Pediatric Extracorporeal Life Support (ECLS) Systems: Education and Training at Penn State's Milton S. Hershey Medical Center Children's Hospital

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ABSTRACT

We share our experience in transitioning from our old Extracorporeal Life Support (ECLS) system to our current system. This was not an evolutionary change but a revolution in support as ECLS advanced in simplicity and reliability, using a long-term hollow fiber oxygenator and centrifugal pump. The operation of our previous ECLS circuit was in the hands of perfusionists/ECLS coordinator and ECLS technicians. The aim of the current project was to familiarize all clinicians (physicians, fellows, residents, practitioners, nurse educators, perfusionists, and ICU nurses) with our new simplified circuit. This aim was met by involving the *Pediatric Cardiovascular Research Center* and animal research facility in the training program.

Methods:

Our new ECLS circuit used a Quadrox$_D$ hollow-fiber membrane oxygenator and Rotaflow centrifugal pump (Maquet Inc. , Bridgewater NJ, USA). This circuit had already been tested in vitro in our research facility (1-4) During the didactic part of the course, the circuit was demonstrated as a wet lab. The final part the course was a voluntary visit the animal research facility. The main objective of this training was to provide an opportunity for all of our clinicians to have "hands on" experience with the next generation oxygenators and blood pumps in ECLS. The focus of the sessions included: setup, priming and normal operation of the ECLS system. Clinical situations requiring intervention with one or more team member were reviewed. The session included the participants demonstrating and verbalizing normal parameters and appropriate interventions in the event of an emergency. A handout with documentation of the session with clinical scenarios and an evaluation was provided.

Animal Labs:

Our ECLS model was a domestic swine piglets (n = 5), ranging in size from 17.3 – 20.9 kg were anesthetized with Ketamine (20 mg/kg) and Acepromazine (1 mg/kg), given intramuscularly. Following intubation, mechanical ventilation was initiated using 1.5 % Isoflurane in 100% oxygen. Peripheral venous access was established using auricular veins for fluid and Fentanyl continuous rate infusions (CRI). Following a 50 mcg IV Fentanyl bolus, a Fentanyl CRI (6-8 mcg/kg/hr) was maintained for the duration of the procedure. Heparin (300 units/kg IV) was administered prior to cannulae placement in the right carotid artery and right internal jugular vein. Activated clotting time was measured every 45-60 minutes, with a target range of 200-250 seconds; additional doses of heparin were administered as needed. Arterial blood pressure and blood gasses were measured via a right femoral artery catheter. Other physiologic parameters measured included heart rate, ECG, oxygen saturation, respiratory rate, end tidal CO_2, tidal volume, and body temperature. Total time on circuit ranged from 5-6 hours; pigs were euthanized with a commercial euthanasia solution (Euthasol®) at the conclusion of the training laboratory.

We used intra-operative echocardiography for this study. Echocardiographic monitoring was provided as guidance for the instrumentation of the animal. This involved transthoracic and epicardial imaging as appropriate. A GE Vivid I system was used (GE Healthcare, Milwaukee, WI) with 3.5 MHz or 5 MHz transducers as needed. The position of the cannulae was ascertained with 2D echocardiography. Cardiac function was assessed using conventional parameters such as fractional shortening and ejection fraction and color tissue Doppler imaging. The animal was monitored for complications such as pericardial effusion, thrombus or valvular insufficiency.

Protocol for Training Sessions:

The sessions were designed in two-hour increments. The initial content provided a demonstration of the normal operating procedures of the Rotaflow console and drive unit, oxygenator and input to the entire ECLS circuit. An "ECLS patient" and circuit were reviewed for both normal and abnormal clinical presentations during support. Participants were required to identify derangements of normal ECLS operation (without the participant's awareness of the circuit changes) and demonstrate corrective interventions and reassessment. Emphasis was placed on teamwork and working with multiple teammates to solve clinical scenarios. The remainder of the training session was devoted to reviewing clinical scenarios to reinforce what was learned during the ECLS course.

Results:

In the fall of 2009, the entire pediatric ECLS team had an opportunity to train in the animal laboratory. These training sessions were also available to clinicians in the adult and neonatal units that offer ECLS. A total of 54 participants were trained in 5 days of training. The Pediatric Intensive care Unit (PICU)at the Penn State Hershey Children's Hospital has a total of 29 ECLS trained nurses. At present, 93% of the ECLS trained staff have participated in this educational update. All PICU and Pediatric Intermediated Care Unit (PIMCU) staff, (both ECLS trained and pre-ECLS trained) are required to demonstrate proper steps to assist with emergency intervention in the event of a circuit failure.

Following the training, the participants evaluations listed the following benefits:

1. The scenarios encouraged critical thinking in order to arrive at the best intervention given the patient's condition.
2. The animal laboratory setting provided a "safe" environment to learn more about normal and abnormal equipment function.
3. Corrective interventions and re-assessment of potential emergency situations were offered in a guided, constructive approach.

Conclusions:

With the revolutionary change in ECLS equipment (Quadrox$_D$), a new approach to ECLS education at the Penn State Hershey Children's Hospital was developed. In collaboration with the *Pediatric Cardiovascular Research Center* and animal research facility, we were able to provide both didactic & "hands on" education for our ECLS team. The effort throughout this process was to build a competent ECLS team able to address clinical situations which may arise. The goal with this initiative is to provide patient's requiring ECLS support at the Penn State Hershey Children's Hospital, a greater chance for full recovery.

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Conclusions:

With the revolutionary change in ECLS equipment (Quadrox$_D$), we took an entirely new view of support. Most of the changes had little or nothing in common with our old ECLS system.: personnel, education and training of the staff and management of support. In collaboration the the *Pediatric Cardiovascular Research Center and* animal research facility, we were able to provide both didactic & "hands on" education for our ECLS team. The effort throughout this process was to build a competent ECLS team able to deal with clinical situation which may arise. The goal with this initiative is to provide patient's requiring ECLS support at the Penn State Hershey Children's Hospital, a greater chance for full recovery.

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