Cardiac Support
Emphasis on Venoarterial ECMO

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KEYWORDS

- Venoarterial extracorporeal membrane support • Cardiogenic shock
- Extracorporeal cardiopulmonary resuscitation • Pulmonary hypertension
- Pulmonary embolism

KEY POINTS

- Venoarterial extracorporeal membrane oxygenation (ECMO) can be used as a bridge to recovery or definitive therapy for several conditions, including cardiogenic shock, pulmonary embolism, intoxication or poisoning, and hypothermia.
- Important considerations when developing a cannulation strategy for venoarterial ECMO include cardiac and pulmonary function, need for mobilization, anticipated duration of support, and the urgency of the time to cannulation.
- Careful management of patients having venoarterial ECMO is required to minimize the risk of common complications, including limb ischemia, bleeding, infection, thrombosis, and cerebral ischemia.

INTRODUCTION

In 1972, the first successful use of venoarterial (VA) extracorporeal membrane oxygenation (ECMO) was reported in a 24-year old man who was severely injured in a motorcycle accident.[1] After 3 days, the patient was weaned from ECMO and eventually recovered. Major advances in extracorporeal support have been made since this groundbreaking first case. Increasing experience, as well as advances in ECMO equipment and options for definitive therapy following ECMO support, have led to improved outcomes and increased use of this technology.[2] Since data collection started in 1990, support of more than 10,000 adult patients with VA ECMO has been reported to the Extracorporeal Life Support Organization (ELSO) registry, with 40% of these patients surviving to hospital discharge.[3] This article provides an

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overview of VA ECMO for clinicians not well versed in this technology. It first discusses the components of the VA ECMO circuit and contrasts VA ECMO with venovenous (VV) ECMO. It then addresses patient selection, including indications and contraindications to use of ECMO. It next covers cannulation strategies and basic management of VA ECMO, including commonly encountered complications.

WHAT IS VENOARTERIAL EXTRACORPOREAL MEMBRANE OXYGENATION AND HOW DOES IT DIFFER FROM VENOVENOUS EXTRACORPOREAL MEMBRANE OXYGENATION?

The basic components of any ECMO circuit include a cannula to drain blood from the venous system (inflow cannula), a pump, an oxygenator, and a cannula to return blood to the body (outflow cannula). In addition to these essential components, most ECMO circuits contain a console where pump speed can be adjusted, a heat exchanger, various ports for blood sampling and medication infusion, a saturation sensor on the inflow cannula, and a flow sensor on the outflow cannula. The inflow cannula generally sits in the right atrium or inferior vena cava (IVC). Modern adult ECMO circuits are typically powered by a centrifugal pump, which rapidly rotates a magnetically levitated impeller, generating negative pressure and entraining blood into the circuit. The entrained venous blood is then passed through a membrane oxygenator, which facilitates gas exchange. In the oxygenator, blood separated by a porous membrane is passed by a countercurrent sweep gas, allowing oxygen to enter the blood, carbon dioxide to be removed, and heat to be exchanged[4] (**Fig. 1**). The now oxygenated and warmed blood is delivered through the outflow cannula to the body. More detailed explanation of the individual circuit components is beyond the scope of this article but can be found elsewhere.[4,5]

In VV ECMO, the superoxygenated blood in the outflow cannula is delivered to the venous system, where it then traverses the pulmonary circulation and is pumped to the body by the native left ventricular (LV) output. This system allows respiratory support in patients with impaired gas exchange by bolstering the oxygen content of blood delivered to the right side of the heart. VV ECMO provides no direct hemodynamic support, although hemodynamic benefit is often seen with the initiation of VV ECMO because hypoxia, hypercarbia, and acidosis improve

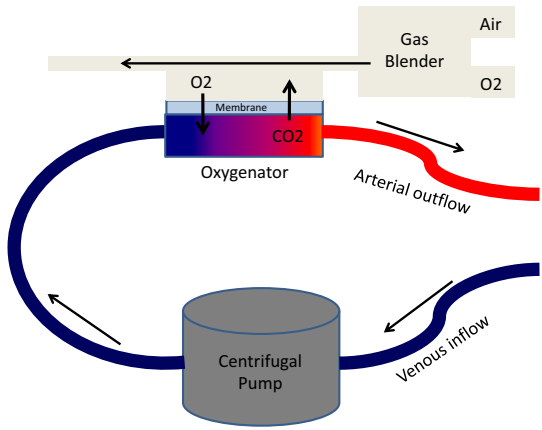

Fig. 1. An ECMO circuit. Blood is drawn into venous inflow by the centrifugal pump. It is then pumped through an oxygenator where the blood is separated from a countercurrent gas flow by a thin permeable membrane. Oxygen enters the blood and carbon dioxide is removed. The oxygenated and decarboxylated blood is then returned to the body.