Four-Year Experience With Extracorporeal Membrane Oxygenation for Kidney Transplant Patients With Severe Refractory Cardiopulmonary Insufficiency

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ABSTRACT

Background. Kidney transplant (KT) recipients are vulnerable to infections because of their immunosuppressive treatments, and they occasionally exhibit serious acute cardiopulmonary dysfunction. The purpose of this study was to report the clinical outcomes of using extracorporeal membrane oxygenation (ECMO) in KT recipients and to identify risk factors for ECMO weaning failure.

Methods. We retrospectively reviewed the electronic medical records of KT patients who experienced severe cardiopulmonary dysfunction refractory to conventional therapy and received ECMO at the Asan Medical Center Surgical Intensive Care Unit between December 2010 and December 2014.

Results. During the 4-year study period, 12 KT patients required ECMO management. Six of these patients were successfully weaned from ECMO; the mean duration of ECMO support was 9.1 days (range, 3.5–15.1 days). Indications for ECMO included pneumonia (8 cases required venovenous ECMO and 1 case required venoarterial [VA] ECMO), stress-induced cardiomyopathy due to fungemia (1 case required VA ECMO), and septic shock due to either urinary tract infection or unknown origin (2 cases required VA ECMO). In assessing risk factors leading to a failure of ECMO weaning, the pH on arterial blood gas analysis performed just before the beginning of this intervention was significantly lower in the nonsurvivors than in the survivors ($P = .046$).

Conclusions. ECMO can be a beneficial rescue therapy in immunosuppressed patients with cardiopulmonary dysfunction refractory to treatment. Severe acidosis before the administration of EMCO is a major determinant of ECMO weaning failure.

KIDNEY transplantation (kt) is a known therapeutic option for patients with end-stage renal disease. Immunosuppressive therapy is necessary for transplant recipients to prevent rejection of the graft, but these patients are consequently vulnerable to infections. Furthermore, infection and septic shock are the major causes of death of KT recipients, following cardiovascular disease.

Extracorporeal membrane oxygenation (ECMO), also referred to as extracorporeal life support (ECLS), in its actual application is an evolution of the heart–lung machines used in cardiac surgery; it is used to support respiratory function, circulation, or both. It has been proposed as a possible therapeutic option for patients with severe acute respiratory distress syndrome who have refractory hypoxia or hypercapnia [1]. Septic shock is no longer regarded as a contraindication to ECMO [2,3]. However, increased use of ECMO, with its associated need for resources, may also increase hospital costs [4]. It is therefore

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necessary to define risk factors for failure of ECMO weaning or death before starting ECMO support [5].

The purpose of the current study was to report the clinical outcomes of ECMO in KT recipients and to identify risk factors for ECMO weaning failure in these patients.

PATIENTS AND METHODS

We retrospectively reviewed the electronic medical records of KT patients who subsequently developed severe cardiopulmonary dysfunction refractory to conventional therapy and thus received ECMO in the surgical intensive care unit of the Asan Medical Center from December 2010 to December 2014. At baseline, age, sex, body mass index, underlying diseases, and characteristics of the KT cohort were recorded; this information included cause of end-stage renal disease, type of KT, AB0-incompatible KT, and previous rejection history. In addition, we recorded peri-ECMO variables, including cause of intervention, type of support provided, duration of ECMO and of mechanical ventilation before the procedure, and arterial blood gas analysis (ABGA) profiles measured just before the beginning of ECMO.

The indications for venovenous ECMO were persistent hypoxemia or hypercapnia refractory to conventional management. Indications for venoarterial (VA) ECMO support were coexistent cardiopulmonary injury, as well as profound shock despite vigorous resuscitation and administration of vasopressor agents. Patients were defined as survivors if they could be successfully weaned from ECMO and survive for at least 3 months thereafter.

Categorical variables are presented as frequencies and percentages; continuous variables are expressed as means with standard deviations or medians with ranges. All data were analyzed by using SPSS version 18 (IBM SPSS Statistics, IBM Corporation, Armonk, NY, United States), and a P value $< .05$ was considered to be statistically significant.

RESULTS

Twelve patients who underwent KT and subsequently received ECMO during the 4-year period of this study were selected for analysis. The profiles of these cases are summarized in Table 1. In our study series, 6 patients were successfully weaned from ECMO and lived for at least 3 months after this treatment. The mean duration of ECMO support for these survivors was 9.1 days (range, 3.5–15.1 days). Conversely, the other 6 patients continued to receive ECMO support until death with no attempt made at weaning.

The study population comprised 8 male subjects and 5 female subjects. Seven KT procedures in our cohort involved living donors and 5 involved cadaveric donors. Among the 12 study patients, 5 patients were treated with steroids, rituximab, or bortezomib for graft rejection within 6 months of undergoing ECMO. All patients stopped immunosuppressive agents except low-dose steroids. The mean period between the KT and the ECMO support was 44.4 months (range, 1.2–184.3 months); 3 patients received ECMO support while staying in the hospital right after surgery, whereas the other 9 cases returned to the hospital through the emergency department.

Table 1. Patient Demographic and Clinical Characteristics of KT Patients Receiving ECMO

Case No.	Sex/Age	Cause of ESRD	KT Type	Previous Rejection	ECMO Start After KT (mo)	ECMO Type	ECMO Start After Symptom Onset (d)	Reason for ECMO	ECMO Duration (d)	Patient Survival[†]	
										3 Months	6 Months
1	M/57	DM	Living	Yes	178.2	VV	9	Viral pneumonia (influenza A)	15.1	Alive	Alive
2	M/53	DM	Cadaveric	Yes	9.5	VV	12	Combined viral/bacterial pneumonia (HMPV, *Streptococcus pneumoniae*)	8.7	Alive	Alive
3	M/62	HTN	Living	Yes	3.6[*]	VV	10	IPA with bacterial pneumonia (CRAB)	3.5	Alive	Alive
4	M/39	HTN	Living	No	184.3	VV	11	IPA with viral pneumonia (influenza A)	7.7	Alive	Alive
5	F/58	PCKD	Living	Yes	13.3	VA	2	Septic shock (r/o UTI)	7.9	Alive	Dead (4.8 mo)
6	M/34	CGN	Cadaveric	No	11.3	VV	21	Pneumocystis pneumonia	11.9	Alive	Dead (3.6 mo)
7	F/62	Unknown	Living	No	1.8[*]	VA	8	Septic shock (r/o pneumonia)	0.3	Dead	
8	F/54	DM	Living	Yes	1.0	VV	10	IPA with viral pneumonia (parainfluenza virus)	7.6	Dead	
9	M/32	Unknown	Cadaveric	No	111.3	VV	11	Viral pneumonia (rhinovirus)	12.8	Dead	
10	M/62	HTN	Cadaveric	No	1.9[*]	VV	35	IPA with bacterial pneumonia (CRPA)	2.5	Dead	
11	F/57	HTN	Cadaveric	No	1.2	VA	7	Fulminant myocarditis	23.2	Dead	
12	M/63	HTN	Living	No	15.0	VA	6	Bacterial pneumonia (*Klebsiella pneumoniae*)	2.6	Dead	

Abbreviations: CGN, chronic glomerular nephropathy; CRAB, carbapenem-resistant *Acinetobacter baumani*; CRPA, carbapenem-resistant *Pseudomonas aeruginosa*; DM, diabetes mellitus; ECMO, extracorporeal membrane oxygenation; ESRD, end-stage renal disease; F, female; HMPV, human metapneumovirus; HTN, hypertension; IPA, invasive pulmonary aspergillosis; KT, kidney transplantation; M, male; PCKD, polycystic kidney disease; r/o, rule out; UTI, urinary tract infection; VA, venoarterial ECMO; VV, venovenous ECMO.

[*]ECMO started during the same hospital stay right after kidney transplantation.

[†]Survival time after weaning from ECMO. All nonsurvivor cases received the ECMO support until death.