Interventional procedure overview of VA ECMO for severe acute heart failure in adults

Contents

Table 1 Abbreviations

Abbreviation	Definition
ADHF	Acute decompensated heart failure
AMI	Acute myocardial infarction
BP	Blood pressure
CABG	Coronary-artery bypass grafting
CI	Confidence interval
CNS	Central nervous system
CPC	Cerebral Performance Category
CPR	Cardiopulmonary resuscitation
CS	Cardiogenic shock
CV	Cardiovascular
dMCS	Durable mechanical circulatory support
ECLS	Extracorporeal life support
ECPR	Extracorporeal cardiopulmonary resuscitation
EEG	Electroencephalogram
ELSO	Extracorporeal Life Support Organization
HF	Heart failure
HR	Hazard ratio
HRQoL	Health related quality of life
HTx	Heart Transplant
IABP	Intra-aortic balloon pump
ICU	Intensive care unit
IHCA	In hospital cardiac arrest
INTERMACS	Interagency Registry for Mechanically Assisted Circulatory Support
IP-1	INTERMACS profile 1
IQR	Interquartile range
ITT	Intention to treat
LV	Left ventricular
LVAD	Left ventricular assist device
LVEF	Left ventricular ejection fraction
MAP	Mean arterial pressure
MCS	Mechanical circulatory device
MI	Myocardial infarction
NSTEMI	Non-ST-elevation myocardial infarction
OHCA	out of hospital cardiac arrest
PCI	Percutaneous coronary intervention

RR	Relative risk
SCAI	Society for cardiovascular angiography and interventions
SD	Standard deviation
STEMI	ST-elevation myocardial infarction
VA ECMO	Venoarterial extracorporeal membrane oxygenation
VAD	ventricular assist device
VTE	Venous thromboembolism

The condition, current practice, unmet need and procedure

Information about the procedure, condition, current practice and unmet need is available in NICE's interventional procedures guidance on VA ECMO for severe acute heart failure in adults.

Clinical assessment tools

Some studies assessed people with acute heart failure using assessment tools:

- INTERMACS profile (IP): this is a 7-profile categorisation for people with advanced heart failure, ranging from IP-1 as the most critical, to IP-7 as the least critical. IP-1 (critical cardiogenic shock), IP-2 (progressive decline on inotropes), IP-3 (stable but inotrope dependent), IP-4 (resting symptoms on oral therapy at home), IP-5 (exertion intolerant), IP-6 (exertion limited), IP-7 (placeholder – living comfortably with meaningful activity limited to mild physical exertion).
- Society for Cardiovascular Angiography and Interventions (SCAI) SHOCK classification: this is a 5-category classification (A to E) that indicate the severity of cardiogenic shock. A (haemodynamically stable, not experiencing symptoms of CS, but at risk for its development), B (clinical evidence of haemodynamic instability without evidence of hypoperfusion), C (clinical evidence of hypoperfusion that requires pharmacologic or mechanical

support), D (clinical evidence of shock that worsens or fails to improve despite therapy escalation), E (refractory shock or actual/impending circulatory collapse).

Outcome measures

The main outcomes included survival or mortality. Some studies evaluated neurological outcomes. The measures used are detailed in the following paragraphs.

- Cerebral performance categories (CPC): this 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 to be a poor neurological outcome.

Evidence summary

Population and studies description

This interventional procedure overview is focused on acute HF. Two additional overviews have been developed focusing on VA ECMO for postcardiotomy cardiogenic shock and for extracorporeal cardiopulmonary resuscitation (ECPR). Some of the evidence includes a mix of indications and has been presented in more than one overview.

This overview is based on more than 48,000 people from 7 systematic reviews (Elsaeidy 2024, Sohail 2022, Alba 2021, Vishram-Nielsen 2023, Son 2024, Stub 2025, Low 2024), 3 randomised controlled trials (5 publications; Thiele 2023, Desch 2024, Banning 2023, Ostadal 2023, Ostadal 2025), 1 retrospective

registry study (Olson 2020), 2 single centre retrospective studies (Cheng 2019, Scriba 2025), and 1 review and case series (Bain 2025). The 3 randomised controlled trials (Thiele 2023, Banning 2023, Ostadal 2023) were also included in Elsaeidy (2024) and Low (2024). There was some overlap in primary studies included across the systematic reviews. This is a rapid review of the literature, and a flow chart of the complete selection process is shown in figure 1. This overview presents 14 studies (16 publications) as the key evidence in table 2 and table 3, and lists 94 other relevant studies in appendix B, table 5.

All randomised controlled trials included in the key evidence, and those included in the systematic review by Elsaeidy (2024), were conducted in Europe (Thiele 2023, Banning 2023, Ostadal 2023). The 3 systematic reviews of observational studies included in the key evidence included studies from Asia, Australia, Europe, North America and South America (Sohail 2022, Alba 2021, Vishram-Nielsen 2023). The included registry study used data from the Extracorporeal Life Support Organization (ELSO) which collates data worldwide (Olson 2020). The single centre retrospective study was conducted in the US (Cheng 2019).

Most key evidence studies included people with cardiogenic shock (CS). Of the key studies including people with CS, 2 systematic reviews and 2 randomised controlled trials specifically included people with CS complicating acute myocardial infarction (AMI) (Sohail 2022, Elsaeidy 2024, Banning 2023, Thiele 2023). 1 systematic review included people receiving VA ECMO for fulminant myocarditis (Vishram-Nielsen 2023), and 1 registry study included people receiving VA ECMO for peripartum cardiomyopathy (Olson 2020).

The systematic review by Elsaeidy (2024) included 4 randomised controlled trials including 611 people. Three of these are reported separately in the key evidence (Thiele 2023, Banning 2023, Ostadal 2023), the other study being a pilot study preceding the randomised controlled trial by Ostadal (2023). Half of the studies were deemed to have an overall low risk of bias, and 2 had some concerns of

bias overall about deviations from the intended intervention and outcome measurement (Thiele 2023) and about the selection of the reported results (Ostadal 2023). The comparator in all trials was standard medical therapy, however 1 trial also allowed people to later cross-over to VA ECMO if they continued to be haemodynamically unstable. The mean age of people included in the studies ranged from 60 to 68 years, and the proportion of males ranged from 73 to 95%. All studies reported outcomes at 30 days and 2 studies reported outcomes at 1-year follow up.

The randomised controlled trial reported by Thiele (2023) and Desch (2024) compared VA ECMO to standard medical therapy alone in 417 adults with CS complicating AMI. Two thirds of people included presented with ST-segment elevation myocardial infarction (STEMI). All trial participants received early revascularisation ahead of the intervention. Intraaortic balloon pump (IABP) was permitted as an escalation therapy, and although the trial protocol forbade any cross-over, VA ECMO was initiated in 26 people in the control group (12.5%). The median age was 62 years and 81% of the population were male. Outcomes at 30 days were reported in Thiele (2023) and 1-year results were described in Desch (2024).

The randomised controlled trial reported by Banning (2023) compared early peripheral VA ECMO to standard medical therapy alone in 35 adults with CS complicating AMI. Due to the impact of the COVID-19 pandemic, the trial was stopped before completion of recruitment. The median age was 67 years and 81% of the population were male. Trial outcomes were reported at 30 days and 1-year follow-up.

The randomised controlled trial reported by Ostadal (2023, 2025) compared immediate VA ECMO to early conservative therapy in 117 adults with rapidly deteriorating or severe CS. The most common cause of CS in both arms was STEMI (50%) followed by decompensation of chronic heart failure (23%). The

study permitted cross-over from the control group, to receive VA ECMO in the case of worsening haemodynamic stability. 39% of the control group required downstream VA ECMO therapy. The median age was 67 years and 74% of the population were male. Trial outcomes were reported at 30 days (Ostadal 2023) and at 1 year (Ostadal 2025).

The systematic review by Sohail (2022) included 72 observational studies reporting on 10,276 adults who had VA ECMO for CS complicating AMI. The median concomitant IABP use across the included studies was 70%. The median age was 60 years and 78% of the population were male. Meta-analyses of the studies pooled short-term outcomes from studies with follow-ups of 7 days, 30 days and hospital discharge.

The systematic review by Alba (2021) included 306 observational studies reporting on 29,289 people with CS of any aetiology. The largest number of studies reported on people with CS after cardiac arrest (ECPR), CS complicating AMI, and postcardiotomy cardiogenic shock. Risk of bias across studies was considered low in 219 (72%), moderate in 81 (26%), and high in 6 (2%) studies. The age of people included in the studies ranged from 47 to 61 years, and 22% to 59% of the population were female. Meta-analyses of the studies pooled short-term outcomes from studies with follow-ups of 30 days and hospital discharge.

The systematic review and meta-analysis by Son (2024) included 25 observational studies reporting on 10,409 people with CS or cardiac arrest. Of the 25 included studies, most were carried out in Asia, Europe and the UK, and 3 were described as international studies. The survivors' mean age ranged from 31.5 to 71 years, whereas non-survivors' mean age ranged from 33 to 70 years. Short-term outcomes were reported for follow-up duration until hospital discharge.

The systematic review and meta-analysis by Stub (2025) included 5 propensity score-matched studies with 9,871 people with CS. Of these people, 1,153 had VA ECMO and 987 had Impella. The included 5 studies were done in Europe and the US. The mean age ranged from 60 to 68 years, and the proportion of males ranged from 70% to 86%. Short-term outcomes were reported (in-hospital or 30 days).

The systematic review and network meta-analysis of 38 studies with 48,749 people with CS by Low (2024). Twenty-four studies included people with AMICS, 13 studies included people with mixed aetiologies of CS, and 1 study included people with NMICS. The included 38 studies were conducted in Asia, Europe, America and Australia. The pooled age was 63.1 years and 74% of the population were male. Outcomes were reported at 30 days.

The single-centre retrospective study conducted in the US by Cheng (2019) included 149 people who survived VA ECMO (n=118) or CentriMag VAD (n=31) support as a bridge to recovery. The most common indication for ECMO intervention was postcardiotomy CS (36%), followed by allograft failure (27%), AMI (24%) and acute decompensated heart failure (ADHF) (14%). The median age was 59 years and 68% of the population were male. The median follow-up time was 306 days (IQR: 59 to 916 days).

The systematic review by Vishram-Nielsen (2023) included 54 observational studies reporting on 2,388 people with fulminant myocarditis. The median age was 41 years and 50% of the population were male. Meta-analyses of the studies pooled short-term outcomes from studies with follow-ups of 30 days and hospital discharge.

The retrospective ELSO registry study by Olson (2020) reported outcomes for people with peripartum cardiomyopathy treated with VA ECMO. The median age

was 31 years and 42% were of white ethnicity. Outcomes were reported for follow-up period until hospital discharge.

There are 2 safety studies. The retrospective single-centre case series by Scriba (2025) included 264 people who had femoral VA ECMO. This study aimed to assess the prevalence, symptoms and sequelae of buttock ischaemia in people on VA ECMO. The review and case series by Bain (2025) focused on ischaemic spinal cord injury in people on VA ECMO. This study included 30 people who had VA ECMO for CS secondary to various aetiologies. The mean age was 47.7 years. When reported, 13 people were male and 11 were female.

Table 2 presents study details.

Figure 1 Flow chart of study selection

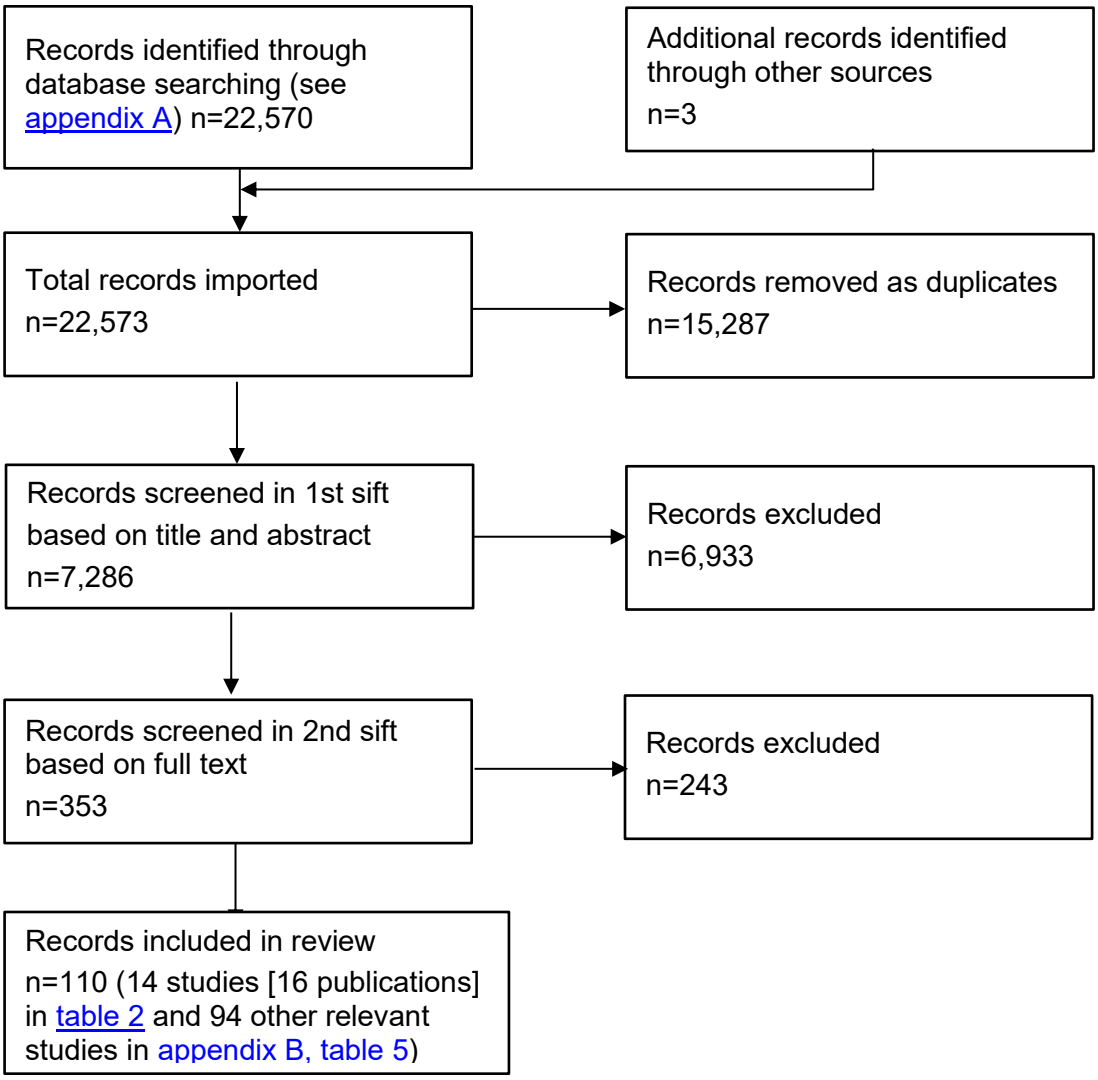

Table 2 Study details

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	Elsaeidy, 2024 Belgium, Czech Republic, Germany, Latvia, Norway, Slovenia Spain, UK	**n=611** Mean age ranged from 60 to 68 years Males: 80% (range 73% to 95%) Type of MI: STEMI (range 0 to 61.9%) NSTEMI (range 6.7% to 61.9%)	Systematic review and meta-analysis of 4 RCTs (Banning, 2023; Thiele, 2023; Ostadal, 2023, Lackermair, 2021) Search date: Sept 2023 All open label RCTs	RCTs that investigate the efficacy and safety of ECMO compared to standard care in managing **CS-complicating AMI** patients.	• Intervention: immediate VA ECMO • Comparator: usual medical therapy alone	30 days (4 studies) 1 year (2 studies)

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	Thiele, 2023, Germany, Slovenia ELCS-SHOCK	**n=417** (ECLS n=209) Median age (years) • Standard=63 • ECLS=62 Male (%) • Standard=81.2 • ECLS=81.3 Median LVEF on admission • Standard=30% • ECLS=30% Two thirds of patients presented with ST-segment elevation myocardial infarction. 77.7% patients underwent CPR before randomisation. PCI was performed in 96.6% patients.	Randomised controlled trial, open label. Randomisation was done by means of a web-based system with the use of randomly changing blocks and stratification according to the trial site.	Patients aged between 18 and 80 with **CS-complicating AMI** and planned early revascularisation by either PCI or coronary-artery bypass grafting (CABG) CS defined as stage C, D, or E of the SCAI criteria. Excluded were people who had undergone CPR for more than 45 minutes before randomisation or who had a mechanical cause of CS or severe peripheral-artery disease precluding the insertion of cannulae.	• Intervention: ECLS plus usual medical therapy • Comparator: usual medical therapy alone ECLS was not initiated in 17 patients in the ECLS group (8.1%), including in 4 patients who died before initiation. ECLS was initiated in 26 patients in the control group (12.5%), including 22 patients within 24 hours after randomisation and 4 patients thereafter. IABP was permitted as escalation therapy for the control group.	30 days

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
	Desch S, 2024 Germany, Slovenia 44 sites ECLS-SHOCK trial (baseline data is from Thiele 2023)	**n=417 (209 ECLS)** Median age (years) • Standard=63 • ECLS=62 Male (%) • Standard=81.2 • ECLS=81.3 Median LVEF on admission • Standard=30% • ECLS=30% 78% of the overall population had been resuscitated before enrolment.	Randomised, multicentre, open-label trial June 2019 to November 2022	Patients aged between 18 and 80 with **CS-complicating AMI** and planned early revascularisation by either PCI or coronary-artery bypass grafting (CABG). CS defined as stage C, D, or E of the SCAI criteria. Excluded were people who had undergone CPR for more than 45 minutes before randomisation or who had a mechanical cause of CS or severe peripheral-artery disease precluding the insertion of cannulae.	• Intervention: ECLS plus usual medical therapy • Comparator: usual medical therapy alone	1 year

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
3	Banning, 2023, Belgium, Germany, Latvia, Norway, Spain, UK EURO SHOCK	**n=35** (VA ECMO n=17) Median age (years) • Standard=67 • ECMO=68 Male (%) • Standard=89% • ECMO=81% Median LVEF on admission • Standard=25% • ECMO=20%	Randomised controlled trial, open label. Randomisation was carried out using a web-based randomisation system stratified by out-of-hospital cardiac arrest (OHCA). Due to the impact of the COVID-19 pandemic, the trial was stopped before completion of recruitment.	People presenting with **CS-complicating AMI** and who had had attempted/ successful primary PCI (PPCI) of the culprit lesion were enrolled if there was persistent CS 30 mins after the procedure. CS defined as BP below 90 mmHg or maintained above 90 mmHg with the addition of vasopressor or inotropic support, with evidence of hypoperfusion.	• Intervention: Immediate PCI plus early peripheral VA ECMO and standard care (pharmacological support). • Comparator: Immediate PCI plus standard care (pharmacological support). IABP was permitted as escalation therapy for the control group, or for left ventricular unloading in the VA ECMO group. 5 patients randomised to ECMO did not receive ECMO.	30 days, 1 year
4	Ostadal, 2023 Czech Republic ECMO-CS	**n=117** (ECMO n=58) Median age (years)	Randomised controlled trial, open label.	People over 18 with **rapidly deteriorating or severe CS**.	• Intervention: Immediate VA ECMO • Comparator: early conservative therapy	30 days

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		• Standard= 65 (58 to 71) • ECMO= 67 (60 to 74) Male (%) • Standard= 72.9 • ECMO= 74.1 The most common cause of CS in both arms was STEMI (50.4%) followed by decompensation of chronic heart failure (23.1%).	An automated, web-based system was used for randomisation with permuted blocks, with stratification according to the type of cardiogenic shock (rapidly deteriorating or severe), and the trial centre.	Rapidly deteriorating CS defined as SCAI stage D to E Severe CS defined as SCAI stage D	• 39% of the conservative therapy group required downstream “bailout” VA ECMO therapy in case of hemodynamic worsening.	
	Ostadal, 2025 Czech Republic ECMO-CS trial	**n=117 (58 ECMO)** Severe or rapidly progressing CS of various aetiologies (50% STEMI) Median age=66 years Male=73.5% Caucasian=100%	Randomised controlled trial, open label (4 centres)	People over 18 with **rapidly deteriorating or severe CS**. Rapidly deteriorating CS defined as SCAI stage D to E. Severe CS defined as SCAI stage D. Exclusion criteria included life expectancy less than 1 year.	• Intervention: immediate ECMO • Comparator: conservative therapy	1 year

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		The baseline characteristics of the 2 study groups at the time of randomisation were balanced.		Exclusion criteria included several specific conditions that may cause or influence CS, including high suspicion of pulmonary embolism, cardiac tamponade, bradycardia, tachycardia, aortic regurgitation, or obstructive hypertrophic cardiomyopathy. People who survived cardiac arrest were also excluded.	• 39% of the conservative therapy group needed downstream "bailout" VA ECMO therapy in case of hemodynamic worsening.	
5	Sohail, 2022, Asia, Australia, Europe, North America	**n=10,276** Median age (years)=60 (IQR 56.35 to 63.94) Male % = 78%	Systematic review and meta-analysis of 72 studies. Search date: August 2020	Adults (over 18 years) receiving VA ECMO for **CS complicating AMI**.	• Intervention: VA ECMO • Median concomitant IABP use = 70% (IQR 35.1 to 86)	Short term mortality (7, 30 days, discharge)
6	Alba, 2021	**n=29,289** Age (years): Range 47 to 61 Female %: Range 22 to 59	Systematic review and meta-analysis of 306 observational studies.	Adults (aged 18 and over) with **CS of any aetiology**, with VA ECMO implantation.	• Intervention: VA ECMO • Concomitant IABP: Range 20 to 67%	30 day or 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
	Europe, Asia, North America, South America, Australia	Indication • ECPR: 7,814 (113 cohorts) • Post-AMI: 7,774 (80 cohorts) • Postcardiotomy: 8,231 (64 cohorts) • Post-HTx: 771 (25 cohorts) • Heart failure: 3,567 (33 cohorts) • Myocarditis: 906 (13 cohorts) • Pulmonary embolism: 221 (10 cohorts)	Search date: June 2019			
7	Cheng, 2019 US	**n=149** (ECMO n=118) Median age (years)=59 (51-67) Male=67.8%	Single centre retrospective study (26-bed ICU)	People who survived VA ECMO or CentriMag VAD support as a short-term MCS as **bridge to recovery**.	• Intervention: VA ECMO (n=118)	Median 306 days (IQR 58.925 to 916.75)

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		Aetiology: • AMI: 24.2% • Acute decompensated HF: 14.4% • Postcardiotomy CS: 35.6% • Allograft failure: 26.8%	Search date: 2010 to 2016			
8	Vishram-Nielsen, 2023 Asia, Australia, Europe, North America	**n=2,388** Median age (years) = 41 (IQR 37 to 47) Male % = 50%	Systematic review and meta-analysis of 54 retrospective studies. Search date: July 2020	Adult (aged 18 and over) patients with **fulminant myocarditis**, evaluating short-term mortality after VA ECMO implantation.	• Intervention: VA ECMO	30 day, hospital discharge
9	Olson, 2020 Worldwide	**n=88** Median age (years): 31.1 (IQR 25.4 to 35.2)	Retrospective ELSO registry study Search date: 2007 to 2019	People with **peripartum cardiomyopathy** treated with ECMO.	• Intervention: VA ECMO	Hospital 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
10	Son Y-J, 2024 Korea, Taiwan, Japan, France, China, US, Germany, Italy. 3 studies were described as 'International'.	**n=10,409 people with CS or cardiac arrest** The survivors' mean age ranged from 31.5 to 71 years, whereas non-survivors' mean age ranged from 33 to 70 years.	Systematic review and meta-analysis Search date: December 2023 25 studies were included. Most studies were retrospective and there were no randomised controlled trials.	Studies were included in the analysis if they: included people aged 18 years or older; included people who had VA ECMO; reported data on in-hospital mortality and its risk factors; were published in English or Korean as a full article; were published from May 2008 to December 2023. Studies were excluded if they: were proceedings, abstracts only, editorials, or review articles; examined an additional ECMO mode other than VA; described an ECMO indication other than cardiogenic shock or cardiac arrest; described intra-operatively inserted ECMO; discussed the diagnosis of unwitnessed cardiac arrest.	VA ECMO 16 studies (64%) reported the duration of ECMO support (from 28 hours to 10 days).	To hospital 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
		The percentage of male survivors ranged from 45% to 100% and male non-survivors ranged from 28.6% to 87.9%. The causes of CS or cardiac arrest were identified as all-cause (15 studies, 60%), myocardial infarction (6 studies, 24%), myocarditis (1 study, 4%), ischaemic heart disease (1 study, 4%), and other cause (2 studies, 8%).				

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
11	Stub D, 2025 Germany, US, 'Europe'	**n=9,871 (1,153 VA ECMO; 987 matched) people with CS** The proportion of males ranged from 70% to 86% in the studies. The mean age was consistent across studies, ranging from 60.0 to 67.7 years old. The most common aetiology of shock in the included studies was AMI-CS.	Systematic review and meta-analysis 5 propensity score-matched or adjusted studies were included. Search date: July 2023	The study had to be a comparative study of Impella versus VA ECMO, include people with CS and must have reported survival data. Studies were excluded if: outcomes data were not stratified by intervention type, the study was incomplete with no available data, or the study was not available in full-text form. Studies that did not propensity score match patients or did not conduct adjusted analyses to account for variation in baseline demographic or disease characteristics were also excluded.	• VA ECMO • Impella	In-hospital or 30 days

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
12	Low C, 2024 Asia, Europe, America. 1 included study was multiregional (North America, Australia, Europe).	**n=48,749 (3,847 had ECMO, in 16 studies)** The pooled age was 63.1 years (95% CI 62.1 to 64.2) and 74.1% (95% CI 70.9 to 77%) were male. 24 studies included people with AMICS, 13 studies included people with mixed aetiologies of CS, and 1 study included people with NMICS.	Network meta-analysis 38 studies with 40 pairwise comparisons comparing 8 treatment strategies were included. 13 studies (n=1,529) were randomised controlled trials, and 25 (n=47,220) were propensity score-matched.	Only randomised controlled trials and propensity score-matched studies comparing a mechanical circulatory support device with another device or with medical therapy in CS were included. Studies enrolling animals, people primarily under 18 years old, and other observational designs were excluded. In the case of overlapping patient data, only the largest study was included.	• ECMO (16 studies, n=3,847) • ECMO-IABP (4 studies, n=1,466) • ECMO with microaxial ventricular assist device (mVAD; 3 studies, n=300) • IABP (21 studies, n=20,031) • mVAD (12 studies, n=9,047) • mVAD-IABP (1 study, n=7) • centrifugal VAD (2 studies, n=40) • medical therapy without mechanical circulatory support (21 studies, n=14,011). All ECMO procedures used peripheral ECMO.	30 days

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
				Of the 38 included studies, 27 reported a prespecified definition for CS, all corresponding to a Society for Cardiovascular Angiography and Intervention classification of C to E.		
13	Bain E, 2025 Country of individual cases not reported	**n=30** Sex: 13 male, 11 female, 6 not reported Mean age=47.7 years	Review and case series There were 10 reports with individual patient data identified and an additional 3 people at the study centre.	Reports of ischaemic spinal cord injury in people on VA ECMO. Exclusion criteria for included cases were paediatric age and lack of individual patient data.	VA ECMO The total duration on ECMO ranged from 3 to 47 days with a median of 10 days. In 7 people (23%), an IABP was used during the ECMO support. In all people, the arterial cannula of the ECMO was placed peripherally in the femoral artery. Two people who originally had central ECMO were switched to peripheral (femoral).	Median 12 months (for 10 people)

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
		Aetiology of CS shock included acute myocardial infarction (40%), primary graft dysfunction after cardiac transplantation (20%), ischaemic and nonischaemic cardiomyopathy (18%), and, less commonly, prosthetic valve dysfunction, septic cardiomyopathy, pulmonary embolism, and right heart failure of other aetiologies. 9 people (30%) had cardiac arrest before the cannulation for VA ECMO.				
14	Scriba V, 2025 Germany	**n=264**	Retrospective single-centre case series	Age over 18 years.	Femoral VA ECMO	Not reported

Study no.	First author, date country	Characteristics of people in the study (as reported by the study)	Study design	Inclusion criteria	Intervention	Follow up
			January 2018 to December 2023	People who died within 24 hours of ECMO implantation were excluded.		

Table 3 Study outcomes

First author, date	Efficacy outcomes	Safety outcomes
Elsaeidy, 2024	**Pooled 30-day mortality (4 trials)** • VA ECMO: 45.9% (140/305) • Control: 48.4% (148/306) RR 0.95, 95% CI: 0.80 to 1.12; p=0.54, I^2=0% **Pooled 30-day reinfarction (3 trials)** • VA ECMO: 1.6% (4/244) • Control: 2.0% (5/247) RR 0.87, 95% CI: 0.25 to 3.04; p=0.83, I^2=0%	**Pooled bleeding events (4 trials)** • VA ECMO: 25.2% (76/302) • Control: 11.8% (36/306) RR 2.14, 95% CI: 1.49 to 3.07; p<0.0001, I^2=0% **Pooled acute kidney injury/RRT (3 trials)** • VA ECMO: 8.9% (25/281) • Control: 14.0% (40/285) RR 0.65, 95% CI: 0.41 to 1.04; p=0.07, I^2=0% **Pooled stroke (4 trials)** • VA ECMO: 4.0% (12/302) • Control: 3.6% (11/306) RR 1.14, 95% CI: 0.52 to 2.49; p=0.75, I^2=18% **Pooled sepsis (4 trials)** • VA ECMO: 17.7% (54/305) • Control: 16.7% (51/306)

First author, date	Efficacy outcomes	Safety outcomes
		RR 1.07, 95% CI: 0.77 to 1.48; p=0.85, I^2=0% **Pooled pneumonia (2 trials)** • VA ECMO: 24.0% (18/75) • Control: 24.7% (19/77) RR 0.97, 95% CI: 0.57 to 1.65; p=0.90, I^2=0%
Thiele, 2023 ECLS-SHOCK	**Death from any cause at 30 days** • ECLS: 47.8% (100/209) • Control: 49.0% (102/208) RR 0.98, 95% CI: 0.80 to 1.19; p=0.81 **Myocardial reinfarction** • ECLS: 1% (2/209) • Control: 1% (2/208) RR 1.00, 95% CI: 0.07 to 12.72 **Rehospitalisation for congestive heart failure within 30 days** • ECLS: 1.4% (3/209) • Control: 1% (2/208) RR 1.49, 95% CI: 0.24 to 13.61 **Subgroup analysis death from any cause 30 days by age** <u>Under 65 years</u> • ECLS: 40.3% (50/124) • Control: 36.6% (41/112) RR 1.06, 95% CI: 0.87 to 1.30 <u>65 years or over</u> • ECLS: 58.8% (50/85)	**Moderate or severe bleeding:** • ECLS: 23.4% (49/209) • Control: 9.6% (20/208) RR 2.44, 95% CI: 1.50 to 3.95. **Poor neurological outcome (CPC 3 or 4)** • ECLS: 24.8% (27/109) • Control: 22.6% (24/106) RR 1.03, 95% CI: 0.88 to 1.19 **Peripheral ischaemic vascular complications warranting surgical or interventional therapy** • ECLS: 11% (23/209) • Control: 3.8% (8/208) RR 2.86, 95% CI: 1.31 to 6.25. **Renal replacement therapy** • ECLS: 8.1% (17/209) • Control: 13.9% (29/208) RR 0.58, 95% CI: 0.33 to 1.03 **Stroke or systemic embolisation** • ECLS: 3.8% (8/209) • Control: 2.9% (6/208)

First author, date	Efficacy outcomes	Safety outcomes
	• Control: 63.5% (61/96) RR 0.88, 95% CI: 0.61 to 1.28	RR 1.33, 95% CI: 0.47 to 3.76. **Repeat vascularisation** • ECLS: 8.6% (18/209) • Control: 10.6% (22/208) RR 0.81, 95% CI: 0.45 to 1.47
Desch S, 2024	**Outcomes at 1 year follow-up** **All-cause mortality** • ECLS=55.0% (115/209) • Medical therapy=55.8% (116/208) HR=1.00, 95% CI 0.68 to 1.58 There was no difference in all-cause mortality between the treatment groups in the time period between 30 days and 1 year (HR 1.07; 95% CI 0.52 to 2.21). **Cardiovascular mortality** • ECLS=30.7% (63/205) • Medical therapy=32.8% (68/207) OR=0.91, 95% CI 0.60 to 1.37 **Poor neurological status (cerebral performance category 3 or 4)** • ECLS=3.49% (3/86) • Medical therapy=6.98% (6/86) OR=0.48, 95% CI 0.12 to 1.99 **Recurrent myocardial infarction**	**No safety outcomes were reported**

First author, date	Efficacy outcomes	Safety outcomes
	• ECLS=2.22% (2/90) • Medical therapy=2.20% (2/91) OR=1.01, 95% CI 0.14 to 7.34 **Repeat vascularisation** • ECLS=18.9% (17/90) • Medical therapy=19.8% (18/91) OR=0.94, 95% CI 0.45 to 1.98 **Rehospitalisation for heart failure** • ECLS=17.8% (16/90) • Medical therapy=14.3% (13/91) OR=1.30, 95% CI 0.58 to 2.88 **Quality of life in survivors** **Mobility** • No problems: ECLS=63.5% (54/85), medical therapy=77.1% (64/83) • Some problems: ECLS=31.8% (27/85), medical therapy=19.3% (16/83) • Confined to bed: ECLS=4.7% (4/85), medical therapy=3.6% (3/83) p=0.062 **Self-care** • No problems: ECLS=75.3% (64/85), medical therapy=85.5% (71/83) • Some problems: ECLS=21.2%	

First author, date	Efficacy outcomes	Safety outcomes
	(18/85), medical therapy=7.2% (6/83) • Unable to wash or dress: ECLS=3.5% (3/85), medical therapy=7.2% (6/83) p=0.15 **Usual activities** • No problems: ECLS=60.0% (51/85), medical therapy=71.1% (59/83) • Some problems: ECLS=29.4% (25/85), medical therapy=20.5% (17/83) • Unable to perform usual activities: ECLS=10.6% (9/85), medical therapy=8.4% (7/83) p=0.15 **Pain or discomfort** • No pain or discomfort: ECLS=61.4% (51/83), medical therapy=79.3% (65/82) • Moderate pain or discomfort: ECLS=31.3% (26/83), medical therapy=17.1% (14/82) • Extreme pain or discomfort: ECLS=7.2% (6/83), medical therapy=3.7% (3/82) p=0.013 **Anxiety or depression**	

First author, date	Efficacy outcomes	Safety outcomes
	• Not anxious or depressed: ECLS=67.5% (56/83), medical therapy=78.0% (64/82) • Moderately anxious or depressed: ECLS=28.9% (24/83), medical therapy=19.5% (16/82) • Extremely anxious or depressed: ECLS=3.6% (3/83), medical therapy=2.4% (2/82) p=0.13	
Banning, 2023	**30-day all-cause mortality** • ECMO: 43.8% (7/17) • Standard therapy: 61.1% (11/18) HR 0.56, 95% CI: 0.21 to 1.45; p=0.22 HR 0.40, 95% CI: 0.13 to 1.26; p=0.105 (as-treated analysis) **1 year all-cause mortality** • ECMO: 51.8% (8/17) • Standard therapy: 81.5% (14/18) HR 0.52, 95% CI: 0.21 to 1.26; p=0.14 **1 year readmission for heart failure** • ECMO: 8.0% (1/17) • Standard therapy: 6.9% (1/18) HR 1.19, 95% CI: 0.11 to 13.22; p=0.89) **HRQoL at 30 days EQ-5D-3L summary index** (median [IQR])	**Complications (ITT analysis)** All-cause death: ECMO: 50% (7/14), Standard therapy: 72% (13/18) CV death: ECMO: 14% (2/14), Standard therapy: 33% (6/18) Stroke: ECMO: 0% (0/14), Standard therapy: 11% (2/18) Ischaemic stroke: ECMO: 0% (0/14), Standard therapy: 11% (2/18) Recurrent MI: ECMO: 0% (0/14), Standard therapy: 11% (2/18) Major bleeding: ECMO: 36% (5/14), Standard therapy: 6% (1/18) Escalation to non-VAECMO device for refractory shock ECMO: 0% (0/5), Standard therapy:17% (1/6) Escalation to VA ECMO: Standard therapy: 6% (1/18) Any vascular complications: ECMO: 21% (3/14), Standard therapy: 0 (0/18) Acute kidney injury: ECMO: 29% (4/14), Standard therapy:44% (8/18) Failure of discharge from primary admission: ECMO: 57% (8/14), Standard therapy:83% (15/18) **Serious adverse events** • ECMO: 9 events (6 patients [35.29%])

First author, date	Efficacy outcomes	Safety outcomes
	• ECMO: 0.667 (0.326 to 1.00) • Standard therapy: 0.765 (0.739 to 0.790)	• Standard therapy: 13 events (5 patients [27.78%]) Cardiac events • ECMO: 5 (29.41%); cardiac arrest (1), cardiac tamponade (2), ventricular tachycardia (2), LV thrombus (1). • Standard therapy: 4 (22.2%); cardiac arrest (1), ventricular arrythmia (2), AV block (1), atrial fibrillation (1). Respiratory and Thoracic events • ECMO: 1 (5.88%); pulmonary embolism • Standard therapy: 2 (11.11%); aspiration pneumonia (1), thoracic haemorrhage (1) Infection and infestation • ECMO: 1 (5.88%); post procedural sepsis • Standard therapy: 2 (11.11%); Septic shock (1), Acinetobacter infection (1) Gastrointestinal disorders ECMO: 0 (0%), Standard therapy: 1 (5.56%); intestinal ischemia Hepatobiliary disorders ECMO: 0 (0%), Standard therapy: 1 (5.56%); liver injury VA ECMO related syndromes ECMO: 1 (5.88%); harlequin syndrome, Standard therapy: 0 (0%) Surgical procedures ECMO: 0 (0%), Standard therapy: 1 (5.56%); heart transplant Vascular disorders ECMO: 0 (0%), Standard therapy: 1 (5.56%); Peripheral ischemia
Ostadal, 2023	**Death from any cause, implantation of another MCS device, resuscitated cardiac arrest at 30 days** • ECMO: 63.8% (37/58) • Control: 71.2% (42/59) Risk difference -7.4, 95% CI: -24.3 to 9.5	**Resuscitated cardiac arrest** • ECMO: 10.3% (6/58) • Control: 13.6% (8/59) Risk difference -3.2, 95% CI: -15.0 to 8.5 HR 0.790, 95% CI: 0.274 to 2.277

First author, date	Efficacy outcomes	Safety outcomes
	HR 0.721, 95% CI: 0.463 to 1.123 **All-cause mortality at 30 days** • ECMO: 50.0% (29/58) • Control: 47.5% (28/59) Risk difference 2.5, 95% CI: -15.6 to 20.7 HR 1.110, 95% CI: 0.660 to 1.866 **Implantation of another MCS device at 30 days** • ECMO: 17.2% (10/58) • Control: 42.4% (25/59) Risk difference -25.1, 95% CI: -41.1 to -9.2 HR 0.380, 95% CI: 0.182 to 0.793 **Discharged home at 30 days** • ECMO: 12.1% (7/58) • Control: 11.9% (7/59) **Good neurological status at 30 days (CPC 1)** • ECMO: 24.1% (14/58) • Control: 27.1% (16/59)	**Serious adverse events** • ECMO: 60.3% (35/58) • Control: 61.0% (36/59) Risk difference -0.7, 95% CI: -18.4 to 17.0; p=0.941 **Bleeding** • ECMO: 31.0% (18/58) • Control: 20.3% (12/59) Risk difference 10.7, 95% CI: -5.0 to 26.4; p=0.185 **Leg ischaemia** • ECMO: 13.8% (8/58) • Control: 5.1% (3/59) Risk difference 8.7, 95% CI: -1.8 to 19.2; p=0.107 **Stroke** • ECMO: 5.2% (3/58) • Control: 0% (0/59) Risk difference 5.2, 95% CI: -0.5 to 10.9; p=0.119 **Pneumonia** • ECMO: 31.0% (18/58) • Control: 30.5% (18/59) Risk difference 0.5, 95% CI: -16.2 to 17.3; p=0.951 **Sepsis** • ECMO: 39.7% (23/58) • Control: 39.0% (23/59) Risk difference 0.7, 95% CI: -17.0 to 18.4; p=0.941 **Technical complications** • ECMO: 1.7% (1/58) • Control: 0% (0/59) Risk difference 1.7, 95% CI: -1.6 to 5.1; p=0.496

First author, date	Efficacy outcomes	Safety outcomes
Ostadal, 2025	**All-cause mortality at 1 year** • Immediate ECMO=69.0% (40/58) • Early conservative therapy=67.8% (40/59), HR 1.02, 95% CI 0.66 to 1.58; p=0.93 The major cause of death was refractory shock followed by multi-organ failure in both groups. All survivors had good neurological outcome. **Composite endpoint of death from any cause, resuscitated cardiac arrest, and implantation of another mechanical circulatory support device** • Immediate ECMO=74.1% (43/58) • Early conservative therapy=79.7% (47/59), HR 0.83, 95% CI 0.55 to 1.25; p=0.29 **Resuscitated cardiac arrest** • Immediate ECMO=10.3% (6/58) • Early conservative therapy=13.6% (8/59), OR 0.74, 95% CI 0.23 to 2.42 **Need for another mechanical circulatory support device** • Immediate ECMO=19.0% (11/58) • Early conservative therapy=49.2%	**Stroke** • Immediate ECMO=5.2% (3/58); all 3 people died, 2 from refractory shock and 1 from multiorgan failure • Early conservative therapy=0% (0/59) **Renal replacement therapy** • Immediate ECMO=27.6% (16/58); 12 died • Early conservative therapy=16.9% (10/59); 8 died

First author, date	Efficacy outcomes	Safety outcomes
	(29/59), OR 0.28, 95% CI 0.13 to 0.64 The durations of mechanical ventilation, intensive care unit stay and hospital stay were comparable between groups. Significant interaction with treatment strategy and 1-year mortality was observed in subgroups according to baseline mean arterial pressure, indicating lower mortality in the subgroup with baseline mean arterial pressure less than 63 mmHg: HR 0.58, 95% CI 0.29 to 1.16; p(interaction)=0.017.	
Sohail, 2022	**Pooled short-term mortality (7 day, 30 day and in-hospital)** Meta-analysis 72 studies (n=10,276) • 58% (95% CI: 54 to 61%), I^2=88% **Subgroup analysis short-term mortality by age** Meta-analysis 6 studies (n=497) • Age over 60 years: OR 4.58 (95% CI: 2.71 to 7.72)	**ECMO Complications (median [IQR])** • Infection: 18.0% (11.8 to 43.0) • Limb ischaemia: 9.2% (7.6 to 15.0) • Renal failure: 39.9% (29.5 to 49.8) • VTE: 4.7% (3.3 to 6.8) • Hypoxic brain injury: 11.6% (10.1 to 20.8) • Multi-organ failure: 36.9% (16.4 to 41.7) • Stroke/ICH: 10.5% (5.0 to 16.7) • Bleeding/vascular complications: 27.5% (19.0 to 35.4)
Alba, 2021	**Pooled short-term mortality (30 day and in-hospital)** • Overall: 61% (95% CI 59 to 63) 306 studies n=29,289	**No safety outcomes were reported**

First author, date	Efficacy outcomes	Safety outcomes
	• ECPR OHCA: 76% (95% CI 69 to 82), I^2=94%, 41 studies n=2,974 • ECPR IHCA: 64% (95% CI 59 to 69), I^2=81%, 46 studies n=2,987 • Post AMI: 60% (95% CI 59 to 64), I^2=87%, 80 studies n=7,774 • Postcardiotomy: 59% (95% CI 56 to 63), I^2=87%, 64 studies n=8,231 • AHF: 53% (95% CI 46 to 59), I^2=89%, 33 studies n=3,567 • PE: 52% (95% CI 38 to 66), I^2=75%, 10 studies n=221 • Myocarditis: 40% (95% CI 33 to 46), I^2=65%, 13 studies n=906 • Post-HTx: 35% (95% CI 29 to 42), I^2=64%, 25 studies n=771 **Probability of HTx** Meta-analysis • AHF: 13.1%, 95% CI: 5.5 to 23.7, 16 studies • Myocarditis: 4.5%, 95% CI: 0.3 to 11.7, 5 studies • Post AMI: 2.8%, 95% CI: 0.8 to 5.5, 19 studies • Postcardiotomy: 0.4%, 95% CI: 0.0 to 1.1, 34 studies • Post-HTx: 0.0%, 95% CI: 0.0 to 0.5, 5 studies • PE: 0.0%, 95% CI: 0.0 to 22.8, 1 study	

First author, date	Efficacy outcomes	Safety outcomes
	Probability of VAD Meta-analysis • AHF: 29.0%, 95% CI: 17.3 to 42.1, 17 studies • Post AMI: 9.0%, 95% CI: 4.2 to 15.1, 22 studies • Post-HTx: 2.4%, 95% CI: 0.0 to 6.8, 5 studies • Myocarditis: 2.3%, 95% CI: 0.2 to 5.6, 5 studies • Postcardiotomy: 0.8%, 95% CI: 0.2 to 1.8, 35 studies • PE: 0.0%, 95% CI: 0.0−22.8, 1 study	
Cheng, 2019	**Survival to discharge** • 29.7% (149/502) **Overall survival rate (Kaplan-Meier analysis probability at 3-years) after hospital discharge** • All: 76.7% **Freedom-from-event rate including death or heart replacement therapy (Kaplan-Meier analysis probability at 3-years) after hospital discharge** • All: 74.2%	**Mortality after hospital discharge** • 14.1% (21/149) **Cause of death during follow-up period** • Sudden death or unknown cause: 9/21 • Heart failure related: 4/21 • Sepsis:4/21 • Chronic rejection: 3/21 • Stroke: 1/21

First author, date	Efficacy outcomes	Safety outcomes
	• ADHF: 100% • Postcardiotomy CS: 85.5% • Allograft failure: 74.2% • AMI: 40.4% (p<0.001)	
Vishram-Nielsen, 2023	**Pooled short-term mortality (30 days or during hospitalisation)** Meta-analysis 50 studies (n=2,470) • 34.68% (95% CI: 29.16 to 40.39), I^2=69% **Pooled short-term mortality (death on ECMO)** Meta-analysis 36 studies (n=945) • 27.03% (95% CI: 20.98 to 33.48), I^2=67% **Pooled VAD implantation after VA ECMO** Meta-analysis 22 studies (n=628) • 2.23% (95% CI: 0.13 to 5.85), I^2=67% **Pooled probability of HTx after VA ECMO** Meta-analysis 23 studies (n=635) 3.71% (95% CI: 0.47 to 8.76), I^2=72%	**Pooled neurological events** Meta-analysis 8 studies (n=375) • 7.40% (95% CI: 3.25 to 12.60), I^2=30% **Pooled infections** Meta-analysis 8 studies (n=323) • 34.83% (95% CI: 15.80 to 56.34), I^2=79% **Pooled limb ischaemia** Meta-analysis 6 studies (n=161) • 16.65% (95% CI: 5.78 to 30.65), I^2=69% **Pooled blood transfusions** Meta-analysis 2 studies (n=63) • 54.71% (95% CI: 0.00 to 100.00), I^2=96% **Pooled liver failure** Meta-analysis 2 studies (n=63) • 5.62% (95% CI: 0.41 to 14.20), I^2=0% **Pooled ventricular tachycardia or fibrillation** Meta-analysis 4 studies (n=270) • 22.57% (95% CI: 2.73 to 50.96), I^2=84% **Pooled 3rd degree atrioventricular block** Meta-analysis 3 studies (n=215) • 30.46% (95% CI: 0.00 to 78.46), I^2=93% **Pooled bleeding** Meta-analysis 6 studies (n=152) • 40.32% (95% CI: 22.89 to 58.92), I^2=76% **Pooled dialysis**

First author, date	Efficacy outcomes	Safety outcomes
		Meta-analysis 6 studies (n=327) 35.22% (95% CI: 11.90 to 62.35), I^2=89%
Olson, 2020	**Survival to hospital discharge** • 63.6% (56/88) **ECMO weaning with expected recovery** • 61.4% (54/88) **ECMO weaning to HTx or VAD** • 10.2% (9/88)	**Cardiovascular complications** • 47.6% (30/63); cardiac arrythmia (12), hypertension requiring vasodilators (2), myocardial stun by echocardiogram (2), Inotropes on ECLS (26). **Haemorrhagic complications** • 49.2% (31/63); cannulation site bleeding (16), disseminated intravascular coagulation (2), GI haemorrhage (7), Haemolysis (4), surgical site bleeding (13). **Infectious complications** • 7.9% (5/63); culture proven infection (5), white blood cell count below 1,500/µl (2) **Mechanical complications** • 33% (21/63); cannula problems (6), circuit clots (13), pump malfunction (1) **Metabolic complications** • 11.1% (7/63); hyperglycaemia over 240 mg/dl (2), hyperbilirubinemia (6), pH below 7.20 (2) **Neurological complications** • 14.3% (9/63); seizures by EEG (2), CNS infarction (3), CNS haemorrhage (5) **Pulmonary complications** • 9.5% (6); Pneumothorax requiring treatment (3), pulmonary haemorrhage (3) **Renal complications** • 38.1% (24); renal replacement (16), creatinine elevation (12) **Limb complications** 7.9% (5); limb ischaemia (3), limb fasciotomy (2)

First author, date	Efficacy outcomes	Safety outcomes
Son Y-J, 2024	**In-hospital mortality** • In-hospital mortality ranged from 18.3% to 81.1%. • Overall in-hospital mortality=56.7% (95% CI 23.0% to 85.2%; 25 studies; I^2=97.22%, p<0.001). • In-hospital mortality for CS=49.2% (95% CI 39.4% to 59.0%; 14 studies). • In-hospital mortality for cardiac arrest=75.2% (95% CI 70.1 % to 79.7%; 6 studies). • In-hospital mortality for CS or cardiac arrest=58.1% (95% CI 51.0% to 64.9%; 3 studies) **Risk factors before VA ECMO** In the meta-analysis, older age (14 studies) and lower weight (6 studies) were statistically significant risk factors for in-hospital mortality before VA ECMO insertion. Some clinical characteristics, such as low blood pressure, were identified as risk factors but were only reported in a few studies. **Risk factors during VA ECMO** In the meta-analysis, only the use of renal replacement was a statistically significant risk factor for in-hospital mortality during VA ECMO (OR 3.55, 95 % CI 1.73 to 7.29).	**No safety outcomes were reported.**

First author, date	Efficacy outcomes	Safety outcomes
	Risk factors after VA ECMO In the meta-analysis, bleeding (OR 3.70, 95% CI 1.48 to 9.26, I^2=80.9%, 5 studies), and lower limb ischaemia (OR 3.63, 95% CI 2.05 to 6.40, I^2=14.8%, 6 studies) were identified as risk factors.	
Stub D, 2025	**In-hospital or 30-day mortality** The meta-analysis of the ORs from the included studies demonstrated that Impella statistically significantly reduced the odds of in-hospital or 30-day mortality compared to VA ECMO (OR 0.57, 95% CI 0.44 to 0.74; p<0.0001, I^2=27%). In absolute terms, the proportion of people who had Impella and died in-hospital or within 30 days (pooled 39.6%) was lower than the proportion of those who had VA-ECMO (pooled: 53.8%).	**Bleeding events needing transfusion** The meta-analysis showed statistically significantly lower odds of bleeding events needing transfusion in people who had Impella compared to VA ECMO (OR 0.61, 95% CI 0.46 to 0.80; p=0.0004, I^2=0%). All studies reported a lower proportion of bleeding events needing transfusion in the Impella cohort (pooled: 19.9%) compared to the VA ECMO cohort (pooled: 28.8%).
Low C, 2024	**In-hospital or 30-day mortality=32.5% (15,845/48,749)** **Pooled estimates for OR by intervention (95% CI) compared to medical therapy alone** • Centrifugal VAD=0.9 (0.34 to 2.39) • ECMO=0.99 (0.75 to 1.3)	**Bleeding** (20 studies, n=8,646) Compared to medical therapy, ECMO, microaxial VAD, ECMO with microaxial VAD, and microaxial VAD with IABP were associated with bleeding (low certainty), while it is uncertain if IABP or centrifugal VAD are associated with bleeding (very low certainty). It is also uncertain if ECMO with IABP is associated with less bleeding (very low certainty). **Limb ischaemia** (18 studies, n=3,705)

First author, date	Efficacy outcomes	Safety outcomes
	• **ECMO with IABP=0.54 (0.33 to 0.86)** • ECMO with microaxial VAD=0.61 (0.34 to 1.1) • IABP=1.01 (0.8 to 1.29) • Microaxial VAD=0.97 (0.7 to 1.34) • Microaxial VAD with IABP=4.52 (0.17 to 120.3) Compared to ECMO with IABP, ECMO was associated with higher mortality (OR 1.78, 95% CI 1.19 to 2.68, moderate certainty). From reconstructed individual participant data from 25 studies (n=11,088), a meta-analysis was done comparing the different MCS devices in CS. ECMO with IABP was associated with reduced mortality (stratified HR 0.55, 95% CI 0.46 to 0.66, random effects HR 0.57, 95% CI 0.48 to 0.69) compared to medical therapy, with no reductions in mortality for the other interventions.	ECMO and ECMO with microaxial VAD may be associated with limb ischaemia (low certainty), while it is uncertain if microaxial VAD, centrifugal VAD, ECMO with IABP, and microaxial VAD with IABP were associated with limb ischemia (very low certainty) compared to medical therapy. It is also uncertain if IABP is associated with less ischaemia (very low certainty). **Acute kidney injury** (17 studies, n=22,424) Compared to medical therapy, there is an unclear association between centrifugal VAD, IABP, microaxial VAD, ECMO with IABP, ECMO with microaxial VAD, and ECMO with acute kidney injury (very low certainty). **Haemolysis** (7 studies, n=1,632) It is unclear if any mechanical circulatory support device is associated with haemolysis compared to medical therapy.
Bain E, 2025	**Survival to discharge was reported in 24 cases: 17 (70.8%) survived and 7 (29.2%) died.**	All 30 people with spinal cord infarction or ischaemia identified in the review or at the study centre developed either paraplegia (n=27, 90%) or weakness (n=3, 10%) of both lower extremities. Spine MRI was reported in 26 cases, and the findings were consistent with infarction in 23 (88.5%). Infarction was complicated by haemorrhagic transformation in 2 cases and ischaemia in 3.

First author, date	Efficacy outcomes	Safety outcomes
		Of the 10 people with follow-up information, none had complete recovery. Partial recovery with substantial limitations of mobility was noted in half. The other half had no signs of neurological recovery. All 3 people with weakness rather than paraplegia had partial recovery. In a series of 7 people included in the review, 4 developed faecal incontinence, and 2 of them also had urinary incontinence or retention.
Scriba V, 2025	**Mortality=57.1%**	**Buttock ischaemia (n=7)** • Unilateral buttock ischaemia: n=6 • Bilateral buttock ischaemia: n=1 The average number of people with buttock ischaemia in this case series was 1.4 per year (mean annual prevalence of 2.7%). Buttock ischaemia was accompanied by concomitant elevations in creatine kinase levels. CT angiography in all people revealed that the ECMO cannula had covered the origin of the internal iliac artery, indicating hypoperfusion. No deaths in this study were documented to be caused by buttock ischaemia or its sequelae. Of the people who survived, 3 needed repeated surgery, which led to a prolonged intensive care unit stay in 1 and readmission in another.

Procedure technique

Of the 14 studies, none detailed the ECMO device or combination of devices used. ECMO was started before percutaneous coronary intervention (PCI) in 1 randomised controlled trial of people with CS complicating AMI (Thiele 2023) but was started within 6 hours of randomisation in people who had already undergone PCI in another (Banning 2023). Left ventricular (LV) venting strategies were detailed in 6 studies (Thiele 2023, Banning 2023, Ostadal 2023, Sohail 2022, Alba 2021, Vishram-Neilsen 2023); 2 RCTs had a predefined criteria for LV venting and permitted insertion of an intra-aortic balloon pump (IABP) or Impella device (Thiele 2023, Banning 2023), another randomised controlled trial permitted LV unloading but strategies were left to the discretion of physicians at participating centres (Ostadal 2023). The median concomitant use of IABP reported in systematic reviews was 70% (Sohail 2022), 20 to 67% (Alba 2021) and 60% (Vishram-Neilsen 2023). ECMO with IABP was reported in 4 studies in the network meta-analysis of 34 studies (Low 2024).

Of the 14 studies, 8 detailed the median length of time on ECMO (Thiele 2023, Sohail 2022, Alba 2021, Cheng 2019, Vishram-Neilsen 2023, Olson 2020, Bain 2025, Scriba 2025), which ranged from 2.7 days (Thiele 2023) to 10.5 days (Cheng 2019). One systematic review and meta-analysis by Son (2024) described that the duration of ECMO support ranged from 28 hours to 10 days across 16 studies (64%).

Efficacy

Survival

Survival was reported in 4 studies (Ostadal 2023, Cheng 2019, Olson 2020, Bain 2025). In the randomised controlled trial of 117 people with CS complicating AMI, 12% of people in both the ECMO group and the control group had been discharged home at 30 days (Ostadal 2023).

The retrospective study of 88 people with peripartum cardiomyopathy reported a rate of survival to hospital discharge of 64% (Olson 2020). In the single centre retrospective study, 30% (149 of 502) of people having VA ECMO survived to discharge (Cheng 2019). Of these survivors, the Kaplan-Meier estimate of survival at 3 years was 74% in the overall population but was statistically significantly lower ($p<0.001$) in people with AMI (40%) compared to those with ADHF (100%), postcardiotomy (86%), allograft failure (74%) (Cheng 2019).

In the review and case series of 30 people who had VA ECMO for CS secondary to various aetiologies, survival to hospital discharge was reported in 24 people, with 17 survived and 7 died (Bain 2025).

Short-term mortality

Short-term mortality was reported in 11 studies, ranging from hospital discharge to 1 year.

In the systematic review of 611 people with CS complicating AMI across 4 randomised controlled trials, the pooled 30-day mortality was 46% for those who had VA ECMO, compared to 48% in the control group. The relative risk (RR) was 0.95 (95% CI: 0.80 to 1.12; $p=0.54$, $I^2=0\%$) (Elsaeidy 2024).

In the randomised controlled trial of 417 people with CS complicating AMI, 47% of people who had ECMO and 49% of people in the control group reported death from any cause at 30 days. The RR was 0.98 (95% CI: 0.80 to 1.19; $p=0.81$) at 30 days (Thiele 2023). At 1 year, all-cause mortality was 55% (115/209) in the ECMO group and 56% (116/208) in the control group, and the difference between the treatment groups was not statistically significant (Desch 2024). These results were consistent across all subgroups (sex, age under 65 versus 65 years or over, ST-segment elevation versus non-ST-segment elevation AMI, anterior versus non-anterior ST-segment elevation AMI, lactate levels 6 or under versus over 6 mmol/L, diabetes versus no diabetes, and cardiopulmonary

resuscitation versus no resuscitation before enrolment). Similarly, between 30 days and 1 year, there was no difference in all-cause mortality between the treatment groups (hazard ratio [HR] 1.07; 95% CI 0.52 to 2.21).

In the randomised controlled trial of 117 people with CS complicating AMI, all-cause mortality at 30 days was 50% in the ECMO group compared to 48% in the control group. The risk difference was 2.5 (95% CI -15.6 to 20.7) and HR 1.11 (95% CI 0.66 to 1.87) (Ostadal 2023). At 1 year, all-cause mortality was 69% in the ECMO group compared with 68% in the control group (HR 1.02, 95% CI 0.66 to 1.58; p=0.93). The major cause of death was refractory shock followed by multiorgan failure in both groups (Ostadal 2025).

In the randomised controlled trial of 35 people with CS complicating AMI, 30-day all-cause mortality was 44% for those who had ECMO compared to 61% for those who had standard therapy. HR was 0.56 (95% CI: 0.21 to 1.45; p=0.22). At 1 year follow-up, all-cause mortality was 52% in people who had ECMO, and 82% in those who had standard therapy (HR 0.52, 95% CI 0.21 to 1.26, p=0.14; Banning 2023). In the systematic review of 72 studies of CS complicating AMI, the pooled short-term mortality (30-day and in-hospital) was 58% (95% CI: 54 to 61%), I^2=88% (Sohail 2022). In a subgroup analysis by age in the systematic review of CS complicating AMI, age greater than 60 years was associated with increased mortality OR 4.58 (95% CI: 2.71 to 7.72; Sohail 2022).

In the systematic review of 306 studies of CS of any aetiology, the pooled overall short-term mortality (30-day and in-hospital) was 61% (95% CI 59 to 63) (Alba 2021). Pooled short-term mortality by CS aetiology subgroup, showed the highest mortality was in people with ECPR for out of hospital cardiac arrest (OHCA) (76%; 95% CI 69 to 82%, I^2=94%, 41 studies). This was followed by ECPR for in hospital CA (IHCA) at 64% (95% CI 59 to 69, I^2=81%, 46 studies), post-AMI at 60% (95% CI 59 to 64, I^2=87%, 80 studies), postcardiotomy at 59% (95% CI 56 to 63, I^2=87%, 64 studies). Pooled short-term mortality for people with acute

decompensated heart failure (ADHF) was 53% (95% CI 46 to 59, I^2=89%, 33 studies), 52% in people with pulmonary embolism (95% CI 38 to 66, I^2=75%, 10 studies). It was lowest in people with myocarditis at 40% (95% CI 33 to 46), I^2=65%, 13 studies) and after heart transplant 35% (95% CI 29 to 42, I^2=64%, 25 studies). Using multivariate meta regression analysis, differences in short-term mortality across aetiologies remained statistically significant ($p<0.01$) after adjusting for population age, sex, and recruitment timeframe. Univariate meta regression analysis stratified by aetiology also showed a 7% to 9% increase in mortality per 10-year increase in cohort's age (Alba 2021).

In the systematic review of 54 studies in people with fulminant myocarditis, the pooled short-term mortality (30-day and in-hospital) was 35% (95% CI: 29 to 40, I^2=69%, 50 studies). The pooled short-term mortality from 36 studies looking at death on ECMO was 27% (95% CI: 21 to 34, I^2=67%; Vishram-Nielsen 2023).

In the systematic review of 10,409 people with CS or cardiac arrest, in-hospital mortality following VA ECMO ranged from 18% to 81% (Son 2024). A meta-analysis of 25 studies showed an overall in-hospital mortality of 57% (95% CI 23.0 to 85.2). In the subgroup analysis, in-hospital mortality of VA ECMO for people with CS was 49% (95% CI 39.4 to 59.0; 14 studies) and for people with cardiac arrest was 75% (95% CI 70.1 to 79.7; 6 studies; Son 2024). The authors also reported risk factors for in-hospital mortality before, during and after VA ECMO. Significant risk factors included older age and lower weight before VA ECMO, the use of renal replacement during VA ECMO, and bleeding and lower limb ischaemia after VA ECMO.

In the systematic review and meta-analysis of 9,871 people with CS, in-hospital or 30-day mortality, Impella statistically significantly reduced the odds of in-hospital or 30-day mortality compared with VA ECMO (OR 0.57, 95% CI 0.44 to 0.74; $p<0.0001$; 5 studies; Stub 2025). The authors also found that the proportion

of people who had Impella and died in-hospital or within 30 days (pooled 40%) was lower than the proportion of those who had VA ECMO (pooled: 54%).

In the network meta-analysis of 38 studies with 48,749 people with CS, in-hospital or 30-day mortality was 33% (n=15,845) (Low 2024), Compared with medical therapy alone, ECMO with IABP was probably associated with reduced mortality (OR 0.54, 95% CI 0.33 to 0.86; moderate certainty). Compared with medical therapy alone, there was an uncertain effect of centrifugal VAD (OR 0.90, 95% CI 0.34 to 2.39), ECMO (OR 0.99, 95% CI 0.75 to 1.30), ECMO with microaxial VAD (OR 0.61, 95% CI 0.34 to 1.10), IABP (OR 1.01, 95% CI 0.80 to 1.29), microaxial VAD (OR 0.97, 95% CI 0.70 to 1.34), and microaxial VAD with IABP (OR 4.52, 95% CI 0.17 to 120.26; all very low certainty for predominantly PSM data and imprecision). Compared with ECMO with IABP, ECMO was associated with higher mortality (OR 1.78, 95% CI 1.19 to 2.68, moderate certainty).

In the single centre retrospective study of 149 people who had survived VA ECMO explantation, 14% died after hospital discharge (median follow-up 306 days) (Cheng 2019).

In the retrospective single-centre case series of 264 people who had VA ECMO, mortality was reported in 57% of people (Scriba 2025).

Bridged to heart transplant

The proportion of people who had a heart transplant after ECMO treatment was reported in 2 systematic reviews and 1 registry study. In the systematic review of 306 studies in people on ECMO for CS of any aetiology, meta-analyses demonstrated the probability of having a heart transplant was higher in people with heart failure (13%), compared to those with myocarditis (5%), AMI (3%), and postcardiotomy CS (less than 1%; Alba 2021). In the systematic review of people with fulminant myocarditis, the pooled probability of heart transplant in a meta-

analysis of 23 studies was 4% (95% CI: 0.47 to 8.76, I^2=72%; Vishal-Nielsen 2023). In the registry study of 88 people with peripartum cardiomyopathy, 10% were weaned from ECMO to either heart transplant or a VAD (Olson, 2020).

Bridged to long term device

The proportion of people receiving a ventricular assist device (VAD) after ECMO treatment was reported in 2 systematic reviews and 1 registry study. In the systematic review of 306 studies in people on ECMO for CS, meta-analyses demonstrated the probability of receiving a VAD was higher in people with heart failure (29%), compared to those with AMI (9%), myocarditis (5%), heart transplant (2%) and postcardiotomy (1%; Alba 2021). In the systematic review of people with fulminant myocarditis, the pooled probability of heart transplant in a meta-analysis of 22 studies was 2% (95% CI: 0.47 to 8.76, I^2=72%; Vishal-Nielsen 2023). In the registry study of 88 people with peripartum cardiomyopathy, 10% were weaned from ECMO to either heart transplant or a VAD (Olson, 2020).

Reinfarction

In the systematic review of 4 randomised controlled trials for people with CS complicating AMI, pooled 30-day reinfarction rate was 2% in both the VA ECMO and control group (RR 0.87, 95% CI: 0.25 to 3.04; p=0.83, I^2=0%) (Elsaeidy 2024). In the randomised controlled trial of 417 people with CS complicating AMI, both intervention and control groups reported myocardial reinfarction rates of 1% (Thiele, 2023).

Rehospitalisation for heart failure

Two randomised controlled trials reported on the number of people who were readmitted to hospital because of heart failure. In the randomised controlled trial of 417 people with CS complicating AMI, 1% of people in both the ECMO group and control group were re-hospitalised within 30 days because of heart failure (Thiele, 2023). The randomised controlled trial of 35 people with CS complicating

AMI reported a readmission rate for heart failure of 8% in the ECMO group and 7% in the standard therapy group at 1 year follow-up (Banning 2023).

Quality of life

Quality of life was measured using the EQ-5D-3L questionnaire and reported in 2 randomised controlled trials. One randomised controlled trial reported quality of life at 30 days, however few completed the questionnaire in both the standard therapy (n=2) and VA ECMO (n=4) groups. Among the respondents, the median summary index score for those on ECMO was 0.667 (0.326 to 1.00), and 0.765 (0.739 to 0.790) for those on standard therapy. In the standard therapy group, there were no reported problems with mobility, self-care, or usual activities at 30 days, while half of the respondents from the VA ECMO group reported some difficulties in these domains at 30 days (Banning, 2023).

Another randomised controlled trial reported quality of life at 1 year. Among the 143 survivors, the overall quality of life showed no significant differences between the groups across most dimensions (including mobility, self-care, usual activities, and anxiety or depression). However, people who had ECMO reported a higher rate of pain or discomfort (p=0.013; Desch 2024).

Safety

Bleeding

In the systematic review of 4 randomised controlled trials, the pooled bleeding event rate was 25% (76 out of 302) in the ECMO group compared to 12% (36 out of 306) in the control group (RR 2.14, 95% CI: 1.49 to 3.07; p<0.0001, I^2=0%; Elsaeidy 2024). Moderate or severe bleeding was reported in 23% (49 out of 209) of people on ECMO compared to 12% (20 out of 208) of people in the control group (RR 2.44, 95% CI: 1.50 to 3.95) in the randomised controlled trial of 417 people with CS complicating AMI (Thiele 2023). Major bleeding was reported in 36% (5 out of 14) of people on ECMO and 6% (1 out of 18) of people in the

control group in the randomised controlled trial of 35 people with CS complicating AMI (Banning 2023). Bleeding complications were reported in 31% (18 out of 58) of people on ECMO compared to 20% (12 out of 59) of the control group in the randomised controlled trial of 177 people with CS complicating AMI (Ostadal 2023). Pooled bleeding/vascular complication rates were 28% (19.0 to 35.4) in the systematic review of 72 studies with CS complicating AMI (Sohail, 2022).

A pooled bleeding event rate of 40% (95% CI: 22.89 to 58.92, I^2=76%) was reported in a meta-analysis of 6 studies in the systematic review of people with fulminant myocarditis on ECMO (Vishram-Nielsen 2023).

A meta-analysis of 4 studies showed statistically significantly lower odds of bleeding events needing transfusion in people who had Impella compared with VA ECMO (OR 0.61, 95% CI 0.46 to 0.80; p=0.0004) in the systematic review and meta-analysis of people with CS (Stub 2025).

In the network meta-analysis of 38 studies with 48,749 people with CS, 20 studies reported on bleeding (Low 2024). Compared with medical therapy, ECMO, microaxial VAD, ECMO with microaxial VAD, and microaxial VAD with IABP were associated with bleeding (low certainty), while it was uncertain if IABP or centrifugal VAD were associated with bleeding (very low certainty). It was also uncertain if ECMO with IABP was associated with less bleeding (very low certainty; Low 2024).

Bleeding complications were reported in 49% (31 out of 88) of people on ECMO with peripartum cardiomyopathy. Cannulation site bleeds were reported in 16 out of 88 people and surgical site bleeds in 13 out of 88 people (Olson 2020).

Renal replacement therapy or acute kidney injury

In the systematic review of 4 randomised controlled trials, the pooled acute kidney injury or RRT event rate was 9% (25 out of 281) in the ECMO group

compared to 14% (40 out of 285) in the control group (RR 0.65, 95% CI: 0.41 to 1.04; p=0.07, I^2=0%; Elsaeidy 2024). RRT was reported in 8% (17 out of 209) of people on ECMO compared to 14% (29 out of 208) of people in the control group (RR 0.58, 95% CI: 0.33 to 1.03) in the randomised controlled trial of 417 people with CS complicating AMI (Thiele 2023). RRT was reported in 28% (16 of 58) of people in the ECMO group (12 of them died) compared with 17% (10 of 59) in the control group (8 of them died; Ostadal 2025).

Acute kidney injury was reported in 29% (4 out of 14) of people on ECMO and 44% (8 out of 18) of people in the control group in the randomised controlled trial of 35 people with CS complicating AMI (Banning 2023). Pooled renal failure rates were 40% (16.4 to 41.7) in the systematic review of 72 studies with CS complicating AMI (Sohail, 2022). In the network meta-analysis of 38 studies with 48,749 people with CS, 17 studies reported on acute kidney injury (Low 2024). Compared with medical therapy, there was an unclear association between centrifugal VAD, IABP, microaxial VAD, ECMO with IABP, ECMO with microaxial VAD, and ECMO with acute kidney injury (very low certainty).

A pooled RRT event rate of 35% (95% CI: 11.90 to 62.35, I^2=89%) was reported in a meta-analysis of 6 studies in the systematic review of people with fulminant myocarditis on ECMO (Vishram-Nielsen 2023).

Renal complications were reported in 38% (24 out of 88) people on ECMO with peripartum cardiomyopathy. RRT was reported in 16 out of 88 people (Olson 2020).

Stroke

In the systematic review of 4 randomised controlled trials, the pooled stroke event rate was 4% in both ECMO and control groups (12 out of 302 and 11 out of 306) (RR 1.14, 95% CI: 0.52 to 2.49; p=0.75, I^2=18%; Elsaeidy 2024). Stroke or systemic embolisation was reported in 4% (8 out of 209) of people on ECMO and

3% (6 out of 208) of people in the control group (RR 1.33, 95% CI: 0.47 to 3.76) in the RCT of 417 people with CS complicating AMI (Thiele 2023). Stroke was not reported in any people on ECMO (0 out of 14) but in 11% (2 out of 18) of people in the control group in the randomised controlled trial of 35 people with CS complicating AMI (Banning 2023). Conversely, in the randomised controlled trial of 177 people with CS complicating AMI, stroke was reported in 5% (3 out of 58) of people on ECMO and none in the control group (Ostadal 2023, 2025). Pooled stroke rates were 11% (5.0 to 16.7) in the systematic review of 72 studies with CS complicating AMI (Sohail 2022).

A pooled neurological event rate of 7% (95% CI: 3.25 to 12.60, I^2=30%) was reported in a meta-analysis of 8 studies in the systematic review of people with fulminant myocarditis on ECMO (Vishram-Nielsen 2023).

Neurological complications were reported in 14% (9 out of 88) of people on ECMO with peripartum cardiomyopathy. CNS infarction was reported in 3 out of 88 people, and CNS haemorrhage in 5 out of 88 people (Olson 2020).

Of the 21 people who died after hospital discharge (median follow-up 306 days) in the single centre retrospective study of people who had initially survived VA ECMO explantation, 1 cause of death was reported as due to stroke (Cheng 2019).

Neurological outcome

One randomised controlled trial reported on the proportion of people with a good neurological outcome at 30 days, assessed as category 1 using the Cerebral Performance Category (CPC 1). In the study of 117 people with CS complicating AMI, the proportion of people assessed as CPC 1 was 24% in the ECMO group compared to 27% in the control group (Ostadal 2023).

One randomised controlled trial reported on the proportion of people with a poor neurological outcome at 30 days, assessed as category 3 or 4 using the Cerebral Performance Category (CPC 3 or 4). In the study of 417 people with CS complicating AMI, the proportion of people assessed as CPC 3 or 4 was 25% (27 out of 109) in the ECMO group compared to 23% (24 out of 106) in the control group (Thiele 2023).

Sepsis

In the systematic review of 4 randomised controlled trials, the pooled sepsis event rate was 18% (54 out of 305) in the ECMO group compared to 17% (51 out of 306) in the control group (RR 1.07, 95% CI: 0.77 to 1.48; p=0.85, I^2=0%; Elsaeidy 2024). Post-procedural sepsis was reported in 1 person on ECMO, and septic shock in 1 person in the control group in the randomised controlled trial of 35 people with CS complicating AMI (Banning 2023). Sepsis was reported in 40% (23 out of 58) of people on ECMO compared to 39% (23 out of 59) of the control group in the randomised controlled trial of 177 people with CS complicating AMI (risk difference 0.7, 95% CI: -17.0 to 18.4; p=0.941; Ostadal 2023).

Of the 21 people who died after hospital discharge (median follow-up 306 days) in the single centre retrospective study of people who had initially survived VA ECMO explantation, 4 causes of death were reported as due to sepsis (Cheng 2019).

Haemolysis

In the network meta-analysis of 38 studies with 48,749 people with CS, 7 studies reported on haemolysis (Low 2024). Compared with medical therapy alone, it was unclear if any mechanical circulatory support device was associated with haemolysis.

Infection

The pooled median infection rate was 18% (11.8 to 43.0) in the systematic review of 72 studies with CS complicating AMI (Sohail 2022). A pooled infection event rate of 35% (95% CI: 15.80 to 56.34, I^2=79%) was reported in a meta-analysis of 8 studies in the systematic review of people with fulminant myocarditis on ECMO (Vishram-Nielsen 2023). Infectious complications were reported in 8% (5 out of 88) of people on ECMO with peripartum cardiomyopathy. Culture proven infection was reported in 5 out of 88 people, and white blood cell count below 1,500/µl in 2 out of 88 people (Olson 2020).

Pneumonia

In the systematic review of 2 randomised controlled trials, the pooled pneumonia event rate was 24% (18 out of 75) in the ECMO group compared to 25% (19 out of 77) in the control group (RR 0.97, 95% CI: 0.57 to 1.65; p=0.90, I^2=0%; Elsaeidy 2024). Pneumonia was reported in 31% (18 out of 58 and 18 out of 59) of people in both groups in the randomised controlled trial of 177 people with CS complicating AMI (risk difference 0.5, 95% CI: -16.2 to 17.3; p=0.951; Ostadal 2023).

Limb ischaemia

Peripheral ischaemic vascular complications were reported in 11% (23 out of 209) of people on ECMO compared to 4% (8 out of 208) of people in the control group (RR 2.86, 95% CI: 1.31 to 6.25) in the randomised controlled trial of 417 people with CS complicating AMI (Thiele 2023). Leg ischaemia was reported in 14% (8 out of 58) of people on ECMO compared to 5% (3 out of 59) of the control group in the randomised controlled trial of 177 people with CS complicating AMI (risk difference 8.7, 95% CI: -1.8 to 19.2; p=0.107; Ostadal 2023). Pooled limb ischaemia rates were 9% (7.6 to 15.0) in the systematic review of 72 studies with CS complicating AMI (Sohail 2022). The pooled limb ischaemia event rate of 17% (95% CI: 5.78 to 30.65, I^2=69%) was reported in a meta-analysis of 6 studies in the systematic review of people with fulminant

myocarditis on ECMO (Vishram-Nielsen 2023). Limb complications were reported in 8% (5 out of 88) of people on ECMO with peripartum cardiomyopathy. Limb ischaemia was reported in 3 out of 88 people, and limb fasciotomy in 2 out of 88 people (Olson 2020).

In the network meta-analysis of 38 studies with 48,749 people with CS, 18 studies reported on limb ischaemia (Low 2024). Compared with medical therapy alone, ECMO and ECMO with microaxial VAD might be associated with limb ischaemia (low certainty), while it was uncertain if microaxial VAD, centrifugal VAD, ECMO with IABP, and microaxial VAD with IABP were associated with limb ischaemia (very low certainty). It was also uncertain if IABP was associated with less ischaemia (very low certainty; Low 2024),

Spinal cord infarction or ischaemia

Spinal cord infarction or ischaemia was identified in 30 people in the review and case series of people who had VA ECMO (Bain 2025). They developed either paraplegia (n=27, 90%) or weakness (n=3, 10%) of both lower extremities. Spine MRI was reported in 26 people and the findings were consistent with infarction in 23 people (89%). Infarction was complicated by haemorrhagic transformation in 2 people and ischaemia in 3 people. Faecal incontinence was developed in 4 people, and 2 of them also had urinary incontinence or retention (Bain 2025).

Buttock ischaemia

Buttock ischaemia was reported in 7 people in the retrospective case series of 264 people who had femoral VA ECMO (Scriba 2025). Unilateral buttock ischaemia was observed in 6 people, while bilateral buttock ischaemia was seen in 1 person. CT angiography in all people revealed that the ECMO cannula had covered the origin of the internal iliac artery, indicating hypoperfusion. No deaths were documented to be caused by buttock ischaemia or its sequelae. Of the people who survived, 3 needed repeated surgery.

Cardiac complications

Cardiovascular death was reported in 14% (2 out of 14) of people in the ECMO group, and 33% (6 out of 18) of people in the control group in the randomised controlled trial of 35 people with CS complicating AMI (Banning 2023). The same study reported recurrent MI in 11% (2 out of 18) people in the control group, and none in the ECMO group. It also reported 5 serious cardiac adverse events in people who had ECMO compared to 4 in those who had standard therapy. These included cardiac arrest, cardiac tamponade, ventricular tachycardia, LV thrombus, AV block and atrial fibrillation (Banning 2023). Resuscitated cardiac arrest was reported in 10% (6 out of 58) of people in the ECMO group compared to 14% (8 out of 59) of the control group in the randomised controlled trial of 177 people with CS complicating AMI (risk difference -3.2, 95% CI: -15.0 to 8.5; Ostadal 2023).

A pooled ventricular tachycardia or fibrillation event rate of 23% (95% CI: 1.73 to 50.96; I^2=84%) was reported in a meta-analysis of 4 studies in the systematic review of people with fulminant myocarditis who had ECMO. The same systematic review also reported a pooled rate of third degree atrioventricular block of 23% (95% CI: 0.00 to 78.46; I^2=93%) from 3 studies (Vishram-Nielsen 2023).

Cardiovascular complications were reported in 48% (30 out of 88) of people on ECMO with peripartum cardiomyopathy. These included inotropes on ECMO, cardiac arrhythmia, hypertension requiring vasodilators and myocardial stun by echocardiogram (Olson 2020).

Of the 21 people who died after hospital discharge (median follow-up 306 days) in the single centre retrospective study of people who had initially survived VA ECMO explantation, 4 causes of death were reported as heart failure related (Cheng 2019).

Respiratory complications

The randomised controlled trial of 35 people with CS complicating AMI reported 1 serious respiratory adverse event in people on ECMO compared to 2 in those on standard therapy. These included pulmonary embolism, aspiration pneumonia and thoracic haemorrhage (Banning 2023).

Pulmonary complications were reported in 10% (9 out of 88) of people on ECMO with peripartum cardiomyopathy. This included pneumothorax requiring treatment and pulmonary haemorrhage (Olson 2020).

GI complications

The randomised controlled trial of 35 people with CS complicating AMI reported 1 serious gastrointestinal (GI) adverse event (intestinal ischaemia) in people on standard therapy (Banning 2023).

Hepatic complications

The randomised controlled trial of 35 people with CS complicating AMI reported 1 serious hepatobiliary adverse event (liver injury) in people on standard therapy (Banning 2023).

A pooled liver failure event rate of 6% (95% CI: 0.41 to 14.20; I^2=0%) was reported in a meta-analysis of 2 studies in the systematic review of people with fulminant myocarditis on ECMO (Vishram-Nielsen 2023).

Technical complications

Technical complications were reported in 2% (1 out of 58) of people on ECMO compared to none in the control group in the randomised controlled trial of 177 people with CS complicating AMI (risk difference 1.7, 95% CI: -1.6 to 5.1; p=0.496; Ostadal 2023).

Mechanical complications were reported in 33% (21 out of 88) of people on ECMO with peripartum cardiomyopathy. These included cannula problems, circuit clots, and pump malfunctions (Olson 2020).

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
- 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 studies included in the key evidence had a large number of participants from a variety of countries.
- Due to the impact of the COVID-19 pandemic, the Banning (2023) trial was stopped before completion of recruitment, and therefore had a small sample size (n=35). Olson (2020) study also included a relatively small population (n=88); however, this was the largest study sample identified for the postpartum cardiomyopathy indication.
- Follow-up for most studies were short, reporting key efficacy outcomes at 30 days, or at hospital discharge. Three randomised controlled trials (Desch 2024, Ostadal 2025, Banning 2023) had a follow up of 1 year, and one retrospective study (Cheng 2029) reporting on ECMO as a bridge to recovery had a median follow up period of 306 days (IQR 59 to 917).
- The systematic reviews included as key evidence pooled short-term mortality outcomes (30 day, hospital discharge) from included studies.
- CS can have many aetiologies with different risk profiles and outcomes. Most studies included in this review focus on CS complicating AMI, however other included studies report populations with mixed CS aetiologies.
  - People having ECMO for decompensated AHF, myocarditis, peri-partum cardiomyopathy may have better outcomes than people with AMI complicating CS.
- The randomised controlled trials included recruited participants with different classifications of CS; Thiele (2023) included those with SCAI classification C,

which is considered much lower risk, than SCAI D and E, which were included in the Ostadal (2023) study.

- A large proportion of people in the control groups in the included randomised controlled trials were permitted other MCS such as IABP and Impella. In the Ostadal (2023) trial there was also a large amount of cross-over of the control group to receive ECMO (39%).

Ongoing trials

- Assessment of ECMO in Acute Myocardial Infarction Cardiogenic Shock (ANCHOR) (NCT04184635); open label randomised controlled trial, France, n=400, completion October 2026.
- Left Ventricular Unloading to Improve Outcome in Cardiogenic Shock Patients on VA ECMO (UNLOAD ECMO) (NCT05577195), randomised controlled trial, Germany, n=198, completion December 2025.

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).

NICE guidelines

Acute heart failure: diagnosis and management (2014 updated 2021) NICE guideline CG187 - At an early stage, the specialist should have a discussion with a centre providing mechanical circulatory support about: people with potentially reversible severe acute heart failure or people who are potential candidates for transplantation.

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.

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5. Ostadal, P, Rokyta, R, Karasek, J et al. (2023) Extracorporeal Membrane Oxygenation in the Therapy of Cardiogenic Shock: results of the ECMO-CS Randomized Clinical Trial. Circulation 147(6): 454-464
6. Ostadal P, Rokyta R, Karasek J et al. (2025) Extracorporeal membrane oxygenation in the therapy of cardiogenic shock: 1-year outcomes of the multicentre, randomized ECMO-CS trial. European Journal of Heart Failure 27: 30-36
7. Sohail, Shahmir, Fan, Eddy, Foroutan, Farid et al. (2022) Predictors of Mortality in Patients Treated with Veno-Arterial ECMO for Cardiogenic Shock Complicating Acute Myocardial Infarction: a Systematic Review and Meta-Analysis. Journal of cardiovascular translational research 15(2): 227-238
8. Alba, Ana C, Foroutan, Farid, Buchan, Tayler A et al. (2021) Mortality in patients with cardiogenic shock supported with VA ECMO: A systematic review and meta-analysis evaluating the impact of etiology on 29,289 patients. The Journal of heart and lung transplantation: the official publication of the International Society for Heart Transplantation 40(4): 260-268
9. Cheng, Yi-Tso, Garan, Arthur R, Sanchez, Joseph et al. (2019) Midterm Outcomes of Bridge-to-Recovery Patients After Short-Term Mechanical Circulatory Support. The Annals of thoracic surgery 108(2): 524-530
10. Vishram-Nielsen, Julie K K, Foroutan, Farid, Rizwan, Saima et al. (2023) Patients with fulminant myocarditis supported with veno-arterial extracorporeal membrane oxygenation: a systematic review and meta-analysis of short-term mortality and impact of risk factors. Heart failure reviews 28(2): 347-357
11. Olson, T L, O'Neil, E R, Ramanathan, K et al. (2020) Extracorporeal membrane oxygenation in peripartum cardiomyopathy: A review of the ELSO Registry. International journal of cardiology 311: 71-76
12. Son Y-J, Hyun Park S, Lee Y et al. (2024) Prevalence and risk factors for in-hospital mortality of adult patients on veno-arterial extracorporeal membrane oxygenation for cardiogenic shock and cardiac arrest: A systematic review and meta-analysis. Intensive & Critical Care Nursing 85: 103756
13. Stub D, Chan W, Ball J et al. (2025) Impella compared to venoarterial extracorporeal membrane oxygenation in cardiogenic shock: a systematic

review and meta-analysis of propensity score-matched studies. Shock 63: 512-519

14. Low CJW, Ling RR, Lau MPXL et al. (2024) Mechanical circulatory support for cardiogenic shock: a network meta-analysis of randomized controlled trials and propensity score-matched studies. Intensive Care Medicine 50: 209-221
15. Bain E, Rao R, Guglin M (2025) Spinal Cord Injury Following Venoarterial Extracorporeal Membrane Oxygenation: A Scoping Review. Journal of Cardiothoracic and Vascular Anesthesia 39: 526-531
16. Scriba V, Loeschhorn-Becker R, Motekallemi A et al. (2025) Buttock ischemia in adults with femoral venoarterial-extracorporeal membranoxygenation - A single center experience. Perfusion 2676591251321997

Appendix A: Methods and literature search strategy

Methods and literature search strategy

NICE has identified studies and reviews relevant to venoarterial extracorporeal membrane oxygenation (VA ECMO) in the following indications from the medical literature:

- acute heart failure in adults
- extracorporeal cardiopulmonary resuscitation (ECPR) in adults in refractory cardiac arrest
- postcardiotomy cardiogenic shock in adults.

The search was initially developed for the acute heart failure indication only (Tables 4a and 4b) and then modified and updated to cover the additional two indications (Table 4c).

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 for acute heart failure in adults on 18 September 2024 and updated them on 12 May 2025. The search strategy was modified and updated on 19 June 2025 to incorporate the 2 additional interventions. 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, letters and editorial. We excluded the following publication types in MEDLINE: letter, historical article, comment, editorial, news and case reports. English language limits were applied to the search when possible in the database.

The search was limited from March 2013 to the latest update. 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)	18/09/24	Wiley	Issue 8 of 12, August 2024	410
Cochrane Database of Systematic Reviews (CDSR)	20/09/24	Wiley	Issue 9 of 12, September 2024	13
Embase	20/09/24	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

Update search

Table 4b Update search results 1

Database	Date searched	Database platform	Database segment or version	Number of results downloaded
Cochrane Central Register of Controlled Trials (CENTRAL)	12/05/2025	Wiley	Issue 4 of 12, April 2025	39
Cochrane Database of Systematic Reviews (CDSR)	12/05/2025	Wiley	Issue 5 of 12, May 2025	0
Embase	12/05/2025	Ovid	1974 to 2025 May 09	54
INAHTA International HTA Database	12/05/2025	https://database.inahta.org/		4
MEDLINE ALL	12/05/2025	Ovid	1946 to May 09, 2025	195

Additional update search

Table 4c Update search results 2

This version of the search was modified to include 2 additional indications and searched from March 2013 to latest update.

Database	Date searched	Database platform	Database segment or version	Number of results downloaded
Cochrane Central Register of Controlled Trials (CENTRAL)	19/06/25	Wiley	Issue 6 of 12, 2025	295
Cochrane Database of Systematic Reviews (CDSR)	19/05/25	Wiley	Issue 6 of 12, 2025.	0
Embase	19/06/25	Ovid	1974 to 2025 June 17	4461
INAHTA International HTA Database	19/06/25	https://database.inahta.org/	-	29
MEDLINE ALL	19/06/25	Ovid	1946 to June 18, 2025	4707

Search strategy history – initial search strategy September 2024

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 #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 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

Search strategy history – update search strategy June 2026

This version of the search was modified to include two additional indications and searched from March 2013 to latest update.

MEDLINE ALL search strategy

1, Heart Failure/th [Therapy], 31,048

2, Acute Disease/th [Therapy], 1,222

3, 1 and 2, 11

4, *Cardiomyopathies/th, 1,952

5, *Shock, Cardiogenic/th, 2,922

6, Myocardial Stunning/th [Therapy], 155

7, Myocarditis/th [Therapy], 1,333

8, *Myocardial infarction/th [Therapy], 19,394

9, Out-of-Hospital Cardiac Arrest/th [Therapy], 6,031

10, ((acute* or severe* or refract*) 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* or arrest* or stunn*)).tw., 18,262

11, (cardiogen* adj shock).tw., 17,331

12, Myocardit*.tw., 22,410

13, ((Postpartum* or post-partum* or peripartum* or peri-partum*) adj cardiomyopath*).tw., 1,811

14, (postcardiotomy or Post-cardiotomy).tw., 1,230

15, PPCM.tw., 717

16, (myocard* adj (stun* or hibernat* or infarct*)).tw., 241,791

17, Primary Graft Dysfunction/th [Therapy], 109

18, (primary* adj graft* adj dysfunct*).tw., 1,543

19, or/3-18, 301,507

20, *Cardiopulmonary Resuscitation/mt [Methods], 5,700

21, *Extracorporeal Membrane Oxygenation/, 14,654

22, ECMO.tw., 14,889

23, *Extracorporeal Circulation/mt, 1,259

24, (extracorp* adj circulat*).tw., 8,706

25, (extracorp* adj ((cardiopulmon* adj resuscitat*) or CPR)).tw., 1,377

26, ECPR.ti,ab., 1,006

27, (Biomedicus adj pump*).tw., 45

28, (Maquet* adj rotaflow*).tw., 12

29, (jostra adj (pump* or rotaflow*)).tw., 5

30, (levitronix adj (centrimag* or pump* or system* or oxygen*)).tw., 54

31, (Medos adj (Hilite* or oxygen*)).tw., 22

32, (left adj ventricle adj assist adj device).tw., 107

33, or/20-32, 35,941

34, 19 and 33, 6,390

35, animals/ not humans/, 5,314,500

36, 34 not 35, 6,296

37, (exp child/ or exp pediatrics/ or exp infant/ or exp adolescent/) not (exp adult/ or exp middle age/ or exp aged/), 2,281,857

38, 36 not 37, 5,768

39, limit 38 to english language, 5,398

40, limit 39 to ed=20130901-20250630, 3,883

41, limit 39 to dt=20130901-20250630, 4,610

42, 40 or 41, 4,707

EMBASE search strategy

1, heart failure/th [Therapy], 15,823

2, acute disease/th [Therapy], 2,430

3, 1 and 2, 10

4, *cardiomyopathy/th [Therapy], 1,155

5, *cardiogenic shock/th [Therapy], 2,198

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

7, myocarditis/th [Therapy], 874

8, *heart infarction/th [Therapy], 9,266

9, "out of hospital cardiac arrest"/th [Therapy], 3,990

10, ((acute* or severe* or refract*) 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* or arrest* or stunn*)).tw., 32,685

11, (cardiogen* adj shock).tw., 33,626

12, Myocardit*.tw., 33,287

13, ((Postpartum* or post-partum* or peripartum* or peri-partum*) adj cardiomyopath*).tw., 3,113

14, (postcardiotomy or Post-cardiotomy).tw., 2,079

15, PPCM.tw., 1,382

16, (myocard* adj (stun* or hibernat* or infarct*)).tw., 360,780

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

18, (primary* adj graft* adj dysfunct*).tw., 3,390

19, or/3-18, 448,325

20, *resuscitation/, 62,739

21, *extracorporeal oxygenation/, 18,275

22, ECMO.tw., 32,585

23, *extracorporeal circulation/, 9,325

24, (extracorp* adj circulat*).tw., 10,199

25, (extracorp* adj ((cardiopulmon* adj resuscitat*) or CPR)).tw., 2,110

26, ECPR.tw., 2,050

27, (Biomedicus adj pump*).tw., 50

28, (Maquet* adj rotaflow*).tw., 33

29, (jostra adj (pump* or rotaflow*)).tw., 17

30, (levitronix adj (centrimag* or pump* or system* or oxygen*)).tw., 154

31, (Medos adj (Hilite* or oxygen*)).tw., 46

32, (left adj ventricle adj assist adj device).tw., 230

33, or/20-32, 115,373

34, 19 and 33, 15,247

35, Nonhuman/ not Human/, 5,720,207

36, 34 not 35, 14,988

37, (conference abstract* or conference review or conference paper or conference proceeding).db,pt,su., 6,294,375

38, 36 not 37, 6,986

39, (exp child/ or exp pediatrics/ or exp adolescent/) not exp adult/, 2,766,023

40, 38 not 39, 6,431

41, limit 40 to english language, 5,795

42, limit 41 to dd=20130901-20250630, 4,668

43, limit 41 to dc=20130901-20250630, 4,655

44, 42 or 43, 4,669

45, Clinical trial.pt., 533,511

46, 44 not 45, 4,461

Cochrane Library (CDSR) search strategy

#1 MeSH descriptor: [Heart Failure] this term only and with qualifier(s): [therapy - TH] 2567

#2 MeSH descriptor: [Acute Disease] this term only and with qualifier(s): [therapy - TH] 115

#3 #1 and #2 0

#4 MeSH descriptor: [Cardiomyopathies] this term only and with qualifier(s): [therapy - TH] 86

#5 MeSH descriptor: [Shock, Cardiogenic] this term only and with qualifier(s): [therapy - TH] 194

#6 MeSH descriptor: [Myocardial Stunning] this term only and with qualifier(s): [therapy - TH] 3

#7 MeSH descriptor: [Myocarditis] this term only and with qualifier(s): [therapy - TH] 13

#8 MeSH descriptor: [Myocardial Infarction] this term only and with qualifier(s): [therapy - TH] 2729

#9 MeSH descriptor: [Out-of-Hospital Cardiac Arrest] this term only and with qualifier(s): [therapy - TH] 568

#10 ((acute* or severe*or refract*) next (heart* or cardiac* or myocard* or cardio* or ventric*) next (failur* or decompensation* or insufficient* or dysfunct* or stand* or still* or fault* or shock* or arrest* or stunn*)) 2872

#11 (cardiogen* next shock) 1767

#12 Myocardit* 1473

#13 ((Postpartum* or post-partum* or peripartum* or peri-partum*) next cardiomyopath*) 50

#14 (postcardiotomy or Post-cardiotomy) 48

#15 PPCM 41

#16 (myocard* next (stun* or hibernat* or infarct*)) 39538

#17 MeSH descriptor: [Primary Graft Dysfunction] this term only and with qualifier(s): [therapy - TH] 3

#18 (primary* next graft* next dysfunct*) 150

#19 #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 or #17 or #18 44787

#20 MeSH descriptor: [Cardiopulmonary Resuscitation] this term only and with qualifier(s): [methods - MT] 761

#21 MeSH descriptor: [Extracorporeal Membrane Oxygenation] this term only and with qualifier(s): [methods - MT] 103

#22 ECMO 1170

#23 MeSH descriptor: [Extracorporeal Circulation] this term only and with qualifier(s): [methods - MT] 123

#24 (extracorp* next circulat*) 1423

#25 (extracorp* next ((cardiopulmon* next resuscitat*) or CPR)) 80

#26 ECPR 127

#27 (Biomedicus next pump*) 2

#28 (Maquet* next rotaflow*) 2

#29 (jostra next (pump* or rotaflow*)) 0

#30 (levitronix next (centrimag* or pump* or system* or oxygen*)) 0

#31 (Medos next (Hilite* or oxygen*)) 0

#32 (left next ventricle next assist next device) 1

#33 #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 3455

#34 #19 AND #33 with Cochrane Library publication date Between Sep 2013 and Jun 2025, in Cochrane Reviews 30

#35 conference:pt or (clinicaltrials or trialsearch or clinicaltrials.gov or www.who.int) 861611

#36 #34 not #35 0

Cochrane Central (CDSR) search strategy

#1 MeSH descriptor: [Heart Failure] this term only and with qualifier(s): [therapy - TH] 2567

#2 MeSH descriptor: [Acute Disease] this term only and with qualifier(s): [therapy - TH] 115

#3 #1 and #2 0

#4 MeSH descriptor: [Cardiomyopathies] this term only and with qualifier(s): [therapy - TH] 86

#5 MeSH descriptor: [Shock, Cardiogenic] this term only and with qualifier(s): [therapy - TH] 194

#6 MeSH descriptor: [Myocardial Stunning] this term only and with qualifier(s): [therapy - TH] 3

#7 MeSH descriptor: [Myocarditis] this term only and with qualifier(s): [therapy - TH] 13

#8 MeSH descriptor: [Myocardial Infarction] this term only and with qualifier(s): [therapy - TH] 2729

#9 MeSH descriptor: [Out-of-Hospital Cardiac Arrest] this term only and with qualifier(s): [therapy - TH] 568

#10 ((acute* or severe*or refract*) next (heart* or cardiac* or myocard* or cardio* or ventric*) next (failur* or decompensation* or insufficient* or dysfunct* or stand* or still* or fault* or shock* or arrest* or stunn*)) 2872

#11 (cardiogen* next shock) 1767

#12 Myocardit* 1473

#13 ((Postpartum* or post-partum* or peripartum* or peri-partum*) next cardiomyopath*) 50

#14 (postcardiotomy or Post-cardiotomy) 48

#15 PPCM 41

#16 (myocard* next (stun* or hibernat* or infarct*)) 39538

#17 MeSH descriptor: [Primary Graft Dysfunction] this term only and with qualifier(s): [therapy - TH] 3

#18 (primary* next graft* next dysfunct*) 150

#19 #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 or #17 or #18 44787

#20 MeSH descriptor: [Cardiopulmonary Resuscitation] this term only and with qualifier(s): [methods - MT] 761

#21 MeSH descriptor: [Extracorporeal Membrane Oxygenation] this term only and with qualifier(s): [methods - MT] 103

#22 ECMO 1170 #23 MeSH descriptor: [Extracorporeal Circulation] this term only and with qualifier(s): [methods - MT] 123

#24 (extracorp* next circulat*) 1423

#25 (extracorp* next ((cardiopulmon* next resuscitat*) or CPR)) 80

#26 ECPR 127

#27 (Biomedicus next pump*) 2

#28 (Maquet* next rotaflow*) 2

#29 (jostra next (pump* or rotaflow*)) 0

#30 (levitronix next (centrimag* or pump* or system* or oxygen*)) 0

#31 (Medos next (Hilite* or oxygen*)) 0

#32 (left next ventricle next assist next device) 1

#33 #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 3455

#34 #19 AND #33 with Cochrane Library publication date Between Sep 2013 and Jun 2025, in Trials 499

#35 conference:pt or (clinicaltrials or trialsearch or clinicaltrials.gov or www.who.int) 861611 #36 #34 not #35 295

INHTA HTA Database search strategy

1 , "Heart Failure"[mh] , 271

2 , "Acute Disease"[mh] , 44

3 , #2 AND #1 , 2

4 , "Cardiomyopathies"[mh] , 25

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

6 , "Myocardial Stunning"[mh] , 1

7 , "Myocarditis"[mh] , 2

8 , "Myocardial Infarction"[mh] , 122

9 , "Out-of-Hospital Cardiac Arrest"[mh] , 11

10 , ((acute* or severe* or refract*) 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* or arrest* or stunn*) , 268

11 , (cardiogen* AND shock) , 19

12 , Myocardit* , 5

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

14 , (postcardiotomy or Post-cardiotomy) , 0

15 , PPCM , 0

16 , (myocard* AND (stun* or hibernat* or infarct*)) , 236

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

18 , (primary* AND graft* AND dysfunct*) , 3

19 , #18 OR #17 OR #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 , 523

20 , "Cardiopulmonary Resuscitation"[mh] , 23

21 , "Extracorporeal Membrane Oxygenation"[mh] , 28

22 , ECMO , 30

23 , "Extracorporeal Circulation"[mh] , 8

24 , (extracorp* AND circulat*) , 13

25 , (extracorp* AND ((cardiopulmon* AND resuscitat*) or CPR)): , 8

26 , ECPR , 4

27 , (Biomedicus AND pump*) , 0

28 , (Maquet* AND rotaflow*) , 0

29 , (jostra AND (pump* or rotaflow*)) , 0

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

31 , (Medos AND (Hilite* or oxygen*)) , 0

32 , (Left AND ventricle AND assist AND device) , 3

33 , #32 OR #31 OR #30 OR #29 OR #28 OR #27 OR #26 OR #25 OR #24 OR #23 OR #22 OR #21 OR #20 , 72

34 , #33 AND #19 , 29

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.
- Population: adults with acute heart failure.
- 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 in Appendix B: Other relevant studies.

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.

For the original search results identified between March 2013 to September 2024, case studies and observational studies with fewer than 100 people were excluded unless they included outcomes that were not frequently reported.

For the updated search results identified between September 2024 to June 2025, case studies and observational studies with fewer than 250 people were excluded unless they included outcomes that were not frequently reported. Systematic reviews published before 2022 were also excluded.

Table 5 additional studies identified

Study	Number of people and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Ali S, Kumar M, Badu I et al. (2024) Trends and outcomes of different mechanical circulatory support modalities for acute myocardial infarction associated cardiogenic shock in patients undergoing early revascularization. American Heart Journal Plus: Cardiology Research and Practice 46: 100468	Retrospective registry (US Nationwide Readmission Database) n=20,950 hospitalisations (1,322 ECMO)	On propensity-matched cohorts (n=742), the ECMO cohort had higher adverse events than the Impella cohort, including mortality (52% versus 42%), sudden cardiac arrest (41% versus 32%), acute stroke (9% versus 5%) and major bleeding (16% versus 12%), p<0.05.	Retrospective study that focuses on people who had percutaneous coronary intervention.

Ali S, Kumar M, Khlidj Y et al. (2025) Trends and outcomes of different mechanical circulatory support modalities for refractory cardiogenic shock in Takotsubo cardiomyopathy. American Heart Journal Plus: Cardiology Research and Practice 54: 100545	Retrospective registry (US Nationwide Readmission Database) n=2,025 hospitalisations (235 ECMO)	On propensity score matched cohorts (n=131), ECMO had higher in-hospital mortality (39% versus 21%, p<0.001), major bleeding (15% versus 2%, p<0.001), and acute blood loss anaemia (49% versus 19%, p<0.001). The subgroup analysis comparing ECMO when left ventricular unloading was provided by either IABP or Impella, and Impella alone showed no difference in the short-term mortality (42% versus 33%, p=0.384). However, the rates of major bleeding (18% versus 0%, p=0.003) and acute blood loss anaemia (56% versus 22%, p=0.001) were higher for ECMO cohort.	Retrospective study that focuses on people with cardiogenic shock associated with Takotsubo cardiomyopathy.
Alnahhal KI, Majumdar M, Irshad A et al. (2024) Peripheral artery disease and extracorporeal membrane oxygenation: Examining a high-risk cohort over time. Vascular 32: 867-873	Retrospective registry (US National Inpatient Sample) n=6,768	Of the 6,768 people who had VA ECMO, 342 (5%) had peripheral arterial disease (PAD). Patients with PAD were sicker at baseline and experienced more major amputations and higher in-hospital mortality. They have not benefitted from the considerable decrease in complication rates and increase in survival to discharge over time as compared to people without PAD. The findings demonstrate the substantial frailty of the PAD population within an already high-risk cohort	Retrospective study that focuses on people with peripheral arterial disease.

		and highlight the need for better procedural approaches and innovative technologies.	
Araki T, Kondo T, Imaizumi T et al. (2023) Relationship between the volume of cases and in-hospital mortality in patients with cardiogenic shock receiving short-term mechanical circulatory support. American Heart Journal 261: 109-123	Retrospective observational study (JROAD-DPC database, Japan) n=65,837	Higher volumes of IABP and ECMO are associated with a lower mortality. There is an upper limit to the decline.	Retrospective study focusing on relationship between volume of cases and mortality.
Aso S, Matsui H, Fushimi K et al. (2016) In-hospital mortality and successful weaning from venoarterial extracorporeal membrane oxygenation: analysis of 5,263 patients using a national inpatient database in Japan. Critical Care 20: 80	Retrospective observational study (Japanese Diagnosis Procedure Combination database) n=5,263	Most people had cardiogenic shock (88%). In-hospital mortality was about 65% for all underlying diseases, and the rate of weaning from VA ECMO was 64%. Mortality during VA ECMO was 35%, the overall rate of discharge was about 30%, and in-hospital mortality after weaning from VA ECMO was 38%. In the multivariable logistic regression including multiple imputation, higher age and greater or smaller body mass index were significantly associated with in-hospital mortality, whereas hospital volume was not associated with such mortality.	Retrospective study with limited reporting of outcomes.
Attachaipanich T, Attachaipanich S, Kaewboot, K (2025) Timing of	Systematic review and meta-analysis	Early mechanical circulatory support insertion before percutaneous coronary	More comprehensive systematic reviews are

mechanical circulatory support in acute myocardial infarction complicated by cardiogenic shock: A systematic review and meta-analysis. American Heart Journal Plus: Cardiology Research and Practice 50: 100506	n=6,218 (36 studies)	intervention is potentially associated with reduced in-hospital, 30-day, and 6-month mortality compared to insertion after percutaneous coronary intervention in people with AMI related cardiogenic shock.	included.
Bailey KL, Downey P, Sanaiha Y et al. (2018) National trends in volume-outcome relationships for extracorporeal membrane oxygenation. The Journal of Surgical Research 231: 421-427	Retrospective registry (US National Inpatient Sample) n=18,684	Unadjusted mortality at low-volume hospitals was less than that of medium (44% versus 50%, p=0.03) and high-volume hospitals (44% versus 56%, p<0.001).	Retrospective study focusing on relationship between volume of cases and mortality.
Batchelor RJ, Wheelahan A, Zheng WC et al. (2022) Impella versus Venoarterial Extracorporeal Membrane Oxygenation for Acute Myocardial Infarction Cardiogenic Shock: A Systematic Review and Meta-Analysis. Journal of Clinical Medicine 11: 3955	Systematic review and meta-analysis n=7,093 (6 studies)	There was no high-level evidence comparing VA ECMO and Impella in AMI-CS. In available observational studies, mechanical circulatory support with Impella was associated with a reduced risk of in-hospital and medium-term mortality as compared to VA ECMO.	More recent systematic reviews are included.
Baudry G, Girerd N, Duarte, K et al (2025) Sex-Related Prognosis of VA-ECMO-Treated Cardiogenic Shock:	Post-hoc analysis of the HYPO-ECMO trial n=334	Males and females had similar outcomes in CS treated with VA ECMO. Sex did not statistically significantly modify the effect of moderate	Post-hoc analysis of trial that focused on the effect of hypothermia on cardiogenic

A Post-Hoc Analysis of the HYPO-ECMO Trial. Circulation: Heart failure		hypothermia on outcomes.	shock.
Becher PM, Gosling A, Schrage B et al. (2020) Procedural volume and outcomes in patients undergoing VA-ECMO support. Critical Care 24: 291	Retrospective national registry (Germany) n=10,207	30-day in-hospital mortality and likelihood for complications were higher at hospitals with the lowest annual VA ECMO volume.	Retrospective study focusing on relationship between volume of cases and mortality.
Beckmeyer HW, Feld J, Koppe J et al. (2025) Sex-specific outcomes in acute myocardial infarction-associated cardiogenic shock treated with and without V-A ECMO: a retrospective German nationwide analysis from 2014 to 2018. Heart and Vessels 40: 559-569	Retrospective national registry (Germany) n=10,023 (477 VA ECMO)	Women with AMICS presented with a different risk profile, especially a higher age, and had guideline-recommended therapies such as revascularisation less often than men. Female sex, however, was not associated with lower survival in a multivariate analysis. In-hospital mortality was high, regardless of treatment, and V-A ECMO was associated with lower survival in follow-up.	Retrospective study focusing on effect of sex on outcomes for AMICS.
Benenati S, Toma M, Canale C et al. (2022) Mechanical circulatory support in patients with cardiogenic shock not secondary to cardiotomy: a network meta-analysis. Heart Failure Reviews 27: 927-934	Network meta-analysis n=11,117 (24 studies; 4 included ECMO)	Compared with no mechanical circulatory support, ECMO reduced 30-day mortality when used both alone (OR 0.37, 95% CrI 0.15 to 0.90) and together with the micro-axial pump Impella (OR 0.13, 95% CrI 0.02 to 0.80) or intra-aortic balloon pump (OR 0.19, 95% CrI 0.05 to 0.63), although the relevant articles were affected by significant publication bias.	More recent meta-analyses are included.

Boey JJE, Dhundi U, Ling RR et al. (2024) Extracorporeal Membrane Oxygenation for Pulmonary Embolism: A Systematic Review and Meta-Analysis. Journal of Clinical Medicine 13: 64	Systematic review and meta-analysis n=6,409 (39 studies)	More than 50% of people who had ECMO for high-risk pulmonary embolism survived. While outcomes may vary based on the curative therapy used, early ECMO should be considered as a stabilising measure. People who had concurrent systemic thrombolysis had higher mortality than those who had ECMO alone or other therapies, particularly catheter-directed therapies.	Review focuses on people who had pulmonary embolism.
Briasoulis A, Kampaktsis P, Emfietzoglou M et al. (2023) Temporary Mechanical Circulatory Support in Cardiogenic Shock due to ST-Elevation Myocardial Infarction: Analysis of the National Readmissions Database. Angiology 74: 31-38	Retrospective registry (US Nationwide Readmissions Database) n=80,997 (753 ECMO alone)	30-day readmission rates did not differ among groups, whereas 90-day readmissions were higher among those with combined ECMO and IABP or Impella support (p=0.027). In-hospital mortality and complications including haemodialysis, transfusion, and stroke were the highest in the Impella and combined ECMO and IABP or Impella groups.	The number of people who had ECMO alone was relatively small.
Briglio SE, Khanduja V, Lothan JD et al. (2024) Fulminant myocarditis and venoarterial extracorporeal membrane oxygenation: a systematic review. Cureus *16*(2) : e54711	Systematic review n=425 11 studies	Regarding short-term outcomes, one-year post-hospital survival rate ranged from 57.1% to 78% at discharge. For long-term health and survival, studies that recorded long-term survival ranged from 65% to 94.1%.	No meta-analysis.
Burgos LM, Seoane	Systematic	Pooled VA ECMO	Larger, more

L, Diez M et al. (2023) Multiparameters associated to successful weaning from VA ECMO in adult patients with cardiogenic shock or cardiac arrest: Systematic review and meta-analysis. Annals of cardiac anaesthesia 26(1): 4-11	review and meta-analysis n=653 11 studies Follow-up: weaning, hospital discharge	successful weaning [patient survives 48 hours after ECMO explantation] was 45% (95% CI: 39 to 50%, I^2 7%) and in-hospital mortality rate was 46.6% (95% CI: 33 to 60%; I^2 36%).	comprehensive systematic literature reviews and meta-analysis included. 5/11 studies in this SLR were included within the SLRs in the key evidence.
Burrell A, Kim J, Alliegro P et al. (2023) Extracorporeal membrane oxygenation for critically ill adults. Cochrane Database of Systematic Reviews Issue 9. Art. No.: CD010381. DOI: 10.1002/14651858.CD010381.pub3. Accessed 01 July 2025	Systematic review and meta-analysis n=757 (5 studies, 3 on VA ECMO)	ECMO was associated with a statistically significant reduction in day-90 to 1-year all-cause mortality, as well as 3 times increased risk of bleeding. However, the certainty of this result was only low to moderate, limited by a low number of small trials, clinical heterogeneity, and indirectness across studies.	Only 3 studies were included on VA ECMO.
Byun E, Kang PJ, Jung SH et al. (2024) Impact of extracorporeal membrane oxygenation-related complications on in-hospital mortality. PloS one 19: e0300713	Retrospective single-centre study n=769	The incidences of ECMO-related vascular and cerebrovascular complications were 20% and 14%, respectively. The overall in-hospital mortality was 49%: 53% among VA ECMO runs and 29% among VV ECMO runs. Multivariable analysis indicated that age ($p<0.01$), cardiopulmonary cerebral resuscitation ($p<0.01$), continuous renal replacement	Studies with more people or longer follow up are included.

		therapy (p<0.01), and initial platelet count (p<0.01) were associated with an increased risk of in-hospital death. ECMO-related vascular and cerebrovascular complications were not independently associated with higher in-hospital mortality.	
Carroll BJ, Shah RV, Murthy V et al. (2015) Clinical features and outcomes in adults with cardiogenic shock supported by extracorporeal membrane oxygenation. The American journal of cardiology 116(10): 1624-30	Single centre retrospective study, US n=123 (26 postcardiotomy [21%]) Follow-up: In-hospital	Overall, 69 people (56%) were weaned from ECMO, with 48 patients (39%) surviving to discharge.	More recent studies included.
Chatzis G, Patsalis N, Markus B; et al. (2023) Comparison of mechanical circulatory support with venoarterial extracorporeal membrane oxygenation or Impella for patients with cardiogenic shock: a propensity-matched analysis. European Heart Journal 44	Retrospective single-centre study n=423 (123 VA ECMO)	Treatment with Impella 2.5 or CP or VA ECMO was associated with similar hospital and 6-month survival rates. Device-related access site vascular complications occurred more frequently in the VA ECMO group.	Studies with more people or longer follow up are included.
Cheng R, Hachamovitch R, Kittleson M et al. (2014) Clinical outcomes in fulminant myocarditis requiring	Systematic review and meta-analysis n=170 6 studies	The pooled estimate rate of survival to hospital discharge was 66.9% (95% CI 59.4% to 73.7%). More than two-thirds of patients with FM and	More recent systematic reviews and meta-analyses included. 4/6 studies in this SLR were

extracorporeal membrane oxygenation: a weighted meta-analysis of 170 patients. Journal of cardiac failure 20(6): 400-6		either cardiogenic shock and/or cardiac arrest survive to hospital discharge with ECMO.	included within the SLRs in the key evidence.
Cheng R, Hachamovitch R, Kittleson M et al. (2014) Complications of extracorporeal membrane oxygenation for treatment of cardiogenic shock and cardiac arrest: A meta-analysis of 1,866 adult patients. Annals of Thoracic Surgery 97(2): 610-616	Systematic review and meta-analysis n=1,866 20 studies Follow-up: Hospital discharge	Seventeen studies reported survival to hospital discharge, range: 20.8% to 65.4%.	More recent systematic reviews and meta-analyses included. 7/20 studies in this SLR were included within the SLRs in the key evidence.
Chouairi F, Vallabhajosyula S, Mullan C et al. (2020) Transition to Advanced Therapies in Elderly Patients Supported by Extracorporeal Membrane Oxygenation Therapy. Journal of Cardiac Failure 26: 1086-1089	Retrospective registry (US National Inpatient Sample) n=16,132	Survival of people aged 65 years and over needing ECMO for cardiogenic shock is poor and less commonly includes transition to definitive advanced therapies.	Retrospective study focusing on transition to advanced treatments in older people.
Danial P, Olivier M-E, Brechot N et al. (2023) Association between shock etiology and 5-year outcomes after venoarterial extracorporeal membrane	Single centre retrospective study, US n=1,253 Follow-up: in-hospital, 5 years	In-hospital and 5-year survival rates were, respectively, 73.3% and 57.3% for primary graft failure, 58.6% and 54.0% for drug overdose, 53.2% and 45.3% for dilated cardiomyopathy, 51.6% and 50.0% for	Larger, more comprehensive systematic literature reviews and meta-analysis included.

oxygenation. Journal of the American College of Cardiology 81(9): 897-909		arrhythmic storm, 46.8% and 38.3% for massive pulmonary embolism, 44.4% and 42.4% for sepsis-induced cardiogenic shock, 37.9% and 32.9% for fulminant myocarditis, 37.3% and 31.5% for acute myocardial infarction, 34.6% and 33.3% for postcardiotomy excluding primary graft failure, 25.7% and 22.8% for other/unknown aetiology, and 11.1% and 0.0% for refractory vasoplegia shock.	
Dangers L, Brechot N, Schmidt M et al. (2017) Extracorporeal membrane oxygenation for acute decompensated heart failure. Critical Care Medicine 45(8): 1359-1366	Single centre retrospective study, France n=105 Follow-up: 1 year	Survival at 1 year was 42%, with 44% of the cohort receiving heart transplantation. Survival was considerably lower (17%) in people with a high pre-ECMO SOFA score (14 or over), than those with SOFA score less than 7 (52%).	More recent studies from broader regions included.
Dardik G, Ning Y, Kurlansky P et al. (2024) Long-term outcomes of patients bridged to recovery with venoarterial extracorporeal life support. Perfusion 39: 1629-1635	Retrospective single centre study n=158 Follow-up: median 2 years	Kaplan-Meier analysis showed a 1-year survival rate of 86% (95% CI 80 to 91) and a 5-year survival rate of 61% (95% CI 50 to 71). A Cox regression model demonstrated that a history of congestive heart failure was strongly predictive of increased mortality hazard (HR=1.929; p=0.036)	The population size is below the cut-off of 250, but it has been included here because it reports longer term mortality after VA ECMO.
Dettling A, Kellner C, Sundermeyer J et al. (2025) Incidence and predictors of	Retrospective multicentre observational study	Most people (n=410, 60%) were successfully weaned. Among those	Studies with more people or longer follow up are

weaning failure from veno-arterial extracorporeal membrane oxygenation therapy in patients with cardiogenic shock. European Journal of Heart Failure 27: 832-841	n=685	successfully weaned, 150 people (37%) died before hospital discharge. The mortality rate of the overall cohort was 64%, with 248 people (36%) surviving to hospital discharge following liberation from VA ECMO. Prior cardiac arrest and persistent malperfusion were strong drivers of weaning failure whilst in-hospital mortality after successful weaning was largely dependent on the occurrence of complications and extracardiac organ failure.	included.
Dib N, Belaroussi Y, Mansour A et al. (2023) Association of Arterial Blood pH at Cannulation With 1 Year Survival Among Veno-Arterial Extracorporeal Membrane Oxygenation Recipients: The Three Seven Rule. ASAIO Journal 69: e287-e292	Retrospective single-centre observational study n=572 Follow-up: 1 year	pH below 7 and lactate above 7 was associated with less than 7% survival. VA ECMO should be considered with caution in patients with pH below 7.	Retrospective study focusing on the effect of arterial blood pH.
Feistritzer HJ, Zeymer U, Ouarrak T et al. (2025) Different Mechanical Circulatory Support Strategies for Infarct-Related Cardiogenic Shock: a Subanalysis of the ECLS-SHOCK Trial. JACC. Cardiovascular	Randomised controlled trial (ECLS-SHOCK) n=246	Bailout and escalated mechanical circulatory support therapy is associated with numerically higher 30-day mortality compared with upfront ECLS use only. Bailout mechanical circulatory support use is also associated with higher need for renal replacement therapy.	Subanalysis of study already included in table 2 (Thiele 2023).

Interventions 18: 691–701			
Fernando SM, MacLaren G, Barbaro RP et al. (2023) Age and associated outcomes among patients receiving venoarterial extracorporeal membrane oxygenation-analysis of the Extracorporeal Life Support Organization registry. Intensive Care Medicine 49: 1456-1466	Multicentre registry data (ELSO registry) n=15,172	Among people having VA ECMO for cardiogenic shock, increasing age is strongly associated with increasing odds of death and complications, and this association emerges as early as 40 years old.	Registry studies with more relevant outcomes are included.
Flecher E, Anselmi A, Corbineau H et al. (2014) Current aspects of extracorporeal membrane oxygenation in a tertiary referral centre: determinants of survival at follow-up. European Journal of Cardio-thoracic Surgery: official journal of the European Association for Cardio-thoracic Surgery 46(4): 665-671	Single centre retrospective study, France n=325 (postcardiotomy 29%) Follow-up: mean 84 days (SD: 86)	Overall in the VA group, weaning rates were 59%, survival at 30th post implantation day was 44% and survival at the end of the follow-up was 41%.	More recent studies with outcomes split by aetiologies were included.
Frye J, Tao M, Gupta S et al. (2025) Safety and utility of mechanical circulatory support in patients with acute myocardial infarction complicated by	Systematic review and meta-analysis 24 studies (8 ECMO) n=2,752	Use of ECMO was not associated with lower risk of 30-day or long-term mortality compared to percutaneous ventricular assist devices or standard medical therapy with or without	Review included 8 studies on ECMO, 3 of which were RCTs included in the study by Elsaeidy

cardiogenic shock: A systematic review and meta-analysis. Cardiovascular Revascularization Medicine 70: 23–33		intra-aortic balloon counter-pulsation placement but was associated with higher risk of device-related limb complications and moderate to severe bleeding compared to percutaneous ventricular assist devices.	(2024).
Hernandez-Montfort JA, Xie R, Ton VK et al. (2020) Longitudinal impact of temporary mechanical circulatory support on durable ventricular assist device outcomes: An IMACS registry propensity matched analysis. The Journal of Heart and Lung Transplantation: the official publication of the International Society for Heart Transplantation 39(2): 145-156	Retrospective INTERMACS registry study. n=13,813 Follow-up: 48 months	INTERMACS Profile 1 to 3 patients with pre-implant ECMO had 82% survival at 1 month and 44% at 48 months. 22% people requiring ECMO needed biventricular support after dVAD.	Registry studies with more relevant outcomes were included.
Hobohm L, Sagoschen I, Habertheuer A et al. (2022) Clinical use and outcome of extracorporeal membrane oxygenation in patients with pulmonary embolism. Resuscitation 170: 285-292	Retrospective observational study (nationwide German inpatient sample) n=2,197	The findings suggest that the use of VA ECMO alone or as part of a multi-pronged reperfusion approach including embolectomy or thrombolysis might offer survival advantages compared to thrombolysis alone in people with PE deteriorating to cardiac arrest.	Registry studies with more relevant outcomes are included.
Lackermair K, Brunner S, Orban M et al. (2021)	Randomised controlled trial n=42	12-month all-cause mortality was numerically lower, and favourable	Pilot study, superseded by Thiele, 2023

Outcome of patients treated with extracorporeal life support in cardiogenic shock complicating acute myocardial infarction: 1-year result from the ECLS-Shock study. Clinical Research in Cardiology: official journal of the German Cardiac Society 110(9): 1412-1420	Follow-up: 12 months	neurological outcome numerically higher in the ECLS arm compared to the no ECLS arm.	ECLS-SHOCK study
Jentzer JC, Baran DA, Kyle Bohman J et al. (2022) Cardiogenic shock severity and mortality in patients receiving venoarterial extracorporeal membrane oxygenator support. European Heart Journal. Acute Cardiovascular Care 11: 891-903	Multicentre registry data (ELSO registry) n=12,106	A higher Society for Cardiovascular Angiography and Intervention (SCAI) shock stage was associated with increased in-hospital mortality in key subgroups, although the SCAI shock classification was only predictive of mortality in non-surgical (medical) CS and not in post-cardiotomy CS.	Registry studies with more relevant outcomes are included.
Jentzer JC, Drakos SG, Selzman CH et al. (2024) Timing of Initiation of Extracorporeal Membrane Oxygenation Support and Outcomes Among Patients With Cardiogenic Shock. Journal of the American Heart Association 13: e032288	Multicentre registry data (ELSO registry) n=8,619	Longer delays from admission to ECMO initiation were associated with higher mortality. The analysis supports optimisation of door-to-support time and the avoidance of inappropriately delayed ECMO initiation.	Registry studies with more relevant outcomes are included.

Jeong JH, Kook H, Lee SH et al. (2023) Predictors of in-hospital mortality after successful weaning of venoarterial extracorporeal membrane oxygenation in cardiogenic shock. Scientific Reports 13: 17529	Multicentre registry data (RESCUE registry, South Korea) n=485	262 out of 485 people were successfully weaned from ECMO. In-hospital mortality was 18% (n=48). Five independent predictors for in-hospital mortality were identified: use of continuous renal replacement therapy (OR 5.4, 95% CI 2.5 to 11.9, p<0.001), use of intra-aortic balloon pump (OR 3.2, 95% CI 1.1 to 9.3, p=0.032), diabetes mellitus (OR 3.2, 95% CI 1.4 to 7.0, p=0.005), age (OR 1.0, 95% CI 1.0 to 1.1, p=0.003), and left ventricular ejection fraction after ECMO insertion (OR 0.96, 95% CI 0.93 to 0.99, p=0.006).	Studies with more people or longer follow up are included.
Kalra A, Kang JK, Wilcox C et al. (2025) Pulse Pressure and Acute Brain Injury in Venoarterial Extracorporeal Membrane Oxygenation: An Extracorporeal Life Support Organization Registry Analysis. ASAIO Journal 71: 99-108	Multicentre registry data (ELSO registry) n=9,807	Early low pulse pressure (10 mmHg or lower) at 24 hours of ECMO support was associated with acute brain injury, particularly central nervous system ischaemia, in people who had peripheral VA ECMO.	Registry studies with more relevant outcomes are included.
Kim O, Hong D, Choi KH et al. (2025) Sex Differences in Patients With Cardiogenic Shock Receiving Venoarterial Extracorporeal	Multicentre registry data n=1,328	No statistically significant sex difference was found in in-hospital mortality. However, procedure-related complications showed differences between males and females, and female sex was identified as an	Retrospective study focusing on effect of sex on outcomes.

Membrane Oxygenation. Korean Circulation Journal 55: 541-551		independent risk factor for ECMO-related complications.	
Kowalewski M, Zielinski K, Maria Raffa G et al. (2021) Mortality Predictors in Elderly Patients With Cardiogenic Shock on Venoarterial Extracorporeal Life Support. Analysis From the Extracorporeal Life Support Organization Registry. Critical Care Medicine 49: 7-18	Multicentre registry data (ELSO registry) n=2,644 people aged 70 and over	Weaning from ECMO was possible in 1,236 people (47%). Overall, in-hospital mortality was estimated at 68% with highest crude mortality rates observed in the 75- to 79-year-old subgroup (70%). Complications were mostly cardiovascular and bleeding, without apparent differences between subgroups. Airway pressures, 24-hour pH after ECMO start, ECMO duration, and renal replacement therapy were predictive of higher mortality.	Registry studies with more relevant outcomes are included.
Kwon OJ, Aguayo E, Tabibian K et al. (2025) National Outcomes of Venoarterial Extracorporeal Life Support in Patients with Chronic Kidney Disease. Surgery Open Science 26: 87	Retrospective registry (US Nationwide Readmissions Database) n=15,432	Advanced chronic kidney disease is independently associated with increased mortality and perioperative complications in people who have VA ECMO, highlighting the association between preexisting renal dysfunction and adverse outcomes.	Registry studies with more relevant outcomes are included.
Lee JH, Choi N, Kim YJ et al. (2021) Use of extracorporeal life support for heart transplantation: Key factors to improve outcome. Journal of Clinical Medicine 10(12): 2542	Single centre retrospective study, Korea. n=257 (100 ECLS) Follow-up: 30 days and 12 months after HTx	The 30-day mortality rate was 3.9% (9.2% in peripheral ECLS, 2.9% in central ECLS, and 1.9% in non-ECLS). The use of ECLS was not an independent predictor of 30-day and 1-year mortality (p = 0.248 and p = 0.882, respectively).	Larger, more comprehensive systematic literature reviews and meta-analysis included.

Liu Y, Zeng M, Zhou Y et al. (2024) Effect of intra-aortic balloon pump with veno-arterial extracorporeal membrane oxygenation in acute myocardial infarction with cardiogenic shock: A meta-analysis. Perfusion 39: 1323–34	Study design: systematic review and meta-analysis n=4,687 (14 studies)	In-hospital and 30-days mortality were significantly lower in people with acute myocardial infarction related cardiogenic shock who had VA ECMO plus intra-aortic balloon pump versus VA ECMO alone or intra-aortic balloon pump alone. VA ECMO with concomitant intra-aortic balloon pump could increase the proportion of people weaned from VA ECMO, significantly reducing in-hospital mortality, without increasing complications.	Review focuses on the effect of concomitant use of an intra-aortic balloon pump.
Lorusso R, Gelsomino S, Parise O et al. (2017) Venoarterial extracorporeal membrane oxygenation for refractory cardiogenic shock in elderly patients: trends in application and outcome from the Extracorporeal Life Support Organization (ELSO) Registry. Annals of Thoracic Surgery 104(1): 62-69	Retrospective ELSO registry study. n=5,408 (735 with a mean age of 75 years) Follow-up: hospital discharge	Survival to hospital discharge for the entire adult cohort was 41.4%, with 30.5% (224/735) in the elderly patient group and 43.1% (2,016 of 4,673) in the younger patient group (p<0.001). Elderly patients had a higher rate of multiorgan failure. At multivariable analysis age represented an independent negative predictor of in-hospital survival.	Larger, more comprehensive registry studies were included.
Loungani RS, Fudim M, Ranney D et al. (2021) Contemporary use of venoarterial extracorporeal membrane oxygenation:	Retrospective RESCUE registry study. n=723 Follow-up: hospital discharge	40% of the cohort survived to discharge, Mortality for ECMO following heart transplant (42.4%) and cardiomyopathy (59.3%) was less than those receiving ECMO for	Larger, more comprehensive registry studies were included.

insights from the multicenter RESCUE registry. Journal of cardiac failure 27(3): 327-337		postcardiotomy CS (64%), AMI (60.7%).	
Loyaga-Rendon RY, Boeve T, Tallaj J et al. (2020). Extracorporeal membrane oxygenation as a bridge to durable mechanical circulatory support: an analysis of the STS-INTERMACS Database. Circulation. Heart failure, 13(3), e006387.	Retrospective INTERMACS registry study. n=19,824 Follow-up: 2 years	In adult patients who received a durable MCS who were supported with and without VA ECMO, ECMO patients had inferior survival at 12 months (66%) than non-ECMO patients (75%; p<0.0001).	Registry studies with more relevant outcomes were included.
Lu SY, Ortoleva J, Colon K et al. (2022) Association Between Body Mass Index and Outcomes in Venoarterial Extracorporeal Membrane Oxygenation. Anesthesia and Analgesia 134: 341-347	Retrospective single centre observational study n=355	62% of people survived to ECMO recovery or decannulation, 46% survived to 30 days after ECMO decannulation, and 39% survived to hospital discharge with no statistically significant differences among the BMI groups.	Studies with more people or longer follow up are included.
Malik MI, Fakim D, Drullinksy D et al. (2024) Indication for ECMO predicts time to first actionable bleeding complication. Indian Journal of Thoracic and Cardiovascular Surgery 40: 177-183	Retrospective single centre observational study n=255	108 (42%) people had at least 1 actionable bleeding complication. On multivariate regression, significant predictors for actionable bleeding complications included diabetes (OR 2.01, p=0.03), precannulation haematocrit (OR 0.97, p<0.001), length of support (OR 1.00, p<0.001), use of warfarin	Studies with more people or longer follow up are included.

		(OR 2.28, p=0.03), and post-cardiotomy indication for ECMO (OR 0.77, p=0.02).	
Marbach JA, Faugno AJ, Pacifici S et al. (2022) Strategies to reduce limb ischemia in peripheral venoarterial extracorporeal membrane oxygenation: A systematic review and Meta-analysis. International Journal of Cardiology 361: 77-84	Systematic review and meta-analysis 22 studies	Limb ischaemia was reduced in people who had a small arterial cannula (OR 0.40, 95% CI 0.24 to 0.65, p<0.001) and in those who had a prophylactic distal perfusion catheter (OR 0.31, 95% CI 0.21 to 0.47, p<0.001). Mortality was not statistically significantly reduced with either a small arterial cannula (OR 0.70, 95% CI 0.23 to 2.18, p=0.54) or prophylactic distal perfusion catheter strategy (OR 0.89, 95% CI 0.67 to 1.17, p=0.40).	More recent and more comprehensive systematic reviews are included.
Mastoris I, Tonna JE, Hu J et al. (2022) Use of extracorporeal membrane oxygenation as bridge to replacement therapies in cardiogenic shock: insights from the Extracorporeal Life Support Organization. Circulation. Heart failure 15(1): e008777	Retrospective ELSO registry study n=401 Follow-up: unclear	All-cause hospital mortality was 28.9% for people who received ECMO prior to Heart transplant or LVAD. In those receiving LVAD mortality was 28.7% and heart transplant mortality was 29.1%.	Larger, more comprehensive registry studies were included.
Morrow DA and van Diepen S (2022) The extracorporeal membrane oxygenation in the therapy of cardiogenic shock	Randomised controlled trial n=117 Follow-up: 30 days	There was no significant difference between the two arms for all-cause death at 30 days.	Summary of ECMO-CS trial reported fully in Ostadal, 2023

(ECMO-CS) trial in perspective. European Heart Journal. Acute cardiovascular care 11(12): 933-935			
Mou Z, Guan T, Chen L (2022) Risk Factors of Acute Kidney Injury in ECMO Patients: A Systematic Review and Meta-Analysis. Journal of Intensive Care Medicine 37: 267-277	Systematic review and meta-analysis 12 studies	Adults on ECMO who develop acute kidney injury and severe acute kidney injury incidents are usually older or have higher APACHE 2 scores; in addition, severe acute kidney injury is related to higher SOFA scores, diabetes mellitus, and longer duration of ECMO support.	More recent and more comprehensive systematic reviews are included.
Movahed MR, Soltani MA, Hashemzadeh M (2024) In patients with cardiogenic shock, extracorporeal membrane oxygenation is associated with very high all-cause inpatient mortality rate. Journal of Clinical Medicine 13(12): 3607	Retrospective study of US National Inpatient Sample database. n=13,160	Total inpatient mortality 47.9% with ECMO. In a multivariate analysis adjusting for 47 variables, ECMO utilisation remained highly associated with mortality (OR: 1.78, 95% CI: 1.6 to 1.9, p<0.001). Higher complications associated with the use of ECMO including bleeding, thromboembolic events, infections, and neurologic and vascular complications may contribute to higher mortality.	More comprehensive registry studies, which included CS aetiologies were included.
North M, Samara M, Eckman PM et al. (2022) Survivors of veno-arterial membrane oxygenation have good long-term quality of life. The International journal	Single centre retrospective study, US n=178 surveys (87% VA ECMO) Follow-up: 9 months	Minnesota Living with Heart Failure Questionnaire (MLWHFQ) total scores improved over time (51.7 at 3 months, versus 37.7 at 6 months, versus 25.4 at greater than 9 months; p<0.01)	Larger registry studies with more relevant outcomes are included.

of artificial organs 45(10): 826-832			
Nunez JI, Grandin EW, Reyes-Castro T et al. (2023) Outcomes with peripheral venoarterial extracorporeal membrane oxygenation for suspected acute myocarditis: 10-year experience from the Extracorporeal Life Support Organization Registry. Circulation: Heart Failure 16(7): e010152	Retrospective ELSO registry study n=850 Follow-up: Hospital discharge	During the study period, in-hospital mortality was 58.3% for all all-comers receiving VA ECMO compared with 34.9% for patients with myocarditis ($p<0.001$). 1.8% and 2.4% of patients were bridged to heart transplant or LVAD respectively.	More comprehensive registry studies, which included more CS aetiologies were included.
Nuqali A, Goyal A, Acharya P et al. (2022) Thirty-day readmissions among patients with cardiogenic shock who underwent extracorporeal membrane oxygenation support in the United States: Insights from the nationwide readmissions database. American Heart Journal Plus: Cardiology Research and Practice 13: 100076	Retrospective registry (US Nationwide Readmissions Database) n=4,229	Of the 4,229 people discharged alive, 694 (16%) were readmitted within 30 days. Sepsis was the most common readmission diagnosis followed by congestive heart failure.	Registry studies with more relevant outcomes are included.
Ohira S, Malekan R, Goldberg JB et al. (2021) Axillary artery cannulation for veno-arterial extracorporeal membrane oxygenation support	Retrospective single-centre cohort study n=371	Axillary artery cannulation for VA ECMO is a safe and effective alternative to femoral artery cannulation. It can be considered especially for patients with limited	Studies with more people or longer follow up are included.

in cardiogenic shock. JTCVS Techniques 5: 62		groin access, peripheral vascular disease, or for primary graft failure after heart transplant.	
Orbo MC, Karlsen SF, Pedersen EP et al. (2019) Health-related quality of life after extracorporeal membrane oxygenation: a single centre's experience. ESC heart failure 6(4): 701-710	Single centre retrospective study (Norway) n=74 (87% VA ECMO) Follow-up: Mean 6.5 years since ECMO	41% survival rate identified. 75% reported mental HRQoL (SF-36 Mental Component Summary, mean= 43, SD=5) or physical HRQL (SF-36 Physical Component Summary, mean=43, SD=4.5) within the normal range in comparison with age-matched population data from national norms. All but one person whose condition responded lived independently without any organised care, and 90% reported no problems related to basic self-care. Half of those in working age had returned to work after ECMO treatment. People whose condition responded reported some degree of restrictions in usual daily activities (40%), problems with mobility (35%), anxiety/ depression (35%), or pain/ discomfort (55%). Improved HRQoL was significantly related to an extended time since ECMO treatment.	Larger registry studies with more relevant outcomes are included.
Ouweneel DM, Schotborgh JV, Limpens J et al. (2016) Extracorporeal life support during cardiac arrest and	Systematic review and meta-analysis n=3,333 (CA=3,098, CS after AMI=235),13 studies	In cardiac arrest, the use of ECLS was associated with an increased survival rate as well as an increase in favourable neurological outcome. In the setting of cardiogenic	More recent systematic reviews and meta-analyses included.

cardiogenic shock: a systematic review and meta-analysis. Intensive care medicine 42(12): 1922-1934	Follow-up: 30 days	shock there was an increased survival with ECLS compared with IABP.	
Paddock S, Meng J, Johnson N, Chattopadhyay R et al. (2024) The impact of extracorporeal membrane oxygenation on mortality in patients with cardiogenic shock post-acute myocardial infarction: a systematic review and meta-analysis. European Heart Journal Open; 4(1)	Systematic review and meta-analysis n=1,622 11 studies Follow-up: 30 days, 12 months	Meta-analysis demonstrates no significant difference in 30-day all-cause mortality with VA ECMO compared with standard medical therapy (OR 0.91; 95% CI 0.65 to 1.27). Qualitative synthesis of the observational studies showed that age, serum creatinine, serum lactate, and successful revascularization are independent predictors of mortality.	Meta-analysis includes same RCTs as Elsaeidy et al. study included in key evidence but does not include safety data.
Pang S, Miao G, Zhao X (2022) Effects and safety of extracorporeal membrane oxygenation in the treatment of patients with ST-segment elevation myocardial infarction and cardiogenic shock: A systematic review and meta-analysis. Frontiers in Cardiovascular Medicine 9: 963002	Systematic review and meta-analysis n=1,162 (16 studies)	Pooled mortality estimate was 51%. Age, body mass index, lactate, anterior wall infarction, Thrombolysis in Myocardial Infarction-3 flow after percutaneous coronary intervention, CPR time, and time from arrest to ECPR significantly influence mortality in people with STEMI and CS needing VA ECMO.	More recent systematic reviews are included.
Parikh T, Armin S, Khan SA et al. (2025) Venoarterial extracorporeal membrane oxygenation is a feasible option for patients with	Retrospective registry (US National Inpatient Sample) n=2,010	Of 2,010 females needing VA ECMO, 255 (13%) had a pregnancy-associated diagnosis. Cardiogenic shock was more common among patients without a pregnancy-associated	Retrospective study using an administrative database, focusing on maternal outcomes. Only a few

pregnancy-associated diagnoses who require mechanical circulatory support. Resuscitation Plus 24: 100983		diagnosis. There was no difference in in-hospital mortality between the 2 groups (p=0.15). 70 (28%) females with pregnancy-associated diagnoses and 705 (40%) females without pregnancy-associated diagnoses (p=0.15) died during hospitalisation. Infectious complications (adjusted OR: 1.72, 95% CI 1.01 to 2.93, p=0.05) were positively associated with in-hospital mortality. Pregnancy-associated diagnoses were not associated with survival (OR: 0.51, 95% CI 0.21 to 1.25, p=0.14) in the entire cohort or in a subgroup of patients with COVID-19 (OR: 0.30, 95% CI 0.01 to 19.01, p=0.52.	possible VA ECMO indications were analysed, not including pregnancy-specific conditions such as amniotic fluid embolism and peripartum cardiomyopathy.
Rajsic S, Treml B, Jadzic D et al. (2022) Extracorporeal membrane oxygenation for cardiogenic shock: a meta-analysis of mortality and complications Annals of Intensive Care 12: 93	Systematic review and meta-analysis n=12,756 (32 studies)	62% (pooled estimate, 8,493 out of 12,756) of people died in the hospital. More than one-third died during ECMO support. The most frequent complications were renal failure (51%) with the need for renal replacement therapy (44%) and bleeding (49%), bearing the potential for permanent injury or death. Univariate meta-regression analyses identified age over 60 years, shorter ECMO duration and presence of infection as variables associated with in-	More recent systematic reviews are included.

		hospital mortality.	
Rodenas-Alesina E, Olivella A, Orchanian-Cheff A et al. (2025) Peripheral versus central cannulation of VA-ECMO for primary graft dysfunction after heart transplantation: A systematic review and meta-analysis. JHLT open 7: 100174	Systematic review and meta-analysis n=874 (16 studies)	Peripheral cannulation was associated with a nonsignificant reduction in short-term mortality (OR 0.73, 95% CI 0.41 to 1.28, I^2=56%) and a statistically significant reduction in 1-year mortality (OR 0.60, 95% CI 0.37 to 0.97, I^2=36%). Peripheral cannulation decreased the risk of bleeding but increased the risk of limb ischaemia and infection, with similar rates of stroke and need for renal replacement therapy. Overall, certainty of evidence was low.	Review focuses on association of cannulation site with mortality of VA ECMO for primary graft dysfunction after heart transplantation.
Sahli SD, Kaserer A, Braun J et al. (2022) Predictors associated with mortality of extracorporeal life support therapy for acute heart failure: single-center experience with 679 patients. Journal of Thoracic Disease 14(6): 1960-1971	Single centre retrospective study, Switzerland n=679 (postcardiotomy n=215) Follow-up: In-hospital	In-hospital mortality significantly varied between ECLS indications: 70.7% (152/215) for postcardiotomy, 67.9% (108/159) for cardiopulmonary resuscitation, 47.0% (110/234) for refractory cardiogenic shock, and 9.9% (7/71) for lung transplantation and expansive thoracic surgery (p<0.001).	Larger studies split by CS aetiology were included.
Salna M, Fried J, Kaku Y et al. (2021) Obesity is not a contraindication to veno-arterial extracorporeal life support. European Journal of Cardio-thoracic Surgery 60: 831-838	Retrospective single-centre cohort study n=431	Overall survival to discharge was 48% with no differences between the cohorts split by body mass index (p=0.92). Patients with body mass index 35 kg/m^2 or above had considerably lower survival (10%) in ECPR compared with the other groups (p=0.17). On	Retrospective study focusing on the effects of obesity on outcomes after VA ECMO.

		multivariable logistic regression, body mass index was not statistically significantly associated with failure to survive to discharge.	
Salna M, Takeda K, Kurlansky P et al. (2018) The influence of advanced age on venous-arterial extracorporeal membrane oxygenation outcomes. European Journal of Cardio-thoracic Surgery 53: 1151	Retrospective single-centre cohort study n=355	Multivariable logistic regression using preoperative risk factors identified coronary artery disease, acute decompensated heart failure and an age above 72 years as independent predictors of mortality (age above 72 years: OR 2.71, 95% CI 1.22 to 6.00, p=0.01).	Studies with more people or longer follow up are included.
Sassani K, Syntila S, Waechter C et al. (2025) Venoarterial Membrane Oxygenation in Cardiogenic Shock Complicated from an Acute Myocardial Infarction: An Overview and Comprehensive Meta-Analysis. Biomedicines 13 (no. 1)	Systematic review and meta-analysis n=4,706 (24 studies)	Mean mortality was 63% among all participants, with individual rates ranging from 33% to 92%. The mean overall ischaemia rate was 13%, with a range from 7% to 22%. The overall incidence of bleeding complications was 21%, ranging from 3% to 33%.	The primary objective was to provide a descriptive overview of the literature on acute coronary syndrome-related cardiogenic shock managed with VA ECMO.
Schmidt M, Burrell A, Roberts L et al. (2015) Predicting survival after ECMO for refractory cardiogenic shock: the survival after veno-arterial-ECMO (SAVE)-score. European heart journal, *36*(33), 2246–2256	Retrospective ELSO registry study n=3,846 Follow-up: Hospital discharge	1,601 (42%) patients were alive at hospital discharge. Chronic renal failure, longer duration of ventilation prior to ECMO initiation, pre-ECMO organ failures, pre-ECMO cardiac arrest, congenital heart disease, lower pulse pressure, and lower serum bicarbonate were risk factors associated with mortality.	More recent registry studies were included.

Schupp T, Thiele H, Rassaf T et al. (2025) C-reactive protein levels and outcomes in infarct-related cardiogenic shock: data from the ECLS-SHOCK trial. European Heart Journal. Acute Cardiovascular Care 14: 59–70	Randomised controlled trial (ECLS-SHOCK) n=371	Higher CRP levels were independently associated with the risk of 30-day all-cause mortality in AMI-CS. The use of ECLS did not reduce 30-day all-cause mortality, irrespective of CRP levels on admission. The additional inclusion of CRP to a validated CS risk score may further improve the prediction of short-term prognosis.	Subanalysis of study already included in table 2 (Thiele 2023).
Schupp T, Thiele H, Rassaf T et al. (2024) Prognostic Impact of Admission Time in Infarct-Related Cardiogenic Shock: an ECLS-SHOCK Substudy JACC. Cardiovascular Interventions 17: 2228–39	Randomised controlled trial (ECLS-SHOCK) n=417	ECLS had no prognostic impact on 30-day all-cause mortality in patients with AMI-CS admitted during on-hours or in patients admitted during off-hours. ECLS was associated with an increased risk of bleeding events, especially in patients admitted during on-hours.	Subanalysis of study already included in table 2 (Thiele 2023).
Seong S-W, Jin G, Kim M et al. (2021) Comparison of in-hospital outcomes of patients with versus without ischaemic cardiomyopathy undergoing veno-arterial-extracorporeal membrane oxygenation. ESC Heart Failure 8: 3308-3315	Multicentre registry data (RESCUE registry, South Korea) n=496	Results indicated that among people with cardiogenic shock who have VA ECMO, ischaemic aetiology does not seem to impact in-hospital mortality.	Studies with more people or longer follow up are included.
Stern J, Dupuis C, Kpeglo H et al. (2023) Upper gastrointestinal bleeding in adults	Retrospective single-centre cohort study n=455	48 (10%) people were diagnosed with upper gastrointestinal bleeding after a median of 12 days following ECMO	Studies with more people or longer follow up are included.

treated with veno-arterial extracorporeal membrane oxygenation: a cohort study. European Journal of Cardio-thoracic Surgery 63 (no. 4)		cannulation. Mortality occurred in 36 (75%) people with upper gastrointestinal bleeding and 243 (60%) people without. A history of gastric ulcer, dual antiplatelet therapy and ECPR were independently associated with an increased risk of upper gastrointestinal bleeding.	
Tigano S, Caruso A, Liotta C et al. (2024) Exposure to severe hyperoxemia worsens survival and neurological outcome in patients supported by veno-arterial extracorporeal membrane oxygenation: A meta-analysis. Resuscitation 194: 110071	Systematic review and meta-analysis n=15,651 (10 studies)	As compared to normal oxygenation levels, exposure to severe hyperoxemia was associated with higher mortality (9 studies; OR 1.80 95% CI 1.16 to 2.78; p=0.009; I^2=83%; low certainty of evidence) and worse neurological outcome (4 studies; OR 1.97, 95% CI 1.30 to 2.96; p=0.001; I^2=0%; low certainty of evidence).	Systematic reviews with more outcomes have been included.
Truby L, Mundy L, Kalesan B et al. (2015) Contemporary outcomes of venoarterial extracorporeal membrane oxygenation for refractory cardiogenic shock at a large tertiary care center. ASAIO journal (American Society for Artificial Internal Organs: 1992) 61(4): 403-9	Single centre retrospective study, US. n=179 (100 ECLS) Follow-up: 30 days and hospital discharge	Overall, 38.6% of patients survived to discharge and 44.7% of patients survived to 30 days. Myocardial recovery was achieved in 79.7% of survivors and 39.1% were transitioned to a more durable device.	Larger more recent registry studies were included.
Vadlakonda A, Curry J, Vela RJ et al.	Retrospective registry (US	33,643 (48%) people were treated at a high-	Registry studies with

(2024) Defining the Cross-Volume Effect of Extracorporeal Life Support on Outcomes of Cardiogenic Shock. The Annals of Thoracic Surgery 118: 1318-1326	Nationwide Readmissions Database) n=70,339	volume hospital for ECMO. High volume hospital was associated with decreased odds of in-hospital mortality (adjusted OR 0.85; 95% CI 0.75 to 0.95), respiratory complications (adjusted OR 0.86; 95% CI 0.79 to 0.94), and nonhome discharge (adjusted OR 0.86; 95% CI 0.79 to 0.94).	more relevant outcomes are included.
Vale JD, Kantor E, Papin G et al. (2025) Femoro-axillary versus femoro-femoral veno-arterial extracorporeal membrane oxygenation for refractory cardiogenic shock: A monocentric retrospective study. Perfusion 40: 858-868	Retrospective single-centre cohort study n=333	Compared to femoral artery cannulation, axillary cannulation was associated with similar 90-day mortality rates. Axillary artery cannulation was associated with fewer local infections (OR=0.21, 95% CI 0.09 to 0.51), limb ischaemia (OR=0.37, 95% CI 0.17 to 0.84), bowel ischaemia (OR 0.16, 95% CI 0.05 to 0.51) and pulmonary oedema (OR 0.52, 95% CI 0.29 to 0.92) episodes, but with a higher rate of stroke (OR 2.87, 95% CI 1.08 to 7.62) than femoral artery cannulation.	Studies with more people or longer follow up are included.
Vallabhajosyula S, Bell MR, Sandhu GS et al. (2020) Complications in patients with acute myocardial infarction supported with extracorporeal membrane oxygenation. Journal of Clinical Medicine 9: 839	Retrospective registry (US National Inpatient Sample) n=4,608	Over half of all acute myocardial infarction admissions having ECMO support develop 1 or more severe complications. Complications were associated with higher resource use during and after the index hospitalisation.	More recent studies are included.

Verma A, Hadaya J, Williamson C et al. (2023) A contemporary analysis of the volume-outcome relationship for extracorporeal membrane oxygenation in the United States. Surgery 173: 1405-1410	Retrospective registry (US Nationwide Readmissions Database) n=26,377	49% of people were managed at high-volume hospitals. After risk adjustment, high-volume hospital status was associated with reduced odds of in-hospital mortality, relative to low-volume hospitals (adjusted OR 0.81, 95% CI 0.78 to 0.97).	Registry studies with more relevant outcomes are included.
Wang AS, Nemeth S, Vinogradsky A et al. (2022) Disparities in the treatment of cardiogenic shock: does sex matter? European journal of cardio-thoracic surgery: official journal of the European Association for Cardio-thoracic Surgery 62(6)	Retrospective ELSO registry study n=9,888 (68% male) Follow-up: Hospital discharge	After propensity score matching, there was no difference in in-hospital mortality. Female patients were more likely to experience limb ischaemia, whereas males were more likely to receive renal replacement therapy and have longer hospital stays. Multivariable logistic regression confirmed sex was not independently associated with mortality.	Registry studies with more relevant outcomes are included.
Wang K, Wang L, Ma J et al. (2025) Age Differences in Venoarterial Extracorporeal Membrane Oxygenation for Cardiogenic Shock: Trends in Application and Outcome From the Chinese Extracorporeal Life Support Registry. ASAIO Journal 101097mat0000000000002404	Retrospective registry data (Chinese Extracorporeal Life Support Organization registry) n=5,127	The in-hospital mortality was lower in people aged 65 or less (45%) compared with those aged over 65 (53%, p<0.001). The younger group also had higher ECMO weaning rates (79% versus 75%, p<0.001) and 30 day survival (59% versus 51%, p<0.001). Bleeding, renal, and pulmonary complications were more frequent in younger people, though not statistically significant.	Registry studies with more relevant outcomes are included.

Wang L, Yang F, Zhang S et al. (2022) Percutaneous versus surgical cannulation for femoro-femoral VA-ECMO in patients with cardiogenic shock: Results from the Extracorporeal Life Support Organization Registry. The Journal of Heart and Lung Transplantation 41: 470-481	Multicentre registry data (ELSO registry) n=12,592	Among 12,592 people, 9,249 (73%) had percutaneous cannulation. The proportion of people having percutaneous cannulation increased from 32% to 84% over the study period (p<0.01 for trend). Compared with surgical cannulation, percutaneous cannulation was independently associated with lower in-hospital mortality and fewer complications.	More comprehensive registry studies are included.
Weiner L, Mazzeffi MA, Hines EQ et al. (2020) Clinical utility of venoarterial-extracorporeal membrane oxygenation (VA ECMO) in patients with drug-induced cardiogenic shock: a retrospective study of the Extracorporeal Life Support Organizations' ECMO case registry. Clinical toxicology (Philadelphia, Pa.) 58(7): 705-710	Retrospective ELSO registry study n=104 Follow-up: Hospital discharge	52.9% of the cases survived to discharge. VA ECMO significantly improved haemodynamics, acidaemia/ acidosis and ventilatory parameters. Non-survivors showed persistent acidaemia/ acidosis at 24 hours after VA ECMO cannulation compared to survivors. Renal replacement therapy (50.9%) and arrhythmia (26.3%) were the most frequently reported complications.	Larger, more comprehensive registry studies were included.
Wilson-Smith AR, Bogdanova Y, Roydhouse S et al. (2019) Outcomes of venoarterial extracorporeal membrane oxygenation for refractory cardiogenic shock: systematic review	Systematic review and meta-analysis n=17,515, 52 studies Follow-up: 5 years	Aggregated survival rates at 1, 2, 3, 4 and 5 years were 36.7%, 34.8%, 33.8%, 31.7% and 29.9%, respectively.	Larger, more recent SLRs for multi-aetiology CS included with more comprehensive outcomes.

and meta-analysis. Annals of cardiothoracic surgery, 8(1), 1–8.			
Yang C-T, Cheng Y-T, Chan Y-H et al. (2025) Impact of ejection fraction changes on long-term outcomes in VA-ECMO patients. Medicine (United States) 104: e42306	Retrospective multicentre cohort study n=899	The most common indication for VA ECMO was post-cardiotomy shock, and those who survived until discharge were more likely to have a post-cardiotomy shock as an indication (42% versus 32%). Ejection fraction percentile improvement from insertion to hospital discharge and a higher absolute ejection fraction value before discharge were associated with lower long-term mortality.	Retrospective study focusing on impact of ejection fraction on outcomes.
Yang C, Feng I, Kurlansky P et al. (2025) Outcomes of emergency medical service transport on venoarterial extracorporeal life support in cardiogenic shock. Perfusion https://doi.org/10.1177/02676591251331952	Retrospective cohort study n=547	94 people were transported from referring hospitals. In-hospital mortality was higher in those who were transported (60% versus 49%, p=0.042). The transport group had higher rates of acute kidney injury needing dialysis (28% versus 39%, p=0.035) and cerebrovascular accident (6% versus 13%, p=0.026). Kaplan-Meier curves showed 6-month survival was statistically significantly lower in the transport group (48% versus 37%, p=0.021). Multivariate analysis demonstrated ECMO indication of acute myocardial infarction (OR 1.43, p=0.037),	Retrospective study focusing on effect of transporting people on VA ECMO.

		ECPR (OR 2.45, p<0.001), and history of COPD (OR 1.55, p=0.014) were predictors of mortality within 12 months. Notably ECMO transport was not a statistically significant risk factor.	
Yang H, Luo L, Song Y et al. (2024) ECMO versus IABP for patients with STEMI complicated by cardiogenic shock undergoing primary PCI: a Chinese National Study and propensity-matched analysis. Hellenic Journal of Cardiology https://doi.org/10.1016/j.hjc.2024.09.008.	Retrospective national database (Chinese Cardiovascular Association database) n=9,635 (2,028 ECMO, 7,607 IABP)	People supported by ECMO had a lower in-hospital mortality than those supported by IABP (7% versus 15%, p<0.001). Within the propensity-matched cohort, there was a 34% reduced risk of in-hospital mortality among people supported by ECMO compared with those supported by IABP (8% versus 12%; OR 0.66; 95% CI 0.53 to 0.80; p<0.001) independent of age, sex, systolic blood pressure, obesity, smoke, hypertension, diabetes, dyslipidemia, family history of coronary artery disease, coronary artery disease, stroke, atrial filiation, peripheral artery disease, chronic kidney disease, vascular lesion sites, 3A-grade hospital, and regional distributions in China.	Study only includes people who had percutaneous coronary intervention, supported by ECMO or IABP.
Yeh T-C, Chang H-H, Wang J-O et al. (2022) Age and comorbidities as predictors of hospital mortality in adult patients who receive extracorporeal	Retrospective cohort study (Taiwan National Health Insurance Research Database) n=5,834	2,270 patients (39%) were discharged from the hospital. Age and comorbidities were strongly associated with hospital mortality among ECMO patients.	More recent studies are included.

membrane oxygenation therapy: A population-based study. Journal of Medical Sciences 42: 120			
Yue H-Y, Peng W, Luo K et al. (2024) Impact of awake extracorporeal membrane oxygenation on patients mortality with cardiogenic shock: a systematic review and trial sequential meta-analysis based on observational studies. BMJ Open 14: e086383	Systematic review and meta-analysis n=1,044 (5 studies)	Compared with non-awake ECMO, awake ECMO was associated with a lower mortality of people with cardiogenic shock (OR 0.28; 95% CI 0.15 to 0.49; p<0.0001; I^2=50%).	More comprehensive systematic reviews are included.
Zaki HA, Yigit Y, Elgassim M et al. (2024) A systematic review and meta-analysis unveiling the pivotal role of extracorporeal membrane oxygenation (ECMO) in drug overdose treatment optimization. Bulletin of emergency and trauma, 12(3), 103–110.	Systematic review and meta-analysis n=694,10 studies Follow-up: Hospital discharge	The pooled analysis of ECMO in drug-overdosed/ poisoned people showed survival to hospital discharge rate of 65.6% (95% CI: 51.5% to 77.4%, p=0.030). However, the outcomes were highly heterogeneous (I^2=83.47%), which could be attributed to the use of several medicines by different studies. ECMO was associated with a rate of adverse events of 23.1% (95% CI: 12.3% to 39.2%, p=0.002).	Larger, more comprehensive systematic literature reviews and meta-analysis included.
Zavalichi MA, Nistor I, Nedelcu A-E et al. (2020) Extracorporeal membrane oxygenation in cardiogenic shock	Systematic review and meta-analysis n=1,998, 9 studies Follow-up:	Survival rate varied from 30.0% to 79.2% at discharge and from 23.2% to 36.1% at 12 months. Reported serious adverse events were gastrointestinal	No meta-analysis included.

due to acute myocardial infarction: a systematic review. BioMed Research International 2020: 6126534	hospital discharge, 12 months	bleeding (3.6%) and peripheral complications (8.5%).	
Zeymer U, Freund A, Hochadel M et al. (2024) Do DanGer-SHOCK-like patients benefit from VA-ECMO treatment in infarct-related cardiogenic shock? results of an individual patient data meta-analysis. European Heart Journal. Acute Cardiovascular Care 13: 658–61	Subgroup analysis of 4 randomised controlled trials n=202	Mortality after 6 months was numerically lower with VA ECMO between the groups (45% in VA ECMO group versus 51% in control group; hazard ratio 0.84; 95% CI 0.56 to 1.26, while major bleeding (OR 2.24; 95% CI 1.08 to 4.64) and peripheral vascular complications (OR, 3.65; 95% CI 1.15 to 11.56) were increased with the use of VA ECMO.	Subanalysis of 4 trials, 3 of which are included in the key evidence.
Zeymer U, Freund A, Hochadel M et al. (2023) Venoarterial extracorporeal membrane oxygenation in patients with infarct-related cardiogenic shock: an individual patient data meta-analysis of randomised trials. Lancet 402: 1338-1346	Individual patient-based meta-analysis n=567 (4 trials)	VA ECMO did not reduce 30-day mortality compared with medical therapy alone in people with infarct-related cardiogenic shock, and an increase in major bleeding and vascular complications was observed.	A similar study is included (Elsaeidy 2024).
Zhigalov K, Sa MPBO, Safonov D et al. (2020) Clinical outcomes of venoarterial extracorporeal life support in 462 patients: Single-center experience. Artificial organs	Single centre retrospective study, Germany n=462 (postcardiotomy n=357) Follow-up: In-hospital	Overall, the in-hospital survival rate was 26%. There was no statistically significant difference between the groups: 26.3% for PCS and 24.8% for non-PCS, respectively (p>0.05). Weaning from VA-ECLS was possible in 44.3%	Larger studies split by CS aetiology were included.

44(6): 620-627		for PCS and in 29.5% for non-PCS (p=0.004).	