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SHORT COMMUNICATION

The story of the survival of a newborn with severe Meconium Aspiration Syndrome and cardiorespiratory arrest by using ECMO

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Abstract: Extra Corporeal Membrane Oxygenation (ECMO) is used as a rescue therapy in cardiac and respiratory failure until the reversible condition settles. It provides extracorporeal circulation for gas and heat exchange before entering the patient. While the use of ECMO has been advancing as a promising life-saving modality since 1953, our country still lags behind, having only one ECMO centre for the whole country. The need to improve ECMO is emphasized by the fact that candidates who had grim prognosis being survived by using ECMO. This is the story of a term baby weighing 3770 g who had severe meconium aspiration at birth, requiring intubation within first hour for severe respiratory distress. Irrespective of High Frequency Oscillatory Ventilation and four inotropes baby had refractory desaturation, hypotension and rising oxygen index with a cardiac arrest needing both cardiac and respiratory support for survival. Baby was commenced on Veno-Arterial ECMO monitoring vitals, cardiac status respiration, coagulation, cerebral status for haemorrhage, electrolytes, renal and liver status while treating for sepsis. Our baby fully recovered without complications, while precious smile on the face of the baby highlights an important point, Hi-Tech measures in proper manner do account for their survival and normal development. Progress beyond 'Ambulatory-ECMO' shows how advanced technology can be well utilized for patients' benefits. It is important to expand and improve ECMO facilities in Sri Lanka aiming at a better survival of our patients.

***Keywords**: Meconium Aspiration Syndrome, ECMO, Cardiac Arrest, Oxygen Index*

Introduction

Extra Corporeal Membrane Oxygenation (ECMO) is used as rescue therapy in both respiratory and cardiac failure by means of using an extracorporeal circulation for gas and heat exchange. It was first successfully used for cardiac surgery in 1953 and has been showing promise on using it for various other indications. Even though this procedure has been developed well as an advanced life support modality in developed countries, we still lag behind having only one ECMO center for the whole country. The need to promote ECMO is emphasized by the fact that candidates who had a grim prognosis being survived by using ECMO. We report a baby who had severe meconium aspiration at birth requiring early intubation and failing conventional ventilation underwent High-Frequency Oscillatory Ventilation (HFOV) with rising Oxygen Index who had a witnessed cardiac arrest while on ventilator surviving with Extra Corporeal Membrane Oxygenation. (ECMO)

Case Report

The firstborn baby to non-consanguineous healthy parents following an uncomplicated antenatal period was delivered by emergency LSCS at term due to thick meconium-stained liquor and fetal distress. The baby girl was delivered at a local hospital with initial crying (Apgar $1^{6}5^{8}10^{10}$) but progressive grunting and respiratory distress requiring intubation within the first hour after birth. She was transferred to our institute for ventilation and intensive care. Her birth

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weight was 3700 g. The baby required high settings in the ventilator from the time of connection and continued to have low saturation on the monitor. At the 12th hour of life, she was started on HFOV but the maximum saturation achieved was 80%. She soon required Inotropes for fluid refractory hypotension. Her initial echocardiogram showed severe pulmonary hypertension, non-restricted Patent Ductus Arteriosus, and Patent Fossa Ovalis shunting Left to Right. Irrespective of high settings in HFOV and administration of surfactant, she continued Magnesium Sulphate, and oral Sildenafil to desaturate with refractory respiratory acidosis. Her Oxygen Index at the beginning was 55 which gradually increased to 100 by the 20th hour after birth. At the 19th hour of life, the baby had a cardiac arrest requiring Cardiopulmonary resuscitation for 20 minutes. She was on four inotropes. At this point, the decision to commence on ECMO was made. Other than that she needed both respiratory and cardiac support. She also had inadequate tissue perfusion despite the adequate intravascular volume and persistent shock with therapy as indications to start on ECMO.

Baby's pre-ECMO parameters were: Pre ductal saturation 72%, post ductal saturation 33%, pH 7, CO_2 68 mmHg, PaO2 10 mmHg, base deficit 6, HCO_3 23mEq/L lactate 12mmol/L, Mean airway pressure 22cm H_2O, frequency 8Hz , amplitude 60, FiO_2 100%, and evidence of poor circulation. As for the gloomy prognosis, we started the baby on ECMO at the 23rd hour of life. It was a veno arterial ECMO, cannulating Right Internal Jugular Vein and Right Common Carotid Artery.

Problems we encountered during her procedure are as follows.

1. Coagulopathy and thrombocytopenia- before commencing on ECMO needed both FFP and platelets, vitamin K daily dose.
2. Initial low oxygen saturation despite starting on ECMO which slowly improved over 6 hours.
3. Difficulty switching to conventional ventilation from HFOV while on ECMO. This was done slowly over 24 hours.
4. Sepsis- Rising high CRP and thrombocytopenia- IV Meropenum, Vancomycin given.
5. Bradycardia – Electrophysiologist's opinion taken as sinus bradycardia to manage with Atropine.
6. Transient hypertension- Settled with Hydralazine infusion (This may be a result of veno-arterial support and can settle without intervention.

Other than the ventilation, and inotropic support, our management was comprised of:

1. Daily chest x-ray, 2D echocardiogram, Ultrasound brain for assessment and to exclude bleeding.
2. Monitoring vital parameters and coagulation (Activated Clotted Time), electrolytes and correction accordingly, observing for clots in the system every 6 hours.
3. Repeated blood cultures from the periphery and central line, ET cultures every third day, and broad-spectrum antibiotics.
4. Early chest physiotherapy.
5. Daily updating of parents.

On the 5th day of life as the baby's saturation and other parameters were all maintained within normal range a trial off ECMO was done with the reversed flow and decannulated after 90 hours of ECMO. Post decannulation saturation, blood pressure, and other parameters were all maintained well. Extubation was done successfully after three days. Xrays [Figure 1 and 2] confirmed the remarkable clinical improvement. Meanwhile, Baby's neck wound was gaping and took much time to heal. She required oxygen for two weeks after decannulation. Other than that, she did not exhibit any post-procedure complications.

We discharged the baby on the 26th day of life with general movement, hearing, and visual assessment and commencing on occupational therapy.

When our patient came to us two months after the procedure, we were extremely happy to see her in good health together with her growth parameters lying at medium to +1SD (standard deviation) and age-appropriate development in all domains.

Discussion

The world's first neonate to undergo a successful ECMO procedure was a baby with MAS in 1975. She was given the name 'Esperanza' meaning 'hope' in Spanish, which reminds the fact that ECMO is the hope of the patients with respiratory or cardiac failure when other strategies have failed. It involves the drainage of blood via a cannula into an extracorporeal circuit including an artificial membrane where gas and heat exchange occurs (Robinson , 2015). There are two types of ECMO venoarterial (VA) or venovenous (VV). Both provide respiratory support but only VA ECMO provides hemodynamic support.

ECMO inclusion criteria vary according to the institute and usually, children placed on ECMO have reversible conditions without coagulopathy. Oxygen Index (OI) as depicted by:

$$OI=\frac{\text{mean airway pressure } (cmH_2O) \times FiO_2\ (\%)}{PaO_2\ (mmHg)}$$

> 40 is a marker of severe respiratory failure (MacLaren , 2015).

In meconium aspiration syndrome there is a triad of meconium-stained amniotic fluid, respiratory distress, and having typical radiological features. A neonate requiring assisted ventilation for more than 48 hours belongs to the category of severe meconium aspiration. Meconium aspiration can cause direct damage to alveoli, surfactant dysfunction, obstruction to airways, and oxidative damage. Persistent pulmonary hypertension is an important cause of death in MAS. Other than supportive treatment such as mechanical ventilation, sedation, exogenous surfactant therapy, steroids, and antibiotics, popular treatment modalities that reduce the need for ECMO are high-frequency Oscillatory Ventilation (HFOV), and inhaled Nitric Oxide (iNO). Inhaled nitric oxide acts on vascular smooth muscle causing selective pulmonary vasodilation thus is an effective agent against PPHN. Neonates with severe MAS, refractory respiratory failure would benefit from ECMO and if started survival rate goes up to 95% (Chettri , 2016).

The goal of ECMO is to buy time providing gas exchange and oxygenation until the underlying disease process recovers (Jenks, 2017). Proper monitoring and careful evaluation for possible complications are very important in the management of a patient on ECMO. Two most common complications are heparin induced coagulopathy and infections due to invasiveness of the procedure. Regular assessment and correction of coagulation, Daily Renal and liver functions, albumin level, CRP, chest x-ray and every third-day cultures need to be done.

It is a costly procedure, [Figure 3 showing the circuit] but has a good prognosis and a high success rate especially with regards to Meconium Aspiration Syndrome in neonates. The success rate for those patients at Karapitiya is 100%. The cost is similar to that of a valve replacement in cardiac surgery in Sri Lanka. While spending for cardiac patients who are old and have higher disability, we cannot disregard the young children with a full recovery, which can be more productive in the long run, so being more cost effective. The real cost is also minimized in our low resource setting by re-using the consumables following plasma sterilization. Moreover, the value of the Life of an otherwise well patient cannot be compared with the cost of the procedure [Figure 4].

In the modern era children have undergone ambulatory ECMO (Garcia , 2010) and carry out their daily functions while on this complicated procedure, new ECMO circuits performing 'heparin-free' perfusion (Silvetti , 2015) are also used in other countries embarking on us the value of ECMO and the need to establish it in other centers of the country and improve ECMO facilities aiming at a better survival of our patients.

Figure 1: Initial chest X ray

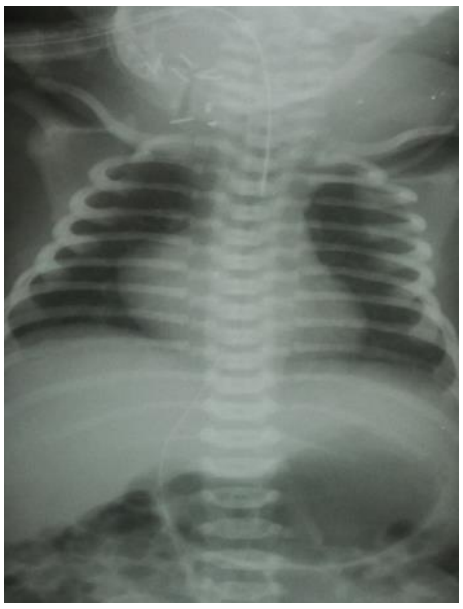

Figure 2: Chest X ray on the 3rd day of ECMO

Figure 3: Baby connected to ventilator and ECMO circuit

Figure 4: Two months after discharge with a precious smile

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