ELSO Standardized Core Curriculum for Neonatal & Pediatric ECMO

Title	Learning Objective	Learning Objective	Learning Objective	Learning Objective
ECMO Overview	☒**Describe the different modes of ECMO support.**	☒Discuss global trends in ECMO utilization.	☒Describe the risks and benefits of ECMO support in children	
History of ECMO	☒List the key milestones in the development of ECMO.	☒Describe the evolution of the Extracorporeal Life Support Organization.		
Circuit Overview	☒**Define the main components of an ECMO circuit.**	☒**List circuit monitoring tools.**	☐Compare and contrast priming volume, rated blood flow rate and circuit component sizing in children	☐Describe the process of initiation of ECMO support
Cannulas and Tubing	☒ Define the differences in ECMO cannula design specific to patient age and size	☒ List the considerations for selecting the appropriate ECMO cannula specific to patient age and size		
Pump	☒ **Describe the function/mechanism of action of an ECMO pump**	☒ Compare and contrast the working of a centrifugal pump vs roller pump	☒Describe the utility of a blood flow meter	
Membrane Lung and Blender	☒Describe the structure and function of the membrane lung	☒Describe the function of the blender		
Pressure Monitoring	☒**List the different pressure zones in an ECMO circuit**	☒Discuss the utility of monitoring drainage pressure	☒**Discuss the utility of monitoring pre- and post-membrane lung pressures**	

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Other Circuit Components	☒ Describe the function of a bladder on a roller pump	☒ Describe the function and mechanism of action of the heater	☒ Describe the utility of circuit clamps	☒Describe the role of a bridge in a pediatric ECMO circuit
Cannulation	☐List the differences between percutaneous and open cannulation	☐ List the resources needed for neo/pediatric cannulation	☐ Discuss the resources needed for ECMO deployment including coordination of multiple disciplines	
Percutaneous Cannulation	☐Outline the process of percutaneous cannulation	☐Discuss the role of ultrasound in cannulation		
Open Cannulation	☐Outline the process of open cannulation			
VV ECMO Configurations	☐ List the different configuration options for VV ECMO by patient age and size	☐ Review the benefits and limitations of specific VV configurations by patient age and size		
VA ECMO Configurations	☒ List the different configurational options for VA ECMO by patient age and size	☐ Review the benefits and limitations of specific VA configurations by patient age and size		
Cannulation Complications	☐ **Identify complications of ECMO cannulation in children**	☐ **Describe steps to prevent, recognize and treat complications**		
Priming the Circuit	☐Define blood priming and its appropriate use/timing			

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Oxygen Delivery & Uptake	☒Describe the normal physiology of oxygen delivery and uptake.			
Gas Transfer in the Membrane Lung	☒Describe the key determinants of oxygen uptake in the membrane lung.	☒Describe the key determinants of carbon dioxide removal in the membrane lung.	☒ Discuss utility and indications for CO2/air mixtures into sweep gas	
Hemodynamic Monitoring on VV ECMO	☒List the hemodynamic changes that accompany VV ECMO	☒Describe the changes in hemodynamic monitoring on VV ECMO		
Hemodynamic Monitoring on VA ECMO	☒**Discuss the hemodynamic changes that accompany VA ECMO**	☒Describe the changes in hemodynamic monitoring on VA ECMO		
Drainage Insufficiency	☐**Define and diagnose drainage insufficiency.**	☐ **Describe ways to manage drainage insufficiency**		
Return Obstruction	☐ **Define return obstruction and identify its causes**	☐ Diagnose and manage return obstruction	☐Distinguish between management of return obstruction in roller pump vs centrifugal pump	
Respiratory Failure Overview	☒ Provide an overview of respiratory failure in the neonatal and pediatric population	☐ List standard management strategies for respiratory failure	☒ Describe rationale of VV ECMO in respiratory failure for neonates and pediatric indications (Use of VA ECMO in Neonatal Respiratory Failure)	
Patient Selection for VV ECMO	☒ List the general indications and			

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	contraindications for VV ECMO support in children			
Neonatal Respiratory Failure	☒Describe indications and outcomes in neonatal diseases such as Persistent Pulmonary Hypertension of the Newborn, Meconium Aspiration Syndrome; exclusion of TAPVR			
Patent Ductus Arteriosus	☒Describe the challenges associated with ECMO management in patients with patent ductus arteriosus			
Congenital Pulmonary Diseases (ACD)	☒Describe the challenges associated with ECMO management in patients with congenital pulmonary diseases (ACD), including Congenital Surfactant Deficiency			
Pediatric Respiratory Diseases	☒Describe indications and outcomes in pediatric respiratory diseases such as ARDS,			

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	bronchiolitis/status asthmaticus, drowning (hypothermia element)			
Initiation of VV ECMO	☒**Describe the steps in initiating a neonatal patient on to VV ECMO**	☒**Describe the steps in initiating a pediatric patient on to VV ECMO**	☒Discuss timing of normalization of blood gas; CO2 and O2 targets	
VV ECMO Maintenance	☒ Define physiologic targets for adequate VV ECMO support in neonates and pediatric patients based on disease specific indications	☒ Describe titration of blood flow and gas flow to achieve adequate support on VV ECMO	☒**Describe the concept of native lung rest and the correlating ventilator settings to achieve this**	
Recirculation	☐**Define and identify recirculation.**	☐ Describe methods of managing recirculation		
Weaning VV ECMO	☒**Describe the process of weaning VV ECMO support.**	☒ List exit strategies for the VV ECMO patient based on disease specific indications		
Cardiac Failure Overview	☒ Provide an overview of cardiac failure in neonates and children	☒ List standard management strategies for neonatal and pediatric cardiac failure	☒ **Describe rationale of VA ECMO in cardiac failure for neonates and pediatric indications**	
Patient Selection for VA ECMO	☒ **List the indications and contraindications for VA ECMO support in neonates and children**	☒Distinguish between management/ outcomes for cardiac failure in children with single ventricle vs dual ventricle physiology		

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Perioperative Cardiac Support	☒List the indications /contraindications for ductal dependent systemic circulation	☒List indications/contraindications for ductal dependent pulmonary circulation	☒List the indications/contraindications for children with cardiac failure following cardiac surgery, such as the Norwood, Glenn, and Fontan	☒List the indications/contraindications for children with cardiac failure with central shunt
Non-Structural Heart Failure	☒List the indications/contraindications for children with cardiac failure with forms of cardiomyopathy: specifically, DCM vs HOCM vs RCM (Arrhythmias)			
ECMO and Stem Cell Transplant	☐Discuss the indications /outcomes for cardiac failure in children with oncologic diagnoses or stem cell transplant			
Initiation of VA ECMO	☒ **Describe the steps for initiating VA ECMO in a neonate with cardiac failure**	☒**Describe the steps for initiating VA ECMO in a pediatric patient with cardiac failure**		
VA Maintenance	☒ **Describe vasopressor use and blood flow titration for cardiovascular support**	☒Describe the concept of native heart rest.	☒ Describe ventilator management and gas flow titration for pulmonary support and how it is influenced by congenital heart disease	

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Left Heart Unloading	☒ **List the symptoms associated with LV/LA congestion on ECMO.** (ECMO Central Definitions) LV/LA hypertension/distention	☒ Describe the mechanism of LV congestion	☒**List strategies to unload the left ventricle**	
Differential Oxygenation	☐**Define and identify differential oxygenation**	☐ **Define ways to manage differential oxygenation**		
Weaning VA ECMO	☒**Describe the process of weaning VA ECMO support**	☒ List exit strategies for the VA ECMO patient based on disease specific indications	☒Describe the role of LA vent management in weaning from VA ECMO	
ECPR	☒Define ECPR	☒Discuss indications and outcomes related to ECPR	☐Discuss hypothermia population (drowning)	☒Discuss ECPR for respiratory failure vs cardiac failure
Sedation	☐Identify the role of sedation during ECMO support	☐Discuss the paradigm shift towards awake ECMO		
Physiotherapy	☐Describe the rationale for physiotherapy during ECMO	☐ Identify appropriate candidates for physiotherapy in ECMO based on diagnosis and patient age/size		
Anticoagulation	☐**List anticoagulation strategies on ECMO**	☐**Discuss anticoagulation monitoring on ECMO**		
Congenital Diaphragmatic Hernia	☐Describe the indications and outcomes in patients with Congenital	☐Discuss rationale for using VA vs VV support	☐Discuss rationale for surgical repair on or off ECMO	

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	Diaphragmatic Hernia			
Sepsis, Poisoning, and Other	☐Discuss the indications/outcomes for cardiac failure in children with MIS-C	☐Discuss the indications/outcomes for cardiac failure in children with septic shock	☐Discuss the indications/outcomes for cardiac failure in children with ingestion/poisoning/inhalation injury	
Renal Replacement Therapy	☐ Identify the benefits and limitations of administering RRT via a dialysis catheter.	☐ Identify the benefits and limitations of RRT via ECMO circuit		
Mobile ECMO	☐Identify considerations and logistics for intrahospital transport.	☐Identify considerations and logistics for interhospital transport.	☐Discuss the importance of creating networks for referral and standardization of protocols	
Complications Overview	☐**List medical and mechanical complications of ECMO.**	☐**List patient complications of ECMO specific to the neonatal patient**	☐**List patient complications of ECMO specific to the pediatric patient**	
Neurological Complications	☐List the etiology and risk factors for neurological complications.	☐Discuss the management of ischemic and hemorrhagic strokes.		
Bleeding	☐List the etiology of bleeding	☐**Discuss the management of bleeding**		
Thrombosis	☐List the etiology of thrombosis	☐**Discuss the management of thrombosis**		
Hemolysis	☐Understand the etiology and risk factors of hemolysis on ECMO	☐Discuss how to prevent and manage hemolysis	☐Discuss the role of blood flow rate and type of pump as it relates to hemolysis	

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Limb Ischemia	☐List the risk factors for developing limb ischemia on VA ECMO	☐Describe how to monitor limb perfusion	☐Discuss the prevention and management of limb ischemia	
Cardiac Arrest During ECMO	☐Discuss the management of cardiac arrest on VV ECMO	☐Discuss the management of cardiac arrest on VA ECMO		
Pump Failure	☐Define pump failure.	☐Describe how to identify and manage pump failure.		
Membrane Lung Dysfunction	☐Define membrane lung dysfunction.	☐ **Describe how to identify and manage membrane lung dysfunction**		
Air Embolism	☐Define air embolism and its determinants.	☐**Define strategies to prevent air embolism.**	☐**Describe how to detect and manage air embolism.**	
Circuit Disruption	☐Identify determinants of circuit disruption	☐Recognize early signs of circuit disruption	☐Manage circuit disruption	
Accidental Decannulation	☐**Manage an accidental decannulation**			
Coming Off ECMO Emergently	☐List the indications for coming off ECMO emergently	☐List the steps required to come off and back on ECMO emergently		
Historical Studies	☐ List the historical studies and identify their limitations			
Recent Evidence for VV ECMO	☐Interpret the results and limitations of the main cohort studies on VV ECMO.	☐Interpret the results and limitations of the CESAR and the EOLIA trials.		
Recent Evidence for VA ECMO	☐Interpret the results and limitations of the			

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	main cohort studies on VA ECMO.			
Program Operations and Structure	☐Define appropriate bedside staffing model for an ECMO patient	☐List important considerations in developing an ECMO program		

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