

# Overview of Extracorporeal Membrane Oxygenation in Cardiogenic Shock



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## KEYWORDS

- ECMO • Extracorporeal membrane oxygenation • Ventricular assist devices
- Cardiogenic shock • ECMO program development

## KEY POINTS

- Patients with cardiovascular disease who are admitted to the cardiac care unit have higher case mix indexes and increased critical illness.
- Cardiogenic shock is associated with the development of a systemic inflammatory response syndrome contributing to hemodynamic instability.
- The use of extracorporeal membrane oxygenator (ECMO) support for cardiogenic shock is increasing due to the availability of smaller devices.
- An ECMO program can be successfully managed by experienced critical care nurses with advanced hemodynamic and oxygenation expertise.

In recent years, the use of extracorporeal membrane oxygenators (ECMO) has proliferated in cardiovascular intensive care units (ICUs) partially due to advances in technology with the development of smaller, more portable machines, but also owing to the increasing numbers of patients with end-stage heart failure and cardiogenic shock. Another contributing factor surfaced in 2009 with the H1N1 influenza outbreak and again recently in January and February 2014. A serious complication of the H1N1 influenza is acute respiratory failure with “white out” of the lungs on chest x-ray. The use of ECMO has been found to improve survival rates in this deadly situation. The purpose of this article was to discuss the transition of the cardiovascular ICU in the United States, review cardiogenic shock etiologies and the role of ECMO, and discuss the process of implementing a nurse-run ECMO program.

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## TRANSFORMATION OF THE CARDIOVASCULAR INTENSIVE CARE UNIT

The coronary care unit (CCU) has played a pivotal role in the management of patients with coronary artery disease. Over time, and since the opening of the first CCU, outcomes associated with the management of life-threatening rhythm disturbances and prompt recognition and management of acute myocardial infarction (AMI) have improved markedly. In recent years, it has become apparent that the landscape of the CCU has dramatically changed. Although survival rates after AMI have improved, the prevalence of other cardiovascular related diseases has also increased.<sup>1</sup> Katz and colleagues<sup>1</sup> examined temporal trends in patient characteristics, processes of care, and in-hospital outcomes among unselected admissions within today's CCU. Their findings confirmed significant changes have occurred. The number of ST-segment elevation myocardial infarction patients declined, and there has been an increase in the number of non-ST-segment elevation myocardial infarction patients. The volume of patients with noncardiovascular diagnoses, particularly with comorbid critical illnesses, including sepsis, acute kidney injury, and respiratory failure, has grown.<sup>1</sup> More patients are intubated with mechanical ventilator support and are on renal replacement therapy. These changes can be attributed to changing demographics of patients, including an increased volume of elderly, female, and minority patients.<sup>2</sup> The incidence of chronic illness has increased dramatically including diabetes, hypertension, renal insufficiency/failure, and chronic obstructive pulmonary disease. These conditions are now present in many patients with cardiovascular disease admitted to the CCU today. The final result is higher case mix indexes and increased critical illness.<sup>2</sup>

Recently, there has been an escalation of the number of patients being admitted to the cardiovascular ICU with acute and/or end-stage heart failure. These patients are often in cardiogenic shock. Various pharmacologic interventions (inotropes and vasoactive infusions) are initiated along with the insertion of mechanical assist devices, including an intraaortic balloon pump and ventricular assist devices (either percutaneous or implantable), to stabilize these patients. When these interventions are ineffective, patients are often placed on ECMO. These patients often develop multisystem organ dysfunction requiring extensive resources. Morrow and colleagues<sup>2</sup> described some large centers having developed specialized "heart failure ICUs" for the purpose of caring for this patient population.

## CARDIOGENIC SHOCK AND MECHANICAL CIRCULATORY SUPPORT

### *Cardiogenic Shock*

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Cardiogenic shock is defined as having a cardiac index of  $2.2 \text{ L/min}^2$  or less with evidence of tissue hypoperfusion. Associated findings include hypotension, delayed capillary refill, decreased urine output, decreased level of consciousness, and cool and mottled extremities. The most common cause of cardiogenic shock is AMI with an associated loss of 45% to 50% of viable myocardium. It may also occur when there is a mechanical complication of AMI, such as acute mitral regurgitation or a perforated intraventricular septum. The other most common causes are those patients with acute decompensated heart failure and end-stage cardiomyopathy. **Box 1** provides a list of etiologies for cardiogenic shock.<sup>3</sup> Individuals found to be at greatest risk for development of cardiogenic shock include those who are older, female, diabetic, have had an anterior MI or history of previous MI, reduced ejection fraction, or larger MI evidenced by higher cardiac enzyme levels. Patients with a history of peripheral vascular disease or prior cerebrovascular accident also have an increased risk.<sup>3</sup>

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