with ECMO for COVID-19 ARDS will ultimately require lung transplantation. Second, in those patients who ultimately require lung transplantation, a period of rehabilitation, even if these patients are oxygen dependent, may result in more rapid recovery from their eventual transplantation.

The limitations of this study are inherent in its retrospective, observational design. Selection bias is unavoidable and acknowledged; similar bias exists in all available COVID-19 ECMO data. To date, patients with severe COVID-19 have not been randomized to ECMO vs medical therapy. In our opinion, it is the role of the ECMO team to select appropriate patients for this strategy. ECMO is a potentially lifesaving resource that is time intensive and costly. Allocation of such resources was even more complex at the beginning of this global pandemic. The need to avoid futile procedures was heightened by limited resources, including trained staff and health care providers and personal protective equipment. Similarly, the risk to the providers of these procedures was unknown. With this in mind, we chose to avoid offering ECMO as only salvage therapy.

In conclusion, with appropriately selected patients and aggressive management strategies, the use of ECMO support in patients with severe COVID-19 can result in exceptional early survival that, in this cohort, was sustained at 1 year after ECMO cannulation.

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ECMO in COVID-19: Continued Variable Outcomes

INVITED COMMENTARY:

In this issue of *The Annals of Thoracic Surgery*, Smith and colleagues[1] present a mid-term follow up for patients cannulated for venovenous extracorporeal membrane oxygenation (VV-ECMO) during the first wave of the COVID-19 pandemic. The authors seek to expand our understanding of outcomes post-discharge, a topic that has not been clearly addressed. The present analysis includes 30 patients cannulated over 3 months at a single institution, and demonstrates impressive survival—86.7% at a median follow-up of 10.8 months. Significantly, all surviving patients were home, most (25 of 26) required no supplemental oxygen, and pulmonary function tests had generally returned to baseline. These data are in sharp contrast to much of the initial VV-ECMO reports available during the time frame described (March to May 2020), where survival was

noted to be significantly worse than that seen in non-COVID-19 VV-ECMO patients.[2]

Possible reasons for the difference between the current study and other, larger reports from the same period include the somewhat younger and healthier population seen here. The median age and pre-ECMO PaO_2/FiO_2 ratio of this cohort are more favorable at 42 years and 80.0 mm Hg, as compared to 52 years and 61 mmHg reported by Lebreton and colleagues.[3] Similarly, more patients in previous studies required renal replacement therapy and vasoactive infusions pre-ECMO and during support compared with the current study.[3] Additionally, the shorter time from intubation to cannulation, 2 days here vs 5 days for Lebreton and associates,[3] may have partially mitigated the deleterious effect of positive pressure ventilation.

Although this study is notably limited by short follow-up, single-center cohort design, and low number of patients, it does provide further indication that acceptable COVID-ECMO outcomes are possible. These outcomes, and the notably disparate results compared with early data, are possible in significant part because of changes in management adopted for this population. Longer ECMO runs, frequent concurrent interventions (prone positioning on ECMO, routine bronchoscopy), alterations to cannulation strategies, and other changes to management and selection are likely driving outcomes. How these changes will affect patients in the longer term, or indeed how they can be applied to non-COVID respiratory failure patients, remains to be seen. Furthermore, our long-term "exit strategy" in COVID-ECMO now includes lung transplantation in select cases, with over 200 performed to date and demonstrating favorable outcomes.[4] Much as ECMO runs in excess of 100 days have gone from the extreme to the norm (or at least not unanticipated), managing refractory lung failure stemming from viral illness with lung transplantation would have been extremely rare up until this pandemic.

With over 12,000 COVID-ECMO cases worldwide, it is clear that we have accepted ECMO as a therapy for these patients. But with continued variable outcomes, and an Extracorporeal Life Support Organization registry mortality of 48%,[5] it is also clear that the optimal use of this modality has yet to be determined.

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