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Cent. Eur. J. Med. • 8(5) • 2013 • 658-661
DOI: 10.2478/s11536-013-0211-4

Central European Journal of **Medicine**

Application of extracorporeal membrane oxygenation in severe ARDS secondary to pneumonia: a case report

Case Report

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Received 27 December 2012; Accepted 14 May 2013

Abstract: This report describes a 24-year-old patient with marked and continuous hypoxemia resulting from severe acute respiratory distress syndrome (ARDS) secondary to pneumonia, which in turn was refractory to mechanical ventilation and other conventional adjunctive therapies. Veno-venous extracorporeal membrane oxygenation (ECMO) was applied for 14 days and resulted in significant improvement in the hypoxemia. We conclude that ECMO presents a therapeutic option for ARDS patients who fail to respond to conventional mechanical ventilation.

Keywords: *Pneumonia • Acute respiratory distress syndrome • Extracorporeal membrane oxygenation*

1. Introduction

Acute respiratory distress syndrome (ARDS) is a serious respiratory disease that is associated with an in-hospital mortality as high as 42% [1]. Extracorporeal membrane oxygenation (ECMO) therapy has been used to treat patients with ARDS; this treatment has been associated with a reduction in death or severe disability within the first 6 months of the therapy [2]. The main clinical applications of ECMO have been for the management of life-threatening pulmonary or cardiac failure [3,4] and for the safe transport of the critically ill patients, especially during the H1N1 pandemic [5,6]. ECMO has also been used in patients with septic shock [7], severe trauma [8], and profound hypothermia [9]. In this report, we describe our experience using ECMO to rescue a patient with severe ARDS secondary to pneumonia.

2. Case presentation

A 24-year-old woman without past illnesses was admitted to our hospital with symptoms of high fever and productive cough that had lasted for a week. On admission she was febrile (38.4°C) and tachycardiac (heart rate 122 bpm). Her respiratory rate was 28 bpm; the oxygen saturation on room air was 83%. She was centrally cyanotic with dullness to percussion and reduced air entry of the right lung. The arterial blood gas analysis was: pH 7.48; $PaCO_2$, 31 mmHg; PaO_2, 45 mmHg; HCO_{3-}, 23.1 mmol/L; Lac, 1.5 mmol/L; BE, 0.2 mmol/L. The chest-x-ray and chest CT scan revealed massive bilateral infiltrates and right pleural effusion (Figure 1). Echocardiography showed normal cardiac function with a left ventricular ejection fraction of 67%. She was diagnosed with severe pneumonia and type 1 respiratory failure.

The patient was treated with empirical broad spectrum antibiotics (vancomycin and imipenem) and noninvasive positive pressure ventilation (NPPV). The mode

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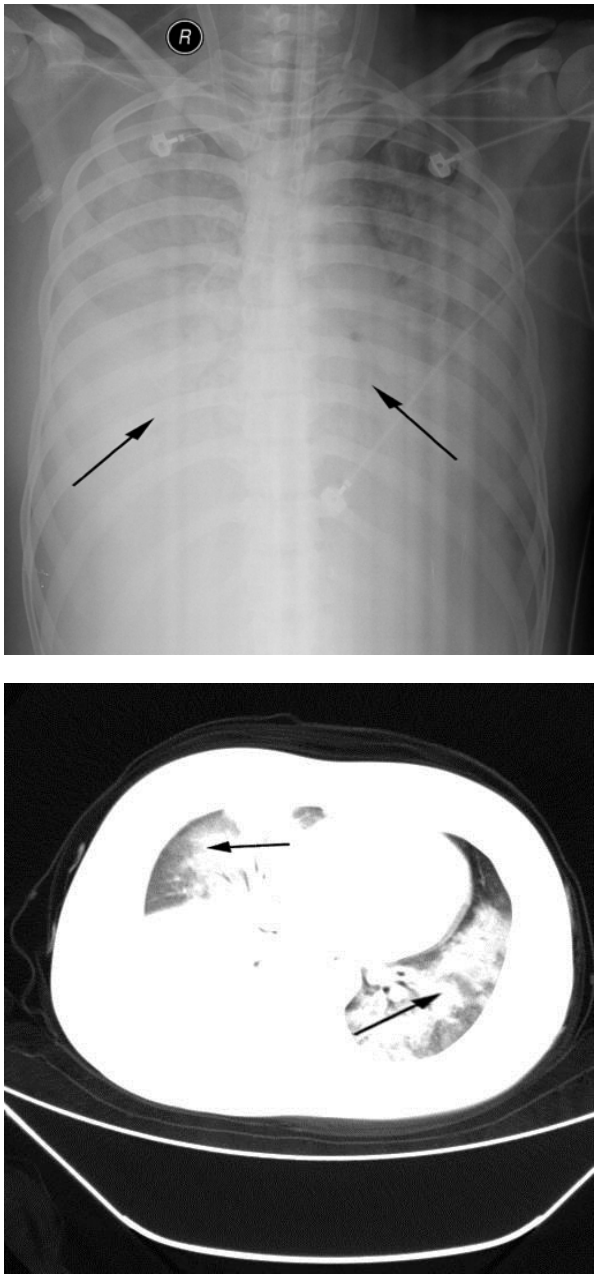

Figure 1. Pre-ECMO chest radiograph and computed tomogram.

of NPPV was S/T; the settings were: IPAP, 16 cm H_2O; EPAP, 8 cm H_2O; and FiO_2, 80%. After 55 hours of NPPV, hypoxemia persisted and her liver function began to deteriorate, with progressive reduction in albumin levels. On day 3, moxifloxacin and oseltamivir were added to the empirical therapy along with intubation and mechanical ventilation. The ventilation mode was PCV, and the settings were: PC, 22 cmH_2O; PEEP, 8 cmH_2O; and FiO_2, 100%. However, there was a marked and continuous hypoxemia even after 48 hours of mechanical ventilation; the SpO_2 and the oxygenation index were 85% and 45, respectively. Repeated bacterial cultures of tracheal aspirate, bronchoalveolar lavage fluid, blood, and pleural fluid were all negative.

Veno-venous ECMO was subsequently instituted. A 21-F cannula was placed percutaneously in the right femoral vein, and another 14-F cannula was placed in the right internal jugular vein. Venous blood was withdrawn from the superior vena cava, driven by a centrifugal pump (MAQUET Cardiopulmonary AG), then through an artificial lung (MAQUET Cardiopulmonary AG) for gas exchange before being returned to the patient. Extracorporeal blood flow was initially set to 3.5 L/min, gas flow through the artificial lung to 3 L/min of oxygen. Anticoagulation was maintained with continuous infusion of unfractionated heparin. All antibiotics were substituted by linezolid, azithromycin, and moxifloxacin.

In the first 4 days of ECMO therapy, even with the maximal support of veno-venous ECMO (blood flow 5.4 L/min, gas flow 7 L/min, FiO_2 100%), the patient became hypotensive and oliguric, with upper gastrointestinal bleeding and severe anemia. There was also severe hypoproteinemia, hypokalemia, hypocalcemia, and an increased lactic acid level. Blood transfusion, omeprazole, and somatostatin were applied, and electrolyte disturbances were corrected. Inotropic support with norepinephrine (1–2 mg/h) was also administered. On the 5th day of ECMO therapy, the patient's oxygenation and clinical status began to improve. On day 7, the patient was weaned off the ventilator, and extracorporeal respiratory support was withheld successfully 14 days after its institution. A chest CT scan 3 days after ECMO discontinuation showed a partial resolution of lung infection with partial pulmonary consolidation (Figure 2). The patient was transferred to the general ward 18 days after ICU admission.

3. Discussion

ARDS is a type of acute diffuse, inflammatory lung injury, leading to increased pulmonary vascular permeability, increased lung weight, and loss of aerated lung tissues [10]. The clinical features are hypoxemia and bilateral radiographic opacities, associated with increased venous admixture, increased physiological dead space, and decreased lung compliance [10]. The morphological hallmark of the acute phase is diffuse alveolar damage (ie, edema, inflammation, hyaline membrane, or hemorrhage) [11]. Conventional therapeutic strategies to ARDS include mechanical ventilation, such as low tidal-volume ventilation [12], positive end-expiratory pressure (PEEP), high frequency ventilation, and non-mechanical

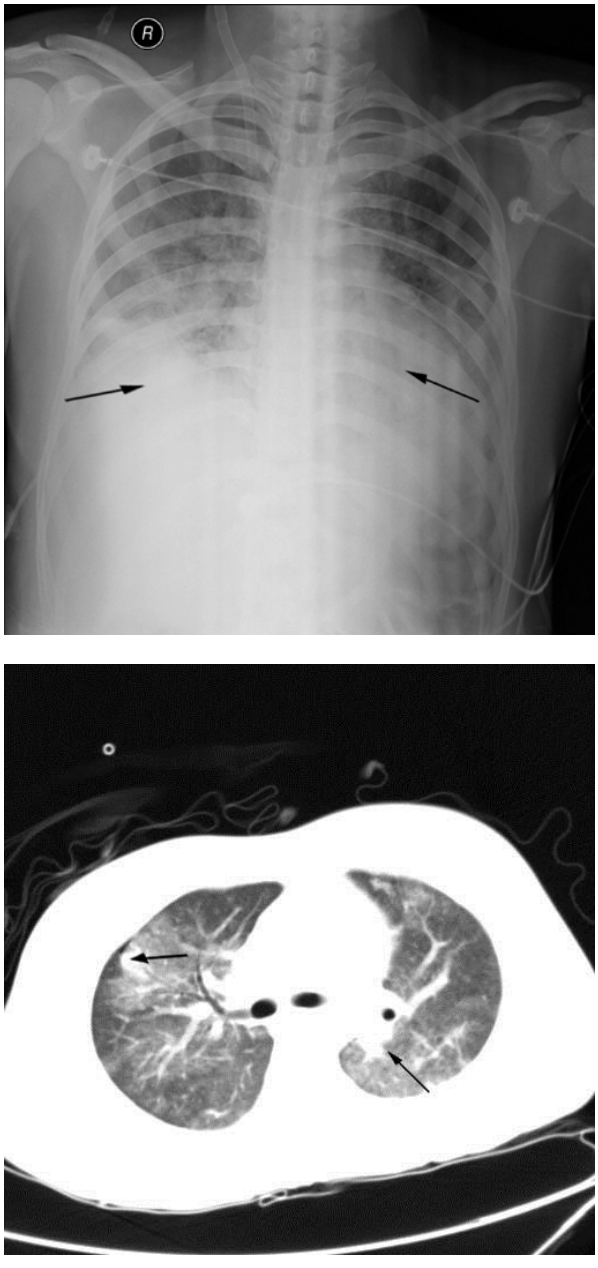

Figure 2. Chest radiograph and computed tomogram after the discontinuation of ECMO.

ventilator adjunctive therapies, such as prone positioning, inhaled pulmonary vasodilators, corticosteroid therapy, neuromuscular blocking agents, conservative fluid management.

As patients with severe ARDS have a high risk of mortality with conventional treatment [13], ECMO could be a therapeutic option that might improve chance of survival.

Extracorporeal gas exchange has been proven to improve survival in severe neonatal respiratory failure [14]. The indications for veno-venous ECMO are respiratory failure, most commonly resulting from ARDS, pneumonia, trauma or primary graft failure following lung transplantation. The goals of therapy are to decrease ventilator settings and to minimize ventilator-induced lung injury while allowing additional time to treat the underlying disease process, to permit recovery from acute injury, and to improve the patient's survival. In the present case report, the patient failed to respond to mechanical ventilation: hypoxemia continued 48 hours after ventilation was initiated. The addition of ECMO for 5 days significantly improved oxygenation as well as the fluid-electrolyte imbalance during the initial stage of the treatment. This enabled withdrawal of ventilator and discharge from the ICU.

ECMO is a complex technique and requires a dedicated team to operate. There are two forms of ECMO. Venous-venous (VV) ECMO was used to return the oxygenated blood into the pulmonary circulation and thereby into the left ventricle. The other form of ECMO is venous-artery (VA) ECMO in which a cannula drains blood from a vena cava and returns it through a major artery. Potential complications associated with ECMO are hemorrhages, such as intracranial bleeds or pulmonary hemorrhage [3]. Other potential complications are coagulopathy, pneumothorax, oliguria, gastrointestinal hemorrhage and infection [3]. In addition, VA ECMO is more likely to cause vascular trauma and systemic embolization. Because the potential complications of ECMO are significant, its use is advocated only in patients who have a substantial risk of death. Trauma and multiple bleeding sites, and also multiple organ failure are relative contraindications for all forms of ECMO [3].

In the present report, VV ECMO was used. The gastrointestinal hemorrhage, thrombocytopenia, and initial renal insufficiency likely resulted from ECMO. Fortunately, these complications were well controlled and did not affect the patient's outcome.

4. Conclusion

ECMO can improve gas exchange, oxygenation, and partially replace pulmonary function. ECMO may be recommended for use in patients with severe ARDS unresponsive to ventilation treatment.

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