Analysis of 75 consecutive COVID-19 ECMO cases in Warsaw Centre for Extracorporeal Therapies

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INTRODUCTION

The spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has become a rapidly devastating global pandemic. Veno-venous extracorporeal membrane oxygenation (V-V ECMO) may be a highly effective and lifesaving therapy for acute refractory respiratory failure (ARRF) in the context of acute respiratory compromise such as that induced by SARS-CoV-2. Recent studies indicate that there is a 35%–50% mortality rate for critically ill patients. However, since the increased prevalence of the British variant strain of COVID-19, patient mortality while on extracorporeal circulation has increased dramatically. This is despite the growing medical experience with COVID-ECMO, previous ECMO therapies, patient selection, and the objectively lower number of serious complications caused by therapy [1]. The study aims to outline the differences between COVID-ECMO during the first and next waves of the pandemic, with a particular interest in mortality, patient characteristics, and referral destination. The current study was not subjected to review by a bioethical committee. The data are anonymous, retrospectively collected, and derived from a single-center registry.

Having predicted the necessity to support patients critically ill with COVID-19 ARRF with V-V ECMO, and in order to make optimal use of the expertise and resources of the Clinical Department of Cardiac Surgery (Central Clinical Hospital of the Ministry of Interior and Administration), this study founded The Centre for Extracorporeal Therapies (CET) at the beginning of the pandemic, on March 20th, 2020. The CET has since been serving as a subunit of the Clinical Department of Cardiac Surgery, using the expertise of cardiac anesthetists, cardiac surgeons, cardiologists, perfusionists, and intensivists and admitting patients from the entire voivodeship and beyond. Recently, due to the growing number of patients requiring extracorporeal therapy, the CET has expanded and now includes the general Department of Anesthesiology and Intensive Care (Central Clinical Hospital of the Ministry of Interior and Administration).

The CET team also established the mobile-ECMO team for patients experiencing mobility barriers. This team involving an anesthetist, cardiac surgeon, and perfusionist to ensure complications can be safely addressed while *en-route* to the CET. In close cooperation with the Polish Medical Air Rescue service and Emergency Medical Services (EMS), this study also established dispatch and transport procedures for ECMO-dependent patients.

METHODS

The registry included all 75 consecutive cases of COVID-ECMOs admitted to our department between March 20th, 2020 to March 20th, 2021. Patients were candidates for ECMO therapy if they tested positive for COVID-19 or displayed a history of having contracted COVID-19. Patients also had to have met the criteria for ECMO support in ARRF as described by the Board of Intensive Care document and adopted by the Agency for Health Technology Assessment and Tariff System (AOTMIT) [2]. This study was approved by the Institutional Review Board but patient consent for inclusion in the registry was waived. Transesophageal echocardiography (TEE) was performed to assess ventricular function and determine the positioning of the ECMO cannulas. All patients underwent computed tomography to determine the extent of pulmonary involvement. When a transition to veno-arterial (V-A) ECMO was necessary, the ECMO heart team would meet this identified need.

Early mortality was defined as mortality (of any cause) during the index hospitalization or within 30 days of admission. Complications were identified through the application of institutional protocols and definitions.

This study examined patients that were treated in the first wave (March 20th 2020–July 30th 2020) vs the next waves (August 1st 2020–March 20th 2021) as per epidemic Renormalisation Group temporal definition [3]. Mean ± standard deviations (SD) were used for normally distributed variables, while for non-normal distributions median and interquartile range (IQR) were used and compared with the Mann–Whitney U test or standard t test as appropriate. A two-tailed *P*-value of <0.05 was considered significant. STATA MP 13.0 (StataCorp, College Station, TX) was used for data analyses.

RESULTS AND DISCUSSION

Seventy-five patients (15 [20.0%] women) underwent ECMO therapy to address COVID-19 symptoms; 16 (21.3%) were treated between March 20th, 2020 and July 30th 2020 and the remaining 59 (78.7%) were treated between August 1st, 2020 and March 20th, 2021. The prevalence of ARRF was the primary consideration for the application of ECMO therapy for all patients. Concomitant symptoms considered for the application of V-V ECMO therapy included sepsis (1 case), massive pulmonary embolism (1 case) and pulmonary PISZEMY AmEng edema (1 case). One patient presented with malignant ventricular arrhythmia and V-A ECMO. In 23 patients (30.6%), ECMO was applied off-site and patients were later transferred to the CET Warsaw location. Eight patients reached CET by air (Figure 1).

The mean age of patients treated before August 1st, 2020 was 53.6 years (SD 9.3) and was significantly higher than this of patients treated after August 1st, 2020 (46.8 [SD 8.5]); $P = 0.007$). The median duration from ventilator use to ECMO therapy was 7 (IQR [3–9]) days in the first temporal group vs 5 days (IQR [2–7]) in the second temporal group. However, this difference was not significant. The mean duration of ECMO therapy was 11 days (SD 6.8) in the first temporal group and 18 days (SD, 7.3) in the second (P <0.001). Ten patients (62.5%) were successfully weaned and survived to discharge in the first temporal group. As of March 29th, 2021, 40 patients died in the second group; of those, 3 after having been weaned from support, translating into 40.7 % weaning and 32.2% survival rates respectively. Twelve ECMOs are currently operating (10 Cardiohelp [Maquet Cardiovascular, Bridgewater, NJ], 1 RotaFlow [Maquet Cardiovascular, Bridgewater, NJ], 1 LivaNova ECC [LivaNova PLC, London, UK] in ECMO setup) (Supplementary material, *Video S1*). Eight patients were listed for lung transplantation; of those, 4 patients received referrals to a lung transplant center and 4 underwent successful lung transplantation.

Our preliminary data suggest that patients with severe refractory respiratory or cardiac failure due to COVID-19 and who were placed on ECMO therapy had a reasonable (62.5%) chance of survival during the first wave of the COVID-19 pandemic. The majority of these individuals could have been successfully discharged from ECMO therapy. During the first wave of therapy, we introduced the mobile COVID-ECMO therapy resource, which continues to be among the most active in Poland, able to apply ECMO therapy off-site and transport patients to the extracorporeal therapy hub. Air medical services provided by the Polish Medical Air Rescue — and by police and military air forces — supported logistics and patient transfer to and from remote site locations and, more recently, supported the transfer of patients to lung-transplant referral centers.

It is significant to note that this study was the first to introduce an ECMO-heart team, a team of professionals including a cardiac surgeon, perfusionist, cardiac anesthetist, cardiologist, and intensivists together with the supportive work of an intensive-care and anesthetist nurse. The cardiologist was a highly valuable addition to the team for various reasons. Peripheral V-V ECMO takes over the pulmonary function of blood oxygenation; by doing so, blood SO_2 is no longer representative of deteriorating heart conditions and RV failure. Routine echocardiographic check-ups help to determine the optimal time to upgrade the V-V ECMO circuit to more advanced configurations, such as V-VV, V-VA, VA-V, or V-VVA. This transition is needed in order to better address a failing RV, avoid differential hypoxia, and react to a patient's rapidly changing health conditions. In addition, optimal anticoagulation poses a major challenge for COVID-19 patients undergoing ECMO therapy, due to increased risk of thrombosis, bleeding, and other coagulation disorders [4].

A recent report from the Extracorporeal Life Support Organization (ELSO) Registry aimed to characterize the epidemiology, hospital course, and outcomes of patients aged 16 years or older with confirmed cases of COVID-19 and who underwent ECMO therapy between January 16th, and May 1st, 2020 at 213 hospitals in 36 countries. The report found that the estimated mortality of patients 90 days after undergoing ECMO therapy was less than 40% [1],

Figure 1. Air medical transport of ECMO patient

aligning with the results of this study regarding the first wave. More recently, the ELSO survey presented less encouraging results. A trend toward increased mortality has been observed across European countries and also reported in a systematic review which found mortality rate in adult patients with COVID-19 on ECMO of about 75% [5] attributable, in part, to novel strains of COVID-19 leading to higher infection rates, more severe manifestations and more COVID-19 hospitalizations and deaths among younger individuals. Additional data analysis is needed to provide information on the demographics, severity of illness, symptoms, and different ECMO therapy management strategies in these patients.

CONCLUSIONS

ECMO is a valuable tool in the treatment of COVID-19 patients presenting with acute respiratory insufficiency refractory to other supportive measures. The trends are changing, however, with regards to patient profile, destination therapy and predicted mortality, with younger patients being admitted, higher observed mortality and the increasing number of candidates for lung transplantation as destination therapy. COVID-19 pandemic required that ECMO-patient transport procedures are formally and practically implemented. Done so, we believe these may serve critically ill patients in the future.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

Article information

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