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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 14 July 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.

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 "Extracorporeal Membrane Oxygenation"[Mesh] OR "ECMO" OR "VA-ECMO" OR "VV-ECMO" OR "ECLS" OR "ECPR"
#2 "Poisoning"[Mesh] OR "Drug Overdose" OR "Intoxication" OR "drug-induced" OR "overdose"

#3 #1 AND #2.

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 None. This review primarily includes single-arm case series and uncontrolled cohorts of patients receiving V-A ECMO for drug-poisoning-induced shock; thus no formal comparator group is defined. Where individual studies report a comparison (e.g., ECMO vs conventional resuscitation), these data will be synthesized narratively.

Study designs to be included Case series , retrospective and prospective cohort studies on patients receiving ECMO for drug-induced poisoning. Cross-sectional studies with extractable outcome data are also eligible. Randomized controlled trials are not expected in this clinical context.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; non-English 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) Comparator – not required (single-arm case series and uncontrolled cohorts eligible); (4) Outcomes – reported at least one key outcome (e.g., survival to hospital discharge, ICU/hospital length of stay, ECMO duration, complications); (5) Study design – case series (≥5 subjects), retrospective and prospective cohort studies, and cross-sectional studies with extractable outcome data.
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) outcomes (survival to discharge). Data were stored in a password-protected Excel file with version control; Covidence/EndNote managed de-duplication and screening. No individual patient data were accessed.

Quality assessment / Risk of bias analysis The methodological quality of included studies was assessed using two tools according to study design:
(1) For cohort studies (if any with a comparator), the ROBINS-I tool (Risk of Bias In Non-randomized Studies of Interventions; Sterne et al., BMJ 2016) was used, covering seven domains (bias due to confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of reported result).

Each domain was rated as low / moderate / serious / critical / no information, with an overall bias judgement.
(2) For case series (the predominant design expected in this topic), the Joanna Briggs Institute (JBI) Critical Appraisal Tool for Case Series was used, assessing ten items including inclusion criteria, description of participants, completeness of follow-up, and outcome measurement.
Two reviewers (Dang,XT and Li,GY) independently performed quality assessment; discrepancies were resolved by consensus or by a third reviewer (Wang,SZ). Results are presented in a summary table (ROBINS-I domain judgements for cohorts; JBI 10-item tally for case series) and incorporated into the GRADE certainty assessment.

Strategy of data synthesis Due to the anticipated predominance of single-arm case series, high clinical heterogeneity (poisoning agents, time to ECMO initiation, concomitant RRT modalities), and absence of comparator groups, a formal meta-analysis comparing ECMO vs non-ECMO was not feasible. Data were synthesized using a mixed approach:
(1) Narrative synthesis – studies were grouped and described by: presence/absence of concomitant RRT. For each group, patient characteristics, ECMO details, RRT details, and survival rates were summarized descriptively.
(2) Proportional synthesis (where applicable) – for the primary outcome (survival to hospital discharge), pooled proportions with 95% CIs were calculated using a random-effects model across all eligible studies, regardless of RRT status, to provide an overall signal of ECMO rescue effectiveness in drug-poisoning shock.
(3) Secondary outcomes (ECMO duration, complications) were presented descriptively with ranges/medians across studies, given their continuous nature and high variability; no pooling was attempted.
All analyses were performed using the Social Sciences (SPSS) version 26.0 or R version 4.3.0.

Subgroup analysis Formal subgroup meta-analyses were not feasible due to the predominance of single-arm case series and limited number of comparative cohorts. Instead, descriptive subgroup presentations were planned according to the following strata:
(1) By RRT utilization – ECMO with concomitant RRT vs ECMO alone, where RRT details (modality, timing) were reported;
(2) By clinical scenario – refractory shock without sustained cardiac arrest vs shock progressing to CA (ECPR context).
Within each stratum, survival to discharge, ECMO duration, and RRT details were summarized descriptively. If sufficient comparative studies become available after full screening, sensitivity analysis by risk-of-bias level (ROBINS-I / JBI) will be performed by excluding studies rated as "critical" risk.

Sensitivity analysis Formal sensitivity analyses via repeated meta-regression were not feasible due to the predominance of single-arm case series and high heterogeneity. Limited sensitivity checks were planned as follows:
(1) Exclusion by risk of bias – studies rated as "critical" on ROBINS-I (for cohorts) or "no" on key JBI items (for case series) were excluded in a sensitivity run of the proportional synthesis for survival to discharge; results were compared with the main (all-eligible-studies) pool to assess robustness.
(2) Exclusion by incomplete RRT reporting – in the ECMO+RRT subgroup, studies that only noted "RRT used" without reporting modality/timing/duration were excluded in a sensitivity description, to test whether RRT detail completeness correlated with overall report quality.
All sensitivity results were presented descriptively with the main pool; no statistical inference on between-run difference was planned given the narrative-synthesis dominant design.

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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