

Increasing Survivability of Cardiac Arrest by Developing an Extracorporeal Cardiopulmonary Resuscitation (E-CPR) Program

Introduction

The primary goal of the E-CPR program is to increase the survival rate from cardiac arrest with preservation of neurological function. Multnomah County Emergency Medical Services (EMS) manages approximately 600 cardiac arrests annually, of which resuscitation is attempted on roughly 400 patients. Approximately 85 of 400 (21%) cases present with ventricular fibrillation or ventricular tachycardia. The survival rate of cardiac arrest is estimated to be approximately 9% in the Portland metropolitan area. There is an urgent need for solutions to improve survivability. Extracorporeal membrane oxygenation (ECMO) during cardiopulmonary resuscitation (CPR), henceforth called E-CPR, is an emerging treatment for refractory cardiac arrest when return of spontaneous circulation (ROSC) does not rapidly occur with traditional advanced cardiac life support (ACLS). Improved patient outcomes have been reported in select patients, with survival rates estimated at 29%. Oregon Health & Science University (OHSU) has a well-established ECMO program, achieving Platinum recognition from the Extracorporeal Life Support Organization (ELSO) Center of Excellence in 2021. OHSU has not yet implemented an E-CPR program.

Research

As described above, approximately 85 cases of ventricular fibrillation or ventricular tachycardia cardiac arrest occur annually in Multnomah County out-of-hospital. Additionally, at OHSU, approximately 300 cases of cardiac arrest presented to the Emergency Department (ED) from January 2019 to May 2022. At OHSU, in-hospital (IHCA) cardiac arrests totaled 203 in the calendar year 2021. 31 of these cases were ventricular tachycardia (VT) or ventricular fibrillation (VF) arrest, or approximately 7.75 cases per quarter. Six of 31 patients died. A subset of these out-of-hospital cardiac arrests (OHCA) and in-hospital cardiac arrests (IHCA) are the target patient group for the E-CPR program. We found that existing OHSU ECMO equipment infrastructure can be leveraged to build the E-CPR program. The staffing need is for a 24/7, 365 days/year ECMO team for the Portland metropolitan area. The initial investment includes ECMO specialist training for an additional 10 nurses. The primary ongoing investment is dedicated E-CPR nurse staffing (4.2 new FTEs) for 24/7, 365 days/year ECMO cannulation support (12-hour shifts). E-CPR providers will cover 12-hour shifts (24/7) and OHSU has plans to hire an additional 3 intensivists to accommodate increasing critical care volume. This, in addition to the existing provider complement, will be sufficient to cover expansion of this service from the physician side.

Summary

We found that existing OHSU ECMO equipment infrastructure can be leveraged to build the E-CPR program. The primary unmet need is for 24/7, 365 days/year E-CPR coverage for the Portland metropolitan area. First year investments in the E-CPR program include ECMO

specialist training for 10 existing critical care nurses, and the hiring of 4.2 FTE dedicated E-CPR nursing staff to provide in-house cannulation coverage. Our cost analysis for the E-CPR program includes variable costs consisting of medical supply disposables and ECMO machine maintenance. Staffing labor constitutes the primary fixed cost for a 24/7, 365 days/year program (730 shifts of 12 hours for nurses). The hourly compensation rate for E-CPR nurse support includes a premium over the base wage for night shifts. First year investment estimates include a \$52,941.60 expense for training 10 E-CPR nurses, and \$632,891.75 expense for a 4.2 FTE dedicated E-CPR nursing staff. This amounts to a total of \$685,833.35 for the first year investment. The revenue projections for the E-CPR program are based on the payor mix observed for OHSU ED cardiac arrest patients (39% Commercial, 33% Medicare, and 28% Medicaid). Using the same Medicare Severity-Diagnosis Related Group (MS-DRG) recognized for Venous-Arterial ECMO (VA-ECMO), and historical VA-ECMO data at OHSU, we estimate a net revenue of \$406,930.22 per case with direct costs of \$177,762.89. The average contribution margin per case is \$229,168.00. This results in an estimated payback of the first-year investment after completing 2.9 cases, which based upon historical data requires 3 to 6 months of operation.

Recommendations

We recommend meeting E-CPR growth in demand by scaling operations in a stepwise fashion. We would start with an OHSU on-call E-CPR team to meet internal (IHCA) needs first and expand the E-CPR nurse complement. This program needs to be championed in marketing initiatives to increase program awareness internally and externally. With the success of the internal program, we would then expand the scope to address out-of-hospital (OHCA) needs and formalize an EMS divert system for E-CPR eligible patients. This may include formalizing a partnership with Legacy Health to share OHCA call duties. There is no initial capital equipment investment required as we leverage existing equipment. Formal consultation pathways with ethics and neurology services will be established for all patients.

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