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Original Article

Survival of patients with cystic fibrosis on ECMO: analysis of the Extracorporeal Life Support Organization Registry

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Abstract: Progressive respiratory failure is a common cause of death in patients with cystic fibrosis (CF). Although this may be related to the disease process itself, acute infectious problems may lead to respiratory failure requiring mechanical ventilation. Given the progressive nature of the disorder, some have suggested that the use of extracorporeal membrane oxygenation (ECMO) is contraindicated. The current study retrospectively reviewed the Extracorporeal Life Support Organization (ELSO) Registry to evaluate the outcomes following the use of ECMO in patients with CF. A total of 73 ECMO runs were identified in CF patients. There were 33 who received VV ECMO, 32 on VA ECMO, and 8 who received combined VA and VA ECMO. The overall survival rate for the cohort was 52% (38 of 73 patients). There was no difference in survival when comparing VA and VV ECMO. We noted an increasing trend for VV ECMO for this patient population over this time period. These data further support the need for a prospective study to evaluate outcomes following ECMO in this population with standardization of care across multiple centers.

Keywords: Cystic fibrosis, extracorporeal membrane oxygenation, survival, venoarterial, venovenous

Introduction

Due to the earlier detection of cystic fibrosis (CF) and advances in preventative measures, therapeutics, and technology, the current average survival of afflicted patients is approximately 37 years [1]. A vital part of the care for CF patients often includes support during acute respiratory failure. Interestingly, mechanical ventilation was initially discouraged in reports from the medical literature over 30 years ago due to universally poor outcomes [2]. More recently, the expected survival in patients with CF and respiratory failure requiring invasive mechanical ventilation has improved due to various strategies including the use of extracorporeal membrane oxygenation (ECMO) to bridge CF patients to lung transplantation [3-5]. Despite the evolving use of these methods of respiratory support for CF patients with respiratory failure, mechanical ventilation and ECMO continue to be contraindications for lung transplant at some centers.

Both venoarterial (VA) and venovenous (VV) modes of ECMO can provide cardiopulmonary support with the potential for long-term survival with resolution of the acute process or as a bridge to transplantation [6-8]. We retrospectively reviewed the Extracorporeal Life Support Organization (ELSO) Registry to evaluate the outcomes following the use of ECMO in patients with CF [9].

Methods

The ELSO Registry contains data from more than 170 worldwide centers with over 45,000 cases reported. The ELSO uses a "limited data set" of information including gender, race,

Table 1. Demographics of study cohort

Patient groups	Number of patients*	Age in years (mean ± SEM)	Male/Female (number)*
Alive (All patients)	38	26.2 ± 1.8	12/25
Expired (All patients)	35	23.0 ± 1.8	16/18
Alive (VV ECMO)	19	28.6 ± 2.8	6/12
Expired (VV ECMO)	14	22.6 ± 2.7	5/8
Alive (VA ECMO)	14	23.0 ± 2.4	3/11
Expired (VA ECMO)	18	22.2 ± 2.6	10/8
Alive (VA-VV ECMO)	5	26.1 ± 5.1	3/2
Expired (VA-VV ECMO)	3	30.0 ± 7.6	1/2

*Gender missing for 2 patients from VV ECMO series. VA = venoarterial. VV = venovenous. ECMO = extracorporeal membrane oxygenation.

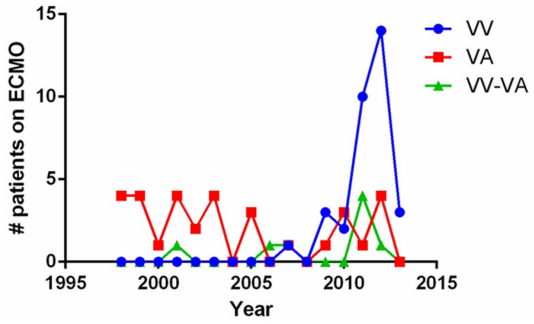

Figure 1. The number of extracorporeal membrane oxygenation runs since 1998. VA = venoarterial, VV = venovenous.

nature and severity of illness, technical details of extracorporeal support used, complications and outcome [9]. We queried the ELSO Registry for all CF patients who received ECMO support between January 1998 and April 2013.

Results

A total of 73 ECMO runs were identified in CF patients during the study time period. The demographics of these patients including their eventual outcome are outlined in **Table 1**. There were 33 who received VV ECMO, 32 on VA ECMO, and 8 who received combined VV and VA ECMO. The overall survival rate for the cohort was 52% (38 of 73 patients). As only 8 patients were treated with combined VV and VA ECMO, statistical analysis was not feasible and they were excluded from further analysis. The overall survival percentages between VV and VA ECMO were not different. Fifty-six percent (19 of 33 patients) of those receiving VV ECMO survived versus 44% (14 of 32) of those receiving VA ECMO (P = NS). **Figure 1** illustrates the trends in VA versus VV ECMO utilization for patients with CF since 1998. We noted an increasing trend for VV ECMO for this patient population over this time period.

Discussion

Acute hypercapnic respiratory failure with worsening respiratory acidosis is a common occurrence in patients with CF and advanced lung disease. Although initial therapies may include non-invasive ventilation or the progression to endotracheal intubation and controlled ventilation, progressive respiratory failure may require extracorporeal support in an attempt to achieve long-term survival. In general such support is generally not indicated unless the primary etiology of the respiratory failure is thought to be reversible. As such, there has been a hesitancy to implement such aggressive therapies in patients with end-stage CF. However, in the current cohort of patients, survival was more than 50% with 38 of 73 patients surviving their ECMO run.

When extracorporeal support is chosen, options include either the VA or VV mode. Both of these approaches require a pump that is capable of generating flow rates of 3-5 liters per minute to ensure sufficient organ perfusion and oxygenation in adults and adolescents. Our experience, and personal bias, is to implement VV ECMO in patients with primary respiratory failure given its less invasive nature and improved adverse effect profile with compared with VA techniques [10]. Improvements in technology have made VV ECMO feasible using a single, bilumen cannula [10, 11]. In the setting of respiratory and right ventricular failure, VA or VV-VA ECMO are options to consider; however, VV ECMO may require the facilitation of right-to-left atrial level shunting via atrial septostomy to maintain systemic hemodynamic function. As the ELSO Registry does not identify patients who underwent atrial septostomy, these outcomes could not be evaluated.

Limiting factors in our analysis include the small cohort size and the restricted peri-ECMO data recorded by the ELSO registry. The data available did not permit development of predic-

tive modeling, which may provide the ability to ascertain which CF patients are best served by ECMO. Despite these limitations and lack of standardization of care, our findings clearly demonstrate the potential for effective survival following ECMO in patients with CF and respiratory failure that cannot be treated with conventional techniques of mechanical ventilation. These data further support the need for a prospective study to look at outcomes following ECMO in this population with standardization of care across multiple centers. There should also be consideration of prospective trials comparing VA with VV techniques. Despite the progressive nature of CF and the high mortality once respiratory failure has developed, aggressive support with ECMO is not futile in this patient population.

Disclosure of conflict of interest

None to declare.

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References

[1] Cystic Fibrosis Foundation Patient Registry. 2011 Patient Registry Annual Data Report. http://www.cff.org/UploadedFiles/research/ClinicalResearch/2011-Patient-Registry.pdf. Accessed September 20, 2012.

[2] Davis PB, di Sant'Agnese PA. Assisted ventilation for patients with cystic fibrosis. JAMA 1978; 239: 1851-4.

[3] Hayes D Jr, Mansour HM. Improved outcomes of patients with end-stage cystic fibrosis requiring invasive mechanical ventilation for acute respiratory failure. Lung 2011; 189: 409-15.

[4] Hayes D Jr, Kukreja J, Tobias JD, Ballard HO, Hoopes CW. Ambulatory venovenous extracorporeal respiratory support as a bridge for cystic fibrosis patients to emergent lung transplantation. J Cyst Fibros 2012; 11: 40-5.

[5] Hoopes CW, Kukreja J, Golden J, Davenport DL, Diaz-Guzman E, Zwischenberger JB. Extracorporeal membrane oxygenation as a bridge to pulmonary transplantation. J Thorac Cardiovasc Surg 2013; 145: 862-7.

[6] Bermudez CA, Rocha RV, Sappington PL, Toyoda Y, Murray HN, Boujoukos AJ. Initial experience with single cannulation for venovenous extracorporeal oxygenation in adults. Ann Thorac Surg 2010; 90: 991-5.

[7] Fuehner T, Kuehn C, Hadem J, Wiesner O, Gottlieb J, Tudorache I, Olsson KM, Greer M, Sommer W, Welte T, Haverich A, Hoeper MM, Warnecke G. Extracorporeal membrane oxygenation in awake patients as bridge to lung transplantation. Am J Respir Crit Care Med 2012; 185: 763-8.

[8] Javidfar J, Brodie D, Iribarne A, Jurado J, Lavelle M, Brenner K, Arcasoy S, Sonett J, Bacchetta M. Extracorporeal membrane oxygenation as a bridge to lung transplantation and recovery. J Thorac Cardiovasc Surg 2012; 144: 716-21.

[9] Extracorproeal Life Support Organization ECMO Registry. Available at: http://www.elsonet.org/index.php/registry.html. Accessed April 11, 2013.

[10] Hayes D Jr, Tobias JD, Kukreja J, Preston TJ, Yates AR, Kirkby S, Whitson BA. Extracorporeal life support for acute respiratory distress syndrome. Ann Thor Med 2013; 8: 133-141.

[11] Hayes D Jr, Yates AR, Duffy VL, Tobias JD, Mansour HM, Oshlove VF Jr, Preston TJ. Placement of a bicaval dual-lumen catheter in a swine model of venovenous extracorporeal membrane oxygenation. J Investigative Surg 2014; 27: 27-31.