

High Flow Nasal Cannula with Heliox for Post Extubation Respiratory Failure on an infant with Unrepaired Congenital Heart Disease.

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INTRODUCTION: A 4.6 Kg 4 month old with transitional AV Canal, Cleft Mitral Valve, Mitral Stenosis, and resultant pulmonary artery hypertension (PAH), and gastro-esophageal reflux (GER) was admitted to Children's Healthcare of Atlanta's cardiac intensive care unit (CICU) following a diagnostic cardiac catheterization. Previous surgical interventions included an end to end anastomosis of a coarctation, gastric tube, and a fundoplication. The cardiac catheterization data revealed a pulmonary vascular bed that was responsive to oxygen. The pulmonary vascular resistance decreased from 13.2 units to 3.8 units with application of 100% O₂ during the procedure. The patient remained on O₂ via a 2 LPM nasal cannula and was started on both IV Milrinone at 0.7 mcg/Kg/min and Sildenafil. Post cardiac catheterization day # 1, the patient developed bradycardia (sustained HR < 80 BPM) and desaturation (SpO₂/SaO₂ < 60%), the patient was intubated and mechanically ventilated.

CASE STUDY: On CICU day # 8, the patient was able to be supported on low levels of mechanical support. The pre extubation settings were PSV/CPAP 40%, +5 cm CPAP, +8 cm PSV, Vt (exh.) 4.5cc/Kg, and RR at 30 BPM.

Extubation Hour	HR/RR BPM	CVP mm/Hg	FiO ₂ / Total Flow/ HeO ₂ Flow	pH	PvCO ₂	BE/ HCO ₃	SvO ₂ POC/ SpO ₂	Glucose POC
0	109/32	13	PSV/ CPAP	7.41	56	+9/36	74%/ 96%	91
1	125/34	14	100%/ 2L / 0	7.29	76	+7/37	57%/ 93%	144
3	138/44	16	50%/ 10L / 0	7.28	73	+5/34	56%/ 92%	182
4	149/50	15	50%/ 13L / 0	7.33	71	+9/38	58%/ 94%	252
7	155/50	15	40%/ 10L / 5L	7.36	64	+9/37	66%/ 96%	254
8	113/24	7	40%/ 10L / 5L	7.42	54	+8/35	80%/ 99%	268
14	110/20	7	40%/ 10L / 5L	7.40	59	+9/37	72%/ 99%	89
30	116/22	6	40%/ 8L / 5L	7.38	57	+7/34	80%/ 96%	89

DISCUSSION: The patient's post extubation respiratory failure was due to CO₂ clearance issues that resulted in an increase in WOB, HR, and patient stress exhibited by a rapid elevation in patient glucose levels. There also was an increase in PVR due to increasing respiratory acidosis as evidenced by an increase in CVP and desaturation. There was some relief with the institution of HFNC via vapotherm Nasal Cannula System, but the patient still remained tachypenic and physiologically stressed. The addition of Heliox (HeO₂) at an 80/20 mix enhanced CO₂ clearance in combination with the positive pressure characteristics of the HFNC. The benefit of HeO₂ is in the physical properties of the gas, specifically the density and the viscosity. These characteristics combined with the velocity of flow through the HFNC were able to improve the alveolar-pulmonary capillary interface and improve alveolar ventilation. The patient's CO₂ clearance issues most likely were a result of long standing GER and a cardiac lesion that increase pulmonary blood flow creating peri-bronchial cuffing (a reversible physiologic mechanical obstruction, AKA cardiac asthma). With the interventions that promoted improving CO₂ clearance the patient was able to relax due to ease of WOB and there was a steady physiological response to decreasing levels of stress.

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