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ECMO: A Bridge between Life and Death

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Abstract

The use of ventilators and cardiac support machines taken its prime role by the advent of technology. ECMO is one among those type of management used for cardiac and pulmonary dysfunction and mostly been used on children with congenital cardiac diseases. ECMO works by removing blood from person's body and artificially exchanging CO_2 and oxygen from red blood cells. It's been used in children and adults by the different approaches like veno venous, veno arterial method of blood removal. Later the blood will be oxygenated by removing carbon dioxide artificially and provides adequate pressure to the blood stream in the body for maintaining cellular oxygenation.

Keywords: Extra Corporal Membrane Oxygenation; ECMO; Artificial Oxygenation; Life Support.

Technology is getting advanced day by day. In the field of critical care there is a drastic change which happens around the globe. The use of ventilators and cardiac support machines taken its prime role. ECMO is one among those type of management used for cardiac and pulmonary dysfunction. This intervention has mostly been used on children but is seeing more use in adults with cardiac and respiratory failure.

ECMO works by removing blood from person's body and artificially exchanging CO_2 and oxygen from red blood cells. A brief description of the method is follows by giving light to its main function, machine, problems encountered and the role of care professionals.

Extra Corporal Membrane Oxygenation or Extra Corporal Life Support (ECLS)

It is a temporary treatment that uses a pump to circulate blood through an artificial ling back into the blood stream which deliver adequate amount of gas exchange to sustain life. It is a system that provides heart-lung bypass support.

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Purpose

- To provide enough oxygen to body while allowing time for lungs and heart to heal.

Historical Background of ECMO

- 1918-Mclean & Howell isolated heparin.
- 1938-Introduced the Heparin to the clinical field widely.
- 1944-Kolff and Berk noted that blood become oxygenated as it pass through cellophane chambers of artificial kidney.
- 1953-Gibbon used artificial oxygenation & perfusion for open heart surgery.
- 1954-Lillehei developed cross circulation technique.
- 1955–Kirplin et al improved Gibbon's device and repaired ASD.
- 1960-Kolobow introduced the membrane lung into the
- 1965-Rashkind & coworkers used bubble oxygenator as support in neonate.
- 1969–Dorson & Colleagues reported use of membrane oxygenator for CPB.
- 1970–Baffes et al reported use of ECMO for infants with congenital heart defects.
- 1972-Long term ECMO as support for severe respiratory failure in adult with post traumatic respiratory failure by Hil.
- 1975–Bartlett et al were the first to successfully

use ECMO in neonates with severe respiratory failures because of me conium aspiration.

Clinical Conditions

- Severe Pneumonia and ARDS.
- Later treatment of cardiac and respiratory failures.
- In children with birth defect of heart.
- Hypoxemic respiratory failure with Pa O_2/ F_1 O_2< 100 mm of Hg
- Hypercapnic respiratory failure with arterial p^H < 7.20.
- Refractory Cardiogenic shock.
- A bridge to either heart transplantation or placement of Ventricular assistive devices.

Contra Indications

1. Conditions incompatible with normal life of the persons recovers.
2. Age & size of patient.
3. Preexisting diseases affect future Quality of life. (CNS disorders, Cancer).
4. Advanced Cancer.
5. ARDS associated with bone marrow transplantation.
6. Pulmonary fibrosis.
7. Chronic lung disease.
8. Futility –patients who are too sick.

Types

There are mainly two types which are based on the blood input and output from body.

Veno Arterial (VA)

In this venous canula is placed on common femoral vein for extraction and an arterial canula is placed into femoral artery for infusion. Venous canula is at junction of inferior venacava /right atrium white arterial canula is at level of iliac artery. While during cardiac surgery it can be used for establishing cardiopulmonary bypass canulas (at right atrium ascending aorta). This method is mostly used for cardiac failure.

Veno Venus (VV)

Here the canulas are at common femoral vein and for infusion at jugular veins. This method is mostly used for respiratory failure clients.

Arterio Venous (A V)

This type is limited to low blood flow and specifically for CO_2 removal.

How It Differs

Equipment

Consist of blood pump with raceway tubing, a venous reservoir, oxygenation and a counter assent heat exchanger responsible for exchanging both oxygen and co_2 and is the important part of ECMO. The oxygenators can be bubble, membrane & countercurrent mechanism. In membrane oxygenates it may be solid silicon, rubber, micro porous, hollow

S. No.	Veno Arterial	Veno Venous
1	Higher PaO_2 is achieved	Lower PaO_2 is achieved
2	Lower perfusion rate are needed	Higher perfusion rate are needed
3	Bypass pulmonary circulation	Maintain Pulmonary circulation
4	Decrease pulmonary artery pressure	Elevates mixed venous PO_2
5	Provide Cardiac Support	Does not Provide Cardiac Support
6	Arterial Cannulation	Venous Cannulations
7	Ligation of a major artery is needed	Avoided ligation is avoided and reduces distal complications

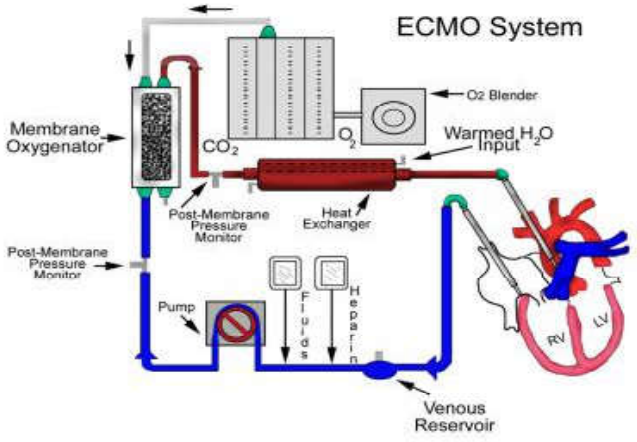

Fig. 1: Pictorial representation of ECMO system

fiber or solid hollow fiber mostly an external water bath generally a temperature <40^0C at 37^0C. (Fig. 1.)

- Air bubble detector- to identify microscopic air bubble in the arterialized blood.
- Arterial Line Filters- Placed between heat exchanger & the arterial cannula and are used to trap air, thrombi and other emboli.
- Pressure Monitor – Placed before & after the oxygenator measure the pressure of the circulating blood.
- Pump-The pump should be able to provide full blood for patients.
- Sweep Gas-the sweep gas will be 100% oxygen or 5% co_2.
- Venous Oxygen Saturation Monitor
- Temperature Monitor

Members Needed for Managing (ECMO Team)

- Intensivist – VV cannulation, transport, ECMO critical care management
- Respiratory Therapist – ECMO Maintenance.
- Perfusionist –ECMO initiation, transport & Backup.
- Cardiothoracic surgeon –VA cannulation.
- Nursing Staff –ECMO trained.

Process

The person will be anti coagulated and a cannulation by seldinger technique. The circuit is primed with freshest blood/with an isotonic electrolyte solution resembling normal extracellular fluid including 4-5mg/L Potassium under sterile condition. Before attaching the circuit to the patient the water bath is turned on to warm the fluid. Mostly crystalloid prime is used but some team uses human albumin before blood exposure. When blood is added to prime heparin is added as anticoagulant and calcium is added to replace the calcium bound by the citrate in packed blood. After cannulation they are connected to ECMO circuit. Venous reservoir is located 3-4 feet below heart level. Blood is actively pumped by roller pump through oxygenator where countercurrent flow of blood and gas result in gas exchange and blood warmed and returned to body. Increasing the flow rate of blood increases the oxygenation of the whole body, mean arterial pressure and hemodynamic stability. Blood flow is titrated until respiratory and hemodynamic status is stable. The weaning for respiratory failure client is based on improvement in radiographic appearance, pulmonary compliance and oxygenation. For cardiac patient it relates with the ventricular output.

Compare ECMO & Cardio Pulmonary Bypass

Problems While the Patient is on ECMO Machine

- Bleeding
- Blood clot formation (19%)
- Heparin induced thrombocytopenia
- Damage to cannulated vein

S. No.	ECMO	Cardio pulmonary bypass
1	Using Percutaneous Cannulation	Uses Trans thoracic cannulation
2	Local anesthesia	Needs general anesthesia.
3	No suction devices	Coronary suction device present
4	Less anticoagulation	Anticoagulants are used widely
5	No stagnation of Blood	Stagnation of Blood
6	Used for long term support	Short term support.
7	Patient is awake or moving	Control over patients movements
8	Allow intrinsic recovery	Supports during cardiac surgery lings.

- Subarachnoid clot
- Infections.
- Hypoxemia
- Ischemic encephalopathy
- Seizure
- Air embolism
- Pnuemothorax
- Oliguria
- Pump malfunction-Pump, oxygenator, heat exchanger are more
- Coma
- Brain death.

Nurse Role

- Position change Q_4h.
- Pulmonary Hygiene by suctioning Q_4h or whenever is to be monitored.
- Monitor chest radiograph daily.

- Monitor ventilator parameters mostly managed at low setting PEEP should be set to be at 5-15cm of H_2O.
- Monitor neurological states periodically, if patient is sedated.
- Monitor heparin effect periodically.
- Monitor I/O accurately, CVP, MAP, CO, perfusion & intravascular volume, platelets, blood cells etc & other vital parameter continuously.
- Monitor for any bleeding, GI, menstrual, mucous membrane etc.
- Adhere to most advanced aseptic technique is needed.

Prognosis

According to registry maintained by Extra Corporal Life Support Organization (ELSO) on Jan 2015 reported outcome nearly over 65,171 with 53% for neonates, 25% for pediatrics 23% for adults. ECLS should be discontinued promptly if there is no hope for healthy survival. While protecting on disease burden 63% of cases for respiratory support, 29% for cardiac support 8% for extra corporal Cardiopulmonary resuscitation. Patients with congenital diaphragmatic hernia & total anomalous pulmonary venous return (TAPVR) have a mortality rate of 50%. Among 50% of reported deaths are due to severe bleeding. To tackle that

- The patient hemoglobin should be kept around 12-15 g/dl.
- Maintaining platelet count more than 1 lakh/ mil.
- ACT should be checked and maintained at 180-240 sec.
- The high energy requirements should be met using nutritional management.

Conclusion

ECMO become more reliable in the management for the patient with cardiac and pulmonary dysfunction. In the case of the cardiac or respiratory arrest where life is at the last stages the use of ECMO will be surely a helping the medical persons to save the life of the patients.

Key Messages

ECMO is a temporary treatment that used deliver adequate amount of gas exchange to sustain life. It is a system that provides heart-lung bypass support at the cliff where life is going to end.

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