Evaluating the Potential Use of VV-ECMO Services for Patients with Severe ARDS

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Background

Acute respiratory distress syndrome (ARDS) is a condition of acute respiratory failure, which develops under several clinical conditions such as bacterial and viral pneumonia (including COVID-19), prolonged mechanical ventilation and more[1]. In an international prospective study, LUNG SAFE, 10% of the admissions to the intensive care unit (ICU) were accounted for by ARDS events, with a hospital mortality of 40%[2]. Veno-venous extracorporeal membrane oxygenation (VV-ECMO) is a rising treatment modality utilized in cases of severe ARDS that has shown to be a cost-effective treatment improving survival rates and other patient outcomes[2,3]. Thus, identification of patients eligible for VV-ECMO would aid in future program planning and tertiary prevention of poor patient outcomes.

Objectives

- Assess potential for scale-up efforts of VV-ECMO volume in Regina
- Identify number of severe ARDS patients eligible for VV-ECMO in the ICU admissions at Regina General Hospital (RGH)
- Synthesize a local eligibility criteria and practice guidelines for use of VV-ECMO in Regina, through a consensus-based modified Delphi study (ongoing)

Methods

Brief Literature Review

- Literature review was conducted on the epidemiology of VV-ECMO use for ARDS as well as selection criteria and contraindications for VV-ECMO use across countries around the world.
- Databases used: PubMed, the Cochrane Library, Ovid MEDLINE.
- Main MeSH terms used: Respiratory Distress Syndrome, Extracorporeal Membrane Oxygenation, Incidence, Epidemiology.

Retrospective Chart Review

- Data abstraction: ICU admissions charts of 415 patients admitted from October 16, 2018 to January 21, 2021 were reviewed at HIMS Department of RGH, using Sunrise Clinical Manager system.
- Data storage: REDCap (an online database).
- Data analysis: Descriptive Statistics, χ^2 or Fisher's Exact Test for categorical variables, T-test or Mann-Whitney U Test for continuous variables
- VV-ECMO eligibility: Selection criteria and contraindications from: Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome trial (EOLIA), Extracorporeal Life Support Organization (ELSO), Critical Care Services Ontario (CCSO) and ECMO referral program in New South Wales, Australia (NSW).

Results

Table 1: Demographics and outcomes of ICU-admitted patients with ARDS eligible for VV-ECMO by EOLIA, ELSO, New South Wales and CCSO criteria

	EOLIA Criteria (N = 7)	ELSO Criteria (N = 6)	NSW Criteria (N=20)	CCSO Criteria (N=24)
Criteria met, N (%)	7/415 (1.7%)	6/415 (1.5%)	20/415 (4.8%)	24/415 (5.8%)
Age, median years (IQR)	67 (54-70)	49 (31-69)	64 (47-74)	67 (54-73)
Hospital length of stay, median days (IQR)	8 (1-10)	1 (1-9)	12 (3-24)	20 (11-30)
In-hospital mortality, N (%)	6/7 (85.7%)	5/6 (83.3%)	13/20 (65.0%)	12/24 (50%)

Table 2: Comparison of ventilation parameters between all ECMO-eligible and ECMO non-eligible patients admitted to the ICU

	Eligible for EMCO	Non-eligible for ECMO	p-value
Positive end expiratory pressure, median cmH_20 (IQR)	14 (10-18)	10 (8-14)	0.001
Peak inspiratory pressure, median cmH_20 (IQR)	40 (31-44)	30 (25-36)	0.000
Arterial pH, median (IQR)	7.18 (7.11-7.31)	7.30 (7.21-7.38)	0.001
PaO_2/FiO_2, median (IQR)	110 (66-164)	180 (114-266)	0.001
Tidal volume, median ml/kg (IQR)	7.4 (6.9-7.8)	7.8 (7.2-8.3)	0.02
Actual delivered tidal volume, median ml/kg (IQR)	8.3 (7.3-9.9)	8.5 (7.8-9.8)	0.60

Table 3: Use of ventilation strategies and adjunctive therapies across different severities of ARDS, based on Day 1 of mechanical ventilation

	Mild ARDS (N=103)	Moderate ARDS (N=175)	Severe ARDS (N=64)	p-value
Low tidal volume ventilation, N (%)	58 (56.3%)	95 (54.3%)	44 (68.7%)	0.25
High PEEP strategy, N (%)	4 (3.9%)	3 (1.7%)	4 (6.3%)	0.01
Prone positioning, N (%)	6 (5.8%)	27 (15.4%)	23 (35.9%)	0.001
Neuromuscular blockade, N (%)	12 (11.7%)	27 (15.4%)	24 (37.5%)	0.001

Discussion and Conclusion

Between 6 to 24 patients of the 415 admitted to RGH ICU were eligible for VV-ECMO (over a duration of 2.3 years) with use of the EOLIA, ELSO, Australia and CCSO criteria respectively. However, only one patient received ECMO. With these observed number of patients eligible for VV-ECMO, expected case load of VV-ECMO should be between 3 to 10 cases per year. In comparison to results observed in ECMO-eligible patients in our study, ARDS patients randomized to receive ECMO in the EOLIA trial had a lower mean age of 52 and received a lower tidal volume of mean 6.0 ml/kg with a greater percentage of ECMO patients having received prone positioning (56%) and neuromuscular blockade (92%)[4]. Results indicated low usage of high PEEP (positive-end expiratory pressure) and low tidal volume ventilation (two strategies recommended by CCSO for use in patients with severe ARDS). In-hospital mortality rates were smaller (36%) and hospital length of stay was longer with a median of 36 days in ECMO-group of the EOLIA trial compared to ECMO-eligible groups in our study[4]. In conclusion, the study highlights the potential to increase VV-ECMO services in Regina as well as many areas for quality improvement in management of ARDS disease.

Recommendations

- Consider implementation of a Saskatchewan-based ECMO referral program to a main tertiary centre in order and/or establish partnership with existing ECMO programs in other provinces (to meet suggested volume to optimize outcomes)
- Protocolize care for ARDS by establishing local guidelines for treatment strategies across different severities of ARDS (similar to CCSO guidelines)
- Implement staff education through educational programs to increase clinician recognition of ARDS and adherence to established ARDS protocol
- Optimize use of adjunctive therapies like prone positioning and neuromuscular blockade, and ventilation strategies like low tidal volume and high PEEP ventilation

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