

Brief Communication



Neonatal extracorporeal membrane oxygenation: A case report and current state in Mainland China

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Abstract

We report the first successful treatment of extracorporeal membrane oxygenation (ECMO) in a neonate with Group B streptococcus (GBS) sepsis and cardiorespiratory failure, and further conduct a literature review in the experience of neonatal ECMO utility in Mainland China. A term neonate with cardiorespiratory failure secondary to GBS sepsis was put on venous-arterial ECMO at 23 h of age. After 273 h of ECMO running, the patient was saved and without major complications. The comprehensive literature review demonstrated that there were 22 neonates received ECMO previously in Mainland China, 14 of 22 of the patients are cases with congenital heart defects. The overall survival rate was 41% (9/22). Neonatal ECMO was underdeveloped in Mainland, China. Moreover, it does provide a chance of survival for neonates who have a grave prognosis by conventional treatment.

Keywords: Extracorporeal membrane oxygenation, Group B streptococcus, Mainland China, neonate

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Introduction

Extracorporeal membrane oxygenation (ECMO) is an essential part of life support and acts as the last resort for severe cardiorespiratory failure neonates without response to aggressive conventional treatment. ECMO improves oxygenation and organ perfusion and saves precious time for failed heart and lung to recover.^[1] Venous-venous ECMO and Venous-Arterial ECMO are two most common ECMO modes.^[2] Since the first case of successful neonatal ECMO for a severe meconium aspiration syndrome (MAS) neonate in 1976, ECMO has been used and saved thousands of neonates suffering from respiratory and/or cardiac failure world widely.^[3] The most common candidate diseases for neonatal ECMO are MAS, persistent pulmonary hypertension of neonate, congenital diaphragmatic hernia, severe sepsis, etc.^[4] Neonatal ECMO is still at the underdeveloped stage in Mainland China, in comparison with other countries. The current paper reported the first neonate with

early-onset Group B streptococcus (GBS) sepsis saved by V-A ECMO in Mainland China, and we also conducted a comprehensive literature review of neonatal ECMO utility in Mainland China.

Case Report

A term neonate with gestational age of 39 weeks and birth weight of 3180 g was born by spontaneous vaginal delivery with unremarkable maternal history; however, the GBS status was unknown. She did not need aggressive resuscitation in the delivery room, had good Apgar score of 10 and 10 at 1 and 5 min, respectively. Initially, she was sent to the nursery and cared by parents. Eight hours later, she developed respiratory distress and needed to be intubated and received mechanical respiratory support; the antibiotics were also started empirically after blood

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culture sampling. Moreover, the chest X-ray showed right lung infiltration. She was transported to our Neonate Intensive Care Unit (NICU) at the age of 15 h.

In NICU, she developed cardiac and respiratory failure with hypotension and hypoxemia, even though she received an aggressive fluid replacement and inotropic agents including epinephrine and large dose of dopamine. She was put on high-frequency oscillatory ventilation with high mean airway pressure of 17 cmH₂O, and high FiO₂ of 1.0, she was given inhaled Nitric oxide as well due to pulmonary hypertension confirmed by bedside echocardiography. However, the blood gas was poor as following: pH 7.24, PaO₂ 35.5 mmHg, PaCO₂ 40.8 mmHg, and base deficit -9.0 mmol/L. The oxygenation index (OI = MAP × FiO₂/PaO₂) was 45. After ruling out neonatal ECMO contraindications of intracranial hemorrhage, unrepairable congenital heart defects (CHDs), she was put on V-A ECMO at the age of 23 h. In addition, the blood culture sent in referral hospital reported after was positive for GBS and confirmed the diagnosis of early onset GBS sepsis complicated by cardiorespiratory failure with no response to maximal conventional treatment.

Medtronic Minimax Plus oxygenator and Bio-console 560 Centrifugal blood pump was used in this patient. The V-A ECMO cannulation was achieved by right jugular vein and common carotid artery insertion. The positions of the catheters were guided by bedside ECHO. During the 273 h ECMO procedure, the blood gas, lactate level, and glucose level were monitored every 2 h, C-reactive protein, and chest X-ray was done daily. The ECMO flow was maintained at 100–130 ml/kg/min based on hemodynamic monitoring.

She tolerated ECMO well without major complications, apart from mild bleeding at the sites of cannulation, thrombocytopenia, etc. And, she was decannulated at the age of 12 days after 273 h ECMO and extubated the day after. Neurologic evaluations including cranial magnetic resonance imaging and electroencephalogram were normal before discharge at the age of 36 days.

Discussion

Until July 2015, there were totally 69,114 patients registered in the Extracorporeal Life Support Organization (ELSO) received ECMO treatment worldwide based on the data of ELSO. And, more than half of the cases were neonatal cases which consisted 51.4% (35505/69114) of all, and the survive rate were 74% and 41% in respiratory failure and cardiac failure

cases, respectively.^[5] In comparison with the advanced and sophisticated ECMO utility in critical patients in developed countries, the ECMO utility was still at the underdeveloped stage, especially neonatal ECMO, in Mainland China. And, survive rate remains much lower than developed countries.

To know the current state of neonatal ECMO in Mainland, China, we conducted a comprehensive literature review through searching “neonatal ECMO” in Chinese databases, including China Knowledge Resource Integrated Database and Wanfang database; we also used the keywords of “(ECMO) AND CHINA [Affiliation]” as searching strategy in PubMed for papers published by authors from mainland, China. Finally, 176 papers were retrieved from Chinese databases and PubMed. After abstract reviewing, 8 papers were recruited in the full paper assessment. Based on the clinical information, we deleted duplicated cases from the same institutions. After that, we collected 22 reported neonatal cases with the birth weight of 2.8–4.0 kg. The clinical characteristics were demonstrated in Table 1.^[6–12] Fourteen of the 22 patients were patients with CHDs, while the other 8 patients were non-CHD patients, including one MAS, 4 neonatal respiratory distress syndrome (NRDS), 2 pulmonary dysplasia, 1 cardiac arrest secondary to hydronephrosis and electrolytes disturbance. V-A ECMO was utilized in 21 of 22 patients; the duration of ECMO running was 64 ± 42 h (range from 7 to 173 h). Complications occurred in 13 patients, and the survive rate was 41% (9/22). Of note, the survive rate in non-CHD patients was only 25% (2/8), and none of the patients with congenital anomalies, such as pulmonary dysplasia and hydronephrosis survived. The current case is the first neonate case with severe GBS sepsis saved by V-A ECMO in Mainland, China.

In this article, we reported the first neonatal ECMO for GBS sepsis neonate in Mainland China, and the ECMO duration of 273 h was the longest among all reported cases. Among 22 reported neonatal ECMO cases in previous papers, there were only 2 non-CHD patients survived. The ECMO running durations in our case were much longer than the 48 h in the MAS case and 50 h in the NRDS case. According to the available evidence, GBS could cause a severe inflammatory reaction in the patients, which is also manifested in our case by extremely elevated C-reactive protein levels. This kind of inflammation recovers much slower than the self-limited lung diseases such as MAS and NRDS. That could be the underlying reason for a long duration of ECMO running in our case. Of note, because of low survive rate in patients with pulmonary dysplasia;

Table 1: Reported neonatal ECMO cases done in Mainland, China

First author (year)	Age	Gender	BW/GA (kg/Weeks)	Diagnosis	ECMO mode	Duration(h)	Complications	Survive (Yes/No)
Zhao J, 2006 ^[6]	5d	Female	4/-	left hypoplastic heart	V-A	146	Renal failure, infection	No
He XJ, 2009 ^[7]	6d	Male	2.8/40	TGA + ASD + PDA	V-A	87	Bleeding, cardiac tamponade, hemolysis	No
Fu WD, 2011 ^[8]	18d	Male	3.4/-	TGA/IVS, pulmonary hemorrhage	V-A	63	Bleeding, DIC	No
Lin R, 2012 ^[9]	19d	Male	4.0/-	TGA	V-V	15	DIC, MODS	No
Zheng ML, 2013 ^[10]	33h	Male	4.2/-	MAS	V-A	48	Hypertension, thrombocytopenia	Yes
Hong XY, 2013 ^[11]	13d	Male	3.3/-	TGA + IVS + PDA	V-A	96	Oxygenator leaking	Yes
Hong XY, 2015 ^[12]	28d	Male	3.3/-	TGA/IVS, pulmonary hemorrhage	V-A	96	Renal failure	No
	10d	Female	3.0/-	NRDS	V-A	12	Cannula blockage	No
	1d	Male	3.4/-	NRDS	V-A	103	Renal failure	No
	4d	Male	3.3/-	Hydrops Fetalis, pulmonary displasia	V-A	173	Renal failure	No
	27d	Male	4.0/-	TGA/IVS	V-A	69	-	Yes
	30d	Male	3.5/-	TGA/VSD, cardiac arrest	V-A	48	-	No
	7d	Male	3.6/-	TAPVC, Cardiac arrest	V-A	66	-	Yes
	21d	Male	3.1/-	IAA/VSD	V-A	43	-	Yes
	1d	Male	4.0/-	NRDS	V-A	50	-	Yes
	13d	Female	3.0/-	Hydronephrosis, Cardiac arrest	V-A	10	Bleeding, DIC	No
	2d	Female	3.0/-	NRDS/PH	V-A	75	-	No
	24d	Female	2.9/-	CoA/VSD	V-A	7	bleeding	No
	1d	Male	3.1/-	Pulmonary displasia	V-A	42	-	No
	13d	Male	3.6/-	TAG/IVS	V-A	50	-	Yes
	1d	Male	3.1/-	TAPVC	V-A	42	-	Yes
	23d	Male	3.4/-	VSD/CoA	V-A	69	Limb necrosis	No
Current case	23h	Female	3.2/39 ⁺⁶	GBS	V-A	275	Hemolysis, thrombocytopenia	Yes

TGA: Transposition of the great arteries; ASD: Atrial septal defect; PDA: Patent ductus arteriosus; IVS: Intact ventricular septum; DIC: Disseminated intravascular coagulation; MODS: Multiple organ dysfunction syndrome; TAPVC: Total anomalous pulmonary venous connection; IAA: Interrupted aortic arch; CoA: Coarctation of the aorta

the administration of neonatal ECMO in such patients should be cautious.

In Mainland China, the first reported Neonatal ECMO case was a patient with left hypoplastic heart in 2006, and the first reported non-CHD case was a neonate with MAS in 2009. The previous 22 cases reported by Chinese authors were done only by big hospitals located in Beijing, Shanghai, Hangzhou, and Guangdong, these 4 megacities with the highest economical level in Mainland China. The high fee of ECMO not covered by Chinese Medicare is the biggest hurdle for developing neonatal ECMO in China.

Conclusion

The neonatal ECMO was still underdeveloped in Mainland China; however, because of the remarkable effectiveness of ECMO in treating critical patients without response to conventional treatment, ECMO does provide a chance of survival for neonates who have a grave prognosis by conventional treatment.

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Conflicts of interest

There are no conflicts of interest.

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