EXTRACORPOREAL MEMBRANE OXYGENATION IN TRAUMA

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Applications of ECMO in Trauma

Veno-Venous (VV) ECMO:

- **Most common modality in trauma and is used for severe, reversible Acute Respiratory Distress Syndrome (ARDS) or acute respiratory failure. Provides "lung rest" by managing oxygenation and carbon dioxide removal without requiring high, damaging ventilator settings.**
- **Common Causes: Severe pulmonary contusion, inhalation injury, or adult respiratory distress syndrome (ARDS) that develops after a massive transfusion or other systemic insults.**

Veno-Arterial (VA) ECMO:

- **Configuration provides both respiratory and cardiac support. It is reserved for trauma patients who also have refractory cardiogenic shock or who are in traumatic cardiac arrest (ECPR: Extracorporeal Cardiopulmonary Resuscitation).**

CHANGING PARADIGM

Historically, trauma was a relative contraindication for ECMO due to bleeding risks. However, recent data indicate that trauma patients often have better survival rates on VV-ECMO (60–70%+) than medical ARDS patients. Their lungs are usually healthy before the injury and have a higher capacity for complete recovery once the acute inflammatory phase passes.

SURVIVAL RATES FOR TRAUMA PATIENTS SUPPORTED ON ECMO

Survival rates for trauma patients supported with ECMO vary widely by indication and mode, but contemporary series generally report overall survival around 50–65%, higher for VV-ECMO respiratory indications and lower for VA-ECMO/circulatory collapse:

- **The AAST critical care consensus summarizing early series reports trauma ECMO survival ranging from about 28% to 74% in small cohorts, with the largest ELSO trauma registry analysis (279 patients) showing ~61% survival to discharge.**
- **More recent single-center trauma series and registries typically fall in the same range, supporting ECMO as a valuable therapy.**

VV-ECMO

- For trauma-related ARDS or acute lung injury on VV-ECMO, reported survival rates are usually around 50–80%; a systematic review cites VV-ECMO trauma survival in the 50–79%range, and several series cluster near 60–70%.
- A multicenter TR-ARDS cohort on ECMO reported 62.4% survival (226/362), and a VV trauma study found about 70% survival among VV-ECMO patients.
- ELSO trauma registry analysis (279 patients) showing ~61% survival to discharge.

VA-ECMO and ECPR

- VA-ECMO in trauma (cardiogenic shock or combined cardiorespiratory failure) shows lower survival, commonly reported in the 30–50% range; prior summaries describe trauma VA-ECMO survival around 42–63%, with many series closer to the low 40s.

- In traumatic cardiac arrest with extracorporeal CPR, newer cohorts still report hospital survival around 25–30%, which is several-fold higher than the historical 0–7.7% survival seen with conventional CPR alone.

PREDICTORS OF SURVIVAL IN ECMO FOR TRAUMA

Patient and Injury:

- **Age: Multiple datasets (TQIP, TR-ARDS cohorts) show better survival under age 50; older age independently predicts mortality.**

- **Injury pattern and severity: Lower ISS and predominance of thoracic/lung injury (vs. massive external or multisystem injury) are associated with higher survival, whereas external AIS ≥3 and extensive soft-tissue injury predict death. Severe acidosis and high ISS predict failure.**

Timing and Indication:

- **Early ECMO: Initiation within the first 1–2 days of refractory severe ARDS, or within a few hours of presentation in select shock cases, correlates with lower mortality compared with delayed runs.**

- **Clear, reversible indication: Survival is higher when ECMO is used for potentially reversible hypoxemic respiratory failure (e.g., lung contusions, TR-ARDS) rather than profound mixed shock or non-salvageable TBI.**

SIMPLE CALIBRATED SELECTION CRITERIA FOR ECMO IN TRAUMA

Favor:

- **Younger patients, potentially reversible lung or cardiac injury, no devastating neurologic insult, salvageable physiology (pH >≈7.0–7.1, lactate not extreme), and a clear path to surgical/hemostatic control and rehabilitation.**

Avoid:

- **Unsurvivable TBI, prolonged low-flow arrest without signs of neurologic viability, uncontrolled exsanguination, or overwhelming multisystem injury where ECMO will not change trajectory.**

SUMMARY OF INDICATIONS & CONTRAINDICATIONS

Clear Indications	Relative Contraindications	Absolute Contraindications
Post-traumatic ARDS	Active bleeding*	Unsurvivable TBI / CNS injury
Pulmonary Contusion	Recent TBI (case-by-case)	Uncontrolled, massive hemorrhage
Tracheal/Bronchial disruption	Age > 65-70 (center specific)	Terminal illness pre-injury
Traumatic Asphyxia	Prolonged CPR (>60 mins)	?

TRAUMATIC BRAIN INJURY (TBI)

TBI was once considered an absolute contraindication. This is changing.

Rationale:

- **Hypoxia and hypercapnia (high CO2) are devastating to an injured brain (causing vasodilation and increased intracranial pressure). VV-ECMO can rapidly normalize O2 and CO2, potentially saving the brain better than a ventilator can.**

Current Consensus:

TBI is now often viewed as a relative rather than an absolute contraindication.

- **Outcomes: Recent studies (2024) have shown survival rates of ~70% in selected TBI patients on VV-ECMO, with favorable neurological outcomes.**
- **Selection: Candidates generally need a GCS > 7–8 (pre-sedation) and potentially survivable CT findings (e.g., avoiding those with massive midline shift or herniation).**

ANTICOAGULATION AND BLEEDING

- Major barrier to ECMO in trauma is hemorrhage and trauma-induced coagulopathy
- ECMO circuits are typically heparin-coated, and centers often use low-dose, delayed, or even heparin-sparing strategies initially.
- High-risk conditions (TBI, spinal/epidural hematoma, solid-organ injury with active bleeding) are relative, not absolute, contraindications
- Teams individualize anticoagulation and prioritize rapid definitive hemostasis.

HEPARIN-FREE/HEPARIN-LITE CIRCUITS

The biggest hurdle in trauma ECMO is managing anticoagulation in a patient with active bleeding or high hemorrhagic risk (e.g., liver lacerations, pelvic fractures, TBI).

The Concept:

It is possible to run a modern ECMO circuit without any systemic anticoagulation for days (sometimes 5–7 days) if flow rates are maintained high enough to prevent thrombus formation.

Protocol:

- **No Bolus: Cannulation is performed without the standard heparin bolus.**
- **High Flow: Flow rates are kept high (>3–4 L/min) to "wash" the circuit and prevent clot formation.**
- **Monitoring: The circuit is inspected visually for clot formation (especially at connector sites and the oxygenator).**
- **Transition: Once bleeding is surgically controlled (usually 24–48 hours), a low-dose heparin infusion is started, often targeting a lower PTT (40–50s) or anti-Xa levels than standard medical ECMO.**

CONFIGURATION, TIMING, AND LOGISTICS

Mode selection:

- VV for isolated respiratory failure or shock primarily from hypoxemia; VA for true pump failure or mixed cardiopulmonary collapse.

Timing:

- Early consultation and cannulation (before prolonged high driving pressures, extreme hypoxemia, or profound lactate elevation) correlate with better outcomes.

Cannulation:

- Usually bi-caval IJ, femoral–IJ or femoral–femoral for VV; femoral–femoral or central for VA in the OR for damage-control scenarios, balancing access with existing injuries.

ORGAN SUPPORT AND COMPLICATION AVOIDANCE

Organ protection:

- Avoidance or mitigation of AKI and brain edema. Both are strong independent predictors of mortality in trauma ARDS cohorts on ECMO.

Anticoagulation:

- In TBI and high-hemorrhage-risk trauma, individualized anticoagulation (heparin-sparing or delayed low-dose) that prevents catastrophic ICH while limiting circuit thrombus is associated with acceptable bleeding rates and improved survival.

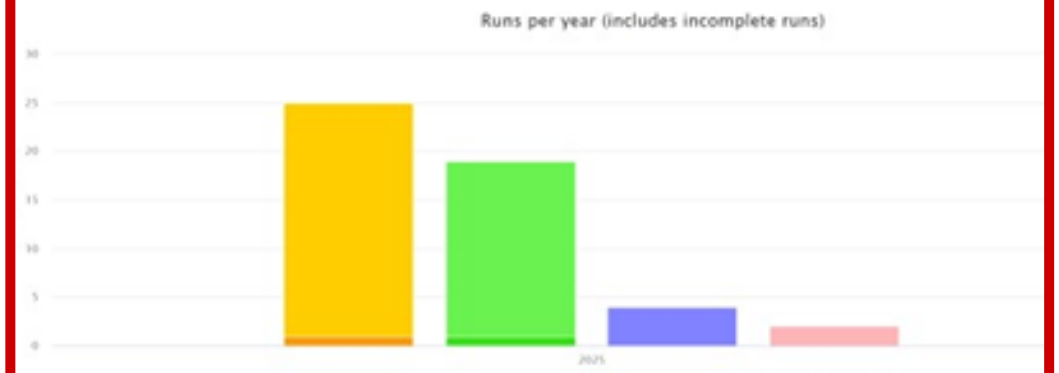
SYSTEM AND TEAM FACTORS

- **High-volume, protocolized programs:**
  - Care in centers with ECMO experience, structured selection criteria, and multidisciplinary trauma–ECMO teams is associated with better outcomes than sporadic use in low-volume settings.

- **Rapid hemostasis and damage-control:**
  - Early definitive control of hemorrhage (OR/IR) before or in parallel with cannulation reduces fatal bleeding and supports successful weaning and recovery.

UMC ECMO RESULTS
(All Cases)

Start-to-Date (January 31st – Present)



25 Patients
19 V-V
3 V-A
1 ECPR
2 Other Configurations (V-AV)

6 Out-of-Hospital Transfers Placed on ECMO
1 Out-of-Hospital Transfer consulted for ECMO, managed without

VV ECMO (Trauma Cohort)

- Total Cases 12 /19 63 %
- Survival to Discharge 10/12 83 %

VA/V-AV ECMO (Trauma Cohort)

- Total Cases 1
- Survival to Discharge 0

- Total Cases – 25
- Survival to Discharge – 64% (All Cases)
- Pulmonary (VV) – 79% Survival
- Cardiac (VA) – 25%

UMC ECMO Compared to ELSO Registry

University Medical Center of El Paso

- Total Cases– 25
- Survival to Discharge– 64% (All Cases)
- Pulmonary (VV) – 79% Survival
- Cardiac (VA) – 25%

ELSO Live Registry (11/18/2025)

	Total	Survived to DC or Transfer
	263,300	54%
Adult	166,205	50%
Pulmonary	69,283	60%
Cardiac	73,508	48%
ECPR	23,414	31%

INDEX VV-ECMO CANNULATION

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QUESTIONS?

“ECMO Chihuahua”
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