



ELSO GUIDELINES FOR TRAINING AND CONTINUING EDUCATION OF ECMO SPECIALISTS

PURPOSE

The "*ELSO Guidelines for Training and Continuing Education of ECMO Specialists*" is a document developed by the Extracorporeal Life Support Organization (ELSO) as a reference for current and future ECMO centers. It is to be used as a guideline for designing training and education programs for ECMO specialists. It is assumed that each ECMO center must develop their institution specific guidelines and policies for training ECMO Specialists, which may vary. In the development of these documents and programs, ECMO Directors and Coordinators must take into account their institution's requirements for in-house training programs, and must have policies and procedures reviewed by appropriate hospital committees. Please note that institutional and personnel requirements for ECMO programs are addressed in the ELSO document, "*Guidelines for ECMO Centers*", and will not be discussed in this document.

INTRODUCTION

The term "ECMO Specialist" is defined for the purpose of these guidelines as "the technical specialist trained to manage the ECMO system and the clinical needs of the patient on ECMO under the direction and supervision of a licensed ECMO trained physician. The individual functioning as the ECMO Specialist should have a strong critical care background in neonatal, pediatric and/or adult critical care and have attained one of the following:

1. Successful completion of an approved school of nursing and achievement of a passing score on the state written exam given by the Board of Nursing for that state;
2. Successful completion of an accredited school of respiratory therapy and have successfully completed the registry examination for advanced level practitioners and be recognized as a Registered Respiratory Therapist (RRT) by the National Board of Respiratory Care (NBRC).
3. Successful completion of an accredited school of perfusion and national certification through the American Board of Cardiovascular Perfusion (ABCP).
4. Physicians trained in ECMO who have successfully completed institutional training requirements for the clinical specialists.
5. Other medical personnel such as biomedical engineers or technicians who received specific ECMO training and have practiced as an ECMO specialist since the initiation of their programs, and who have completed equivalent training in ECMO management as the other specialists, have successfully documented necessary skills as an ECMO specialist, and who have been approved specifically as an ECMO specialist by the medical director. These personnel can be approved institutionally as an ECMO specialist under the "grandfather" principle. However ELSO does not encourage or support the new training of individuals except as outlined in 1-4 above.

TRAINING

Training of the ECMO will be divided into two parts. Training for new ECMO programs (centers which have not treated patients) will be covered separately from training for experienced ECMO programs (centers which have been in ongoing operation and are training new ECMO specialists).

TRAINING OUTLINE: NEW ECMO PROGRAM

- A. **Didactic Course:** The didactic course should include, but not be limited to the following topics. Between 24 to 36 hours will be required to cover the following material. Case presentations are encouraged.

Topics could include, but are not limited to the following:

- ***Introduction to ECMO:***
 - History
 - Current status
 - Indications
 - Risks and benefits
 - Membrane gas exchange physics and physiology
 - Oxygen content, delivery and consumption
 - Shunt physiology
 - Types of ECMO
 - Future applications
 - Research

- ***Physiology of the diseases treated with ECMO:***
 - Persistent Pulmonary Hypertension
 - Meconium Aspiration Syndrome
 - Respiratory Distress Syndrome
 - Congenital Diaphragmatic Hernia
 - Sepsis/pneumonia
 - Post-operative congenital heart disease/heart transplantation
 - Cardiomyopathy/myocarditis
 - ARDS
 - Aspiration pneumonia
 - Pulmonary embolism

- ***Pre ECMO Procedures:***
 - Notification of the ECMO Team
 - Cannulation procedure
 - open
 - percutaneous
 - Initiation of bypass
 - Responsibility of team members

- ***Criteria and contraindications for ECMO including:***
 - Patient Selection
 - Selection criteria
 - Pre-ECMO evaluation

- ***Physiology of coagulation including:***
 - Coagulation cascade
 - Activated clotting times (ACT's)
 - Disseminated intravascular coagulation
 - Blood products and interactions
 - Blood product management of the bleeding patient
 - Blood surface interactions
 - Laboratory tests
 - Heparin pharmacology
 - Use of Amicar, Protamine and other drugs

- ***ECMO equipment including:***
 - Circuit priming
 - Oxygenator function and blood gas control
 - ECMO circuit design
 - ECMO circuit components (cannula, pump, venous return monitor, in-line saturation monitor, pressure monitor, heater, hemofilter, bubble detector)

- ***Physiology of Venoarterial and Venovenous ECMO:***
 - Indications
 - Physiology
 - Advantages/disadvantages

- ***Daily Patient and Circuit management on ECMO including:***
 - Patient:*
 - Fluid, electrolytes and nutrition
 - Respiratory
 - Neurologic
 - Infection control
 - Sedation and pain control
 - Hematology
 - Cardiac
 - Psychosocial

 - Circuit:*
 - Aseptic technique
 - Pump/gas flow
 - Pressure monitoring
 - Blood product infusion techniques
 - Circuit infusions
 - Management of anticoagulation
 - Circuit checks
 - Hemofiltrations set-up
 - Bedside care of the ECMO patient

- ***Emergencies and complications during ECMO:***

- *Medical:*

- Intracranial and other hemorrhage
 - Pneumothorax/pneumopericardium
 - Cardiac Arrest
 - Hypotension/hypovolemia
 - Severe coagulopathy
 - Seizures
 - Hemothorax/hemopericardium
 - Uncontrolled bleeding

- *Mechanical:*

- Circuit disruption
 - Raceway rupture
 - System or component alarm/failure (pump, bladder, venous return monitor, oxygenator, heater)
 - Air embolus
 - Inadvertent decannulation
 - Clots

- ***Management of complex ECMO cases:***

- Surgery on ECMO
 - post-operative bleeding
 - Transport on ECMO (inter and intra-hospital)

- ***Weaning from ECMO (techniques and complications):***

- Clinical indications of pulmonary/cardiac recovery
 - Pump/gas flow weaning techniques
 - ACT changes during weaning
 - Ventilatory changes during weaning
 - Trial off/decannulation from low flow

- ***Decannulation procedures:***

- Personnel needed
 - Medications required
 - Potential complications
 - Vessel ligation
 - Vessel reconstruction
 - Percutaneous approach

- ***Post ECMO complications:***

- Platelet and electrolyte alterations

- **Short and long-term developmental outcome of ECMO patients:**
 - Institutional follow-up protocol
 - Literature review

- **Ethical and social issues:**
 - Consent process
 - Parental and family support
 - Withdrawal of ECMO support

- B. Water-drills:** These sessions should be small enough so that each individual has hands-on experience. A full understanding of all possible circuit emergencies and the appropriate intervention should be accomplished by the end of this session. Each trainee should be able to describe and conceptually demonstrate how to change the major equipment (oxygenator, heat exchange, bladder) in a reasonable period of time. They should be able to change less complicated components of the circuit (raceway, pigtails, and checking pump head occlusion on ECMO) in a pre-established period of time.

- **Basic Session should include a discussion and demonstration of the equipment including:**
 - Review of Circuit configuration and function
 - Access and sample ports to the circuit
 - ‘The basic circuit check’
 - Basic troubleshooting
 - Pigtail and stopcock changes

- **Emergency Session, should include training in the management of:**
 - Raceway ruptures
 - Heat exchanger, bladder, membrane lung changes (assist with procedure only)
 - Venous/arterial air
 - Pump head occlusion checks
 - Power failure
 - Inadvertent decannulation

- C. Animal Laboratory Sessions:** As bedside training sessions are not possible in a new ECMO center, more extensive laboratory training is required compared to an experienced center.
 - The species of animal and the duration of the ECMO training run will vary depending on the institution's ability to supply long-term support of animals during these sessions. ECMO centers typically have used newborn lambs, adult sheep or piglets. It is recommended that animal labs be conducted for a continuing 24-72 hour period to decrease the number of animals needed for

these sessions and to simulate around the clock management of the ECMO system.

- Trainees should be divided into small teams with the instructor for four to eight hour sessions.
- Sessions should include a review of the circuit and the access and sampling ports and the trainees should practice such tasks such as blood product administration, IV solution administration, medication administration and blood gas, ACT, and laboratory sampling. The use of documentation such as the flowsheet, physician and standing orders should be incorporated used during this session.
- Each specialist should be able to manage the patient on ECMO while the parameters (ACT, PaO₂, and Post PCO₂) are altered. It is recommended that this session should last 8-12 hours.
- A session, lasting 4-8 hours, should focus on emergencies including:
 - Cracked pigtailed and connectors
 - Leaking stopcocks
 - Raceway rupture
 - Membrane oxygenator failure
 - Air in the circuit
 - Loss of venous return
 - Inadvertent decannulation
 - Pump stop scenarios and handcranking
 - Power failure
- For new centers these sessions should be repeated until all team members gain a solid understanding of the management of the ECMO system and are fully competent managing simulated ECMO emergencies. After initial sessions, most centers require one - two additional eight-hour sessions per specialist.

EXPERIENCED CENTER: TRAINING OUTLINE

- A. **Didactic Sessions** - as above
- B. **Water-drills** - as above
- C. **Animal Sessions:** Time in the animal lab is not required for experienced centers, but may be useful. If animals are not used, additional water drill time can be added.
- D. **Bedside Training:** The bedside training time of the new Specialist should be between 16 and 32 hours in 8 or 12-hour shifts. The preceptor should be an experienced specialist.

EVALUATION AND INSTITUTIONAL CERTIFICATION OF THE ECMO SPECIALISTS

- A. **Written Evaluation:** Each specialist should have on record a written evaluation of their skills and competence during all sessions of the ECMO training course including; course attendance, water-drills, animal lab sessions and examinations.
- B. **Written/Oral Exam:** Written exam, with pre-determined passing level, covering didactic and laboratory sessions should be taken by all Specialists.
- C. **Institutional Certification:** Institutional certification of Specialists will be granted after successful completion of the ECMO training course (didactic, water drills/animal labs, bedside training) and successfully passing the oral and/or written exam.

CONTINUING EDUCATION OF THE ECMO SPECIALIST

- A. **Formal team meetings, which include:**
 - Case reviews
 - Updates on ECMO therapy
 - Quality assurance
 - Review of ECMO policy and procedures
 - Administrative information
- Frequency of meetings should be based on the size of the team and the volume of ECMO patients treated.
- Attendance records should be monitored and team members should be required to attend a certain number of meetings as specified by the particular ECMO center.

- B. Water-drills:** Water drills should be held periodically throughout the year as specified by the particular ECMO center (every six months is recommended as a minimum). The exact interval should be based on volume of ECMO patients treated in the ECMO center.
- C. Annual examination:** This is recommended to verify the knowledge and skills of all specialists. Ongoing evaluation of performance should also be conducted and reviewed with the Specialist.
- D. Minimum number of hours of pump time:** Each center should set a minimum amount of pump time for the specialist to maintain competency. For example, a center might specify that each Specialist performs at least one 8-hour clinical shift every eight weeks in order to maintain certification. Re-training should be undertaken if this standard is not met.