ECMO And Thoracic Organ Transplantation

AL HEUER, PHD, MBA, RRT-ACCS, RPFT, FAARC
PROFESSOR-RUTGERS UNIVERSITY
CO-OWNER- A & T LECTURES

Learning Objectives

- Explain Indications for EtCO2
- Illustrate Some of the Equipment
- Review related research
- Define what is a normal EtCO2 value
- Define what are abnormal values/waves & their causes
- Identify the different wave forms
- Furnish Add'l Resources

Uses of ECMO: Neonatal Hypoxemic Respiratory Failure

- Persistent pulmonary hypertension of the newborn (PPHN)
- Meconium aspiration syndrome (MAS)
- Respiratory distress syndrome (RDS)
- Sepsis
- Air leak syndromes
- Selection criteria

Uses of ECMO: Respiratory Failure in Infants and Children

- Infectious and aspiration pneumonias
- ARDS caused by trauma, surgery, medical condition
- OI > 35 or pre-ECMO pH < 7.20

Uses of ECMO: Cardiac Applications

- Congenital heart disease
- Fulminant myocarditis or cardiomyopathy
- Extracorporeal cardiopulmonary resuscitation (ECPR)

Modes of ECMO Support: Venoarterial

- Right common carotid and right internal jugular
- Central cannulation
- 80% of cardiac output supported by ECMO
- Nonpulsatile

Modes of ECMO Support: Venovenous

- Blood drained and re-infused back into the venous circulation
- Recirculation
- Preferred mode of ECMO support in infants and children

ECMO Systems

- Pumps
  - Roller pumps
  - Centrifugal pumps
- Artificial gas exchange devices
  - Silicone membrane
  - Microporous membrane
- Temperature regulation
- Circuits and circuit preparation
- Cannulas and establishing support
- Hemofiltration

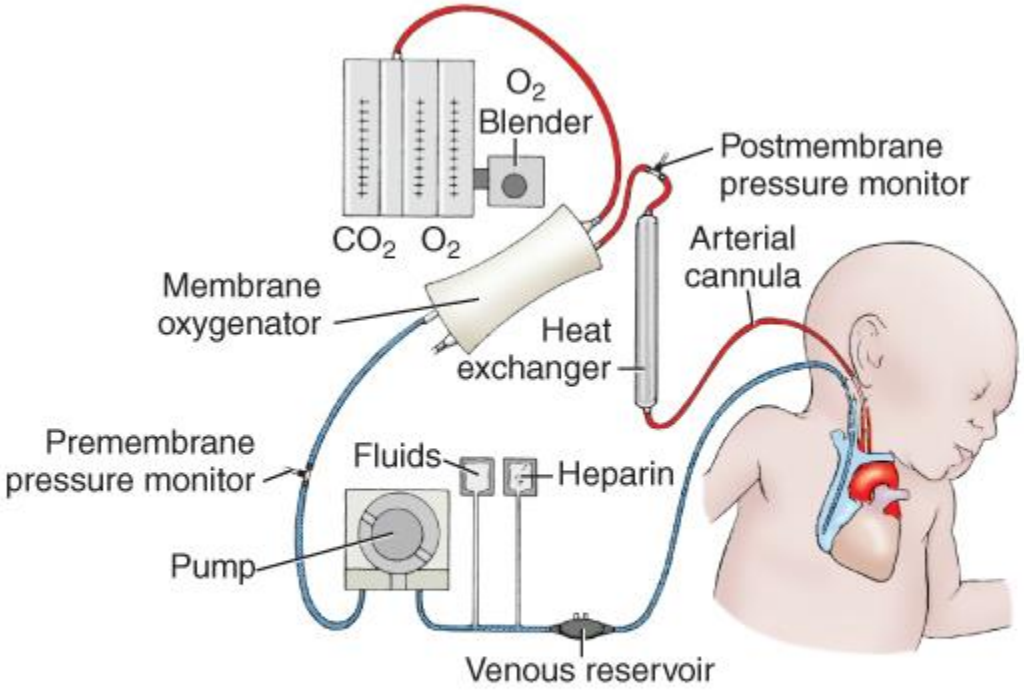

FIGURE 19-2 Circuit for extracorporeal life support. Classic ECMO circuit—infant, VA mode, roller pump, and silicone membrane.

Clinical Management

- Anticoagulation
  - Heparin
- Monitoring circuit function
  - Water temperature
  - Venous saturation
  - Circuit integrity
  - Pre- and postmembrane blood gases
  - Air bubbles

Clinical Management (Cont.)

- Hemodynamics
- Organ perfusion
- Laboratory tests
- Neurologic assessment
- Respiratory support
  - VT = 5-7 mL/kg
  - 10-12 breaths/min
  - PEEP = 5-7 cm H_2O
- Fluid and nutrition

Liberation from ECMO

- ECMO flow = 20-30 mL/kg
- Lung compliance checks
- Chest x-ray appearance
- Need to add more CO_2 into the sweep gas
- Increase ventilator settings
- Trial separation

Complications

- Technical
  - Unplanned decannulation
  - Tubing or component rupture
  - Witnessed air embolism
- Physiologic
  - Intracranial hemorrhage
  - Bleeding

Outcomes

- Main goal is discharge without any disability
- Survival to discharge > 65% in infants

THORACIC ORGAN TRANSPLANTATION

Introduction

- 1960s South Africa and Mississippi
- Lower number of heart-lung transplantations
- Lung transplantation procedure of choice for isolated pulmonary disease
- Organ donation trends
- Lung infection and atelectasis
- Quality of life after transplantation

Heart Transplantation

- Cardiomyopathy
- Congenital heart defects
  - 40% in children < 1 year old
  - Mortality
    - Graft failure and rhythm disorders

Heart-Lung Transplantation

- Limited availability of coupled heart-lung donations
- Three separate donations
- Decreased risk of cardiac rejections with single isolated lung transplant
- Decreased risk of premature coronary artery disease
- The high demand for donor hearts by very ill heart transplant candidates with ventricular assist devices or artificial hearts in place

Heart-Lung Transplantation Indications

- End-stage lung disease with left ventricular failure
- Irreparable congenital heart disease with pulmonary hypertension or other intrinsic lung disease

Lung Transplantation

- Cystic fibrosis is the most common indication for bilateral lung transplantation
  - More than 6 years of age
- One-year survival = 85%
- Five-year survival = 50%
- Early deaths (<90 days) due to graft failure
- Donor-recipient size matching

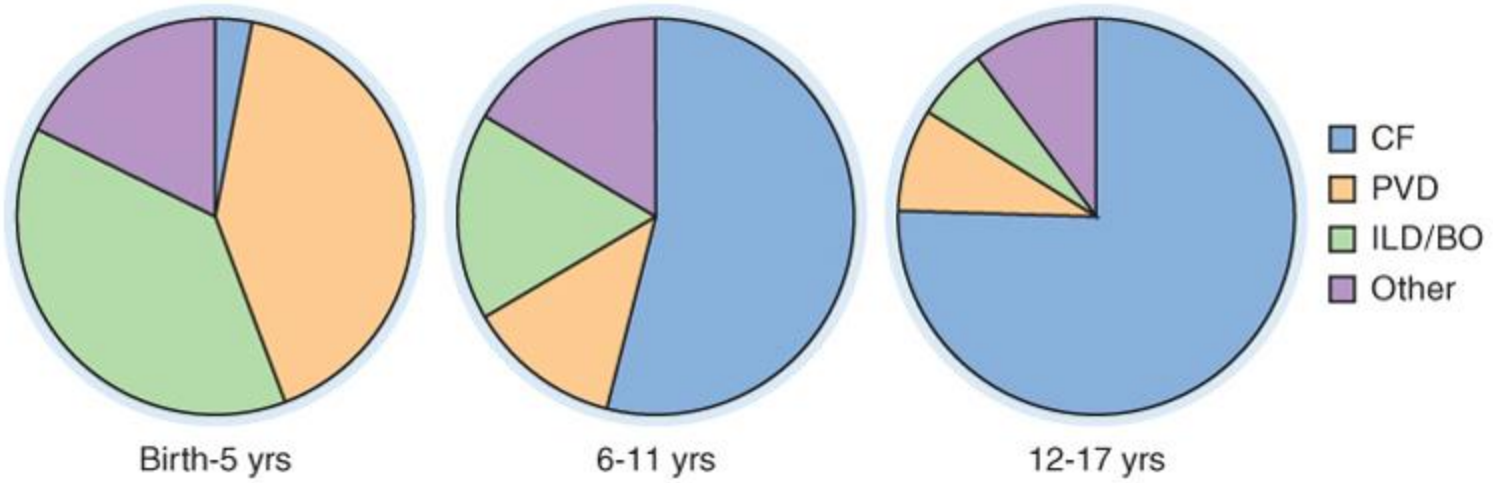

FIGURE 21-4 Frequency of primary diseases leading to lung transplantation in children by age. **A,** Diagnoses from birth through age 5 years. **B,** Diagnoses from birth through age 6 to 11 years. **C,** Diagnoses age 12 through 17 years. *BO,* Bronchiolitis obliterans; *CF,* cystic fibrosis; *PVD,* pulmonary vascular disease; *ILD,* interstitial lung disease; *ReTxp*, retransplantation.

Data from http://optn.transplant.hrsa.gov; and Benden C, Edwards LB, Kucheryavaya AY, et al. The registry of the International Society for Heart and Lung Transplantation: fifteenth pediatric lung and heart–lung transplantation report—2012. *J Heart Lung Transplant* 2012;31:1087.

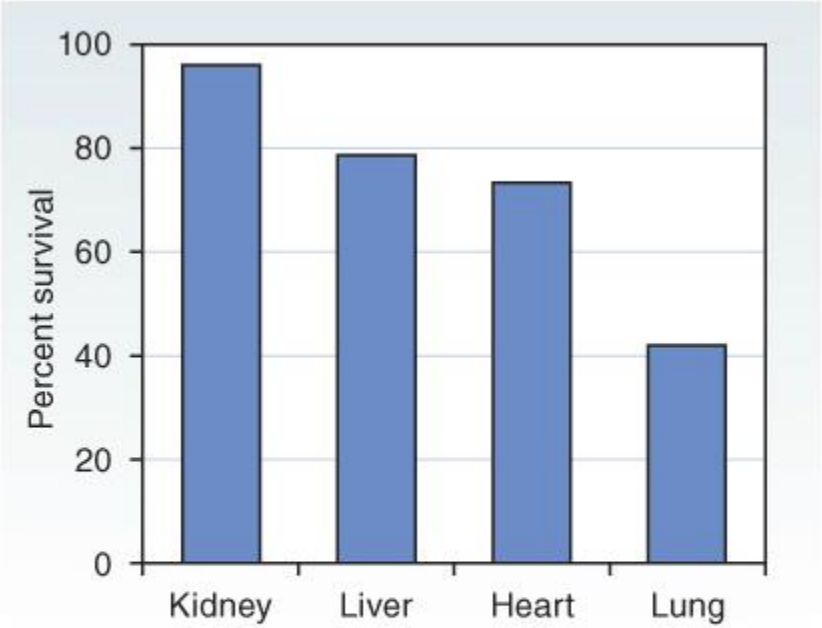

FIGURE 21-5 Five-year survival of patients younger than 18 years after kidney, liver, heart, and lung transplants in the United States. Because of the availability of renal dialysis, patient survival exceeds graft survival by more 20% at 5 years for kidney transplant recipients.

Data from http://optn.transplant.hrsa.gov.

Immunosuppressive Regimens

- Cyclosporine
- Tacrolimus (most commonly utilized immunosuppressive agents)
- Azathioprine
- Mycophenolate mofetil (most commonly utilized immunosuppressive agents)
- Prednisone

Complications

- Respiratory problems
- Organ rejection
- Infection
- Bronchiolitis obliterans
- Drug toxicity
- Other complications

Survival and Quality of Life

- Heart transplantation 60% survival at 10 years
- Lung transplantation <40% survival at 10 years
- HRQOL similar to other chronic disease groups

Role of the Respiratory Therapist

- Familiarity with diseases leading to transplantation
- Routine care of patients with CF
- Pulmonary function testing
- Mechanical ventilatory support
- Maintenance of artificial airway
- Aerosolized bronchodilators
- Bronchopulmonary hygiene
- Rehabilitation

References

- Costello, J. P., Carvajal, H. G., Abarbanell, A. M., Eghtesady, P., & Nath, D. S. (2021). Surgical considerations in infant lung transplantation: Challenges and opportunities. *American Journal of Transplantation*, *21*(1), 15-20.
- Lin, Y., Davis, T. J., Zorrilla-Vaca, A., Wojcik, B. M., Miyamoto, S. D., Everitt, M. D., ... & Rajab, T. K. (2021). Neonatal heart transplant outcomes: A single institutional experience. *The Journal of Thoracic and Cardiovascular Surgery*.
- Roeleveld, P. P., & Mendonca, M. (2019). Neonatal cardiac ECMO in 2019 and beyond. *Frontiers in pediatrics*, *7*, 327.
- Yu, X., Yang, Y., Zhang, W., Guo, Z., Shen, J., Xu, Z., ... & Wang, W. (2021). Postcardiotomy Extracorporeal Membrane Oxygenation in Neonates. *The Thoracic and cardiovascular surgeon*, *69*(S 03), e41-e47.