Novel eCPR Manikin Updates and Improvements – Bringing Excellence in Simulation to Frontline Workers


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Background

Out of hospital cardiac arrest (OHCA) affects up to 350,000 people per year, with only 11% surviving until hospital discharge.[1] New research out of the University of Minnesota Medical Center showed promising results using early ECMO-facilitated resuscitation in OHCA patients with refractory ventricular fibrillation.[2] Data from the Extracorporeal Life Support Organization (ELSO), an increasing amount of ECMO centers[3] and positive results from observational studies reflect an increasing demand for and utilization of eCPR for OHCA[4-7]. Currently, there is NO way to simulate ECMO cannulation under eCPR. The authors will construct a first of its kind manikin specifically for multidisciplinary teams from OHSU to train on early ECMO-facilitated resuscitation. For this manikin to accurately represent real life, it needs to be able to arrive in an ambulance, transition into a trauma bay, and be worked on by surgeons, nurses, respiratory therapists, and other trauma team members. Should the authors succeed, OHSU would have the first model in the nation to simulate eCPR at a multidisciplinary level, from first response to the trauma bay.

Methods

A de-commissioned mid-fidelity manikin was used as a starting point. Two distinct components needed to be developed to make this manikin work:

1. A compressible, closed-loop circulatory system and
2. Re-usable or easily replicable tissue blocks that could be cannulated and then visualized under ultrasound.

Ballistics gelatin was used for the first tissue blocks, but it disintegrated during cannulation. The current model utilizes silicon for the tissue blocks, which is more robust. A 3D-printed mold was used to cast tissue blocks, which were inlaid with latex tubing to create vessels.

Beginning with a siphon pump for the compressible heart, the authors used suction tubing to create an initial circulatory loop. This loop was then augmented with one-way valves to create uni-directional flow and a pressure relief line to absorb the pressure generated during compressions.

Mario is the first manikin ever to allow for simulation of ECMO cannulation under eCPR, a crucial first step in bringing this life-saving procedure to OHSU – and beyond.

Scan here to download the poster and references

Results

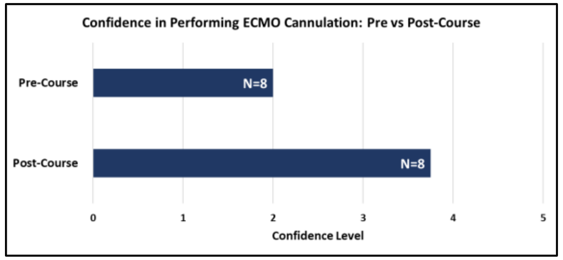

Figure 1. Responses to the question "what is your confidence in performing ECMO cannulation," before and after simulation with Mario, rated on a 1-5 Likert scale.

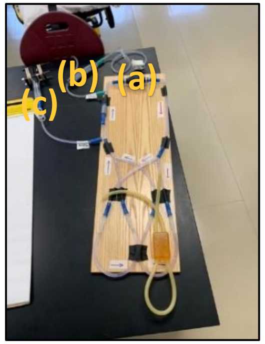

Figure 2. Mario's closed-loop circulatory system, including a compressible heart (a), fill line (b), pressure-relief line (c) and fluid release line (not pictured).

Figure 3. OHSU fellows practice placing guidewires (left) and cannulas (right) as part of the ECMO cannulation procedure.

Next Steps

- Experimenting with various silicon types and preparation methods in an effort to increase vasculature visibility on ultrasound and to decrease resistance to cannulation.
- Creation of a tissue block near the heart to allow for assessment of correct inferior vena cava catheter placement.
- Creation of a hinged tissue block holder to allow for quick swaps of tissue blocks between learner groups as well as serving as a tissue retention system.
- Addressing durability and elasticity of siphon pump over time.
- Vascular priming to remove all air bubbles prior to cannulation.

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