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### **The Impella™ Left Ventricular Assist Device (LVAD) combined with veno-venous Extra-Corporeal Membrane Oxygenation (ECMO): An alternative to veno-arterial ECMO**

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**Background:** Acute cardio-pulmonary failure refractory to maximal medical therapy has been traditionally managed with veno-arterial (VA) Extra-Corporeal Membrane Oxygenation (ECMO). Although the advantage of this technology includes rapid deployment and complete circulatory rescue, the disadvantages include its inability to unload the left ventricle, retrograde systemic flow (when utilized in the bi-femoral configuration), potential for peripheral arterial complications, and the inability to uncouple cardiac and respiratory support. The purpose of this report is to describe a hybrid configuration utilizing the micro-axial flow Impella™ LVAD with veno-venous (VV) ECMO as an alternative to veno-arterial (VA) ECMO.

**Methods:** Two adult patients with refractory cardiopulmonary failure were managed with combined Impella™ LVAD-VV ECMO:

*Patient 1:* A 37 year old man with chronic non-ischemic cardiomyopathy (EF 20%) presented with acute decompensated heart failure requiring intubation (with aspiration) and vasopressor resuscitation. An Impella™ 5.0 LVAD was inserted via the right trans-axillary artery using a 10mm graft. Three days later he developed polymicrobial pneumonia requiring VV ECMO using a two cannula system—right femoral vein inflow (25 Fr) and right internal jugular vein outflow (19 Fr). Flows for the two systems averaged 4.5 L/min.

*Patient 2:* A 47 year old man with dyslipidemia and tobacco abuse presented to the emergency room with an ST segment elevation MI. Cardiac catheterization showed severe three-vessel CAD and an LVEF of 15%. Intubation, Vasopressor and IABP support did not restore circulatory stability. An Impella CP™ LVAD was percutaneously inserted via the right femoral artery. Heavy sputum secretions—cultures were positive for *Serratia marcescens*—contributed to ventilator-dependent respiratory failure requiring VV ECMO. This was accomplished with percutaneous insertion of the Avalon Elite™ trans-jugular double lumen cannula. Device flows averaged 4 L/min. Systemic anticoagulation was achieved with a heparin infusion with aPTT ranging between 45-55 seconds. Outcome measures included death, end-organ complications, bleeding, infection, and length of stay (LOS).

**Results:** *Patient 1:* There were no technical complications inserting the hybrid system. The LVAD was removed after two weeks of support by withdrawing it from the graft and over sewing it with an endo-stapler flush with the axillary artery. The VV ECMO cannulae were removed seven days later at the bedside using manual pressure and two pursestring sutures. The patient was discharged to a rehabilitation facility on hospital day 44. There were no end-organ failures, no bleeding complications or infectious complications related to the devices.

*Patient 2:* There were no technical complications inserting the hybrid system. The LVAD was removed after 9 days of support by removing it from its percutaneous insertion site and applying manual pressure (i.e. similar to IABP removal). The ECMO cannula was removed at the bedside two weeks later, securing the percutaneous insertion site with a pursestring suture. Acute Kidney Injury (AKI) developed while on mechanical circulatory support requiring temporary renal replacement therapy (RRT). Kidney function recovered during the hospitalization. The patient was discharged to a rehabilitation facility on hospital day 49 with all end-organ systems intact.

**Conclusions:** The combination of the Impella™ LVAD with VV ECMO as a hybrid configuration is technically feasible and clinically efficacious for acute cardio-pulmonary failure refractory to maximal medical therapy. This unique configuration has distinct advantages over traditional VA ECMO: 1) direct LV unloading; 2) antegrade system blood flow; and 3) the ability to uncouple mechanical cardiac from pulmonary support during differential organ system recovery.

#### **Biography**

Louis Samuels received his under graduation education at the University of Rochester in New York and attended Medical School at Hahnemann University in Philadelphia. He completed his General Surgery and Cardiothoracic Surgery training at Hahnemann and joined the faculty in 1995, assuming the Directorship of the Heart Transplant and Ventricular Assist Device Program in 1997. In 2001, along with his team implanted the world's fifth total artificial heart (AbioCor). In 2003, he joined the Main Line Health System at Lankenau Medical Center (Wynnewood) as the Surgical Director of Heart Failure and rose to the rank of Full Professor of Surgery at Thomas Jefferson University School of Medicine (Philadelphia). Since 2009 he has published more than 100 peer-reviewed manuscripts, has participated as Principle or Co-Investigator in numerous Ventricular Assist Device (VAD) trials, serves as the medical monitor for and Clinical Events Committee member of VAD trials, and continues to engage in a busy clinical practice.

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