Multidisciplinary ECMO Simulation using High Fidelity Cannulation Mannequin

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Introduction:

Cannulation for emergent ECMO procedures requires succinct decision making and multidisciplinary teamwork. Children's Hospital of Wisconsin ECMO initiative has developed a series of ECMO cannulation simulations across a broad spectrum of patient scenarios and locations allowing team members to practice in a realistic environment. These simulations take place with high fidelity, hemodynamically responsive, pulsatile cannulation mannequins in ICU rooms with a full surgical team. We present our simulation process, describe the attributes of the mannequin, and the modifications to the circuit allowing changes circuit pressures to simulate common issues identified during an ECMO run.

Methods:

The mannequin is a modified, commercially available, pediatric vascular mannequin (Vascular Access Child™ Simulab Corporation, Seattle Wa). The mannequin was modified to allow cannulation via the neck or groin. A hidden venous reservoir within the mannequin, along with a suspended IV bag, act as a variable compliance chamber for the venous system. The pulsatile arterial system is generated by a roller pump, which gives the vessel's their pulse; allowing the surgeon the ability to palpate and doppler the vessels prior to cannulation.

ECMO simulations are executed in realistic settings, such as the ICU or cath lab, with team members from perfusion, surgery, anesthesia, critical care, nursing, surgical technician and pharmacy present and participating. For AV cannulation, chest compressions are performed until cannulation is achieved, with rotating compressors and a quality observer providing point of care feedback. VV ECMO is performed with pulsatility provided through the roller pump to give the surgeons a realistic vascular experience during the cannulation. Simulations are structured to follow two pathways; one in which reactions and decisions of the team are carried out in finality, and the other, where undesired actions are noted and discussed in the moment while steering the team back as if the desired action had been taken. Lastly, once an end point has been reached, simulation is halted and a discussion involving all specialties takes place over the events of the case and how they affected the patient and subsequent teams.

Once cannulated, the simulation manager creates changes in the circuit pressures that change flow characteristics similarly to those events seen in patient care scenarios. Using a Bluetooth enabled syringe pumps, air can be discretely entrained into the mannequin reservoir and ECMO circuit during cannulation, as well as causing large pressure swings inside the ECMO circuit simulating clot and obstruction. SimBaby software may be used during the simulation to project the patient's vitals for all participants to see. Being sensitive to the team member's time and other tasks, the simulation takes about 30 – 45 minutes followed by whole team discussion with breakout amongst individual specialties thereafter. We perform 6 – 10 whole team simulations a year, with partial simulations occurring roughly 12 times a year for section specific training. The simulation mannequins (3 total) are used to provide the biannual wet lab teachings for all ECMO technicians.

Conclusions:

The use of a high fidelity ECMO simulator for full and partial team simulations is critical to maintain team function and confidence during periods of low ECMO use. The mannequins add a component of reality that water labs, using reservoir bags, fail to capture. Simulations have been well received by all who participated and groups have requested more simulation experience. This has improved staff satisfaction overall in regards to preparing disciplines for ECMO cannulation. Providing quantifiable baseline training and high fidelity ECMO simulation for multidisciplinary teams has allowed for greater comfort and decision making for teams as they come together to cannulate patients in real-life scenarios.