Case Report

Successful support by veno-arterial extracorporeal membrane oxygenation for severe septic shock caused by Aeromonas hydrophila

Takuto Ishida,1 Kazuki Miyazaki,1 Mayu Hikone,1 Kazuhiro Sugiyama,1 Takahiro Tanabe,1 and Yuichi Hamabe1

1Tertiary Emergency Medical Center, Tokyo Metropolitan Bokutoh Hospital, Tokyo, Japan

Background: Septic shock is a subset of sepsis accompanied by profound circulatory and cellular metabolism abnormalities. Although veno-arterial extracorporeal membrane oxygenation (VA-ECMO) can provide temporary cardiac support to improve organ perfusion, hemodynamic support by VA-ECMO for adult patients with septic shock is still controversial.

Case presentation: A 67-year-old man was transferred to our hospital with generalized weakness. He suffered septic shock refractory to vasopressors and inotropes, and his cardiac function deteriorated rapidly. Because of concern for sudden cardiac arrest, he was placed on VA-ECMO 9 h after his arrival. Blood culture was positive for Aeromonas hydrophila. He was weaned off VA-ECMO on day 7 and was discharged without any sequelae on day 30.

Conclusion: Veno-arterial extracorporeal membrane oxygenation is a viable treatment option for adult patients with refractory septic shock accompanied by cardiac dysfunction. Further research is warranted to identify the candidates for support by VA-ECMO in a timely fashion.

Key words: Aeromonas hydrophila, cardiac dysfunction, septic shock, veno-arterial extracorporeal membrane oxygenation

INTRODUCTION

Sepsis is life-threatening organ dysfunction caused by a dysregulated host response to infection. Septic shock is a subset of sepsis accompanied with profound circulatory and cellular metabolism abnormalities.1 Although mortality from sepsis has declined with advances in critical care, the mortality of septic shock remains high, reportedly up to 40%.1 Death from septic shock is due to compromised organ perfusion and subsequent multiple organ failure.

Veno-arterial extracorporeal membrane oxygenation (VA-ECMO) is an extracorporeal technique of providing temporary cardiac support to improve organ perfusion for patients with severe cardiac dysfunction. Historically, sepsis was considered a contraindication to ECMO because of concerns that bacteria would seed the ECMO circuit, leading to intractable bacteremia and death. Although this assumption has been refuted by recent reports,2 the use of this technology for adult patients with septic shock remains controversial, especially in elderly patients.3

Here we report on a 67-year-old male patient with refractory septic shock who was successfully supported by VA-ECMO.

CASE PRESENTATION

A 67-year-old man was transferred to our emergency medical center with generalized weakness. He ate water shield a day prior to admission. His medical history was unremarkable other than hypertension, atrial fibrillation, and diabetes mellitus. He underwent catheter ablation for atrial fibrillation 2 years ago and sinus rhythm has been maintained. He was alert on arrival at the hospital. His initial vital signs were as follows: temperature, 39.3°C; heart rate, 158 b.p.m.; blood pressure, 75/43 mmHg; respiratory rate, 22 breaths/min; and oxygen saturation, 100% on O2 6 L by mask. His physical examination was unremarkable except for generalized expiratory wheezes by auscultation. An
electrocardiogram showed atrial fibrillation with rapid ventricular response. He underwent electrical cardioversion three times with i.v. amiodarone, which successfully restored sinus rhythm. His electrocardiogram after sinus restoration was normal. In spite of the restoration to sinus rhythm, he remained in shock with a mean blood pressure lower than 50 mmHg, hence, fluid bolus and subsequent vasopressors (noradrenaline and vasopressin) were initiated. An antibiotic regimen of meropenem and vancomycin was started as well. He was intubated and placed on mechanical ventilation because of hemodynamic instability. Initial transthoracic echocardiography (TTE) showed hyperdynamic left ventricular systolic function. Initial laboratory tests revealed: white blood cell count, 2,800/µL; hemoglobin, 13.5 g/dL; platelet count, 95,000/µL; blood urea nitrogen, 40.5 mg/dL; creatinine, 2.11 mg/dL; C-reactive protein, 0.15 mg/dL; activated partial thromboplastin time, 41.0 s; prothrombin time, 13.8%; and D-dimer, 2.8 µg/mL. An arterial blood gas analysis showed: pH 7.383; PaO2, 158.0 mmHg; PaCO2, 31.1 mmHg; HCO3, 18.1 mmHg; and lactate, 10.90 mmol/L. These findings are consistent with severe metabolic acidosis. A urine test was unremarkable. Contrast-enhanced computed tomography did not reveal the source of infection. Although the dose of noradrenaline was escalated to 0.5 µg/kg/min and dobutamine was added at 5 µg/kg/min, his mean blood pressure remained lower than 50 mmHg, and his lactate level elevated to 14 mmol/L. Subsequent TTE, which the patient underwent 7 h after arrival at hospital, showed marked left ventricular systolic dysfunction and dilation of inferior vena cava without respiratory variation despite aggressive resuscitation. On concern about sudden cardiac arrest, he was placed on VA-ECMO and intra-aortic balloon pumping 9 h after his arrival at hospital. An ECMO venous drainage cannula (22 Fr) and arterial return cannula (16 Fr) (both Senko Medical Instruments, Tokyo, Japan) were percutaneously inserted into right femoral vessels and a distal reperfusion catheter (4 Fr) was also inserted into the superficial femoral artery. Hemodynamic support by ECMO (MERA centrifugal blood pump system HAS-CFP; MERA NHP exelung NSH-R HPO-23WH-C; Senko Medical Instruments) with blood flow of 4.0 L/min and sweep gas of 1.5 L/min was initiated. Blood flow of ECMO was titrated to maintain the mean blood pressure above 65 mmHg and to avoid the elevation of the level of lactate.

Although it took several days for the patient’s cardiac function to recover, he was weaned off the VA-ECMO on day 7. The antibiotics regimen was changed to ciprofloxacin based on the results of blood culture, which was positive for Aeromonas hydrophila. On day 8, he was weaned off the intra-aortic balloon pumping and extubated. On day 30, he was recovered without any sequelae and transferred to another hospital for further rehabilitation.

**DISCUSSION**

We reported on the patient with refractory septic shock accompanied by severe cardiac dysfunction due to *A. hydrophila* who was successfully supported by VA-ECMO. *Aeromonas hydrophila* is a gram-negative bacillus that is an inhabitant of both fresh water and sea water and can cause enterocolitis, meningitis, soft tissue infections, and bacteremia. Although the majority of cases of *A. hydrophila* sepsis develops in immunocompromised patients, fulminant sepsis in healthy persons can occur. This patient was supposed to be infected with this organism by eating contaminated water shield.

The pathophysiology of septic shock is different depending on the age group. Left ventricular dysfunction with reduced cardiac output is commonly seen in neonates and infants, however, distributive shock with high cardiac output is usually observed in adults. Considering this difference of pathophysiology of septic shock among age groups, it is plausible that the effectiveness of VA-ECMO for adults is less established than that for neonates and infants. Brechot et al. reported that 70% of patients with severe septic shock who were supported by VA-ECMO survived until discharge, and the hemodynamic profile of these survived patients was characterized by low cardiac index, elevated filling pressure, and elevated systemic vascular resistance, which was similar to the hemodynamic profile among neonates. In our patient, TTE showed marked left ventricular systolic dysfunction and dilation of inferior vena cava without respiratory variation, which indicated low cardiac index, elevated filling pressure, and indicated low cardiac index and elevated filling pressure, respectively. Adult patients with this hemodynamic profile reportedly account for less than 20% of all adult cases. However, VA-ECMO can be a valuable therapeutic option for these selected patients as myocardial dysfunction associated with septic shock is reversible in most cases and the mortality rate of these patients is reportedly 40–70%. To maximize the utility of this promising therapeutic technology, it is important not only to provide this technology for appropriate patients, but also in a timely fashion. Cardiac dysfunction reportedly occurs among as many as 50% of patients with septic shock during the first 48 h of treatment, and can occur within several hours among some patients. Park et al. reported the outcomes of patients with septic shock who were supported by VA-ECMO, which showed that all patients who survived until hospital discharge received VA-ECMO support within 30 h after the onset of septic shock, and cardiac arrest was an independent predictor of in-hospital mortality. In our

© 2019 The Authors. Acute Medicine & Surgery published by John Wiley & Sons Australia, Ltd on behalf of Japanese Association for Acute Medicine.
patient, his cardiac function deteriorated dramatically within 9 h despite adequate resuscitation. Frequent assessment of hemodynamic state, including left ventricular systolic function, volume status, and lactate clearance, in patients with severe septic shock is mandatory to providing support by VA-ECMO without delay before they suffer cardiac arrest.

**CONCLUSION**

WE REPORTED A patient who recovered without any sequelae from septic shock accompanied by severe cardiac dysfunction, treated with VA-ECMO for hemodynamic support. The outcome of our patient showed the promising efficacy of this technology for appropriate subjects, namely those with refractory septic shock accompanied by cardiac dysfunction. Frequent assessment of the hemodynamic state in patients with severe septic shock is mandatory to provide support by VA-ECMO without delay. Further research is warranted to identify candidates who would most benefit from timely VA-ECMO.

**DISCLOSURE**

Approval of the research protocol: N/A.  
Informed consent: Written informed consent was obtained from the patient for publication of this case report and any accompanying images.  
Registry and the registration no. of the study/trial: N/A.  
Animal studies: N/A.  
Conflict of interest: None declared.

**REFERENCES**

1. Singer M, Deutschman CS, Seymour CW *et al.* The third international consensus definitions for sepsis and septic shock (sepsis-3). *JAMA* 2016; 315: 801–10.  
2. Maclaren G, Butt W. Extracorporeal membrane oxygenation and sepsis. *Crit. Care Resusc.* 2007; 9: 76–80.  
3. Cheng A, Sun HY, Tsai MS *et al.* Predictors of survival in adults undergoing extracorporeal membrane oxygenation with severe infections. *J. Thorac. Cardiovasc. Surg.* 2016; 152: 1526–36.  
4. Tang HJ, Lai CC, Lin HL *et al.* Clinical manifestations of bacteremia caused by Aeromonas species in Southern Taiwan. *PLoS ONE* 2014; 9: e91642.  
5. Brechot N, Luyt CE, Schimidt M *et al.* Venoarterial extracorporeal membrane oxygenation support for refractory cardiovascular dysfunction during severe bacterial septic shock. *Crit. Care Med.* 2013; 41: 1616–26.  
6. Parker MM, Shelhamer JH, Natanson C *et al.* Serial cardiovascular variables in survivors and nonsurvivors of human septic shock: heart rate as an early predictor of prognosis. *Crit. Care Med.* 1987; 15: 923–9.  
7. Vieillard-Baron A, Caille V, Charron C *et al.* Actual incidence of global left ventricular hypokinesia in adult septic shock. *Crit. Care Med.* 2008; 36: 1701–6.  
8. Carpentier J, Luyt CE, Fulla Y *et al.* Brain natriuretic peptide: a marker of myocardial dysfunction and prognosis during severe sepsis. *Crit. Care Med.* 2004; 32: 660–5.  
9. Park TK, Yang JH, Jeon K *et al.* Extracorporeal membrane oxygenation for refractory septic shock in adults. *Eur. J. Cardiothorac. Surg.* 2015; 47: e68–74.