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Clinical Outcomes and Healthcare Resource Utilization Among Patients Receiving Extracorporeal Membrane Oxygenation in Hunan Province, 2021–2024: A Retrospective Study

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BACKGROUND & OBJECTIVES

- Extracorporeal membrane oxygenation (ECMO) is a vital life-support modality for refractory cardiac and respiratory failure, stabilizing hemodynamics in conditions like cardiogenic shock, fulminant myocarditis, and severe Acute Respiratory Distress Syndrome (ARDS).
- In China, ECMO use has expanded due to improved Intensive Care Units (ICU) and multidisciplinary teams, with indications now extending to complex scenarios such as multi-organ dysfunction and high-risk perioperative support.
- ECMO is delivered as veno-arterial ECMO (VA-ECMO) for cardio-pulmonary support and veno-venous ECMO (VV-ECMO) for isolated respiratory support, each with distinct complications and resource demands.
- Despite its life-saving potential, ECMO is resource-intensive, and real-world evidence is needed in China to guide patient selection, optimize outcomes, and improve healthcare resource allocation.

METHODS

- **Study Design：** Retrospective cohort of adult patients receiving ECMO in Hunan Province, China (Jan 2021 – Dec 2024). Cohort established by linking Hospital Discharge Database and Regional Intensive Care Quality Control Registry.
- **Study Patients**
  - **Inclusion**: Adults (≥18 years) who received ECMO during study period.
  - **Exclusion**: primary severe trauma or massive hemorrhage, or insufficient ECMO documentation.
- **Data Collection**
  - **Hospital Discharge Database:** demographics, admission route, length of stay, hospital costs.
  - **ICU registry**: ECMO indications, cannulation sites, flow rates, complications, in-hospital mortality, and successful weaning (≥48h survival post-ECMO removal).
- **Statistical Analysis**
  - Costs adjusted to 2025 CNY using Consumer Price Index.
  - Descriptive statistics for baseline, outcomes, resource use, and costs.
  - Continuous variables: mean ± SD or median [IQR]; categorical: counts (%)
  - Time-to-event: logistic regression and Kaplan–Meier curves for mortality and ECMO weaning.

RESULTS

Patient Characteristics

- A total of 1,383 ECMO patients were identified, with 775 included (VA n=530; VV n=245). The characteristics are summarized in Table 1.
- VA-ECMO patients were younger with cardiac causes and cardiogenic shock/Extracorporeal Cardiopulmonary Resuscitation (ECPR), while VV-ECMO patients were older with respiratory failure and severe ARDS, as shown in Figures 1 and 2.

Table 1. Baseline characteristics of patients supported with ECMO

Characteristic	VA-ECMO (N=530) median (IQR)/%	VV-ECMO (N=245) median (IQR)/%
Demographics		
Age (years)	54.5 (42.0-64.0)	60.0 (51.0-69.0)
Sex (male)	69.1%	73.9%
BMI (kg/m²)*	23.1 (21.5-25.1)	23.1 (21.6-24.6)
Geographic region		
Rural	52.1%	40.8%
Urban	43.6%	48.6%
Mode of admission		
Emergency	63.6%	65.7%
Outpatient	26.8%	24.5%
Inter-hospital transfer	8.5%	9.4%
Pre-ECMO		
Antibiotic therapy	35.5%	90.6%
Bacterial infection	22.5%	82.4%
Comorbidities		
Coronary artery disease	47.2%	12.7%
Hypertension	24.2%	29.0%
Arrhythmia	20.9%	6.1%
Anemia	19.2%	28.2%
Diabetes mellitus	18.1%	18.8%
Heart failure	17.7%	7.8%
Chronic kidney disease on dialysis	9.2%	13.9%
Cardiomyopathy	8.1%	3.3%
Valvular heart disease	8.1%	0.0%
Non-alcoholic fatty liver disease	5.8%	6.9%
Hyperlipidemia	5.1%	4.1%
Malignancy	2.8%	9.4%

*The sample size was 394 patients in the VA-ECMO group and 169 patients in the VV-ECMO group.

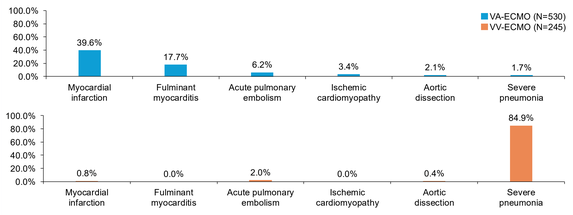

Figure 1. Primary diagnosis of patients supported with ECMO

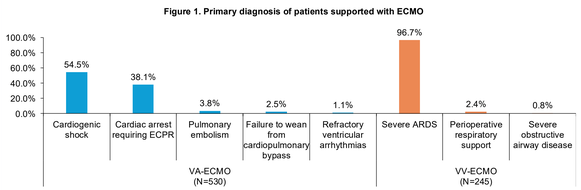

Figure 2. Indications for ECMO initiation of patients supported with ECMO

Clinical outcome

- **VA-ECMO Patients**
  - **In-hospital mortality**: 60.4%; **weaning success**: 43.2%
  - Multivariable Cox regression identified cardiac arrest requiring ECPR as an independent risk factor for in-hospital mortality (HR = 1.873; P < 0.001) (Figure 3).

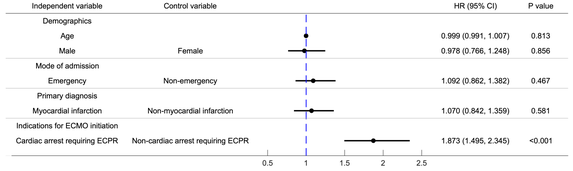

Figure 3. Multivariable Cox Regression for In-Hospital Mortality in VA-ECMO Patients

- Emergency admission was independently associated with a lower likelihood of successful weaning (HR = 0.655; P = 0.002) (Figure 4).

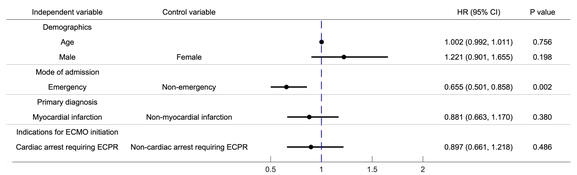

Figure 4. Multivariable Cox Regression for Successful Weaning in VA-ECMO Patients

- **VV-ECMO Patients**
  - **In-hospital mortality:** 66.9%; **weaning success**: 38.0%
  - Multivariable Cox regression analysis showed that severe pneumonia increased mortality (HR = 2.350; P < 0.001) (Figure 5).

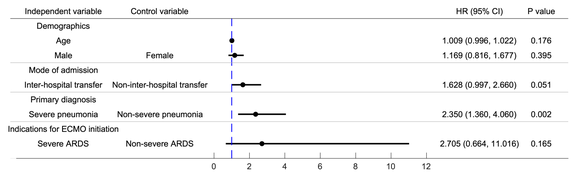

Figure 5. Multivariable Cox Regression for In-Hospital Mortality in VV-ECMO Patients

- Lower successful weaning was independently associated with older age (HR 0.972), inter-hospital transfer (HR 0.287), severe pneumonia (HR 0.375), and severe ARDS (HR 0.026) (all P<0.05) (Figure 6).

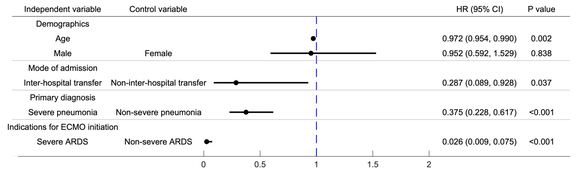

Figure 6. Multivariable Cox Regression for Successful Weaning in VV-ECMO Patients

- **Kaplan–Meier survival curves**
  - Kaplan–Meier survival curves indicated a median time to weaning of 6.1 days and a median in-hospital survival time of 13.0 days in VA-ECMO Patients (Figure 7A).
  - Kaplan–Meier survival curves showed a median time to weaning of 18.1 days and a median in-hospital survival time of 22.0 days in VV-ECMO Patients (Figure 7B).

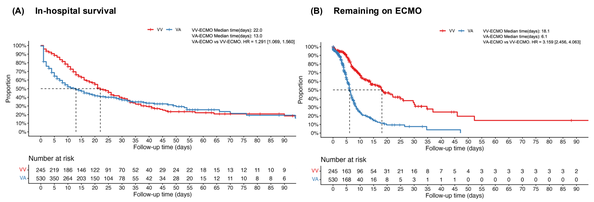

Figure 7. Kaplan–Meier survival analysis for in-hospital survival and weaning success in patients receiving ECMO.

- **Complication**
  - Major complications included Acute kidney injury, severe bleeding, thromboembolic events, and infections in both VA-ECMO and VV-ECMO patients, with additional ventricular dysfunction observed in VA-ECMO patients (Figure 8 and 9).

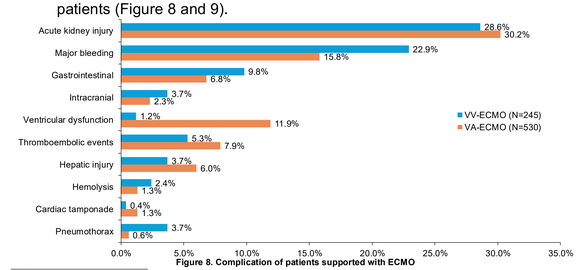

Figure 8. Complication of patients supported with ECMO

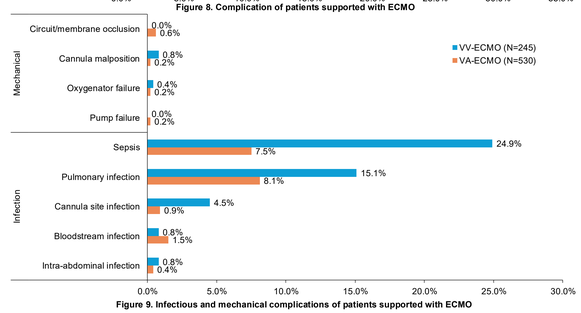

Figure 9. Infectious and mechanical complications of patients supported with ECMO

Resource Utilization & Costs

- VV-ECMO patients had longer hospital and ICU stays, longer ECMO and mechanical ventilation duration, and higher hospitalization costs compared with VA-ECMO patients (median Length of Stay : 19.0 vs 9.0 days; median cost: ¥301,683 vs ¥181,437) (Table 2).

Table 2. Healthcare costs and resource utilization in patients supported with ECMO

Outcomes	VA-ECMO (N=530) median (IQR)/%	VV-ECMO (N=245) median (IQR)/%
Length of stay (days)	9.0 (2.0-21.0)	19.0 (10.0-32.0)
ECMO duration (days)	3.0 (0.9-6.0)	7.7 (3.9-13.9)
ICU	90.2%	99.2%
Length of ICU stay (days)*	7.0 (2.0-15.0)	15.1 (8.0-25.0)
Mechanical Ventilation	91.5%	98.0%
Mechanical Ventilation duration (days) †	4.0 (1.0-9.0)	12.4 (6.0-21.0)
Costs (CNY) ‡		
Total hospitalization	¥181,437 (¥113,722-¥289,983)	¥301,683 (¥179,123-¥482,074)
Out-of-pocket	¥64,010 (¥16,027-¥120,839)	¥95,109 (¥5,948-¥186,003)

*The sample size was 478 patients in the VA-ECMO group and 243 patients in the VV-ECMO group.
†The sample size was 485 patients in the VA-ECMO group and 240 patients in the VV-ECMO group.
‡The sample size was 510 patients in the VA-ECMO group and 244 patients in the VV-ECMO group.

CONCLUSIONS

- This study highlights the substantial clinical and economic burden of ECMO in China, with in-hospital mortality exceeding 60% and high healthcare costs.
- Cardiac arrest requiring ECPR in VA-ECMO and severe pneumonia in VV-ECMO were identified as key risk factors for weaning failure and mortality.
- Improving outcomes may require a shift toward precision-based patient selection, centralized care, and cost reduction strategies.