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EXTRACORPOREAL MEMBRANE OXYGENATION FOR BURN-ASSOCIATED ACUTE RESPIRATORY DISTRESS SYNDROME: A CONTEMPORARY REVIEW AND INSTITUTIONAL EXPERIENCE

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Every week, approximately 50 faculty attending surgeons and surgical residents meet to conduct postmortems on cases that did not go well. That "Mortality and Morbidity" conference is followed immediately by Grand Rounds.

This collection is not intended as a scholarly journal, but in a significant way it is a peer reviewed publication by virtue of the fact that every presentation is examined in great detail by those 50 or so surgeons.

It serves to honor the presenters for their effort, to potentially serve as first draft for an article for submission to a medical journal, to let residents and potential residents see the high standard achieved by their peers and expected of them, and by no means least, to contribute to better patient care.

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Extracorporeal Membrane Oxygenation for Burn-Associated Acute Respiratory Distress Syndrome: A Contemporary Review and Institutional Experience

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Abstract

Acute respiratory distress syndrome (ARDS) remains one of the most lethal complications of major thermal injury and smoke inhalation. Although advances in lung-protective ventilation, burn resuscitation, infection control, and surgical critical care have improved survival, a subset of patients develop refractory hypoxemic or hypercapnic respiratory failure despite optimal conventional management. Veno-venous extracorporeal membrane oxygenation (VV ECMO) provides temporary extracorporeal gas exchange and allows the lungs to recover under less injurious ventilatory conditions. Its role in burn care, however, remains controversial because patients with severe thermal injury present challenges not encountered in most ARDS populations: inhalation injury, systemic inflammation, massive fluid shifts, repeated excision and grafting, coagulopathy, infection risk, renal failure, and the competing demands of anticoagulation and surgical hemostasis.

This article reviews the contemporary role of VV ECMO in burn-associated ARDS, with emphasis on patient selection, timing of cannulation, predictors of survival, and practical management. The review deliberately minimizes generic ECMO mechanics and instead focuses on what burn surgeons and surgical intensivists need to know when considering extracorporeal support. The article also presents the recent Detroit Medical Center Burn Program experience in an IMRAD format. Between July 2020 and March 2026, 12 patients with burn or inhalation injury and severe ARDS underwent VV ECMO. Mean pre-cannulation PaO2/FiO2 ratio was approximately 62, mean time to cannulation was 7.3 days, and mean ECMO duration was 21.4 days. Observed mortality was approximately 17%, comparing favorably with predicted mortality and with several previously published international series. These findings do not prove efficacy, but they challenge the assumption that severe burns are intrinsically poor candidates for ECMO. Contemporary evidence supports a measured conclusion: in experienced multidisciplinary burn centers, carefully selected patients with potentially reversible respiratory failure may achieve outcomes far better than historical reports suggest.

1. Introduction

Respiratory failure remains one of the principal determinants of death after major burn injury. Over the past several decades, specialized burn centers have achieved remarkable improvements in survival through advances in resuscitation, early excision and grafting, infection control, nutrition, rehabilitation, and critical care. Yet severe pulmonary failure, particularly when associated with inhalation injury, continues to place patients at high risk of death. Acute respiratory distress syndrome after burns is not simply conventional

ARDS in a patient who happens to have a burn. It is a distinct clinical syndrome that arises within a physiological environment shaped by thermal injury, smoke inhalation, systemic inflammation, capillary leak, large-volume fluid resuscitation, hypermetabolism, repeated operative intervention, and frequent infection.

VV ECMO has become an established therapy for carefully selected patients with severe ARDS refractory to conventional management. Its purpose is not to cure lung injury but to provide time: time for inflammation to resolve, time for infection to be controlled, time for pulmonary edema to improve, and time for lung-protective ventilatory strategies to prevent additional ventilator-induced injury. In the general ARDS population, the role of ECMO has been strengthened by randomized trials, registry data, and large-scale experience during the H1N1 and COVID-19 pandemics. Burn patients, however, have remained underrepresented in major trials, leaving clinicians to rely largely on retrospective series and institutional experience.

This gap matters. The decision to cannulate a burn patient for ECMO is rarely straightforward. Extensive eschar may complicate vascular access. Large wounds and planned excisions increase bleeding risk. ECMO circuits require anticoagulation, while burn surgery requires hemostasis. Fluid resuscitation may worsen pulmonary edema, but under-resuscitation may jeopardize organ perfusion and wound viability. Renal failure, sepsis, and multiple organ dysfunction often coexist. The central question is therefore not whether ECMO can improve oxygenation in these patients. It can. The more important question is which burn patients are likely to benefit from extracorporeal support, when ECMO should be initiated, and how it should be integrated into the broader priorities of burn care.

This article addresses that question from a contemporary perspective. It synthesizes the burn-specific literature, reviews the evolution of ECMO only insofar as that history explains modern practice, and presents the recent experience of the Detroit Medical Center Burn Program. The DMC experience is not offered as definitive proof of efficacy. Its value lies in demonstrating that, under contemporary conditions and within an experienced multidisciplinary program, outcomes may be substantially better than those reported in earlier pessimistic series. The paper therefore argues for neither routine use nor therapeutic nihilism. It argues for disciplined selection, timely referral, and integrated burn-ECMO care.

2. Burn-associated ARDS: why this population is different

Burn-associated ARDS begins with overlapping insults. Inhalation injury causes airway edema, mucosal sloughing, bronchospasm, impaired clearance of secretions, and formation of obstructive casts. Smoke exposure adds chemical injury and systemic toxicity. Carbon monoxide and cyanide poisoning may dominate the earliest presentation, but elimination of these toxins does not end the pulmonary process. The inflammatory response initiated by smoke exposure may continue to evolve over the next several days, explaining why some patients appear initially stable and then deteriorate rapidly.

Major cutaneous burns amplify pulmonary injury through systemic inflammation. Extensive tissue destruction activates cytokine cascades, complement pathways, endothelial injury, and capillary leak. Pulmonary vascular permeability increases, alveolar flooding develops, and lung compliance falls. Early burn resuscitation, while necessary to treat burn shock, may worsen interstitial and alveolar edema in lungs already rendered vulnerable by inflammation. The burn surgeon therefore manages a paradox: inadequate resuscitation risks shock, renal injury, and wound compromise, whereas aggressive resuscitation may worsen respiratory failure.

Infection and hypermetabolism further complicate this trajectory. Ventilator-associated pneumonia, bloodstream infection, wound infection,

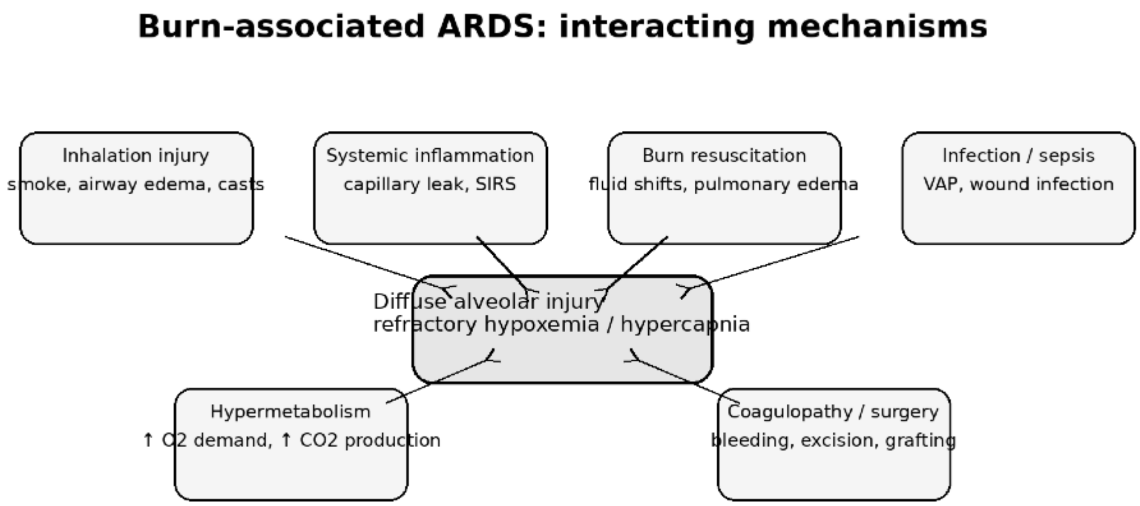

Figure 1. Proposed mechanisms of burn-associated ARDS. Pulmonary failure reflects the interaction of inhalation injury, systemic inflammation, resuscitation-related pulmonary edema, infection, hypermetabolism, and operative/coagulation challenges.

and abdominal sepsis may superimpose new inflammatory insults on already damaged lungs. Hypermetabolism increases oxygen consumption and carbon dioxide production, making respiratory failure harder to manage even when oxygenation is partially supported. Mechanical ventilation itself can contribute additional injury if adequate gas exchange can be maintained only through high pressures, high FiO2, and aggressive ventilatory settings.

These features make burn-associated ARDS a distinct ECMO population. Oxygenation indices remain important, but they are insufficient. Burn size, inhalation injury, age, renal function, hemodynamic stability, planned operative procedures, bleeding risk, vascular access, and trajectory of organ dysfunction must all inform candidacy. A patient with isolated inhalation injury and severe but reversible respiratory failure may be a better candidate than a patient with massive TBSA burn, profound shock, renal failure requiring CRRT, and established multiple organ dysfunction, even if their PaO2/FiO2 ratios are similar. This distinction is essential for interpreting the literature.

3. Evolution of ECMO: why contemporary outcomes are different

The history of ECMO is relevant here because it explains why early adult outcomes should not be treated as definitive evidence against modern extracorporeal support. ECMO evolved from cardiopulmonary bypass technology introduced in the 1950s. In 1972, J. Donald Hill and colleagues reported prolonged extracorporeal support in an adult trauma patient with severe post-traumatic respiratory failure. Shortly thereafter, Richard Bartlett and colleagues at the University of Michigan demonstrated successful neonatal ECMO, including the landmark case of Esperanza. These early successes proved that prolonged extracorporeal gas exchange could sustain patients while otherwise fatal pulmonary failure recovered.

The early adult experience was nevertheless disappointing. The 1970s NIH trial of ECMO in adult ARDS produced survival of only about 10%, leading to decades of skepticism. In retrospect, those outcomes reflected more than failure of the concept. Early circuits were large, traumatic to blood elements, and difficult to manage. Oxygenators were less efficient. Anticoagulation

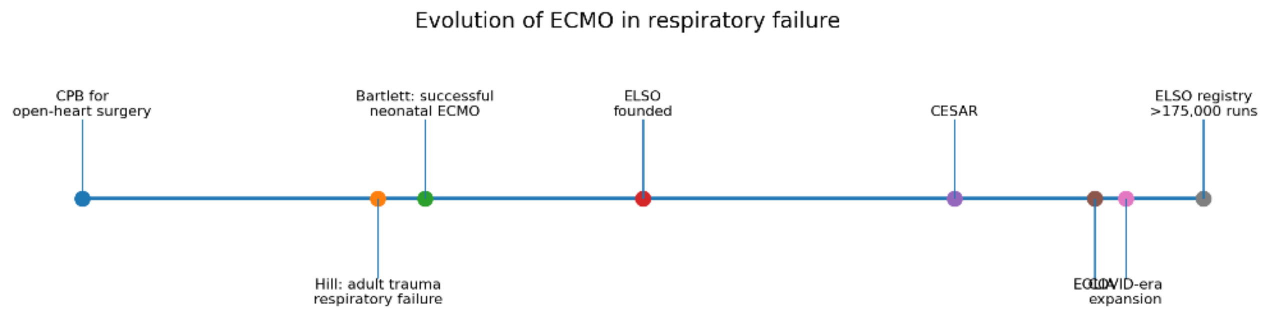

Figure 2. Selected milestones in the evolution of ECMO for respiratory failure.

was less predictable. Lung-protective ventilation had not yet become standard. Most importantly, ECMO was often initiated very late, after severe ventilator-induced injury, renal failure, sepsis, and multiple organ dysfunction had already developed.

The modern ECMO era is different. Centrifugal pumps, polymethylpentene oxygenators, heparin-bonded circuits, portable integrated systems, improved anticoagulation strategies, standardized protocols, and the growth of ELSO have changed both the technical and organizational basis of care. The CESAR trial suggested improved survival without severe disability among patients referred to an ECMO center for severe respiratory failure. The EOLIA trial did not meet conventional statistical significance for its primary endpoint, but mortality favored ECMO, and crossover from the control group likely reduced the apparent treatment effect. Subsequent experience during H1N1 influenza and COVID-19 further matured ECMO programs worldwide.

The most important change has been conceptual. ECMO is no longer viewed solely as heroic salvage for patients in extremis. Contemporary practice increasingly asks whether continued conventional ventilation is likely to inflict more harm than extracorporeal support. This shift is particularly relevant to burn patients. If ECMO is delayed until renal failure, profound acidosis, sepsis, and multiple organ dysfunction dominate the clinical picture, survival will be poor regardless of the circuit. If support is initiated while respiratory failure remains potentially reversible and before systemic deterioration becomes irreversible, outcomes may be quite different.

4. Contemporary role of VV ECMO in severe ARDS

VV ECMO should be understood as part of a staged escalation strategy rather than a standalone procedure. Initial management of ARDS centers on lung-protective ventilation, appropriate PEEP, controlled plateau pressures, permissive hypercapnia when acceptable, and treatment of the underlying cause. Adjunctive measures include neuromuscular blockade, prone positioning when feasible, conservative fluid management when compatible with perfusion goals, recruitment maneuvers in selected patients, and inhaled pulmonary vasodilators. ECMO is considered when these interventions cannot maintain adequate gas exchange without injurious ventilator settings.

Typical indications include refractory hypoxemia, often reflected by a sustained PaO2/FiO2 ratio below 80 despite maximal conventional therapy, and severe hypercapnic respiratory failure with pH below approximately 7.25 despite safe ventilator settings. ECMO may also serve as a bridge to recovery, bridge to decision, or bridge to transplant in selected patients. Contraindica-

Domain	Consideration
Potential indications	Refractory hypoxemia despite optimized ventilation; severe hypercapnic acidosis; inability to maintain gas exchange without injurious ventilator settings; potentially reversible respiratory failure.
Favorable features	Younger age; isolated or predominant inhalation injury; limited or moderate TBSA; preserved neurologic function; absence of irreversible organ failure; early referral before prolonged injurious ventilation.
High-risk features	Advanced age; very large TBSA; profound acidosis; renal failure requiring CRRT; uncontrolled sepsis; multiple organ dysfunction; uncontrolled bleeding; inability to anticoagulate safely.
Burn-specific cautions	Need for serial excision and grafting; vascular access through burned tissue; unreliable aPTT; capillary leak; infection risk; difficulty with prone positioning.

Table 1. Practical indications and cautions for VV ECMO in severe burn-associated ARDS.

tions are usually relative rather than absolute, but prolonged high-intensity mechanical ventilation, irreversible neurological injury, severe immunosuppression, advanced malignancy, uncontrolled bleeding, and irreversible multisystem organ failure all reduce the likelihood of benefit.

The RESP score is useful for framing prognosis in adult patients receiving respiratory ECMO, but it has not been validated specifically in burns. It includes variables such as age, duration of ventilation before ECMO, immunocompromised status, central nervous system dysfunction, nonpulmonary infection, neuromuscular blockade, nitric oxide use, bicarbonate infusion, and cardiac arrest. Important burn-specific variables, including TBSA, inhalation injury, timing of excision, and burn-related coagulopathy, are not fully captured. The score should therefore support, not replace, burn-specific clinical judgment.

For surgeons, the essential ECMO physiology can be stated briefly. VV ECMO drains venous blood, passes it through a membrane oxygenator, removes carbon dioxide, adds oxygen, and returns oxygenated blood to the venous circulation. Native cardiac function remains responsible for systemic perfusion. VV ECMO therefore supports gas exchange, not circulation. Its clinical value lies in allowing lower ventilator pressures, lower FiO_2, and reduced ventilator-induced lung injury while the lungs recover. In burn patients, the technical act of oxygenation is rarely the hardest problem. The harder problems are timing, patient selection, access, anticoagulation, surgery, infection control, renal replacement, and multidisciplinary coordination.

5. What the burn ECMO literature shows

The burn ECMO literature is limited but informative. Unlike general ARDS, burn patients have not been studied in large randomized trials. Most evidence comes from retrospective cohorts, case series, and registry analyses. These studies differ in patient selection, burn severity, inhalation injury, ECMO timing, anticoagulation strategies, and institutional expertise. Nevertheless, several themes recur.

First, severe respiratory failure requiring ECMO is uncommon. Even among mechanically ventilated burn patients, only a small subset progresses to refractory hypoxemia or hypercapnia severe enough to justify extracorporeal support. These patients often have inhalation injury, severe inflammatory lung injury, or both. Importantly, TBSA alone does not define respiratory risk. Isolated inhalation injury may produce life-threatening ARDS in patients with minimal cutaneous burns, while patients with large burns may avoid severe ARDS if airway injury is absent and systemic complications are controlled.

Second, poor outcomes correlate strongly with systemic illness. Across published series,

Study / source	Design and population	Key findings	Interpretation
German cohort	Single-center retrospective study, 2012-2022; 21 burn patients treated with VV ECMO.	Survival approximately 24%; mortality associated with larger TBSA, acidosis, renal failure, RRT, and MODS.	Poor outcomes likely reflected systemic severity and advanced organ dysfunction.
PRONOBURN, France	Retrospective multicenter experience, 2013-2016; 609 burn admissions, 82 ARDS, 11 ECMO.	Approximately 91% in-hospital mortality among ECMO patients.	Patients were profoundly ill at cannulation; results caution against very late salvage use.
DMC Burn Program	Single-center retrospective institutional experience, 2020-2026; 12 patients.	Observed mortality approximately 17%; mean P/F 62; mean ECMO duration 21.4 days.	Contemporary multidisciplinary care and selection may yield substantially better outcomes.
ELSO registry	International registry experience; not burn-specific.	Adult pulmonary ECMO survival to discharge/transfer approximately 60%.	Provides broad benchmark but not burn-specific risk adjustment.

Table 2. Selected burn ECMO experiences discussed in the presentation.

advanced age, larger TBSA, metabolic acidosis, renal failure requiring CRRT, and multiple organ dysfunction are repeatedly associated with mortality. Oxygenation severity alone is less discriminating because most candidates for ECMO already have severe ARDS at the time of consideration. The practical implication is that ECMO candidacy must focus on reversibility and physiologic reserve, not simply the depth of hypoxemia.

Third, survival varies widely among reports. A German single-center retrospective study over 10 years included 21 burn patients receiving VV ECMO and reported survival of approximately 24%. Non-survivors had larger burns, worse acidosis, higher SOFA and ABSI scores, more renal failure, greater need for renal replacement therapy, and more multiple organ dysfunction. The French PRONOBURN experience was even more discouraging: among 11 burn patients requiring ECMO, in-hospital mortality was approximately 91%. These patients were profoundly ill at cannulation, with severe hypoxemia, acidosis, high plateau pressures, poor compliance, and high SOFA scores.

These results can be read pessimistically, as evidence that ECMO has little role in burns. A more useful interpretation is that ECMO was applied to patients with advanced systemic deterioration. In that setting, extracorporeal gas exchange may be technically successful but clinically insufficient. ECMO can rest the lungs; it cannot reverse irreversible multiple organ failure, uncontrolled sepsis, or non-survivable burn physiology. The DMC experience suggests that outcomes may differ when patients are selected and managed within a contemporary multidisciplinary program before irreversible deterioration has occurred.

6. Detroit Medical Center institutional experience

Methods

A retrospective review was performed of patients treated with VV ECMO for burn-associated severe ARDS at the Detroit Medical Center Burn Program between July 2020 and March 2026. Eligible patients sustained acute thermal injury, inhalation injury, or both, and developed severe ARDS or refractory hypoxemia despite maximal conventional therapy. Patients were considered for extracorporeal support after optimization of lung-protective ventilation and appropriate adjunctive therapies, which could include neuromuscular blockade, inhaled pulmonary vasodilators, corticosteroids, and prone positioning when feasible. The decision to cannulate was made through multidisciplinary consultation involving burn surgery, surgical critical care, and the ECMO team.

Variables abstracted included age, sex, injury mechanism, TBSA, presence of isolated inhalation injury, pre-cannulation PaO2/FiO2 ratio, use of adjunctive therapies, time from admission or respiratory failure to cannulation, duration of ECMO support, observed mortality, and discharge disposition. Observed mortality was compared with predicted mortality estimated by the Revised Baux score and APACHE II. Because of the small cohort size, analysis was descriptive. The purpose of the review was not to establish causal efficacy but to characterize contemporary outcomes and compare them with published experience.

Results

Twelve patients met inclusion criteria. The mean age was approximately 45 years. Nine patients were male and three were female. Injury mechanisms included flame burns in seven patients, electrical injury in one patient, and isolated inhalation injury in four patients. Mean TBSA was approximately 24%, but the range was wide, from less than 1% to more than 80%. This range emphasizes that severe respiratory failure in the burn population is not determined by cutaneous burn size alone.

The cohort was severely hypoxemic immediately before ECMO. Mean pre-cannulation PaO2/FiO2 ratio was approximately 62, placing the patients firmly within severe ARDS. Conventional therapies were used before cannulation according to clinical circumstances. Neuromuscular blockade was common. Inhaled vasodilators, systemic steroids, and prone positioning were used selectively, reflecting both physiologic indications and practical constraints imposed by burns, wounds, and operative needs.

Mean time to cannulation was 7.3 days, and mean ECMO run time was 21.4 days. Observed mortality was approximately 17%, substantially lower than the mortality reported in the German and French series and lower than mortality predicted by conventional scoring systems in the DMC cohort. Half of the patients were discharged

Variable	Value
Number of patients	12
Sex	9 male / 3 female
Mean age	45 ± 15 years
Injury mechanisms	Flame 7; electrical 1; isolated inhalation 4
Mean TBSA	24 ± 27%
TBSA range	0.3%-83%
Mean pre-ECMO P/F ratio	62 ± 21
Mean time to cannulation	7.3 days
Mean ECMO run time	21.4 days
Observed mortality	17%
Home discharge	50%

Table 3. Detroit Medical Center burn ECMO cohort, July 2020-March 2026.

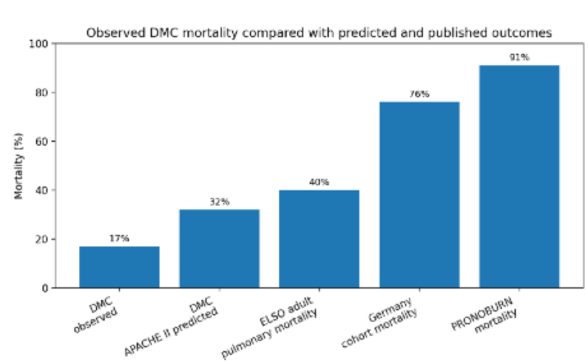

Figure 3. DMC observed mortality compared with predicted mortality and published outcomes.

home, with others discharged to rehabilitation, long-term acute care, or psychiatric care as clinically indicated. These outcomes suggest that prolonged ECMO support in burn-associated ARDS can be compatible with meaningful recovery in selected patients.

Discussion of the institutional experience

The DMC experience is striking because it differs so substantially from several earlier published series. A small retrospective cohort cannot prove that ECMO caused improved survival, and selection bias is unavoidable. Patients selected for ECMO may have had reversible disease and physiologic reserve that distinguished them from patients not offered support. Nevertheless, the observed outcomes demonstrate that excellent survival is achievable in a contemporary burn-ECMO program.

Several explanations are plausible. First, patient selection may have been more favorable, with support offered to patients whose respiratory failure was severe but still reversible. Second, cannulation may have occurred before progression to irreversible multiple organ dysfunction in a larger proportion of patients. Third, DMC combines burn expertise with access to ECMO resources, allowing integration of respiratory support with operative burn care rather than treating ECMO as an isolated rescue procedure. Fourth, the cohort reflects a modern era of extracorporeal technology, critical care, and anticoagulation practice. Finally, accumulated institutional experience may have improved coordination around cannulation, anticoagulation, operative timing, transfusion, infection control, and decannulation.

The most appropriate interpretation is therefore cautious optimism. The DMC results do not justify routine ECMO in all burn patients with ARDS. They do justify early multidisciplinary discussion when a burn patient has severe, potentially reversible respiratory failure and conventional therapy is failing. The data also support the view that historical pessimism may reflect late salvage use in profoundly ill patients rather than the intrinsic ineffectiveness of ECMO in burns.

7. Practical management considerations in burn ECMO

The dominant practical issue in burn ECMO is not the oxygenator; it is the integration of extracorporeal support with burn surgery. Cannulation requires careful selection of access sites. Extensive eschar over the neck or groin may make standard cannulation more difficult and increase infection risk. Ultrasound-guided access to unburned or minimally injured sites is preferred when feasible. Dual-cannula femoral-internal jugular configurations are widely used, while dual-lumen bicaval internal jugular cannulas may facilitate mobilization in selected patients but require appropriate imaging and operator expertise.

Anticoagulation is the central dilemma. ECMO circuits are thrombogenic and generally require systemic anticoagulation. Burn surgery, by contrast, often requires early tangential excision and grafting of large raw surfaces where bleeding can be substantial even without anticoagulation. Management therefore requires continuous coordination between burn surgeons, intensivists, perfusionists, anesthesiologists, pharmacists, and nurses. Anticoagulation may need to be reduced or temporarily interrupted around operations, then restarted promptly to protect the circuit.

Monitoring anticoagulation is also more complex in burns. aPTT may be unreliable because factor VIII is an acute-phase reactant, and burn patients may develop acquired antithrombin deficiency through capillary leak and consumption. Anti-Xa monitoring and direct thrombin inhibitors such as bivalirudin are increasingly used in high-volume centers, although comparative evidence remains limited. The correct strategy should be individualized and revisited frequently.

Operative management should not necessarily be delayed until decannulation. Burn wounds still require source control, excision, grafting, and

Issue	Burn-specific problem	Practical implication
Cannulation	Eschar or wounds may overlie standard access sites.	Prioritize unburned sites, ultrasound guidance, and planning around operative positioning.
Anticoagulation	Circuit thrombosis risk conflicts with excision-related hemorrhage.	Coordinate anticoagulation changes around operations; monitor closely for bleeding and circuit clot.
Monitoring	aPTT may be unreliable; antithrombin deficiency may reduce heparin effect.	Consider anti-Xa monitoring or direct thrombin inhibitors where appropriate.
Operations	Serial excision and grafting may be necessary during ECMO.	Do not delay essential burn care solely because of ECMO; plan with anesthesia and perfusion.
Renal failure	CRRT is repeatedly associated with poor outcomes.	Treat AKI as a major prognostic and management variable.
Rehabilitation	Prolonged runs risk deconditioning.	Begin mobilization and rehabilitation as soon as cannulation strategy and stability permit.

Table 4. Practical management issues unique to burn patients receiving VV ECMO.

dressing management. Available experience suggests that the number of trips to the operating room while on ECMO is not by itself a determinant of mortality. The more important determinants are physiologic reserve, renal function, sepsis control, and whether surgery can be performed safely with coordinated anticoagulation and transfusion planning.

Successful burn ECMO is therefore a program, not a procedure. It requires the combined expertise of burn surgery, surgical critical care, ECMO specialists, perfusion, anesthesia, respiratory therapy, pharmacy, nutrition, rehabilitation, and specialized nursing. The circuit may support the lungs, but the system of care supports the patient.

8. Discussion

The available evidence suggests that the role of VV ECMO in burn-associated ARDS has been underestimated when judged solely by older or highly selected pessimistic series. Earlier reports showed poor survival, but they also described patients with profound acidosis, renal failure, high illness severity scores, and established multiple organ dysfunction. In that setting, ECMO may restore gas exchange without changing the

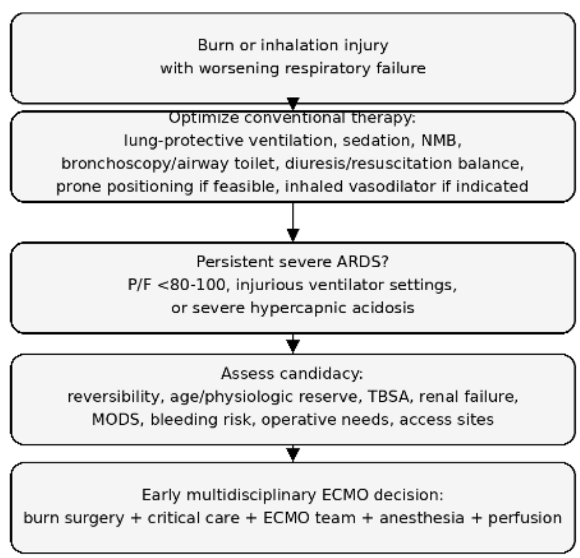

Figure 4. Proposed burn-specific decision framework for considering VV ECMO in severe burn-associated ARDS.

outcome because the dominant problem is no longer isolated respiratory failure.

The DMC experience supports a different interpretation. In a contemporary multidisciplinary burn program, carefully selected patients with severe respiratory failure can survive at rates approaching or exceeding those expected in broader respiratory ECMO cohorts. The central determinants appear to be timing, reversibility, and system-level expertise. This does not mean ECMO should be used broadly. It means that severe burn or inhalation injury should not be considered a categorical barrier to ECMO when the respiratory process remains potentially reversible.

The terminology of rescue therapy may itself require refinement. ECMO is certainly a rescue therapy in the sense that it is used when conventional treatment fails. But if rescue means waiting until death is imminent and multiple organ failure is irreversible, then the concept is harmful. Contemporary burn ECMO should be considered rescue before collapse: a therapy used when ongoing conventional ventilation is likely to worsen injury and when extracorporeal support may preserve the possibility of recovery.

Several limitations must be acknowledged. The DMC series is retrospective, single-center, and small. It lacks a contemporaneous non-ECMO control group. Selection bias is unavoidable. Mortality prediction using Revised Baux and APACHE II is imperfect because neither model was developed specifically for burn patients receiving ECMO. The institutional data should therefore be interpreted as hypothesis-generating. They demonstrate feasibility and favorable contemporary outcomes, not definitive efficacy.

Future progress will require multicenter collaboration. Because burn ECMO is uncommon, randomized trials are unlikely. More realistic goals include standardized registry reporting, burn-specific ECMO variables, common definitions of timing and rescue therapy, and collaborative analyses comparing outcomes by TBSA, inhalation injury, renal failure, cannulation timing, and anticoagulation strategy. The field also needs burn-specific prognostic tools rather than reliance on general ECMO scores that omit key features of thermal injury.

9. Conclusions

VV ECMO should not be considered routine therapy for burn-associated ARDS, but neither should it be reserved only for patients in irreversible physiologic collapse. Burn patients differ from other ARDS populations because respiratory failure occurs in the context of inhalation injury, systemic inflammation, massive fluid shifts, repeated surgery, coagulopathy, infection, and hypermetabolism. These features increase risk, but they do not eliminate the possibility of benefit.

The contemporary evidence supports disciplined optimism. Patients most likely to benefit are those with severe but potentially reversible respiratory failure, acceptable physiologic reserve, and no established irreversible multiple organ dysfunction. Poor candidates include patients with advanced systemic deterioration, uncontrolled sepsis, profound acidosis, severe renal failure requiring CRRT, or non-survivable burn burden. The DMC experience suggests that when selection is careful and management occurs within an experienced multidisciplinary burn-ECMO program, outcomes can be substantially better than historical reports imply.

The practical message for burn surgeons is clear: ECMO should be discussed early, not reflexively and not belatedly. The decision is neither a purely respiratory decision nor a purely technological one. It is a burn critical care decision requiring integration of pulmonary physiology, operative planning, anticoagulation, organ failure, and institutional capability. Used in that manner, VV ECMO represents a valuable contemporary option for selected patients with burn-associated severe ARDS.

* * *

Key clinical messages

- Burn-associated ARDS is a distinct clinical entity and should not be managed by extrapolation from general ARDS alone.
- ECMO candidacy depends on reversibility, timing, physiologic reserve, and systemic organ dysfunction, not oxygenation indices alone.
- Advanced age, large TBSA, renal failure requiring CRRT, metabolic acidosis, and MODS are recurrent predictors of poor outcome.
- The main management conflict is anticoagulation for circuit patency versus bleeding risk during serial excision and grafting.
- The DMC experience suggests that contemporary multidisciplinary burn-ECMO programs can achieve outcomes better than historical series imply.

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