

## Case Report

# *Successful Vaginal Delivery of a Male Infant During Extracorporeal Carbon Dioxide Removal: A Case Report*

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### ABSTRACT

Extracorporeal carbon dioxide removal (ECCO<sub>2</sub>R) has become an effective strategy for the support of newborn infants with severe respiratory failure, but the survival rate for children and adults undergoing this procedure is only 50%. We initiated ECCO<sub>2</sub>R in a 20 year old, gravida 3, white female who developed severe respiratory distress after seeking treatment for a fever of four days duration and a nonproductive cough. Uterine contractions began shortly after ECCO<sub>2</sub>R was initiated. Nine hours later a male infant was delivered vaginally. Both mother and baby survived. To our knowledge, ECCO<sub>2</sub>R had never been used before to support a woman during labor and vaginal delivery.

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## INTRODUCTION

Extracorporeal carbon dioxide removal (ECCO<sub>2</sub>R) has become an effective strategy for the support of newborn infants with severe respiratory failure. The use of ECCO<sub>2</sub>R for treatment of acute respiratory distress in children and adults has achieved survival rates of approximately 50% (1-3). To our knowledge, however, ECCO<sub>2</sub>R had never been used to support a woman during labor and vaginal delivery.

## CASE REPORT

A 20 year old, gravida 3, para 1, abortus 1, white female came to the emergency department with a four day history of fever and nonproductive cough. She was in approximately the 30th week of gestation, as determined by ultrasound testing performed after admission, and described no prenatal problems. Her medical and surgical history was unremarkable. Obstetrical history included one spontaneous vaginal delivery at term and one voluntary abortion. The patient denied intravenous drug use or alcohol consumption. She smoked one package of cigarettes per day but had abstained during pregnancy.

The physical examination performed after admission revealed a young white female who was resting comfortably. Her blood pressure was 110/62 mmHg, temperature was 37°C, heart rate was 96 beats per minute (BPM), and respiration rate was 20 breaths/min. No abnormalities, other than mild pharyngeal erythema, were noted during the head and neck examination. There was evidence of coarse rhonchi in the lungs but without localized findings. Heart sounds were unremarkable. Her abdomen was not tender and fundal height measured 29 cm. The patient's extremities were normal.

The initial chest roentgenogram was normal. Urinalysis documented pyuria and bacteriuria. Hydronephrosis and a 30 week gestation fetus were revealed by ultrasound examination.

Cefazolin therapy was started after hospital admission, and gentamicin begun on the morning of the first full day in the hospital. On the evening of the first day, the patient's pulmonary function worsened. A chest roentgenogram that day showed bilateral infiltrates at the bases. The patient was given furosemide but her clinical condition did not improve.

Arterial blood gases measured while the patient was breathing room air were 30 mmHg for pCO<sub>2</sub> and 43 mmHg for pO<sub>2</sub>, with a pH of 7.48. The patient was transferred to the intensive care unit and given supplemental oxygen. She became hypotensive and tachypneic. She was intubated, placed on mechanical ventilation, and a pulmonary catheter inserted. Erythromycin was added to the treatment regimen and ceftriaxone substituted for cefazolin. Gentamicin administration was continued.

Initial pulmonary artery pressure was 38/27 mmHg with a pulmonary occlusion pressure of 16 mmHg. The cardiac index was 6.5 L/min/m<sup>2</sup>. Mixed venous saturation was 50% and arterial lactate measured 1.08 mmol/L. The ventilator settings were tidal volume (V) 500 ml (10 ml/kg), 25 breaths/min, FiO<sub>2</sub> 100%, and

positive end expiratory pressure (PEEP) +10 cm H<sub>2</sub>O. Peak respiratory pressure was 38 cm H<sub>2</sub>O and the static compliance was 0.024%. At these settings the arterial blood gases measured 49 mmHg for pCO<sub>2</sub> and 67 mmHg for pO<sub>2</sub>, with a pH of 7.29.

Atracurium and midazolam infusions were provided and blood transfusions given. Despite achieving a cardiac index of 7.16 L/min/m<sup>2</sup> and O<sub>2</sub> delivery of 1160 ml O<sub>2</sub>/ml/m<sup>2</sup>, the patient's mixed venous saturation fell to approximately 30% and her systolic blood pressure was only 100 mmHg. Ventilator peak pressures were 80 mmHg and the compliance fell to 0.013%. Arterial blood gas testing demonstrated a pO<sub>2</sub> of 52 mmHg and a pCO<sub>2</sub> of 38 mmHg. Fetal heart tones, which previously measured in the range of 160-170 BPM, fell to 100 BPM.

Veno-venous extracorporeal CO<sub>2</sub> removal was initiated by means of a percutaneously placed 17 Fr drainage catheter<sup>a</sup> inserted through the left femoral vein and placed in the inferior vena cava, and a 19 Fr insertion catheter<sup>a</sup> inserted through the internal jugular vein and positioned in the superior vena cava. A membrane oxygenator<sup>b</sup> and a centrifugal pump<sup>c</sup> completed the extracorporeal circuit. Blood flow was started at 2 L/min and gradually increased to 3-3.5 L/min. Gas flow was initiated at 2 L/min and increased to 10 L/min with FiO<sub>2</sub> at 100%. Mechanical ventilation was reduced to rest the lungs by adjusting peak inspiratory pressure to less than 50 cm H<sub>2</sub>O and by varying tidal volume, peak flow, PEEP, and the wave form of the delivered breaths. FiO<sub>2</sub> was lowered to 40% to minimize oxygen toxicity. Table 1 lists blood gas values for the patient and membrane oxygenator shortly after the start of ECCO<sub>2</sub>R.

Anticoagulation with continuous heparin infusion was adjusted to maintain an activated clotting time (ACT) between 180 and 200 seconds. ACTs were recorded every 30 minutes. An initial bolus of 10,000 international units (IU) of porcine heparin was given. Hematocrit was maintained at 30% and platelet counts at >100,000 per µl.

Approximately three hours after ECCO<sub>2</sub>R began, uterine contractions were noted. Attempts to halt the contractions with terbutaline were unsuccessful. Because no significant cardiopulmonary changes were observed in the mother and late deceleration was noted in the baby, pitocin augmentation was started. Nine hours later a male infant was delivered vaginally. Apgar scores at 1, 5, and 15 minutes were 2, 2, and 3, respectively. Table 2 lists blood gas values during and after delivery.

The ACT was reduced to 150 seconds for the vaginal delivery. After the delivery, the vaginal area was packed with sterile gauze to reduce bleeding and the ACT was maintained at 150 seconds for the next six hours. Anticoagulation requirements after delivery of the baby increased from an average heparin dosage of 1000-1100 IU per hour to 1600-2000 IU per hour to

- a Medtronic Bio-Medicus, Eden Prairie, MN 55344
- b Sci-Med 4.5 membrane oxygenator, AVecor, Plymouth, MN 55441
- c Delphin centrifugal system, Sarns, 3M Health Care, Ann Arbor, MI 48103

**Table 1**  
Blood gas values shortly after ECCO<sub>2</sub>R initiation.

Date Time Source	pH	pCO <sub>2</sub>	pO <sub>2</sub>	HCO <sub>3</sub>	c/o SAT	Hgb/Hct	Platelets	Total CO <sub>2</sub>	FiO <sub>2</sub>
3-4-91 1959 patient	7.31	39.3	30.6	19.8	53	9.6/29.8	171	21	100
3-4-91 2303 pump	7.44	24.2	619.8	16.6	—	—	—	17.3	100
3-4-91 2344 patient	7.41	22.9	142.1	14.4	98.9	—	—	15.1	100

ECCO<sub>2</sub>R began at 1917 on 3-4-91, and the first patient blood gas analysis after ECCO<sub>2</sub>R initiation was performed at 1959.

**Table 2**  
Blood gas values during and after delivery.

Date Time Source	pH	pCO <sub>2</sub>	pO <sub>2</sub>	HCO <sub>3</sub>	c/o SAT	Hgb/Hct	Platelets	Total CO <sub>2</sub>	FiO <sub>2</sub>
3-5-91 0636 pump	7.46	25.5	601.7	18.3	—	—	—	19.1	80
3-5-91 0733 patient	7.37	41.8	26.9	24.1	—	—	—	25.4	—
3-5-91 0829	7.49	25.1	195.2	19.1	99.4	12.1/36.4	144	19.8	80

The baby was delivered at 0721 on the day after ECCO<sub>2</sub>R began.

achieve an ACT of 180-200 seconds. No major bleeding was noted. Hemodynamic changes after delivery included a reduction in pulmonary artery pressure from an average of 45/30 mmHg to 30/20 mmHg, and a reduction in central venous pressure from an average of 18 mmHg to 12 mmHg.

The patient was successfully weaned from ECCO<sub>2</sub>R after 44 hours (Table 3). *Escherichia coli* was cultured from her blood and urine. Follow-up ultrasound examination showed resolution of the right hydronephrosis. Both mother and baby were well at the three month outpatient visit.

After ECCO<sub>2</sub>R termination, the membrane oxygenator and centrifugal pump head were examined for clots. Minimal fibrin

buildup at the connection sites was the only notable finding. We have since modified our circuit to include a 2-4.5 membrane oxygenator<sup>b</sup>, an in-line 3/8" oxygen saturation probe<sup>d</sup>, and pre- and post-membrane pressure transducers.

## REFERENCES

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**Table 3**Blood gas values before and after discontinuing ECCO<sub>2</sub>R.

Date Time Source	pH	pCO <sub>2</sub>	pO <sub>2</sub>	HCO <sub>3</sub>	c/o SAT	Hgb/Hct	Platelets	Total CO <sub>2</sub>	FiO <sub>2</sub>
3-6-91 0702 patient	7.47	31.3	67.9	22.8	94.8	10.5/31.6	143	23.8	40
3-6-91 0702 pump	7.54	27	616.4	23.1	99.9	—	—	23.9	40
3-6-91 1434 pump	7.49	33.5	85.7	25.5	97.2	10.1/30.8	143	26.5	40
3-6-91 1700 patient	7.34	48.2	85.8	25.8	95.8	—	—	27.3	40
3-6-91 2000 patient	7.36	47.7	100.4	27.1	97.3	—	—	28.6	50

ECCO<sub>2</sub>R was discontinued at 1525 on 3-6-91.(shock-lung syndrome). *N Engl J Med.* 1972;286:629-634.

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