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Indications and clinical outcomes of extracorporeal membrane oxygenation combined with renal replacement therapy in adult patients with toxic shock and cardiac arrest: a systematic review

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 14 July 2026 and was last updated on 27 August 2026.

INTRODUCTION

Review question / Objective To evaluate the clinical outcomes and indications of veno-arterial extracorporeal membrane oxygenation (V-A ECMO) combined with renal replacement therapy (RRT) versus ECMO alone in adults with cardiogenic shock secondary and cardiac arrest to drug poisoning.Indications and clinical outcomes of extracorporeal membrane oxygenation combined with renal replacement therapy in adult patients with toxic shock and cardiac arrest.
Additionally, this review performs exploratory quantitative comparison of clinical outcomes between patients receiving V-A ECMO combined with RRT versus ECMO alone.

Rationale Drug-induced poisoning remains a leading cause of preventable mortality in emergency and critical care settings, with severe cases progressing to refractory shock unresponsive or cardiac arrest to conventional resuscitation. Veno-arterial extracorporeal membrane oxygenation (V-A ECMO) has increasingly been employed as rescue therapy in this context, often combined with renal replacement therapy (RRT) for concomitant acute kidney injury or enhanced toxin clearance. However, current evidence is limited to small case series and single-center reports, with no consensus on patient selection, timing of ECMO initiation, indications for combining RRT, or predictors of survival. This systematic review aims to synthesize the available literature on V-A ECMO combined with RRT in drug-poisoning-induced shock, summarizing clinical characteristics, treatment patterns, and outcomes to inform bedside decision-making.

Condition being studied Drug-induced poisoning; Toxic shock; Cardiac arrest.

METHODS

Search strategy (1) toxicology, intoxication, poisoning, overdose, or drug-toxicity terms; (2) ECMO, ECLS, or ECPR terms; and (3) RRT, hemodialysis, or hemofiltration terms. The Embase search was limited to English and 2010–2025; the Cochrane Library search used the corresponding concepts in the title, abstract, and keyword fields with word variations enabled. Reference lists of included studies and relevant reviews were also screened manually. The complete supplementary strategies and item-level screening decisions were retained in the search records.
A two-phase search strategy was employed, with an initial search conducted in January 2026 and a supplementary search in July 2026.

Participant or population Adult patients (aged ≥18 years) with drug-induced poisoning who develop refractory circulatory shock or cardiac arrest and receive veno-arterial extracorporeal membrane oxygenation (V-A ECMO), with or without concurrent renal replacement therapy (RRT).

Intervention V-A ECMO as rescue therapy for refractory shock or cardiac arrest secondary to drug-induced poisoning. Concomitant renal replacement therapy (RRT), when reported, was recorded but not required for eligibility.

Comparator All eligible cases will be allocated into two groups: the ECMO combined with RRT group and the ECMO monotherapy group, for exploratory comparative analysis.
Subgroup Definitions: ECPR (cardiac arrest) subgroup; Shock without cardiac arrest subgroup.

Study designs to be included Study designs to be included studies are predominantly case reports and case series; no randomized controlled trials were found.Exclusion criteria:Non-V-A ECMO or V-V ECMO only; insufficient key outcome data (e.g., survival to discharge); duplicate publications or overlapping cohorts from the same institution; nonEnglish publications or those with unavailable full texts.

Eligibility criteria Inclusion criteria: (1) Population – adult patients (aged ≥18 years) with drug-induced poisoning who develop refractory circulatory shock or cardiac arrest and receive veno-arterial ECMO (V-A ECMO), with or without concurrent renal replacement therapy (RRT); (2) Intervention – V-A ECMO as rescue therapy for refractory shock or cardiac arrest secondary to drug-induced poisoning; (3) All eligible cases will be allocated into two groups: the ECMO combined with RRT group and the ECMO monotherapy group, for exploratory comparative analysis.
Subgroup Definitions: ECPR (cardiac arrest) subgroup; Shock without cardiac arrest subgroup; (4) Outcomes – reported at least one key outcome (e.g., survival to hospital discharge, ICU/hospital length of stay, ECMO duration, complications); (5) Study designs to be included studies are predominantly case reports and case series; no randomized controlled trials were found.Exclusion criteria:Non-V-A ECMO or V-V ECMO only; insufficient key outcome data (e.g., survival to discharge); duplicate publications or overlapping cohorts from the same institution; nonEnglish publications or those with unavailable full texts.
Exclusion criteria: (1) Non-V-A ECMO (e.g., V-V ECMO only for respiratory failure), or V-A ECMO used for non-poisoning indications (e.g., post-cardiotomy shock, myocarditis); (2) non-drug poisoning (e.g., envenomation, mushroom poisoning, carbon monoxide, chemical inhalants); (3) insufficient key outcome data (e.g., survival to hospital discharge); (4) duplicate publications or overlapping cohorts from the same institution; (5) non-English publications or those with unavailable full texts.

Information sources Searches were conducted in PubMed, Embase, and Cochrane Library from January 2010 to December 2025. A supplementary manual search was performed by screening the reference lists of included articles and relevant reviews. No restrictions on language or publication status were applied at the search stage; non-English publications were excluded at the eligibility stage.

Main outcome(s) Survival to hospital discharge (defined as alive at hospital discharge after ECMO support for drug-poisoning-induced shock (with or without preceding cardiac arrest)).

Additional outcome(s) (1) ECMO duration and complications (e.g., bleeding, limb ischemia); (2) RRT details where reported (timing, modality—CVVH/hemoperfusion/TPE, duration).

Data management Two reviewers (Dang,XT and Li,GY) independently performed screening, data extraction, and risk-of-bias assessment using a standardized piloted form; discrepancies were resolved by consensus or by a third reviewer (Wang,SZ). Extracted variables included: (1) study characteristics (author, year, country, design, sample size); (2) patient characteristics (age, sex, poisoning agent); (3) ECMO details (mode, timing, duration, complications); (4) RRT details where

reported (modality, timing, duration); (5)Data Extraction Items: Left ventricular ejection fraction (LVEF), serum lactate, indications for RRT initiation (categorized as AKI, toxin removal, fluid overload, or metabolic disturbance), and physicochemical properties of the toxicant;(6) outcomes (survival to discharge).

Quality assessment / Risk of bias analysis After full literature screening, most eligible studies were case reports and small case series, and no comparative cohort studies were retrieved, so ROBINS-I was not applied in practice. Two separate JBI appraisal tools were adopted: JBI Critical Appraisal Checklist for Case Reports for single-case reports and JBI Critical Appraisal Tool for Case Series for studies with ≥5 patients. All appraisal judgements were recorded in supplementary tables, and studies would not be excluded solely based on low methodological quality.

Strategy of data synthesis Continuous Variables
Continuous variables will be summarized as mean ± standard deviation (SD) or median (interquartile range [IQR]), as appropriate. Between-group comparisons will be performed using independent-samples t-tests or Mann-Whitney U tests, depending on the data distribution.
Categorical Variables and Primary Outcome
Due to the sparsity of mortality events, the primary outcome and subgroup 2×2 tables will be analyzed with two-sided Fisher exact tests. Effect estimates including risk ratios (RRs), odds ratios (ORs), and 95% confidence intervals (CIs) will be reported. A two-sided $p<0.05$ will be considered statistically significant.
Software and Reproducibility
Formal statistical outputs will be generated using a reproducible R script (version 4.3.0 or higher), with the run log retained to ensure transparency and reproducibility of the analytical process.

Subgroup analysis Exploratory subgroup analyses will be performed to evaluate the consistency of mortality outcomes between the ECMO+RRT and ECMO-alone groups across clinically relevant strata.
Specifically, subgroup comparisons will be conducted according to:
(1) Cardiac arrest status — patients who underwent Extracorporeal Cardiopulmonary Resuscitation (ECPR) versus those without sustained cardiac arrest.
(2) RRT utilization — ECMO with concomitant RRT versus ECMO alone.
Given the limited sample size and the predominance of single-arm case series, formal meta-regression or interaction tests are not feasible. Within each stratum, categorical outcomes (e.g., mortality) will be compared using two-sided Fisher exact tests, with Risk Ratios (RRs), Odds Ratios (ORs), and 95% Confidence Intervals (CIs) reported. All subgroup analyses will be interpreted as exploratory and hypothesis-generating rather than confirmatory.
Sensitivity analysis Given the predominance of single-arm case series and high clinical heterogeneity across included reports, formal sensitivity analyses via repeated meta-regression or leave-one-out diagnostics were not feasible.

Language restriction No language restriction was applied at the search stage. However, non-English publications were excluded at the eligibility stage due to the reviewers' language capacity (English, Chinese were considered if key.

Country(ies) involved Countries involved: China (People's Republic of China).

Other relevant information This systematic review was not prospectively registered in PROSPERO and is retrospectively registered in INPLASY to enhance transparency. Given the predominance of single-arm case series and high clinical heterogeneity (poisoning agents, ECMO configuration, RRT utilization), the review employs narrative synthesis with descriptive subgrouping rather than Comparative meta-analysis; risk of bias is assessed using ROBINS-I (cohorts) and JBI critical appraisal tool (case series). Ethical approval was not required (systematic review of published data; no individual patient data accessed).

Keywords Drug Poisoning; Shock Due to Drug Poisoning; Poisoning-Related Cardiac Arrest; Extracorporeal Membrane Oxygenation; Renal Replacement Therapy; Enhanced Elimination.

Dissemination plans The findings of this systematic review will be submitted to a peer-reviewed journal in the field of intensive care or toxicology (e.g., Journal of Intensive Medicine). Key results will be presented at relevant academic conferences (e.g., Chinese Society of Critical Care Medicine, Asian Pacific Association of Poison Control Centres). A plain-language summary may be prepared for dissemination to clinical toxicologists and ECMO centers via professional networks. The INPLASY registration record (DOI) will be cited in the published article to enhance transparency.

Contributions of each author

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