable rhythm compared to 60% in the CCPR group.

The systematic review and meta-analyses by Zhong (2024) included 17 studies (3 RCTs, 5 prospective studies, and 9 retrospective studies) reporting on 167,728 people with OHCA or IHCA. Of the 17 included primary studies, 11 were also included in the Low systematic reviews, including the same 3 RCTs. Of the studies included by Zhong (2024), 10 included people with OHCA, 4 included people with IHCA, and 3 included people with OHCA and IHCA. Using the Cochrane Collaboration's risk assessment tool, no RCT study was considered "high risk of bias" in each domain. Using the Newcastle Ottawa Scale, most of the 10 cohort studies were considered medium quality. Across the included studies, the mean age ranged from 50 to 75 years. People who had ECPR were considerably younger and more likely to have an initial shockable rhythm compared to those in the CCPR group.

Both systematic reviews reported on short-term (30 days from CA) and long-term (90 or more days from CA) outcomes, as well as survival up to 1 year.

OHCA studies

The systematic review and meta-analyses by Gomes (2023) included 3 RCTs comparing ECPR and CCPR in 418 people with OHCA. In the risk of bias assessment of the 3 RCTs, 2 were considered to have ‘some concerns’ due to crossover between the study groups. However, this potential bias was minimised by balanced deviations from intended interventions between study groups and by blinded outcomes assessment. The mean age across the ECPR groups ranged from 54 to 59 years compared to 57 to 58 in the CCPR groups and proportion of males was 82 to 93% and 73 to 89%, respectively. The primary cause of cardiac arrest was acute myocardial infarction in 50% of people in the Prague OHCA trial, and 77% in the INCEPTION trial. In 2 of the included RCTs (ARREST and INCEPTION) most people enrolled had an initial shockable rhythm (98 to 100%), whereas the Prague OHCA trial recruited a high proportion with non-shockable rhythm (mean 61% both arms), a subset known to have worse outcomes.

The systematic reviews and meta-analyses by Cheema (2023), Kiyohara (2023) and Scquizzato (2023) all included the same 3 RCTs and an additional pilot trial (EROCA). The number of people included in each systematic review ranged from 433 to 435 depending on whether they included the intention to treat, per protocol or as-treated analysis set. The mean age across the ECPR groups ranged from 54 to 62 years, and 57 to 61 years in the CCPR group. The proportion of males ranged from 67 to 93% in the ECPR groups and 67 to 89% in the CCPR groups. Each systematic review reported slightly different meta-analysis results as they each used different statistical methods, pooled outcome endpoints differently, and did different subgroup analyses. All 3 systematic reviews conducted risk of bias assessments using the Cochrane Risk of Bias (RoB2) tool. Kiyohara (2023) considered all studies to be low risk of bias, Cheema (2023) considered 3 studies to have a low risk of bias and 1 (EROCA) to be high risk of bias. Scquizzato (2023) considered all studies to be intermediate risk of bias due to the absence of blinding of the treating team in all studies and unblinded assessors of neurological outcome in one study. All 3 systematic reviews reported on outcomes at hospital discharge or 30 days, and at 3 or 6 months.

The systematic review and meta-analyses by Pagura (2024) included 18 studies (3 RCTs and 15 observational studies [6 with PSM design]) reporting on 21,877 people with refractory OHCA. The mean age across the ECPR groups ranged from 46 to 66 years, and 54 to 77 years in the CCPR group. The proportion of males ranged from 70 to 93% in the ECPR groups and 62 to 89% in the CCPR groups. The mean proportion of people in the ECPR groups with initial shockable rhythm was 61% and 60% in the CCPR group. Outcomes were reported up to 6 months.

In the long-term follow-up study of the Prague OHCA RCT, 255 people who survived following the initial trial period were followed for a median of 5.3 years (3.8 to 7.2) after initial cardiac arrest. The median age of people at recruitment was 58 years and 82% were male. More people in the CCPR arm had an initial shockable rhythm (VF) 64%, compared to the ECPR arm 58%. The authors noted that there was no formal power analysis for the long-term follow-up outcomes (Rob 2024).

The retrospective SAVE-J II multicentre registry study by Inoue (2022) included 1,644 adults with OHCA who had ECPR in Japan. The median age was 60 years and 85% of the population were male. Initial shockable rhythm was reported in 69% of people and 59% had a primary cause of CA of acute coronary syndrome. Outcomes were reported until hospital discharge.

The single centre retrospective PSM study by Shih (2024) reported on 1,193 people with OHCA resuscitated with ECPR or CCPR in a high volume emergency department in Taiwan. The PSM cohort included 231 people, of whom 77 had ECPR. The median age was 57 years, 81% were male and the proportion of people with an initial shockable rhythm was 86% and 88% in the ECPR and CCPR arms, respectively. Outcomes were reported until hospital discharge.

Table 2 presents study details.

Figure 1 Flow chart of study selection

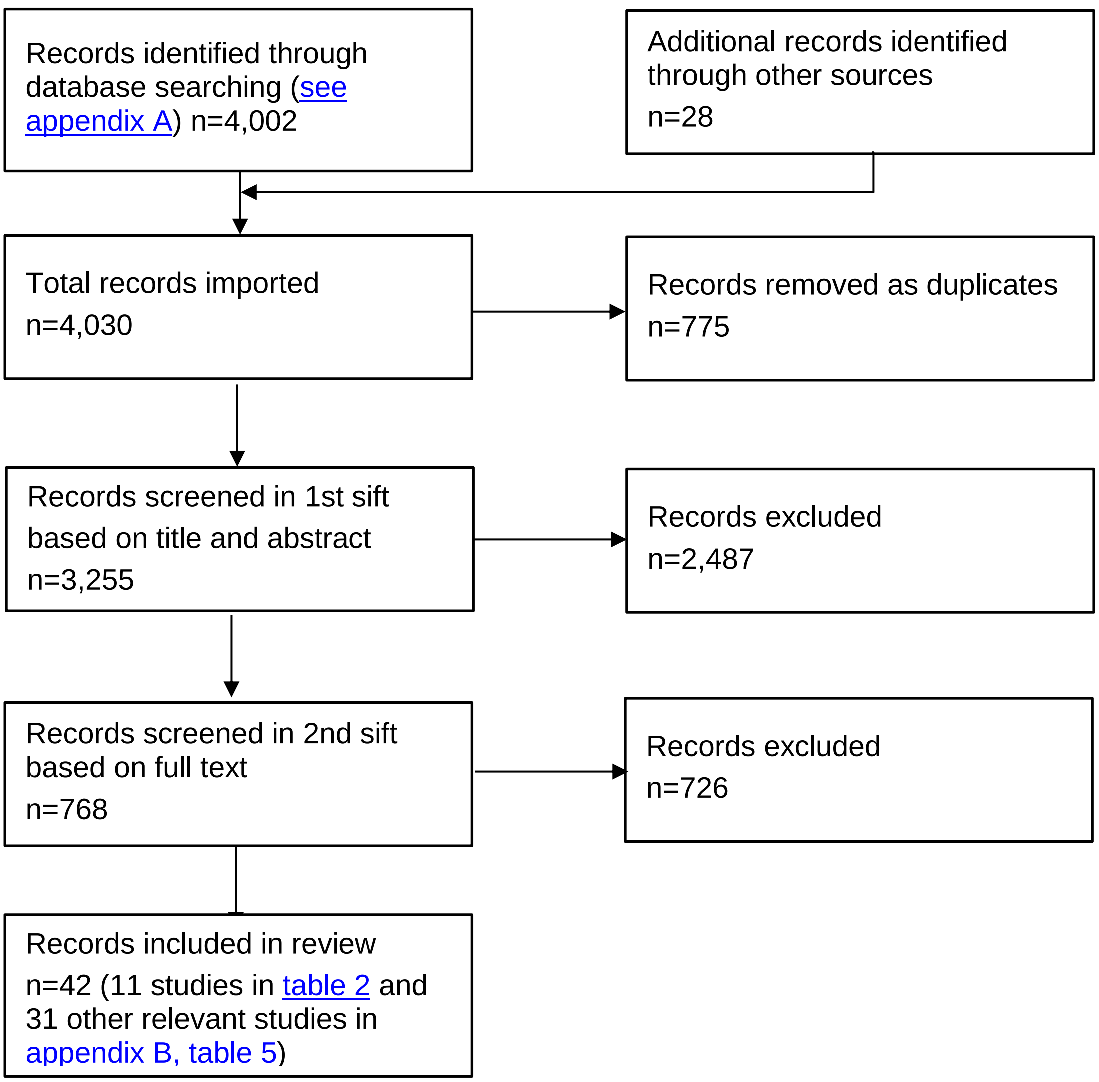

Table 2 Study details

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
1	Low, 2023 Low, 2024 Europe, Asia, North America	**Low, 2023** **n=9,192** (4,595 ECPR) Mean age (years): • ECPR: 59.0 • CCPR: 59.3 Males: • ECPR: 75.3% • CCPR: 78.3% CA cause: • Acute coronary syndrome (32.7% to 76.8%) Shockable rhythm • ECPR: 56.8% • CCPR: 59.5% **Low, 2024** **n=14,048** (6,336 ECPR) Mean age ranged from 55 to 73 years Males: not reported	**Low, 2023** Systematic review and meta-analysis of 11 studies: 3 RCTs and 8 PSMs Search date: April 2023 **Low, 2024** Systematic review and meta-analysis of 13 studies with 14 pairwise comparisons: 3 RCTs and 10 PSMs Search date: November 2023	**Low, 2023** RCTs and PSMs comparing ECPR with CCPR in adults (aged 18 years and over) with OHCA and IHCA. CA location: • OHCA: 6 studies (3 RCTs and 3 PSMs) • IHCA: (4 PSMs) • OHCA and IHCA: (1 PSM) **Low, 2024** CA location: • OHCA: 8 studies (3 RCTs and 5 PSMs) • IHCA: (4 PSMs) • OHCA and IHCA: (1 PSM)	• Intervention: ECPR • Comparator: CCPR Mean low flow time • ECPR: 48 min • CCPR: 44 min	**Low, 2024** In-hospital, 30-day post-discharge, 3mo, 6mo, 1-year **Low, 2024** In-hospital 30-day post-discharge

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
2	Zhong, 2024 Czech Republic, Belgium, France, Germany, Japan, Korea, Netherlands, Taiwan, USA	**n=167,728** (2,308 ECPR) Mean age (years, range): • ECPR: 50 to 72 • CCPR: 57 to 75 Males: not reported Shockable rhythm • ECPR: 1.9% to 100% • CCPR: 2.9% to 100%	Systematic review and meta-analysis of 17 studies: 3 RCTs, 5 prospective studies, 9 retrospective studies. Search date: July 2023	Studies including people over 16 years with IHCA or OHCA comparing CCPR and ECPR. CA location: • OHCA: 10 studies • IHCA: 4 studies • OHCA and IHCA: 3 studies	• Intervention: ECPR • Comparator: CCPR	
3	Gomes, 2023 Czech Republic, Netherlands, USA	**n=418** (208 ECPR) Mean age (years): • ECPR: Range 54 to 59 • CPR: Range 57 to 58 Male (%) • ECPR: Range 82 to 93 • CPR: Range 73 to 89 CA cause: • AMI (50% Prague OHCA, 77% INCEPTION) Shockable rhythm	Systematic review and meta-analysis of 3 RCTs (ARREST, Prague OHCA, INCEPTION) Search date: March 2023 All RCTs were open label.	RCTs which compared ECPR with standard CPR for OHCA.	• Intervention: ECPR • Comparator: standard CPR Time from arrest to ECPR	In-hospital, 6 months

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		• ECPR: 58 to 100% • CCPR: 64 to 100%			• ARREST: 59 min • Prague OHCA: 61 min • INCEPTION: 74 min	
4	Cheema, 2023 Czech Republic, Netherlands, USA	**n=434** (220 ECPR) Mean age: • Not reported Male (%): • Not reported	Systematic review and meta-analysis of 4 RCTs (ARREST, Prague OHCA, INCEPTION, EROCA) Search date: March 2023 All RCTs were open label.	RCTs comparing ECPR with conventional CPR in people with OHCA.	• Intervention: ECPR • Comparator: CCPR	In-hospital or 30 days 3 or 6 months

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
5	Kiyohara, 2023 Czech Republic, Netherlands, USA	**n=435** (221 ECPR) Mean age (years): • ECPR: Range 54 to 62 • CCPR: Range 57 to 61 Male (%): • ECPR: Range 67 to 93 • CPR: Range 67 to 89	Systematic review and meta-analysis of 4 RCTs (ARREST, Prague OHCA, INCEPTION, EROCA) Search date: February 2023 All RCTs were open label.	RCTs comparing the clinical outcomes of ECPR and CCPR for people with OHCA	• Intervention: ECPR • Comparator: CCPR Time from arrest to ECPR • ARREST: 59 min • Prague OHCA: 61 min • INCEPTION: 74 min • EROCA: 66 min	In-hospital or 30 days 6 months
6	Scquizzato, 2023 Czech Republic, Netherlands, USA	**n=433** (220 ECPR) Mean age: • Not reported Male: • Not reported	Systematic review and meta-analysis of 4 RCTs (ARREST, Prague OHCA, INCEPTION, EROCA) Search date: February 2023	RCTs enrolling adults with refractory OHCA randomised to have ECPR or CCPR alone	• Intervention: ECPR • Comparator: CCPR	In-hospital or 30 days Longest follow-up available

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
			All RCTs were open label.			
7	Pagura, 2024 Asia, Europe, US	**n=21,877** (3,129 ECPR) Mean age (years): • ECPR: Range 46 to 66 • CCPR: Range 54 to 77 Male (%): • ECPR: Range 70 to 93% • CCPR: Range 62 to 89% CA cause ACS: • ECPR: Range 21 to 85% • CCPR: Range 4 to 89% Shockable rhythm • ECPR: Range 0 to 100% (mean 61%) • CCPR: Range 0 to 100% (mean 60%)	Systematic review and meta-analysis of 18 studies: 3 RCTs (ARREST, Prague OHCA, INCEPTION) and 15 observational studies (6 with PSM design). Search date: April 2023	Observational and RCTs, comparing the effect of ECPR and CCPR in refractory OHCA.	• Intervention: ECPR • Comparator: CCPR	In-hospital or 30 days 6 months

Study no.	**First author, date country**	**Characteristics of people in the study (as reported by the study)**	**Study design**	**Inclusion criteria**	**Intervention**	**Follow up**
8	Rob, 2024 Czech Republic	**n=255** (123 ECPR) Median age at randomisation (years): • ECPR: 59 (48 to 66) • CCPR: 57 (47 to 65) Male (%): • ECPR: 82% • CCPR: 83% Shockable rhythm (VF) • ECPR: 58% • CCPR: 64%	Long-term follow-up of the Prague OHCA RCT. The original RCT was a single-centre, prospective, open label RCT. Randomisation was done on-scene (pre-hospital) by web-based system. Functional assessments during follow-up were done by evaluators who were blinded to group allocation.	Adults aged 18 to 65 years with witnessed OHCA of presumed cardiac aetiology, who had received a minimum of 5 minutes of advanced cardiac life support without ROSC. Patients with unwitnessed, non-cardiac cause CA, and had suspected or confirmed pregnancy, had ROSC within 5 minutes, had obvious life-limiting comorbidities, bleeding diathesis, DNR order or prearrest CPC ≥3 were excluded.	• Intervention: ECPR Comparator: CCPR 20/256 patients (7.8%) were crossed over (11 crossovers from the CCPR to the ECPR group and 9 from the ECPR group to the CCPR group)	Median 5.3 years (IQR 3.8 to 7.2) from CA.
9	Inoue, 2022 Japan	**n=1,644** Median age (years): 60 (18 to 93)	Retrospective SAVE-J II multicentre registry study	Adults with OHCA who had ECPR.	• ECPR	In-hospital

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		Male (%): 84.6% Initial shockable rhythm: 69.4% CA cause ACS: 59%	Search date: 2013 to 2018			
10	Shih, 2024 Taiwan	**n=1,193** (85 ECPR) **PSM cohort=231** (77 ECPR) Median age (years): • ECPR: 57 (47 to 65) • CCPR: 56 (44 to 66) Male (%): • ECPR: 81.8% • CCPR: 80.5% Initial shockable rhythm: • ECPR: 85.7% • CCPR: 87.7%	Single centre retrospective PSM study (Taiwan) Search date: 2016 to 2021	Adults over 20 years old with refractory OHCA resuscitated in the emergency department (ED). Excluded people with non-cardiac causes for arrest, and those who achieved sustained ROSC within 15 mins at the ED.	• Intervention: ECPR • Comparator: CCPR Estimated low flow time <100 min.	In-hospital or 30 days

Table 3 Study outcomes

First author, date	**Efficacy outcomes**	**Safety outcomes**
Low, 2023 Low, 2024	The analysis in Low (2024) provides updated meta-analysis estimates for mortality, 30-day survival, and short term survival with neurologically favourable outcome. **In-hospital mortality (Overall population)** <u>Low, 2023</u> Meta-analysis 3 RCTs, 8 PSMs (n=9,192) • ECPR: 75.2% (3,454 of 4,595) • CCPR: 80.7% (3,708 of 4,597) OR 0.67, 95% CI: 0.51 to 0.87, I^2=42%; p=0.0034 Sensitivity analysis excluded one study that contributed substantial weight, due to its large sample size (n=7,652) OR 0.60, 95% CI 0.41 to 0.89; p=0.010 <u>Low, 2024</u> Meta-analysis 3 RCTs, 11 PSMs (n=14,048) • ECPR: 76.7% (4,859 of 6,336) • CCPR: 83.1% (6,411 of 7,712) OR 0.63, 95% CI: 0.50 to 0.79, I^2=64% **In-hospital mortality (OHCA)** <u>Low, 2023</u> Meta-analysis 3 RCTs, 3 PSMs (n=8,662) OR 0.76, 95% CI: 0.54 to 1.07, I^2=54%; p=0.12	**Bleeding (Overall)** <u>Low, 2023</u> Meta-analysis 4 studies OR 4.84, 95% CI: 1.91 to 12.24; p=0.0009

First author, date	Efficacy outcomes	Safety outcomes
	Sensitivity analysis excluding one study that contributed substantial weight, due to its large sample size (n=7,652) did not significantly change the pooled estimates (OR 0.71, 95% CI: 0.39 to 1.27; p=0.24). Low, 2024 Meta-analysis 3 RCTs, 6 PSMs (n=13,518) OR 0.67, 95% CI: 0.51 to 0.88, I^2=74% **In-hospital mortality (IHCA)** Low, 2023 Meta-analysis 4 PSMs (n=370) OR 0.42, 95% CI: 0.25 to 0.70, I^2=0%; p=0.0009 **Short-term survival with favourable neurological outcome (CPC 1 or 2; 30 days after CA) (Overall population)** Low, 2023 Meta-analysis 7 studies OR 1.65, 95% CI: 1.02 to 2.68; p=0.042 Low, 2024 Meta-analysis 2 RCTs, 8 PSMs • ECPR: 12.8% (306 of 2,391) • CCPR: 8.8% (331 of 3,767) OR 1.57, 95% CI: 1.14 to 2.15, I^2=56% **Short-term survival with favourable neurological outcome (CPC 1 or 2; 30 days after CA) (OHCA)**	

First author, date	Efficacy outcomes	Safety outcomes
	Low, 2023 Meta-analysis 3 studies OR 1.24, 95% CI: 0.65 to 2.36; p=0.51 **Short-term survival with favourable neurological outcome (CPC 1 or 2; 30 days after CA) (IHCA)** Low, 2023 Meta-analysis 4 studies OR 2.37, 95% CI: 1.34 to 4.19; p=0.0031 **Long-term survival with favourable neurological outcome (CPC 1 or 2; 90 days or more after CA) (Overall population)** Low, 2023 Meta-analysis 8 studies OR 2.04, 95% CI: 1.41 to 2.94; p=0.0001 **Long-term survival with favourable neurological outcome (CPC 1 or 2; 90 days or more after CA) (OHCA)** Low, 2023 Meta-analysis 4 studies OR 1.96, 95% CI: 1.02 to 3.79; p=0.045 **Long-term survival with favourable neurological outcome (CPC 1 or 2; 90 days or more after CA) (IHCA)** Low, 2023	

First author, date	Efficacy outcomes	Safety outcomes
	Meta-analysis 3 studies OR 2.80, 95% CI: 1.31 to 6.00; p=0.008 **30-day survival** Low, 2023 Meta-analysis 7 studies OR 1.45, 95% CI: 1.08 to 1.96; p=0.015 Low, 2024 Meta-analysis 1 RCTs, 8 PSMs • ECPR: 24.2% (1,377 of 5,689) • CCPR: 18.1% (1,030 of 5,697) OR 1.70, 95% CI: 1.29 to 2.26, I^2=71% **3-month survival** Low, 2023 Meta-analysis 3 studies OR 3.98, 95% CI: 1.12 to 14.16; p=0.033 **6-month survival** Low, 2023 Meta-analysis 6 studies OR 1.87, 95% CI: 1.36 to 2.57; p=0.0001 **1-year survival** Low, 2023	

First author, date	Efficacy outcomes	Safety outcomes
	Meta-analysis 5 studies OR 1.72, 95% CI: 1.52 to 1.95; p<0.0001	
Zhong 2024	**Short-term favourable neurological status (Overall population)** Meta-analysis 11 studies (ECPR n=1,442, CCPR n=51,221) RR 2.88; 95% CI: 1.96 to 4.23, I^2=76%; p<0.0001 Subgroup analysis with matched data including 3 RCTs and 7 PMSs (RR 1.67, 95% CI: 1.16 to 2.40, I^2=51%; p=0.005) **Short-term favourable neurological status (OHCA)** Meta-analysis 7 studies RR 1.50, 95% CI: 0.98 to 2.29, I^2=55% **Short-term favourable neurological status (IHCA)** Meta-analysis 3 studies RR 2.18, 95% CI: 1.24 to 3.81, I^2=9% **Long-term favourable neurological status (Overall population)** Meta-analysis 11 studies (ECPR n=896, CCPR n=1,977) RR 2.11, 95% CI 1.40 to 3.19, I^2=69%; p=0.0004 Subgroup analysis with matched data including 3 RCTs and 6 PMSs (RR 1.83, 95% CI: 1.32 to 2.53, I^2=14%; p=0.0003)	**No safety outcomes reported.**

First author, date	Efficacy outcomes	Safety outcomes
	Long-term favourable neurological status (OHCA) Meta-analysis 5 studies RR 1.95, 95% CI: 1.01 to 3.59, I^2=11% **Long-term favourable neurological status (IHCA)** Meta-analysis 3 studies RR 2.17, 95% CI: 1.19 to 3.94, I^2=0% **Overall survival (Overall population)** Meta-analysis matched data 3 RCTs, 9 PSMs RR 1.51, 95% CI: 1.20 to 1.89, I^2=62%; p=0.0004 **Survival at discharge (OHCA and IHCA)** Meta-analysis matched data RR 1.25, 95% CI 1.00 to 1.56, I^2=57%; p=0.05, **3- to 6- month survival (OHCA and IHCA)** RR 2.73, 95% CI: 1.67 to 4.48, I^2=0%; p<0.0001 **1 year survival (OHCA and IHCA)** RR 1.92, 95% CI: 1.14 to 3.25, I^2=0%; p=0.01 **Short-term survival (discharge or 1 month; OHCA)** Meta-analysis 9 studies RR: 1.10, 95% CI: 0.91 to 1.34, I^2=44% **Short-term survival (discharge or 1 month; IHCA)** Meta-analysis 3 studies RR: 2.03, 95% CI: 1.30 to 3.18, I^2=0% **Long-term survival (3- to 6- month or 1 year; OHCA)**	

First author, date	**Efficacy outcomes**	**Safety outcomes**
	Meta-analysis 3 studies RR: 3.16, 95% CI: 1.36 to 7.38, I^2=0% **Long-term survival (3- to 6- month or 1 year; IHCA)** Meta-analysis 3 studies RR: 1.92, 95% CI: 1.14 to 3.25, I^2=0%	
Gomes, 2023	**In-hospital mortality** • ECPR: 71.1% • CPR: 78.6% RR 0.89, 95% CI: 0.74 to 1.07, I^2=53%; p=0.23 **Survival with favourable neurological status (shortest follow-up [in-hospital or 30 days])** • ECPR: 26.4% • CPR: 17.2% RR 1.47, 95% CI: 0.91 to 2.40, I^2=23%; p=0.12 Subgroup analysis of people with shockable rhythms at presentation: RR 1.62, 95% CI 0.95 to 2.76; p=0.07 **Survival with favourable neurological status (6 months)** • ECPR: 28.3% • CPR: 18.6% RR 1.48, 95% CI: 0.88 to 2.49, I^2=28%; p=0.14 • Subgroup analysis of people with shockable rhythms at presentation: RR 1.50, 95% CI 0.90 to 2.50; p=0.12	**No safety outcomes reported.**

First author, date	**Efficacy outcomes**	**Safety outcomes**
	• Sensitivity analysis excluding ARREST trial (most significant result): RR 1.39, 95% CI 0.97 to 1.99; p=0.07).	
Cheema, 2023	**Mid-term survival (in-hospital or 30 days)** Meta-analysis 4 studies RR: 1.21, 95% CI: 0.64 to 2.28, I^2=48%; p=0.55 **Long-term survival (3 or 6 months)** Meta-analysis 3 studies RR 1.32, 95% CI: 0.18 to 9.5, I^2=64%; p=0.79 **Mid-term favourable neurological outcome (in-hospital or 30 days)** Meta-analysis 4 studies RR: 1.59, 95% CI: 1.09 to 2.33, I^2=0%; p=0.02 **Long-term favourable neurological outcome (3 or 6 months)** Meta-analysis 4 studies RR: 1.47, 95% CI: 0.89 to 2.43, I^2=25%; p=0.13	**Adverse events** Meta-analysis 2 studies RR: 3.22, 95% CI: 1.18 to 8.80, I^2=63%; p=0.02
Kiyohara, 2023	**Short-term survival with favourable neurological outcome (in-hospital or 30 days)** Meta-analysis 4 studies OR: 1.84, 95% CI: 1.14 to 2.99, I^2=0%; p=0.01	**No safety outcomes reported.**

First author, date	Efficacy outcomes	Safety outcomes
	6 month survival Meta-analysis 4 studies OR: 1.50, 95% CI: 0.67 to 3.36, I^2=50%; p=0.33 **6 month survival with favourable neurological outcome (Overall)** Meta-analysis 4 studies OR: 1.74, 95% CI: 0.86 to 3.51, I^2=35%; p=0.12 **6 month survival with favourable neurological outcome (shockable rhythm)** Meta-analysis 4 studies OR: 1.91, 95% CI: 0.90 to 4.03, I^2=36%; p=0.09 **6 month survival with favourable neurological outcome (non-shockable rhythm)** Meta-analysis 4 studies (2 studies had no people with no shockable rhythm) OR: 3.92, 95% CI: 0.42 to 36.35, I^2=NA; p=0.23	
Scquizzato, 2023	**Survival with good neurological outcome (3 or 6 months)** Meta-analysis 4 studies	**Survival with unfavourable neurological outcome** • ECPR: 0% (0/220) • CPR: 1.9% (4/214) OR 0.24, 95% CI: 0.05 to 1.26, I^2=0%; p=0.780

	• ECPR: 27% (59/220) • CPR: 18% (39/213) OR 1.72, 95% CI: 1.09 to 2.70, I^2=26%; p=0.02 **Survival with good neurological outcome (3 or 6 months) (shockable rhythm)** Meta-analysis 4 studies • ECPR: 34% (55/164) • CPR: 23% (38/165) OR 1.90, 95% CI: 1.16 to 3.13, I^2=23%; p=0.011 **Survival with good neurological outcome (hospital discharge or 30 days)** Meta-analysis 4 studies • ECPR: 25% (55/220) • CPR: 16% (34/212) OR 1.82, 95% CI: 1.13 to 2.92, I^2=0%; p=0.013 **Survival with good neurological outcome (hospital discharge or 30 days) (shockable rhythm)** Meta-analysis 4 studies • ECPR: 31% (51/164) • CPR: 21% (34/164) OR 1.93, 95% CI: 1.16 to 3.23, I^2=0%; p=0.012 **Survival (longest follow-up available)** Meta-analysis 4 studies	

First author, date	Efficacy outcomes	Safety outcomes
	• ECPR: 28% (61/220) • CPR: 22% (47/214) OR 1.31, 95% CI: 0.49 to 3.49, I^2=58%; p=0.592 **Survival (hospital discharge or 30 days)** Meta-analysis 4 studies • ECPR: 33% (72/220) • CPR: 27% (58/214) OR 1.35, 95% CI: 0.55 to 3.29, I^2=0%; p=0.514	
Pagura, 2024	**Survival with favourable neurological outcome (in-hospital or 30 days)** Meta-analysis 14 studies • ECPR: 14% (385/2,842) • CPR: 7% (1,339/18,188) OR: 2.35, 95% CI: 1.61 to 3.43, I^2=80%; p<0.0001 Subgroup analysis including only RCTs OR: 1.83, 95% CI: 1.13 to 2.96, I^2=0%; p=0.01 Subgroup analysis including in-hospital follow-up only (7 studies) OR: 1.77, 95% CI: 1.15 to 2.73, I^2=73%; p=0.009 Subgroup analysis including 30 day follow-up only (8 studies) OR: 3.04, 95% CI: 1.59 to 5.80, I^2=83%; p<0.001	**No safety outcomes reported.**

First author, date	Efficacy outcomes	Safety outcomes
	Survival with favourable neurological outcome (6 months) Meta-analysis 6 studies • ECPR: 16% (118/725) • CPR: 8% (61/793) OR: 2.72, 95% CI: 1.47 to 5.04, I^2=47%; p=0.002 **Survival (in-hospital or 30 days)** Meta-analysis 13 studies • ECPR: 20% (430/2,156) • CPR: 10% (1,621/16,149) OR 1.71, 95% CI: 1.18 to 2.46, I^2=81%; p=0.004 Subgroup analysis including in-hospital follow-up only OR: 1.38, 95% CI: 0.95 to 2.02, I^2=69%; p=0.094 Subgroup analysis including 30 day follow-up only OR: 2.26, 95% CI: 1.09 to 4.68, I^2=86%; p=0.029	

Rob, 2024	**Long-term survival (ITT analysis)** Median follow-up 5.3 years • ECPR: 27.6% (34/123) • CCPR: 19.7% (26/132) Log rank p=0.01 **Long-term survival (per protocol analysis)** Median follow-up 5.3 years • ECPR: 29.8% (34/114) • CCPR: 18.2% (22/121) Log rank p=0.008 **Long-term survival (as-treated analysis)** Median follow-up 5.3 years • ECPR: 30.4% (38/125) • CCPR: 16.9% (22/130) Log rank p<0.001 **Long-term favourable neurological outcome (ITT analysis)** Median follow-up 5.3 years • ECPR: 26.8% (33/123) • CCPR: 18.9% (25/132) RR 0.90, 95% CI: 0.79 to 1.03, p=0.13 Similar results were observed for CPC and mRS categories. **Long-term survival (per protocol analysis)** Median follow-up 5.3 years • ECPR: 28.9% (33/114)	**Long-term poor neurological outcome (ITT analysis)** Median follow-up 5.3 years • ECPR: 2.9% (1/34) • CCPR: 3.8% (1/26) **Death after discharge during follow-up (ITT analysis)** • ECPR: 10.3% (4/39) • CCPR: 20% (6/30) RR 0.51, 95% CI: 0.16 to 1.66, p=0.26 **Hospitalisation after discharge during follow-up (ITT analysis)** • ECPR: 76.9% (30/39) • CCPR: 60% (18/30) RR 1.28, 95% CI: 0.91 to 1.8, p=0.15 **CV hospitalisation after discharge during follow-up (ITT analysis)** • ECPR: 64.1% (25/39) • CCPR: 50% (15/30) RR 1.28, 95% CI: 0.84 to 1.97, p=0.26 **Myocardial infarction (ITT analysis)** • ECPR: 2.6% (1/39) • CCPR: 3.3% (1/30) p=0.91 **Stroke (ITT analysis)**

First author, date	Efficacy outcomes	Safety outcomes
	• CCPR: 17.4% (21/121) RR 0.86, 95% CI: 0.75 to 0.99, p=0.035 Similar results were observed for CPC and mRS categories. **Long-term survival (as-treated analysis)** Median follow-up 5.3 years • ECPR: 29.6% (37/125) • CCPR: 16.2% (21/130) RR 0.84, 95% CI: 0.73 to 0.96, p=0.007 Similar results were observed for CPC and mRS categories. **Quality of life (Mean EQ-VAS value)** • ECPR: 71.0 • CCPR: 76.3 P=0.30	• ECPR: 0% (0/39) • CCPR: 3.3% (1/30) p=0.34 **Heart failure hospitalisation (ITT analysis)** • ECPR: 5.1% (2/39) • CCPR: 10% (3/30) p=0.57 **Ventricular arrhythmia hospitalisation (ITT analysis)** • ECPR: 2.6% (1/39) • CCPR: 10% (3/30) p=0.22

First author, date	Efficacy outcomes	Safety outcomes
Inoue, 2022	**Favourable neurological outcome at hospital discharge** • Overall: 14.1% (231 of 1,644) • Shockable rhythm: 16.7% • PEA rhythm: 9.2% • Asystole: 3.9% **Survival to hospital discharge** • Overall: 27.2% (447 of 1,644) • Shockable rhythm: 32% • PEA rhythm: 18.5% • Asystole: 10.8%	**Complications during ECPR: 32.7% (535 of 1,644)** Procedure-related complications: 21.2% (346 of 1,644) • Cannula malposition: 4.9% (81 of 1,644) • Unsuccessful cannulation: 0.7% (11 of 1,644) • Cannulation-related bleeding: 16.4% (268 of 1,644) • Other: 1.6% (26 of 1,644) ECMO-related complications: 3.1% (50 of 1,644) Haemorrhage: 8.5% (139 of 1,644) Ischaemia: 1.6% (26 of 1,644)
Shih, 2024	**Survival with favourable neurological outcome (follow-up unclear)** • ECPR: 18.2% (14/77) • CCPR: 5.2% (8/154) PSM multivariate analysis: aOR 13.31, 95% CI: 1.61 to 109.9, p=0.016 **Survival (in-hospital or 30-day)** • ECPR: 28.6% (22/77) • CCPR: 7.8% (12/154) PSM multivariate analysis: aOR 6.02, 95% CI: 2.19 to 16.52	**No safety outcomes reported.**

Procedure technique

Of the 11 studies, none detailed the ECMO device or combination of devices used. Only a few of the studies detailed ECMO procedures. ECPR was initiated at the hospital (either catheterisation laboratory or emergency department) in all studies reporting on the use of ECPR for OHCA (Gomes 2023, Cheema 2023, Kiyohara 2023, Scquizzato 2023, Pagura 2024, Inoue 2022, Shih 2024). Six OHCA studies included in the systematic reviews by Low et al. also reported ECPR initiation in hospital, but one did not specify the location of ECPR initiation. One systematic review detailed that targeted temperature management after cardiac arrest was used in 45% of people having ECPR and 15% of patients having CCPR (Low 2023).

Efficacy

Short-term survival with favourable neurological outcomes

Short-term survival with favourable neurological outcome was reported in 10 out of 11 studies included in the key evidence. Most often favourable neurological outcome was defined as CPC 1 or 2 on the cerebral performance category. One systematic review also included studies using the MGOS (Zhong 2024), and 2 systematic reviews included studies using the mRS (Scquizzato 2023, Pagura 2024). Mostly, short-term was defined as hospital discharge or 30 days after initial CA.

OHCA and IHCA studies

Three publications reporting on 2 systematic reviews presented meta-analyses for short-term survival with favourable neurological outcomes in both OHCA and IHCA (Low 2023, Low 2024, Zhong 2024). Both systematic reviews defined short-term as to hospital discharge or 30 days after initial CA.

In the systematic review of 11 studies reporting on adults with OHCA or IHCA, ECPR was associated with improved short-term survival with favourable neurological outcomes compared to CCPR in a meta-analysis of 7 studies (OR 1.65, 95% CI: 1.02 to 2.68; p=0.042) (Low 2023). The updated analysis of 10 studies also found ECPR was associated with favourable neurological outcomes at short-term follow-up (OR 1.57, 95% CI 1.14 to 2.15) (Low 2024). A meta-analysis of 11 studies in people with OHCA and IHCA (including 1,442 patients who had ECPR and 51,221 who had CCPR), showed improved short-term survival with favourable neurological outcomes with ECPR compared to CCPR (RR 2.88, 95% CI: 1.96 to 4.23, I^2=76%; p<0.0001; Zhong 2024). This result was consistent in a subgroup analysis using RCTs and PSM data only (RR 1.67, 95% CI: 1.16 to 2.40, I^2=51%; p=0.005; Zhong, 2024).

After stratifying based on the location of cardiac arrest, subgroup meta-analysis of 4 studies, showed that statistically significantly more people having ECPR for IHCA had short-term favourable neurological outcomes compared to people having CCPR for IHCA (OR 2.37, 95% CI: 1.34 to 4.19; p=0·0031, Low 2023). Similar outcomes were also seen in a subgroup meta-analysis of 10 studies (RR 2.18, 95% CI: 1.24 to 3.81, I^2=9%; Zhong 2024). In a subgroup meta-analysis of 3 studies, no significant differences in the rate of short-term favourable neurological outcome were observed in people with OHCA treated with ECPR or CCPR (OR 1.24, 95% CI: 0.65 to 2.36; p=0.51). Similar outcomes were also seen in a subgroup meta-analysis of 10 studies (RR 1.50, 95% CI: 0.98 to 2.29, I^2=55%; Zhong 2024).

OHCA studies

Five systematic reviews (Gomes 2023, Cheema 2023, Kiyohara 2023, Scquizzato 2023, Pagura 2024), 1 retrospective registry study (Inoue 2022), and 1 single-centre retrospective PSM study (Shih 2024) presented short-term survival with favourable neurological outcomes in people with OHCA. Short-term was defined as hospital discharge or 30 days after initial CA (although this was labelled ‘mid-term’ in the Cheema (2023) systematic review).

In the systematic review of 3 RCTs including 418 people with OHCA, ECPR was associated with a non-statistically significant higher rate of survival with a favourable neurological outcome at the shortest follow-up (26%) compared with standard CPR (17%), RR 1.47 (95% CI: 0.91 to 2.40; p=0.12; Gomes 2023). A subgroup analysis of patients with an initial shockable rhythm showed similar findings to the main analysis, with a non-statistically significant benefit of ECPR (RR 1.62, 95% CI: 0.95 to 2.76; p=0.07; Gomes 2023).

Across 3 systematic reviews and meta-analyses including the same 4 RCTs reporting on people with OHCA, the rate of short-term survival with favourable neurological outcome was statistically higher in the ECPR groups compared to CCPR (Cheema 2023, Kiyohara 2023, Scquizzato 2023). Pooled survival with favourable neurological outcome was 25% for those who had ECPR compared to 16% who had CCPR (Scquizzato 2023). Using a Mantel-Haenszel, random-effects meta-analysis, the odds ratios reported were 1.82, 95% CI: 1.13 to 2.92; p=0.01, I^2=0% (Scquizzato 2023) and 1.84, 95% CI: 1.14 to 2.99, I^2=0%; p=0.01 (Kiyohara 2023). The risk ratio (RR) using an inverse-variance, random effects meta-analysis was 1.59, 95% CI: 1.09 to 2.33, I^2=0%; p=0.02 (Cheema 2023). A subgroup analysis of patients with an initial shockable rhythm showed higher rate of short-term survival with favourable neurological outcome in the ECPR (31%) groups compared to CCPR (21%), OR 1.93, 95% CI: 1.16 to 3.23, I^2=0%; p=0.012; Scquizzato 2023).

In a meta-analysis of 14 studies (3 RCTs and 11 observational studies) in people with OHCA, the rate of short-term survival with favourable neurological outcome was significantly improved with ECPR (14%) compared with CCPR (7%); OR 2.35, 95% CI: 1.61 to 3.43, I^2=80%; p<0.0001. This was consistent in subgroup analysis including only RCTs OR: 1.83, 95% CI: 1.13 to 2.96, I^2=0%; p=0.01 (Pagura 2024).

In the retrospective SAVE-J II multicentre registry study which included 1,644 adults with OHCA who had ECPR in Japan, the overall rate of survival with favourable neurological outcome at hospital discharge was 14% (Inoue 2022). This rate was higher in those with an initial shockable rhythm (17%), and lower in those with a non-shockable rhythm (9% PEA, 4% asystole) (Inoue 2022). Multivariable analysis showed that younger age, initial shockable rhythm at the scene, and location of cardiac arrest were significantly associated with both favourable outcome and survival to hospital discharge (p<0.01) (Inoue 2022).

In the single centre retrospective PSM study reporting on people with OHCA resuscitated with ECPR or CCPR in a high volume emergency department in Taiwan, the rate of survival with favourable neurological outcome was 18% among those who had ECPR, compared to 5% in those who had CCPR. The PSM multivariate analysis reported an adjusted odds ratio (aOR) of 13.31, 95% CI: 1.61 to 109.9, p=0.016 (Shih 2024). Higher rates of favourable neurological outcome were associated with younger age (48 versus 59 years, p=0.001), CPR duration (37 min versus 51 min, p=0.006) and collapse to ECMO flow initiation time (76 versus 98.0 min, p=0.031).

Long-term survival with favourable neurological outcomes

Long-term survival with favourable neurological outcome was reported in 8 out of 11 studies included in the key evidence. Most often favourable neurological outcome was defined as CPC 1 or 2 on the cerebral performance category. One systematic review also included studies using the MGOS (Zhong 2024), and 2 systematic reviews included studies using the mRS (Scquizzato 2023, Pagura 2024). Mostly, long-term was defined as 3 or 6 months after initial CA.

OHCA and IHCA studies

Two systematic reviews presented meta-analyses for long-term survival with favourable neurological outcomes in both OHCA and IHCA (Low 2023, Zhong 2024). Both systematic reviews defined long-term as 3 months or more after initial CA.

In the systematic review of 11 studies reporting on adults with OHCA or IHCA, ECPR was associated with statistically significantly improved long-term survival with favourable neurological outcomes compared to CCPR in a meta-analysis of 8 studies (OR 2.04, 95% CI: 1.41 to 2.94; p=0.0001) (Low 2023). A meta-analysis of 11 studies in people with OHCA and IHCA (including 896 patients who had ECPR and 1,977 who had CCPR), showed improved long-term survival with favourable neurological outcomes with ECPR compared to CCPR (RR 2.11, 95% CI 1.40 to 3.19, I^2=69%; p=0.0004; Zhong 2024). This result was consistent with a subgroup analysis using RCTs and PSM data only (RR 1.83, 95% CI: 1.32 to 2.53, I^2=14%; p=0.0003; Zhong, 2024).

After stratifying based on the location of cardiac arrest, subgroup meta-analysis of 3 studies, showed a statistically significantly higher rate of long-term favourable neurological outcomes in ECPR groups compared to CCPR in people with IHCA (OR 2.80, 95% CI: 1.31 to 6.00; p=0.008), and in people with OHCA (4 studies: OR 1.96, 95% CI: 1.02 to 3.79; p=0.045; Low 2023). Similar outcomes were also seen in a subgroup meta-analysis of 3 studies in people with IHCA (RR 2.17, 95% CI: 1.19 to 3.94, I^2=0%), and of 5 studies in people with OHCA (RR 1.95, 95% CI: 1.01 to 3.59, I^2=11%; Zhong 2024).

OHCA studies

Five systematic reviews (Gomes 2023, Cheema 2023, Kiyohara 2023, Scquizzato 2023, Pagura 2024) and 1 long-term RCT follow-up study (Rob 2024), presented long-term survival with favourable neurological outcomes in people with OHCA. Long-term was defined as 3 or 6 months in 2 systematic reviews (Cheema 2023, Scquizzato 2023), or 6 months in 3 systematic reviews (Gomes 2023, Kiyohara 2023, Pagura 2024). Median follow-up was 5.3 years after initial CA in the RCT follow-up study (Rob 2024).

In the systematic review of 3 RCTs including 418 people with OHCA, ECPR was associated with a non-statistically significant higher rate of survival with a favourable neurological outcome at 6 months (28%) compared with standard CPR (19%), RR 1.48, 95% CI: 0.88 to 2.49, I^2=28%; p=0.14 (Gomes 2023). A subgroup analysis of patients with an initial shockable rhythm showed similar findings to the main analysis, with a non-significant benefit of ECPR (RR 1.50, 95% CI 0.90 to 2.50; p=0.12; Gomes 2023).

In 2 systematic reviews and meta-analyses including the same 4 RCTs reporting on people with OHCA, unlike short-term survival with favourable neurological outcomes, the rate of long-term survival with favourable neurological outcomes was not statistically significantly higher in the ECPR groups compared to CCPR (Cheema 2023, Kiyohara 2023). In a systematic review using a Mantel-Haenszel, random-effects meta-analysis, the OR was 1.74, 95% CI: 0.86 to 3.51, I^2=35%; p=0.12 (Kiyohara 2023) and in another, the risk ratio (RR) using an inverse-variance, random effects meta-analysis was 1.47, 95% CI: 0.89 to 2.43, I^2=25%; p=0.13 (Cheema 2023). However, in a systematic review and meta-analysis of the same 4 RCTs, pooled survival with favourable neurological outcome was 27% for those treated with ECPR compared to 18% on CCPR (OR 1.72, 95% CI: 1.09 to 2.70, I^2=26%; p=0.02; Scquizzato 2023). Although trial sequential analysis confirmed the statistically significant beneficial effect of ECPR, the sample size included in the meta-analysis did not reach the required information size (n=520; Scquizzato 2023). The systematic review by Scquizzato (2023) also reported no difference in patients surviving with poor neurological outcomes at the longest follow-up available (0% ECPR, 2% CCPR [OR 0.24, 95% CI: 0.05 to 1.26, I^2=0%; p=0.780]).

Two systematic reviews considered long-term survival with favourable neurological outcomes in subgroup meta-analyses in patients with an initial shockable rhythm. The rate of long-term survival with favourable neurological outcomes was 34% in the ECPR group compared with 23% in the CCPR group, OR 1.90, 95% CI: 1.16 to 3.13, I^2=23%; p=0.011 (Scquizzato 2023), and OR 1.91, 95% CI: 0.90 to 4.03, I^2=36%; p=0.09 (Kiyohara 2023).

One systematic review did a subgroup meta-analysis of studies by design (single-centre or multi-centre). A statistically significant difference in long-term survival with favourable neurological outcome with ECPR compared to CCPR was confirmed among single-centre studies (30% ECPR compared to 19% CCPR; OR 1.88, 95% CI: 1.11 to 3.19, I^2=48%; p=0.02; Scquizzato 2023).

In a meta-analysis of 6 studies (including RCTs and observational studies) in people with OHCA, the rate of long-term survival with favourable neurological outcome was statistically significantly improved with ECPR (16%) compared with CCPR (8%); 2.72, 95% CI: 1.47 to 5.04, I^2=47%; p=0.002; Pagura 2024).

In the long-term follow-up study of the Prague OHCA RCT, 255 people who survived following the initial trial period were followed for a median of 5.3 years (3.8 to 7.2) after initial cardiac arrest. In the ITT analysis, the rate of survival with favourable neurological outcome was 27% in those with ECPR and 19% in those with CCPR (RR 0.90, 95% CI: 0.79 to 1.03, p=0.13). In the per protocol and as-treated analysis, RR were 0.86, 95% CI: 0.75 to 0.99, p=0.035 and RR 0.84, 95% CI: 0.73 to 0.96, p=0.007, respectively (Rob 2024). Only 1 person in each trial arm in the ITT analysis was reported as surviving with a poor neurological outcome (Rob 2024).

Short-term survival

OHCA and IHCA studies

Three publications reporting on 2 systematic reviews presented meta-analyses for short-term survival in both OHCA and IHCA (Low 2023, Low 2024, Zhong 2024). Short-term is defined as survival to discharge or 30 days after initial CA.

In the systematic review of 11 studies reporting on adults with OHCA or IHCA, ECPR was associated with improved 30-day survival compared to CCPR in a meta-analysis of 7 studies (OR 1.45, 95% CI: 1.08 to 1.96; p=0.015) (Low 2023). In the updated analysis of 9 studies (1 RCT and 8 PSM studies), 30-day survival rate was 24% in the ECPR group and 18% in the CCPR group (OR 1.70, 95% CI: 1.29 to 2.26, I^2=71%; Low 2024). A meta-analysis of 3 RCTs and 9 PSM studies in people with OHCA and IHCA, showed improved short-term survival with ECPR compared to CCPR (RR 1.25, 95% CI 1.00 to 1.56, I^2=57%; p=0.05; Zhong 2024).

After stratifying based on the location of cardiac arrest, subgroup meta-analysis of 3 studies showed higher rates of survival at discharge or 1 month in ECPR groups compared to CCPR for people with IHCA (RR 2.03, 95% CI: 1.30 to 3.18, I^2=0%), than for people with OHCA (RR 1.10, 95% CI: 0.91 to 1.34, I^2=44%; Zhong 2024).

OHCA studies

Three systematic reviews (Cheema 2023, Scquizzato 2023, Pagura 2024), 1 retrospective registry study (Inoue 2022), and 1 single-centre retrospective PSM study (Shih 2024) presented short-term survival outcomes in people with OHCA. Short-term was defined as hospital discharge or 30 days after initial CA.

In the 2 systematic reviews and meta-analyses including the same 4 RCTs reporting on people with OHCA, no statistically significant difference in short-term survival was observed in people who had ECPR compared to CCPR. In the inverse variance random effects meta-analysis of the 4 RCTs the RR was 1.21, 95% CI: 0.64 to 2.28, I^2=48%; p=0.55 (Cheema 2023). In the Mantel-Haenszel random effects meta-analysis, short term survival was 33% in the ECPR group and 27% in the CCPR group (OR 1.35, 95% CI: 0.55 to 3.29, I^2=0%; p=0.514; Scquizzato 2023).

In the systematic review of RCTs and observational studies, meta-analysis of 13 studies showed a higher rate of short-term survival with ECPR (20%) than with CCPR (10%) for people with OHCA (OR 1.71, 95% CI: 1.18 to 2.46, I^2=81%; p=0.004; Pagura 2024).

In the retrospective SAVE-J II multicentre registry study which included 1,644 adults with OHCA who had ECPR in Japan, the overall rate of survival to hospital discharge was 27% (Inoue 2022). This rate was higher in those with an initial shockable rhythm (32%), and lower in those with a non-shockable rhythm (19% PEA, 11% asystole). Multivariable analysis showed that shorter low flow time was significantly associated with survival to hospital discharge (p<0.001) (Inoue 2022).

In the single centre retrospective PSM study reporting on people with OHCA resuscitated with ECPR or CCPR in a high volume emergency department in Taiwan, the in-hospital or 30-day survival rate was 29% among those with ECPR, compared to 8% in those with CCPR. The PSM multivariate analysis reported an adjusted OR (aOR) of 6.02, 95% CI: 2.19 to 16.52 (Shih 2024).

Long-term survival

OHCA and IHCA studies

Two systematic reviews presented meta-analyses for long-term survival in both OHCA and IHCA (Low 2023, Zhong 2024). Long-term is defined as 3- to 6-month survival after initial CA. Both studies also report on survival up to 1 year.

In the systematic review of 11 studies reporting on adults with OHCA or IHCA, ECPR was associated with improved survival compared to CCPR at 3 months (3 studies [OR 3.98, 95% CI: 1.12 to 14.16; p=0.033]), 6 months (6 studies [OR 1.87, 95% CI: 1.36 to 2.57; p=0.0001]), and 1 year (5 studies [OR 1.72, 95% CI: 1.52 to 1.95; p<0.0001]) (Low 2023). The meta-analysis of 3 RCTs and 9 PSM studies in people with OHCA and IHCA, also showed improved long-term survival with ECPR compared to CCPR at 3 to 6 months (RR 2.73, 95% CI: 1.67 to 4.48, I^2=0%; p<0.0001) and at 1 year (RR 1.92, 95% CI: 1.14 to 3.25, I^2=0%; p=0.01; Zhong 2024).

After stratifying based on the location of cardiac arrest, subgroup meta-analysis of 3 studies, showed higher rates of survival to 3 to 6 months or 1 year in ECPR groups compared to CCPR for people with OHCA (RR 3.16, 95% CI: 1.36 to 7.38, I^2=0%), than for people with IHCA (RR 1.92, 95% CI: 1.14 to 3.25, I^2=0%; Zhong 2024).

OHCA studies

Three systematic reviews (Cheema 2023, Kiyohara 2023, Scquizzato 2023) and 1 long-term RCT follow-up study (Rob 2024), presented long-term survival in people with OHCA. Long-term was defined in 1 systematic review as 3 or 6 months (Cheema 2023), in 1 systematic review as 6 months (Kiyohara 2023), and in 1 systematic review as 30 days to 6 months. In Scquizzato (2023), survival was reported at the longest follow-up available. Median follow-up was 5.3 years after initial CA in the RCT follow-up study (Rob 2024).

In the 3 systematic reviews and meta-analyses including the same 4 RCTs reporting on people with OHCA, no statistically significant difference in long-term survival was observed in people who had ECPR compared to CCPR (Cheema 2023, Kiyohara 2023, Scquizzato 2023). In the inverse variance random effects meta-analysis of the 4 RCTs the RR for survival at 3 or 6 months was RR 1.32, 95% CI: 0.18 to 9.5, I^2=64%; p=0.79 (Cheema 2023). In the Mantel-Haenszel random effects meta-analyses, survival at the longest follow-up was 28% in the ECPR group and 22% in the CCPR group (OR 1.31, 95% CI: 0.49 to 3.49, I^2=58%; p=0.592; Scquizzato 2023) and the OR for survival at 6 months was 1.50, 95% CI: 0.67 to 3.36, I^2=50%; p=0.33 (Kiyohara 2023).

In the long-term follow-up study of the Prague OHCA RCT, 255 people who survived following the initial trial period were followed for a median of 5.3 years after initial cardiac arrest. In the ITT analysis, Kaplan-Meier estimates of survival were 28% in those with ECPR and 20% in those with CCPR (log rank p=0.01). In the per protocol and as-treated analysis, the difference between groups were log rank p=0.008 and p<0.001, respectively (Rob 2024).

Mortality

OHCA and IHCA studies

Two publications reporting on 1 systematic review presented meta-analyses for in-hospital mortality in both OHCA and IHCA (Low 2023, Low 2024).

In the meta-analyses of 3 RCTs and 8 PSMs of adults with OHCA or IHCA (n=9,192), ECPR was associated with significant reduction in mortality (OR 0.67, 95% CI: 0.51 to 0.87, I^2=42%; p=0.0034 (Low 2023). In-hospital mortality in the updated analysis of 3 RCTs and 11 PSMs of adults with OHCA or IHCA (n=14,048) was 77% in ECPR group and 83% in the CCPR group (OR 0.63, 95% CI: 0.50 to 0.79, I^2=64%; Low 2024).

After stratifying based on the location of cardiac arrest, subgroup meta-analysis of 4 studies, showed a significant reduction in mortality in people having ECPR compared to CCPR in those with IHCA (OR 0.42, 95% CI: 0.25 to 0.70, I^2=0%; p=0.0009; Low 2023), and in people with OHCA (3 RCTs and 6 PSMs: OR 0.67, 95% CI: 0.51 to 0.88, I^2=74%; Low 2024). Pooled HRs across studies showed that longer duration of CPR was associated with increased mortality (HR per min 1.01, 95% CI 1.00 to 1.01; p=0·0001), and an initial presentation with a shockable rhythm was associated with reduced mortality (HR 0.52, 95% CI 0.32 to 0.86; p=0.011). However, it did not show an association between age and mortality (HR per year 1.02, 95% CI 0.98 to 1.06; p=0.41; Low 2023).

OHCA

One systematic review reported in-hospital mortality in people with OHCA. In the systematic review of 3 RCTs including 418 people with OHCA, the mean absolute rate of in-hospital mortality was not significantly lower in the ECPR group (71%) compared to the CCPR group (79%; RR 0.89, 95% CI: 0.74 to 1.07, I^2=53%; p=0.23) (Gomes 2023).

Safety

Of the 11 included studies in the key evidence, only 4 studies reported on any safety outcomes (2 systematic reviews [Low 2023, Cheema 2023], 1 registry study [Inoue 2022] and 1 long-term RCT follow-up study [Rob 2024]).

Bleeding

One systematic review and 1 registry study reported bleeding events. In the systematic review of 11 studies including adults with OHCA or IHCA, people who had ECPR were more likely to have bleeding than those who had CCPR (meta-analysis 4 studies: OR 4.84, 95% CI: 1.91 to 12.24; p=0.0009) (Low 2023). In the retrospective SAVE-J II multicentre registry study which included 1,644 adults with OHCA who had ECPR in Japan, rates of cannulation-related bleeding were 16% (268 of 1,644), and rates of haemorrhage were 8.5% (139 of 1,644; Inoue 2022).

Adverse events

One systematic review of 4 RCTs in people with OHCA reported the comparative rates of adverse events between ECPR and CCPR. Of the 4 RCTs included in the systematic review, only 2 two studies reported the rate of adverse events. Meta-analysis indicated that ECPR was associated with higher rate of adverse events than CCPR (RR: 3.22, 95% CI: 1.18 to 8.80, I^2=63%; p=0.02; Cheema 2023).

In the retrospective SAVE-J II multicentre registry study which included 1,644 adults with OHCA who had ECPR in Japan, the overall reported complication rate during ECPR was 33% (535 of 1,644). This included procedure-related complications (21%, 346 of 1,644) such as cannula malposition and unsuccessful cannulation, ECMO-related complications (3%, 50 of 1,644) and ischaemia (2%, 26 of 1,644) as well as the bleeding complications reported in the section above (Inoue 2022).

Long-term adverse events

In the long-term follow-up study of the Prague OHCA RCT, 255 people who survived following the initial trial period were followed for a median of 5.3 years after initial cardiac arrest. During the follow-up, 39 people (32%) in the ECPR group and 30 (23%) in the CCPR group were discharged from the hospital or long-term hospital facilities after the initial CA event (median time to discharge 19.5 days, IQR 12.5 to 32 days). Of these, 10% (4 of 39) patients in the ECPR group and 20% (6 of 30) in the CCPR group died during the follow-up (RR 0.51, 95% CI: 0.16 to 1.66, p=0.26). At least one rehospitalisation after discharge occurred in 77% (30 of 39) of the ECPR group and 60% (18 of 30) of the CCPR group (RR 1.28, 95% CI: 0.91 to 1.8, p=0.15). At least one cardiovascular rehospitalisation occurred in 64% (25 of 39) of people in the ECPR group and 50% (15 of 30) of those in the CCPR group (RR 1.28, 95% CI: 0.84 to 1.97, p=0.26. One person in each group reported myocardial infarction after discharge, and 1 person treated with CCPR had a stroke. Hospitalisation for heart failure occurred in 5% (2 of 39) of people in the ECPR group and 10% (3 of 30) in the CCPR group, and for ventricular arrhythmia in 3% (1 of 39) people in the ECPR group and 10% (3 of 30) in the CCPR group (Rob 2024).

Anecdotal and theoretical adverse events

Expert advice was sought from consultants who have been nominated or ratified by their professional society or royal college. They were asked if they knew of any other adverse events for this procedure that they had heard about (anecdotal), which were not reported in the literature. They were also asked if they thought there were other adverse events that might possibly occur, even if they had never happened (theoretical).

They listed the following anecdotal and theoretical adverse events:

- Left ventricle overloading
- Deep vein thrombosis
- Arteriovenous fistula
- Pseudoaneurysm
- Harlequin syndrome
- Haemolysis
- Intracerebral haemorrhage
- Major pulmonary bleed
- Failure to cannulate during cardiac arrest

- Malposition of the cannula
- Device clotting
- Air entrainment/embolus
- Embolism
- Oxygenator failure
- Consumption coagulopathy
- Acquired Von Willebrand syndrome
- Systemic inflammatory response syndrome (SIRS)
- Multi-organ failure including kidney, liver, and pancreas.

Sixteen professional expert questionnaires were submitted. Find full details of what the professional experts said about the procedure in the specialist advice questionnaires for this procedure.

Validity and generalisability

- Most of the key papers included are systematic reviews with meta-analyses. There was a significant amount of overlap identified across the systematic reviews included in the overview; much of the available evidence identified in this review is based on the same RCTs. Evidence was mainly for adult patients resuscitated from OHCA; two systematic reviews included studies done in IHCA.
- No RCTs were available for the IHCA population.
- Recent systematic reviews of RCTs in OHCA have varying conclusions of the benefit of ECPR compared to CCPR. This is reflected in the conflicting conclusions of the RCTs themselves.
  - All 3 RCTs and 1 pilot RCT were small and had a high rate of crossovers and deviations from the intended intervention.

  - Authors of the systematic reviews noted that the RCTs may have insufficient power to observe significant differences between intervention arms.
  - There was a high heterogeneity across RCTs, such as the proportion of people with non-shockable rhythms enrolled, the definition of refractory OHCA (5 minutes or 15 minutes without ROSC), the time between cardiac arrest and ECMO initiation, whether there was a standardised emergency medical services protocol in place, whether the RCT was a single or multicentre study, the centre's level of experience with ECPR, and outcome endpoints.
- In the 3 RCTs reported in 8 systematic reviews (Low 2023, Low 2024, Zhong 2024, Gomes 2023, Cheema 2023, Kiyohara 2023, Scquizzato 2023, Pagura 2024), ECPR was initiated in 64% (Prague OHCA), 66% (INCEPTION) and 86% (ARREST) of the patients randomised to the intervention arm. In the additional pilot RCT included in 3 systematic reviews (Cheema 2023, Kiyohara 2023, Scquizzato 2023) 42% randomised to the intervention arm received ECPR (Scquizzato 2023). In the ARREST trial, none of the patients randomised to the standard CPR group received ECPR, while the rate of crossover was 8% in Prague OHCA and 5% in INCEPTION (Scquizzato 2023).
- Some systematic reviews included observational studies, which are at higher risk of bias, particularly in ECPR, as the decision to treat is based on clinician's evaluation of comorbidities and prognostic factors which may have strong impact on the outcome. Authors of the Shih (2024) observational study noted that there may be selection bias for ECPR as there was no protocol for who got ECPR, therefore it was likely patients with better prognosis were selected for ECPR than randomised studies.
- Only 1 follow-up study for 1 RCT reported any outcomes with a follow-up longer than 6 months.

Ongoing trials

- ON-SCENE Initiation of Extracorporeal CardioPulmonary Resuscitation During Refractory Out-of-Hospital Cardiac Arrest (ON-SCENE) (NCT04620070); RCT; Netherlands; n=390; completion date July 2026
- Pre-hospital ECMO or Conventional Resuscitation for Refractory Cardiac Arrest (PACER) (NCT06177730); RCT; Australia and New Zealand; n=10; completion date December 2024

Existing assessments of this procedure

European Resuscitation Council (ERC): Guidelines for resuscitation (2021) on ECPR recommends as follows:

- Consider ECPR as a rescue therapy for selected patients with cardiac arrest when conventional advanced life support (ALS) measures are failing or to facilitate specific interventions (e.g. coronary angiography and percutaneous coronary intervention (PCI), pulmonary thrombectomy for massive pulmonary embolism, rewarming after hypothermic cardiac arrest) in settings in which it can be implemented.

International Liaison Committee on Resuscitation (ILCOR) International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (CoSTR) (2019)

- ECPR may be considered as a rescue therapy for selected patients with cardiac arrest when conventional CPR is failing in settings in which it can be implemented (weak recommendation, very low certainty of evidence).

American Heart Association Focused Update on Advanced Cardiovascular Life Support 2019

- There is insufficient evidence to recommend the routine use of ECPR for patients with cardiac arrest.
- ECPR may be considered for selected patients as rescue therapy when conventional CPR efforts are failing in settings in which it can be expeditiously implemented and supported by skilled providers.

Related NICE guidance

Interventional procedures

Extracorporeal membrane oxygenation (ECMO) for acute heart failure in adults (2014) NICE interventional procedures guidance [IPG 482]. (Recommendation: special arrangements).

Professional societies

- The Intensive Care Society
- Society for Cardiothoracic Surgery in Great Britain & Ireland
- Royal College of Anaesthetists
- Royal College of Surgeons
- Faculty of Intensive Care Medicine
- British Society for Heart Failure
- NHS Blood and Transplant
- British cardiovascular society
- European Extracorporeal Life Support Organisation

Company engagement

NICE asked companies who manufacture a device potentially relevant to this procedure for information on it. NICE received 2 completed submissions. These were considered by the interventional procedures technical team and any relevant points have been taken into consideration when preparing this overview.

References

1. Low CJW, Ramanathan K, Ling RR et al. (2023) Extracorporeal cardiopulmonary resuscitation versus conventional cardiopulmonary resuscitation in adults with cardiac arrest: a comparative meta-analysis and trial sequential analysis. The Lancet. Respiratory Medicine 11(10): 883-893
2. Low CJW, Ling RR, Ramanathan K et al. (2024) Extracorporeal cardiopulmonary resuscitation versus conventional CPR in cardiac arrest: an updated meta-analysis and trial sequential analysis. Critical Care (London, England) 28(1): 57
3. Zhong H, Yin Z, Wang, Y et al. (2024) Comparison of prognosis between extracorporeal CPR and conventional CPR for patients in cardiac arrest: a systematic review and meta-analysis. BMC Emergency Medicine 24(1): 128
4. Gomes DA, Presume J, Ferreira J et al. (2023) Extracorporeal cardiopulmonary resuscitation for refractory out-of-hospital cardiac arrest: a systematic review and meta-analysis of randomized clinical trials. Internal and Emergency Medicine 18(7): 2113-2120
5. Cheema HA, Shafiee A, Jafarabady K et al. (2023) Extracorporeal cardiopulmonary resuscitation for out-of-hospital cardiac arrest: A meta-analysis of randomized controlled trials. Pacing and Clinical Electrophysiology: PACE 46(10): 1246-1250
6. Kiyohara Y, Kampaktsis PN, Briasoulis A et al. (2023) Extracorporeal membrane oxygenation-facilitated resuscitation in out-of-hospital cardiac arrest: a meta-analysis of randomized controlled trials. Journal of Cardiovascular Medicine 24(7): 414-419
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8. Pagura L, Fabris E, Rakar S et al. (2024) Does extracorporeal cardiopulmonary resuscitation improve survival with favorable neurological outcome in out-of-hospital cardiac arrest? A systematic review and meta-analysis. Journal of Critical Care 84: 154882
9. Rob D, Farkasovska K, Kreckova M et al. (2024) Effect of intra-arrest transport, extracorporeal cardiopulmonary resuscitation and immediate invasive assessment in refractory out-of-hospital cardiac arrest: a long-term

follow-up of the Prague OHCA trial. Critical Care (London, England) 28(1): 125

10. Inoue A, Hifumi T, Sakamoto T et al. (2022) Extracorporeal cardiopulmonary resuscitation in adult patients with out-of-hospital cardiac arrest: a retrospective large cohort multicenter study in Japan. Critical Care (London, England) 26(1): 129
11. Shih H-M, Lin W-J, Lin Y-C et al. (2024) Extracorporeal cardiopulmonary resuscitation for patients with refractory out-of-hospital cardiac arrest: a propensity score matching, observational study. Scientific Reports 14(1): 9912

Appendix A: Methods and literature search strategy

Methods and literature search strategy

NICE has identified studies and reviews relevant to extracorporeal membrane oxygenation (ECMO) for acute heart failure in adults from the medical literature.

Search strategy design and peer review

This search report is informed by the Preferred Reporting Items for Systematic reviews and Meta-Analyses literature search extension (PRISMA-S).

A NICE information specialist ran the literature searches on 18th September 2024. See the search strategy history for the full search strategy for each database. Relevant published studies identified during consultation or resolution that are published after this date may also be considered for inclusion.

The principal search strategy was developed in MEDLINE ALL (Ovid interface). It was adapted for use in each of the databases listed in table 4a, taking into account the database's size, search functionality and subject coverage. The MEDLINE ALL strategy was quality assured by a NICE senior information specialist. All translated search strategies were peer reviewed to ensure their accuracy. The quality assurance and peer review procedures were adapted from the Peer Review of Electronic Search Strategies (PRESS) 2015 evidence-based checklist.

Review management

The search results were managed in EPPI-Reviewer version 5 (EPPI-R5). Duplicates were removed in EPPI-R5 using a 2-step process. First, automated deduplication was done using a high-value algorithm. Second, manual deduplication was used to assess low-probability matches. All decisions about inclusion, exclusion and deduplication were recorded and stored.

Limits and restrictions

The CENTRAL database search removed trial registry records and conference material. The Embase search excluded conference material. We excluded the following publication types in MEDLINE: letter or historical article or comment or editorial or news or case reports. We excluded letters and editorial from the Embase search. English language limits were applied to the search when possible in the database.

The search was limited from March 2013 to September 2024. The date limit was included to update searches undertaken for an earlier version of this guidance.

The limit to remove animal studies in the searches is standard NICE practice, which has been adapted from Dickersin K, Scherer R, Lefebvre C (1994) Systematic Reviews: Identifying relevant studies for systematic reviews. BMJ 309(6964): 1286.

Main search

Table 4a Main search results

Database	Date searched	Database platform	Database segment or version	Number of results downloaded
Cochrane Central Register of Controlled Trials (CENTRAL)	18/08/24	Wiley	Issue 8 of 12, August 2024	410
Cochrane Database of Systematic Reviews (CDSR)	20/08/24	Wiley	Issue 9 of 12, September 2024	13
Embase	20/08/24	Ovid	1974 to 2024 September 17	2101
INAHTA International HTA Database	18/09/24	https://database.inahta.org/	-	24
MEDLINE ALL	18/09/24	Ovid	1946 to Sept 17, 2024	1454

[MEDLINE ALL] search strategy

1 , Heart Failure/th , 29,868

2 , Acute disease/th , 1,194

3 , 1 and 2 , 11

4 , *Cardiomyopathies/th , 1,150

5 , *Shock cardiogenic/th , 2,135

6 , Myocardial Stunning/th [Therapy] , 155

7 , Myocarditis/th [Therapy] , 1,294

8 , *Myocardial infarction/ , 138,977

9 , Out-of-Hospital Cardiac Arrest/th [Therapy] , 5,734

10 , ((acute* or server*) adj (heart* or cardiac* or myocard* or cardio* or ventric*) adj (failur* or decompensation* or insufficient* or dysfunct* or stand* or still* or fault* or shock*)).ti,ab. , 9,513

11 , Myocardit*.ti,ab. , 21,440

12 , ((Postpartum* or post-parttum* or peripartum* or peri-partum*) adj cardiomyopath*).ti,ab. , 1,697

13 , PPCM.ti,ab. , 671

14 , (myocard* adj (stun* or hibernat* or infract*)).ti,ab. , 2,258

15 , Primary Graft Dysfunction/th [Therapy] , 99

16 , (primary* adj graft* adj dysfunct*).ti,ab. , 1,392

17 , or/3-16 , 182,062

18 , *Cardiopulmonary Resuscitation/mt [Methods] , 4,116

19 , *Extracorporeal Membrane Oxygenation/ , 13,895

20 , ECMO.ti. , 3,217

21 , *Extracorporeal Circulation/mt [Methods] , 1,090

22 , (extracorp* adj circulat*).ti,ab. , 8,596

23 , (extracorp* adj ((cardiopulmon* adj resuscitat*) or CPR)).ti,ab. , 1,229

24 , ECPR.ti. , 154

25 , (Biomedicus adj pump*).ti,ab. , 45

26 , (Maquet* adj rotaflow*).ti,ab. , 12

27 , (jostra adj (pump* or rotaflow*)).ti,ab. , 5

28 , (levitronix adj (centrimag* or pump* or system* or oxygen*)).ti,ab. , 54

29 , (Medos adj (Hilite* or oxygen*)).ti,ab. , 22

30 , left ventricle assist device.ti,ab. , 106

31 , or/18-30 , 28,477

32 , 17 and 31 , 2,725

33 , animals/ not human/ , 5,225,551

34 , 32 not 33 , 2,680

35 , limit 34 to english language , 2,503

36 , limit 35 to ed=20130331-20240930 , 2,028

37 , limit 36 to (letter or historical article or comment or editorial or news or case reports) , 574

38 , 36 not 37 , 1,454

[Embase] search strategy

1 , heart failure/th [Therapy] , 15,752

2 , acute disease/th [Therapy] , 2,395

3 , 1 and 2 , 10

4 , *cardiomyopathy/th [Therapy] , 1,144

5 , *cardiogenic shock/th [Therapy] , 2,129

6 , stunned heart muscle/th [Therapy] , 53

7 , myocarditis/th [Therapy] , 864

8 , *heart infarction/ , 110,365

9 , primary graft dysfunction/th [Therapy] , 94

10 , "out of hospital cardiac arrest"/th [Therapy] , 3,862

11 , ((acute* or server*) adj (heart* or cardiac* or myocard* or cardio* or ventric*) adj (failur* or decompensation* or insufficient* or dysfunct* or stand* or still* or fault* or shock*)).ti,ab. , 17,537

12 , Myocardit*.ti,ab. , 31,093

13 , ((Postpartum* or post-parttum* or peripartum* or peri-partum*) adj cardiomyopath*).ti,ab. , 2,835

14 , PPCM.tw. , 1,261

15 , (myocard* adj (stun* or hibernat* or infract*)).ti,ab. , 3,555

16 , (primary* adj graft* adj dysfunct*).tw. , 3,009

17 , or/3-16 , 173,201

18 , *resuscitation/ , 60,473

19 , *extracorporeal oxygenation/ , 16,545

20 , ECMO.ti. , 7,837

21 , *extracorporeal circulation/ , 9,094

22 , (extracorp* adj circulat*).ti,ab. , 9,683

23 , (extracorp* adj ((cardiopulmon* adj resuscitat*) or CPR)).ti,ab. , 1,851

24 , ECPR.ti. , 352

25 , (Biomedicus adj pump*).ti,ab. , 50

26 , (Maquet* adj rotaflow*).ti,ab. , 31

27 , (jostra adj (pump* or rotaflow*)).ti,ab. , 16

28 , (levitronix adj (centrimag* or pump* or system* or oxygen*)).ti,ab. , 150

29 , (Medos adj (Hilite* or oxygen*)).ti,ab. , 44

30 , left ventricle assist device.ti,ab. , 217

31 , or/18-30 , 96,434

32 , 17 and 31 , 5,350

33 , Nonhuman/ not Human/ , 5,532,522

34 , 32 not 33 , 5,275

35 , limit 34 to letter/ or (letter or editorial).pt. , 2,165,352

36 , 34 not 35 , 4,904

37 , limit 36 to dc=20130331-20240930 , 3,599

38 , limit 37 to english language , 3,481

39 , (conference abstract* or conference review or conference paper or conference proceeding).db,pt,su. , 6,020,541

40 , 38 not 39 , 2,101

Cochrane Library (CDSR) search strategy

#1 MeSH descriptor: [Heart Failure] explode all trees and with qualifier(s): [therapy - TH] 2591

#2 MeSH descriptor: [Acute Disease] explode all trees and with qualifier(s): [therapy - TH] 118

#3 #1 and #2 0

#4 MeSH descriptor: [Cardiomyopathies] explode all trees and with qualifier(s): [therapy - TH] 248

#5 MeSH descriptor: [Shock, Cardiogenic] explode all trees and with qualifier(s): [therapy - TH] 177

#6 MeSH descriptor: [Myocardial Stunning] explode all trees and with qualifier(s): [therapy - TH] 3

#7 MeSH descriptor: [Myocarditis] explode all trees and with qualifier(s): [therapy - TH] 13

#8 MeSH descriptor: [Myocardial Infarction] explode all trees and with qualifier(s): [therapy - TH] 3337

#9 MeSH descriptor: [Primary Graft Dysfunction] explode all trees and with qualifier(s): [therapy - TH] 3

#10 MeSH descriptor: [Out-of-Hospital Cardiac Arrest] explode all trees and with qualifier(s): [therapy - TH] 539

#11 ((acute* or server*) near/1 (heart* or cardiac* or myocard* or cardio* or ventric*) near/1 (failur* or decompensation* or insufficient* or dysfunct* or stand* or still* or fault* or shock*)) 2663

#12 Myocardit* 1421

#13 (Postpartum* or post-partum* or peripartum* or peri-partum*) near/1 cardiomyopath* 47

#14 PPCM 39

#15 (myocard* near/1 (stun* or hibernat* or infract*)) 342

#16 (primary* near/1 graft* near dysfunct*) 146

#17 #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #168646

#18 MeSH descriptor: [Cardiopulmonary Resuscitation] this term only 1688

#19 MeSH descriptor: [Extracorporeal Membrane Oxygenation] this term only 361

#20 ECMO 1101

#21 MeSH descriptor: [Extracorporeal Circulation] this term only and with qualifier(s): [methods - MT]120

#22 (extracorp* near/1 circulat*) 1423

#23 (extracorp* near/1 ((cardiopulmon* near resuscitat*) or CPR)) 71

#24 ECPR 112

#25 (Biomedicus near/1 pump*) 3

#26 (Maquet* rotaflow*) 3

#27 jostra near/1 (pump* or rotaflow*) 1

#28 (levitronix near/1 (centrimag* or pump* or system* or oxygen*)) 0

#29 Medos near/1 (Hilite* or oxygen*) 0

#30 left ventricle assist device 219

#31 #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #304577

#32 #17 AND #31 494

#33 "conference":pt or (clinicaltrials or trialsearch):so 777352

#34 #32 NOT #33 with Cochrane Library publication date Between Mar 2013 and Sep 2024, in Cochrane Reviews 13

[Cochrane Library CENTRAL)] search strategy

#1 MeSH descriptor: [Heart Failure] explode all trees and with qualifier(s): [therapy - TH] 2591

#2 MeSH descriptor: [Acute Disease] explode all trees and with qualifier(s): [therapy - TH] 118

#3 #1 and #2 0

#4 MeSH descriptor: [Cardiomyopathies] explode all trees and with qualifier(s): [therapy - TH] 248

#5 MeSH descriptor: [Shock, Cardiogenic] explode all trees and with qualifier(s): [therapy - TH] 177

#6 MeSH descriptor: [Myocardial Stunning] explode all trees and with qualifier(s): [therapy - TH] 3

#7 MeSH descriptor: [Myocarditis] explode all trees and with qualifier(s): [therapy - TH] 13

#8 MeSH descriptor: [Myocardial Infarction] explode all trees and with qualifier(s): [therapy - TH] 3337

#9 MeSH descriptor: [Primary Graft Dysfunction] explode all trees and with qualifier(s): [therapy - TH] 3

#10 MeSH descriptor: [Out-of-Hospital Cardiac Arrest] explode all trees and with qualifier(s): [therapy - TH] 539

#11 ((acute* or server*) near/1 (heart* or cardiac* or myocard* or cardio* or ventric*) near/1 (failur* or decompensation* or insufficient* or dysfunct* or stand* or still* or fault* or shock*)) 2663

#12 Myocardit* 1421

#13 (Postpartum* or post-partum* or peripartum* or peri-partum*) near/1 cardiomyopath* 47

#14 PPCM 39

#15 (myocard* near/1 (stun* or hibernat* or infract*)) 342

#16 (primary* near/1 graft* near dysfunct*) 146

#17 #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 8646

#18 MeSH descriptor: [Cardiopulmonary Resuscitation] this term only 1688

#19 MeSH descriptor: [Extracorporeal Membrane Oxygenation] this term only 361

#20 ECMO 1101

#21 MeSH descriptor: [Extracorporeal Circulation] this term only and with qualifier(s): [methods - MT]120

#22 (extracorp* near/1 circulat*) 1423

#23 (extracorp* near/1 ((cardiopulmon* near resuscitat*) or CPR)) 71

#24 ECPR 112

#25 (Biomedicus near/1 pump*) 3

#26 (Maquet* rotaflow*) 3

#27 jostra near/1 (pump* or rotaflow*) 1

#28 (levitronix near/1 (centrimag* or pump* or system* or oxygen*)) 0

#29 Medos near/1 (Hilite* or oxygen*) 0

#30 left ventricle assist device 219

#31 #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #304577

#32 #17 AND #31 494

#33 "conference":pt or (clinicaltrials or trialsearch):so 777352

#34 #32 NOT #33 with Cochrane Library publication date Between Mar 2013 and Sep 2024, in Trials 410

[INAHTA HTA Database] search strategy

1 , "Heart Failure"[mh] , 252

2 , "Acute Disease"[mh] , 46

3 , #2 AND #1 , 2

4 , "Cardiomyopathies"[mh] , 21

5 , "Shock, Cardiogenic"[mh] , 11

6 , "Myocardial Stunning"[mh] , 1

7 , "Myocarditis"[mh] , 1

8 , "Myocardial Infarction"[mh] , 123

9 , "Out-of-Hospital Cardiac Arrest"[mh] , 10

10 , ((acute* or server*) and (heart* or cardiac* or myocard* or cardio* or ventric*) and (failur* or decompensation* or insufficient* or dysfunct* or stand* or still* or fault* or shock*)). , 149

11 , Myocardit* , 5

12 , ((Postpartum* or post-parttum* or peripartum* or peri-partum*) AND cardiomyopath*) , 1

13 , PPCM , 0

14 , (myocard* and (stun* or hibernat* or infract*)) , 2

15 , "Primary Graft Dysfunction"[mh] , 0

16 , (primary* AND graft* AND dysfunct*). , 3

17 , #16 OR #15 OR #14 OR #13 OR #12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 , 291

18 , "Cardiopulmonary Resuscitation"[mh] , 23

19 , "Extracorporeal Membrane Oxygenation"[mh] , 29

20 , ECMO , 31

21 , "Extracorporeal Circulation"[mh] , 9

22 , (extracorp* AND circulat*). , 13

23 , (extracorp* AND ((cardiopulmon* AND resuscitat*) or CPR)) , 8

24 , ECPR , 4

25 , (Biomedicus AND pump*). , 0

26 , Maquet* and rotaflow*) , 0

27 , (jostra and (pump* or rotaflow*)). , 0

28 , (levitronix AND (centrimag* or pump* or system* or oxygen*)). , 0

29 , (Medos AND (Hilite* or oxygen*)). , 0

30 , left ventricle assist device , 3

31 , #30 OR #29 OR #28 OR #27 OR #26 OR #25 OR #24 OR #23 OR #22 OR #21 OR #20 OR #19 OR #18 , 74

32 , #31 AND #17 , 24

Inclusion criteria

The following inclusion criteria were applied to the abstracts identified by the literature search.

- Publication type: clinical studies were included with emphasis on identifying good quality studies. Abstracts were excluded if they did not report clinical outcomes. Reviews, editorials, and laboratory or animal studies, were also excluded and so were conference abstracts, because of the difficulty of appraising study methodology, unless they reported specific adverse events not available in the published literature.
- People with cardiac arrest.
- Intervention or test: VA ECMO.
- Outcome: articles were retrieved if the abstract contained information relevant to the safety, efficacy, or both.

If selection criteria could not be determined from the abstracts the full paper was retrieved.

Potentially relevant studies not included in the main evidence summary are listed in **Error! Reference source not found.**.

Find out more about how NICE selects the evidence for the committee.

Appendix B: Other relevant studies

Other potentially relevant studies that were not included in the main evidence summary (tables 2 and 3) are listed in table 5 below.

Case studies and observational studies with fewer than 100 people were excluded unless they included outcomes that were not frequently reported.

Table 5 additional studies identified

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Alexy T, Kalra R, Kosmopoulos M et al. (2023) Initial hospital length of stay and long-term survival of patients successfully resuscitated using extracorporeal cardiopulmonary resuscitation for refractory out-of-hospital cardiac arrest. European Heart Journal. Acute Cardiovascular Care 12(3): 175-183	Single centre retrospective study, US n=160 Follow-up: 4 years (median follow-up: 3 years)	34% people survived the index admission. These survivors required a median 16 days of intensive care and 24 days total hospital stay. Of these, 80% and 72% were alive at 1 and 4 years, respectively. Most deaths within the first year occurred among the patients requiring discharge to a long-term acute care facility.	Larger, more comprehensive systematic literature reviews and meta-analysis included. Longer-term data included from RCT.
Belohlavek J, Smalcova J, Rob D et al. (2022) Effect of intra-arrest transport, extracorporeal cardiopulmonary resuscitation, and immediate invasive assessment and	Prague OHCA randomised controlled trial n=256 (124 ECPR) Follow-up: 180 days (6 months)	In the main analysis, 32% of the ECPR group and 22% of the CCPR group survived to 180 days with good neurologic outcome (OR, 1.63, 95% CI 0.93 to 2.85; p=0.09). At 30 days, neurologic recovery had occurred	RCT included in all SLRs

treatment on functional neurologic outcome in refractory out-of-hospital cardiac arrest: a randomized clinical trial. JAMA 327(8): 737-747		in 31% in the ECPR group and in 18% in the CCPR group (OR, 1.99, 95% CI 1.11 to 3.57; p=0.02). Bleeding occurred more frequently in the ECPR versus CCPR group (31% vs 15%, respectively).	
Beyea MM, Tillmann BW, Iansavichene AE et al. (2018) Neurologic outcomes after extracorporeal membrane oxygenation assisted CPR for resuscitation of out-of-hospital cardiac arrest patients: A systematic review. Resuscitation 130: 146-158	Systematic review and meta-analysis n=NR, 75 studies (case series and cohort studies) Follow-up: hospital discharge	Among case series, 0 to 71% of patients treated with ECPR survived to discharge with a good neurological outcome. Subgroup analysis of cohort studies demonstrated survival-to-hospital discharge with good neurological recovery in the ECPR group ranged from 8 to 42% compared to 2 to 9% in the CCPR group.	More recent systematic literature reviews with meta-analysis included.
Bougouin W, Dumas F, Lamhaut L et al. (2020) Extracorporeal cardiopulmonary resuscitation in out-of-hospital cardiac arrest: a registry study. European Heart Journal 41(21): 1961-1971	Retrospective registry study (France). n=13,191 Follow-up: hospital discharge	Survival was 8% in ECPR group and 9% in CCPR group (p=0.91). By adjusted multivariate analysis, ECPR was not associated with hospital survival (OR 1.3, 95% CI 0.8 to 2.1; p=0.24). PSM analysis found similar results (OR 0.8, 95% CI 0.5 to 1.3; p=0.41). In the ECPR group, factors associated with hospital survival were initial shockable rhythm (p=0.005), transient ROSC before ECMO (p=0.03), and	Included in SLRs (Pagura 2024)

		prehospital ECMO implantation (p=0.002)	
Chahine J, Kosmopoulos M, Raveendran G et al. (2023) Impact of age on survival for patients receiving ECPR for refractory out-of-hospital VT/VF cardiac arrest. Resuscitation 193: 109998	Single centre retrospective study, US n=391 Follow-up: hospital discharge	Age was independently associated with neurologically favourable survival to discharge, with a 30% decrease in survival with every 10-year increase in age (OR 0.7, 95% CI 0.57 to 0.87, p=0.001).	Larger, more comprehensive systematic literature reviews and meta-analysis included.
Chen Z, Liu C, Huang J et al. (2019) Clinical efficacy of extracorporeal cardiopulmonary resuscitation for adults with cardiac arrest: meta-analysis with trial sequential analysis. BioMed Research International 2019: 6414673	Systematic review and meta-analysis n=NR, 13 observational studies Follow-up: 1 year	ECPR in OHCA and IHCA was associated with a significantly better 30-day survival (RR 1.60, 95% CI 1.25 to 2.06) and 30-day neurologic outcome (RR 2.69, 95% CI 1.63 to 4.46) than CCPR. Relative to CCPR, ECPR improved the survival and neurological outcome of patients who had IHCA. Trial sequential analysis could not confirm better survival and neurologic outcome of ECPR in OHCA patients, suggesting that further studies are needed.	More recent systematic literature reviews included.
Choi DS, Kim TR, Young S et al. (2016) Extracorporeal life support and survival after out-of-hospital cardiac arrest in a nationwide registry: A propensity score-	Retrospective registry study (Korea). n=36,547 (320 ECPR) Follow-up: hospital discharge	There was no significant difference in neurologically favourable survival to discharge between the ECLS group and the non-ECLS group after adjusting for covariates (adjusted OR 0.65, 95% CI 0.41 to 1.04).	Included in SLRs (Zhong 2024, Pagura 2024)

matched analysis. Resuscitation 99: 26-32		In the PSM cohort, there was also no significant difference between the two groups (adjusted OR, 0.94, 95% CI 0.41 to 2.14).	
Choi Y, Park JH, Jeong J et al. (2023) Extracorporeal cardiopulmonary resuscitation for adult out-of-hospital cardiac arrest patients: time-dependent propensity score-sequential matching analysis from a nationwide population-based registry. Critical Care 27(1): 87	PSM retrospective registry study (Korea). n=2,290 (458 ECPR) Follow-up: hospital discharge	ECPR itself was not associated with good neurological recovery (10% in ECPR and 7% in no ECPR; RR 1.28, 95% CI 0.85 to 1.93), but early ECPR was positively associated with good neurological recovery.	Included in SLRs (Zhong 2024, Pagura 2024)
Downing J, Al F, Reem CS et al. (2022) How effective is extracorporeal cardiopulmonary resuscitation (ECPR) for out-of-hospital cardiac arrest? A systematic review and meta-analysis. The American journal of emergency medicine 51: 127-138	Systematic review and meta-analysis n=3,097, 44 studies Follow-up: 90 days	ECPR for OHCA showed survival-to-discharge rate of 24%; 18% survived with favourable neurologic function. 30- and 90-days survival rates were both around 18%.	Larger, more recent and comparative systematic literature reviews and meta-analyses included.

Haas NL, Coute RA, Hsu CH et al. (2017) Descriptive analysis of extracorporeal cardiopulmonary resuscitation following out-of-hospital cardiac arrest-An ELSO registry study. Resuscitation 119: 56-62	Retrospective ELSO registry study n=217 Follow-up: hospital discharge	Reported complications included haemorrhage (31%), limb complications (11%), circuit complications (9%), infection (7%), and seizures (6%). Survival to hospital discharge was 28% (95% CI 22.1 to 34.0%), and male gender was independently associated with mortality (aOR 2.1 (95% CI 1.1 to 4.2, p<0.05). Survival did not differ by region, race, age, or year.	Larger, more recent and comparative systematic literature reviews and meta-analyses included.
Hashem A, Mohamed MS, Alabdullah K, et al. (2023). Predictors of mortality in patients with refractory cardiac arrest supported with VA-ECMO: a systematic review and a meta-analysis. Current Problems in Cardiology, 48(6), 101658.	Systematic review and meta-analysis n=931, 10 studies Follow-up: 90 days	The overall mortality was 69%. The predictors for mortality were age over 65 (OR 4.61, 95% CI 1.63 to13.03, p<0.01), history of chronic kidney disease (OR 2.42, 95% CI 1.37 to 4.28, p<0.01), cardiopulmonary resuscitation duration prior to ECMO more than 40 minutes (OR 6.62, 95% CI 1.39 to 9.02, p<0.01), having an initial non-shockable rhythm (OR 2.62, 95% CI 1.85 to 3.70, p<0.01) and sequential organ failure assessment score higher than 14 (OR 12.29, 95% CI 2.71 to 55.74, p<0.01).	Larger, comparative systematic literature reviews and meta-analyses included.

Havranek S, Fingrova Z, Rob D et al. (2022) Initial rhythm and survival in refractory out-of-hospital cardiac arrest. Post-hoc analysis of the Prague OHCA randomized trial. Resuscitation 181: 289-296	Post-hoc analysis of the Prague OHCA randomised controlled trial n=256 Follow-up: 180 days (6 months)	Favourable neurological survival at 180 days was achieved in 40% patients with a shockable rhythm and in 5% patients with a non-shockable rhythm (p<0.001). The difference between shockable and non-shockable initial rhythms remained statistically significant (35/72 [49%] versus 4/52 [8%] in the ECPR group and 28/84 [33%] versus 1/48 [2%] in the CCPR group; p<0.001).	Original RCT include in all key evidence systematic reviews.
Heuts S, Ubben JFH, Kawczynski MJ et al. (2024) Extracorporeal cardiopulmonary resuscitation versus standard treatment for refractory out-of-hospital cardiac arrest: a Bayesian meta-analysis. Critical Care 28(1): 217	Bayesian meta-analysis of ARREST, Prague OHCA and INCEPTION RCTs n=420 Follow-up: 6 months	The Bayesian meta-analysis found a 71% and 76% posterior probability of a clinically relevant ECPR-based treatment effect on 6-month neurologically favourable survival in patients with all rhythms and shockable rhythms.	Original RCTs included in all key evidence systematic reviews.
Heuts S, van de Koolwijk AF, Gabrio A et al. (2024) Extracorporeal life support in cardiac arrest: a post hoc Bayesian re-analysis of the INCEPTION trial. European heart journal. Acute Cardiovascular	Bayesian meta-analysis of the INCEPTION RCT n=134 Follow-up: 30 days	Bayesian re-analysis of the INCEPTION trial estimated a 42% probability of an MCID between ECPR and CCPR in refractory OHCA in terms of 30-day survival with a favourable neurologic outcome.	Original RCT included in all key evidence systematic reviews.

Care 13(2): 191-200			
Holmberg MJ, Geri G, Wiberg, S et al. (2018) Extracorporeal cardiopulmonary resuscitation for cardiac arrest: A systematic review. Resuscitation 131: 91-100	Systematic review n=25 studies Follow-up: long-term (unclear)	There is inconclusive evidence to either support or refute the use of ECPR for OHCA and IHCA in adults and children.	Larger, more recent comparative systematic literature reviews and meta-analyses included.
Holmberg MJ, Granfeldt A, Guerguerian AM et al. (2023) Extracorporeal cardiopulmonary resuscitation for cardiac arrest: An updated systematic review. Resuscitation 182: 109665	Updated systematic review n=3 RCTs and 27 observational studies Follow-up: in-hospital	Results of individual studies were inconsistent, although many studies favoured ECPR. The risk of bias was intermediate for trials and critical for observational studies. The certainty of evidence was very low to low. Study heterogeneity precluded meta-analyses.	Larger, systematic literature reviews and meta-analyses were included.
Kim SJ, Kim HJL, Hee Y et al. (2016) Comparing extracorporeal cardiopulmonary resuscitation with conventional cardiopulmonary resuscitation: A meta-analysis. Resuscitation 103: 106-116	Systematic review and meta-analysis n=10 studies Follow-up: 1 year	Survival and good neurological outcome tended to be superior in the ECPR group at 3 to 6 months after arrest. The effect of ECPR on survival to discharge in OHCA was not clearly shown.	Larger, more recent systematic literature reviews and meta-analyses included.

Kruit N, Rattan N, Tian D et al. (2023) Prehospital extracorporeal cardiopulmonary resuscitation for out-of-hospital cardiac arrest: a systematic review and meta-analysis. Journal of Cardiothoracic and Vascular Anesthesia 37(5): 748-754	Systematic review and meta-analysis n=222 ECPR, 4 studies Follow-up: hospital discharge	Overall survival at discharge was 23% (95% CI 15.5 to 33.7; I^2=62%). The quality of evidence was assessed to be low, and the overall risk of bias was assessed to be serious, with confounding being the primary source of bias.	Larger, more recent systematic literature reviews and meta-analyses included.
Lunz D, Calabro L, Belliato M et al. (2020) Extracorporeal membrane oxygenation for refractory cardiac arrest: a retrospective multicenter study. Intensive care medicine 46(5): 973-982	Multicentre retrospective study, US n=423 Follow-up: 3 months	Eighty patients (19%) had favourable neurological outcome. ICU survival was 24%. Favourable neurological outcome rate was lower (9% versus 34%, p<0.01) in OHCA than IHCA and was significantly associated with shorter time from collapse to ECMO.	Larger, more recent systematic literature reviews and meta-analyses included.
Okada Y, Komukai S, Irisawa T et al. (2023) In-hospital extracorporeal cardiopulmonary resuscitation for patients with out-of-hospital cardiac arrest: an analysis by time-dependent propensity score matching using a nationwide database in Japan. Critical Care 27(1): 442	PSM retrospective JAAM-OHCA registry study (Japan) n=2,566 Follow-up: 30 days	The OR for 30-day survival in the ECPR group was 1.76 (95% CI 1.38 to 2.25) for shockable rhythm and 5.37 (95% CI 2.53 to 11.43) for non-shockable rhythm, compared to controls. For favourable neurological outcomes, the OR in the ECPR group was 1.11 (95% CI 0.82 to 1.49) for shockable rhythm and 4.25 (95% CI 1.43 to 12.63) for non-	Included in SLRs (Low 2024)

		shockable rhythm, compared to controls.	
Patricio D, Peluso L, Brasseur A et al. (2019) Comparison of extracorporeal and conventional cardiopulmonary resuscitation: a retrospective propensity score matched study. Critical Care 23(1): 27	PSM retrospective study (Belgium) n=160 (80 ECPR) Follow-up: hospital discharge and 3 months	Survival to ICU discharge was 23% versus 18% in the ECPR and CCPR groups, respectively (p=0.42). At 3 months, 21% ECPR patients and 11% CCPR patients had a favourable outcome (p=0.11).	Included in SLRs (Low 2024, Low 2023, Zhong 2024)
Rob D, Komarek A, Smalcova J et al. (2024) Effect of intra-arrest transport, extracorporeal cardiopulmonary resuscitation, and invasive treatment: a post hoc bayesian reanalysis of a randomized clinical trial. Chest 165(2): 368-370	Bayesian meta-analysis of the Prague OHCA RCT n=256 Follow-up: 6 months	Bayesian reanalysis of the study primary outcome showed a benefit of the invasive approach compared with standard resuscitation under a broad set of scenarios.	Original RCT included in all key evidence systematic reviews.
Sakamoto T, Morimura N, Nagao K et al. (2014) Extracorporeal cardiopulmonary resuscitation versus conventional cardiopulmonary resuscitation in adults with out-of-hospital cardiac arrest: a prospective observational study. Resuscitation 85(6): 762-8	Single centre prospective study (Japan) n=160 (80 ECPR) Follow-up: 6 months	In OHCA patients with VF/VT on the initial ECG, a treatment bundle including ECPR, therapeutic hypothermia and IABP was associated with improved neurological outcome at 1 and 6 months after OHCA. CPC 1 or 2 were 12% in the ECPR group and 2% in the non-ECPR group at 1 month (p<0.0001), and 11% and 3% at 6 months (p=0.001), respectively.	Included in SLRs (Zhong 2024, Pagura 2024)

Spangenberg T, Schewel J, Dreher A et al. (2018) Health related quality of life after extracorporeal cardiopulmonary resuscitation in refractory cardiac arrest. Resuscitation 127: 73-78	Single centre retrospective study (Germany) n=60 Follow-up: 1 year	12-month survival was 31%. HRQoL SF-36 scores of survivors ranged markedly below controls (p<0.0001)	Larger, more recent systematic literature reviews and meta-analyses included.
Suverein MM, Delnoij TSR, Lorusso R et al. (2023) Early extracorporeal CPR for refractory out-of-hospital cardiac arrest. The New England Journal of Medicine 388(4): 299-309	INCEPTION randomised controlled trial n=160 (70 ECPR) Follow-up: 6 months	In people with refractory OHCA, ECPR and CCPR had similar effects on survival with a favourable neurological outcome. At 30 days, 14 patients (20%) in the ECPR group were alive with a favourable neurological outcome, compared with 10 patients (16%) in the CCPR group (OR 1.4; 95% CI 0.5 to 3.5; p=0.52). The number of serious adverse events per patient was similar in the two groups.	RCT included all SLRs
Tanimoto A, Sugiyama K, Tanabe M et al. (2020) Out-of-hospital cardiac arrest patients with an initial non-shockable rhythm could be candidates for extracorporeal cardiopulmonary resuscitation: a retrospective study. Scandinavian	Single centre retrospective study (Japan) n=186 Follow-up: hospital discharge	The rate of good outcomes at hospital discharge was not significantly different between the shockable and non-shockable groups (19% versus 16%, p=0.69).	Larger, more recent systematic literature reviews and meta-analyses included.

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Ubben JFH, Suverein MM, Delnoij TSR et al. (2024) Early extracorporeal CPR for refractory out-of-hospital cardiac arrest - A pre-planned per-protocol analysis of the INCEPTION-trial. Resuscitation 194: 110033	Per protocol analysis and Bayesian meta-analysis of the INCEPTION RCT n=81 Follow-up: 30 days	30-day survival with CPC1 or 2 was 15% in the ECPR group versus 9% in the CCPR group (adjusted OR 1.9, 95% CI 0.4 to 9.3; p=0.393). Bayesian analysis showed an 84% posterior probability of any ECPR benefit and a 61% posterior probability of a 5% absolute risk reduction for the primary outcome.	Original RCT included in all key evidence systematic reviews.
Wang J-Y, Chen Y, Dong R et al. (2024) Extracorporeal vs. conventional CPR for out-of-hospital cardiac arrest: A systematic review and meta-analysis. The American journal of emergency medicine 80: 185-193	Systematic review and meta-analysis n=4,669 2 RCTs and 10 observational studies Follow-up: hospital discharge, 6 months	The pooled meta-analysis demonstrated that compared to CCRP, ECPR did not improve survival and neurological outcomes at 180 days following OHCA (RR 3.39, 95% CI 0.79 to 14.64; RR 2.35, 95% CI 0.97 to 5.67). While a beneficial effect of ECPR was obtained regarding 30-day survival and neurological outcomes.	Larger, more comprehensive systematic literature reviews and meta-analyses included.
Wongtanasarasin W, Krintratun S, Techasatian W et al. (2023) How effective is extracorporeal life support for patients with out-of-hospital cardiac arrest initiated at the	Systematic review and meta-analysis n=51,173, 8 studies Follow-up: 30 days	ED-initiated ECPR may not be associated with a significant increase in favourable neurological outcomes (OR 1.43, 95% CI 0.30 to 6.70, I^2=96%). However, this intervention may be linked to improved	Larger, more comprehensive systematic literature reviews and meta-analyses included.

emergency department? A systematic review and meta-analysis. PloS one 18(11): e0289054		survival to hospital discharge (OR 3.34, 95% CI 2.23 to 5.01, I^2=17%).	
Yannopoulos D, Bartos J, Raveendran G et al. (2020) Advanced reperfusion strategies for patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation (ARREST): a phase 2, single centre, open-label, randomised controlled trial. Lancet 396 (10265): 1807-1816	ARREST randomised controlled trial n=35 (15 ECPR) Follow-up: 6 months	Survival to hospital discharge was observed in one (7%) of 15 patients in the standard ACLS treatment group versus six (43%) of 14 patients in the early ECMO-facilitated resuscitation group (risk difference 36.2%, 3.7 to 59.2; posterior probability of ECMO superiority 0.9861). The study was terminated at the first preplanned interim analysis after enrolling 30 patients because the posterior probability of ECMO superiority exceeded the prespecified monitoring boundary. Cumulative 6-month survival was significantly better in the early ECMO group than in the standard ACLS group.	RCT included in all SLRs