Case Report

Extracorporeal Life Support for an Adult with Varicella Pneumonia

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ABSTRACT

In June of 1992 a 32 year old male presented to the emergency room complaining of dyspnea and a headache. He had been exposed to chickenpox three days prior to his admission. His chest X-ray revealed diffuse bilateral infiltrates. Subsequently, the diagnosis of varicella pneumonia was made and he was started on oxygen and an antibiotic regime of acyclovir and erythromycin. He deteriorated over the next six hours and, in spite of maximal conventional ventilatory support, could not maintain arterial oxygen saturations greater than 80%. He was placed on veno-arterial Extracorporeal Life Support (ECLS) for 69 hours. After being weaned off ECLS, the patient required mechanical ventilation for nine days and was discharged 47 days after admission.

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INTRODUCTION

Varicella (chickenpox) is a highly contagious disease caused by the varicella zoster virus. Few people escape the disease as children, therefore it is a rarity in adults. While the disease runs its course in healthy children, pneumonia is a common complication in adults with a reported incidence of 16%-50% (1,2). Varicella, if complicated by pneumonia in adults, has a reported mortality rate as high as 10% to 20% (3). In pregnant women the mortality rate can be as high as 30% to 40% (4). Death from varicella pneumonia is usually secondary to respiratory insufficiency (4).

The first successful use of Extracorporeal Life Support (ECLS) for the support of patients with varicella pneumonia was in 1974 for a five year old with leukemia (5). In 1990 Clark et al reported the successful use of veno-veno ECLS in a 33 year old woman who was 12 weeks pregnant and had varicella pneumonia(6). Our experience, along with Clark et al, is to our knowledge the only reported cases in the literature where adults have been placed on ECLS as a result of acquiring varicella pneumonia.

CASE REPORT

In June of 1992 a 32 year old male weighing 118 kg presented to the emergency room complaining of dyspnea and a headache. He stated that he had been exposed to chickenpox three days prior to his admission to the hospital. Upon examination he was noted to be alert, oriented, and had a rash covering his face and trunk. Vital signs were as follows: blood pressure 126/70 mmHg, respiratory rate 33 breaths per minute, and a temperature of 38°C. An arterial blood gas (ABG) and chest x-ray (CXR) were ordered. The results of the ABG were: ph- 7.41 pCO_2- 37 mmHg pO_2- 31mmHg, and HCO_3- 23 meq/liter, while breathing room air. The CXR revealed diffuse bilateral pulmonary infiltrates, nodular in character, concentrated in the mid to lower lung fields. Subsequently, from the patient's history and clinical findings, the diagnosis of varicella pneumonia was made. He was started on an antibiotic regime of acyclovir and erythromycin along with a 100% oxygen rebreathing mask.

Over the next six hours the patient's respiratory function continued to deteriorate, and he required endotracheal intubation with mechanical ventilation, and insertion of a pulmonary artery catheter. In spite of maximal conventional ventilatory support, and a trial on high frequency jet ventilation, he could not maintain arterial oxygen saturations greater than 80%. Consequently, the decision was made to place him on ECLS.

The extracorporeal circuit consisted of a centrifugal blood pump[a], 3/8 inch tubing, and an 2.5m^2 silicone membrane oxygenator[b] with heat exchanger. The circuit was flushed with CO_2 and then primed with 850 ml of balanced electroyte solution[c] and 50 ml of 25% albumin. The patient was given a 100U/kg bolus of heparin prior to cannulation with a resultant activated clotting time (ACT) of 630 seconds. Vascular access for ECLS was obtained via cannulation of the right femoral artery and vein with 21 french[d] arterial and venous percutaneous cannulae. The patient was then placed on ECLS with an initial flow rate of 2.8 L/min, a sweep rate of 7 L/min, and a fractional inspired oxygen concentration (FiO_2) of 100%. One hour after the initiation of ECLS, pump flow rate was increased to 4.0 L/min. Once the patient's ACT was less than 400 seconds a heparin drip was titrated at 750 U/hr to maintain the ACT between 220 -260 seconds. Throughout the 69 hour run the heparin drip ranged from 750 U/hr to 2600 U/hr.

Within 5 hours after going on ECLS the patient's respiratory function stabilized some, allowing the ventilator $Fi0_2$ to be weaned from 100% to 70% while maintaining oxygen tensions of 60 mmHg (Figure 1).

Over the next 24 hours the patient developed oliguria, hematuria, and gastrointestinal bleeding. Electrolytes and complete blood count (CBC) revealed anemia and thrombocytopenia, along with elevated levels of blood urea nitrogen and creatinine (Table 1). The anemia and thrombocytopenia were treated with the transfusion of packed red blood cells and platelets. Attempts were made to stimulate urine output with diuretic therapy without success, and as a result continuous arteriovenous hemofiltration (CAVH) was initiated. A hollow fiber hemofilter[e] was placed with the arterial inlet port connected to the outlet port of the membrane oxygenator. The venous port of the hemofilter was then connected to a central line that had been placed in the left femoral vein. Over the next 45 hours of ECLS a total of 6.3 liters of filtrate was taken off.

At 35 hours of extracorporeal support the pump flow rate was reduced. This correlated with an improvement in lung compliance, arterial oxygen tensions, and lung fields on CXR. Over the next 5 hours the flow rate was decreased from 4.0L/min to 2.0 L/min, while the ventilator FiO_2 was decreased from 80% to 50% (Figure 1). For the next 20 hours the patient remained at a flow rate of 2.0 L/min. On the 60th hour of bypass the flow rate was reduced to 1.0 L/min and the ventilator FiO_2 to 40%. The patient remained on these settings for 9 hours at which time the decision was made to discontinue ECLS. The patient was extubated 9 days later and placed on a nasal oxygen cannula at 2 L/min. Hemodialysis was continued for 22 days post ECLS. The patient was discharged from the hospital in good condition 47 days after admission.

DISCUSSION

Prolonged ECLS was first used to support adults with respiratory failure by Hill et al in 1971 (7). This success, along with several others, led to a multicenter prospective randomized

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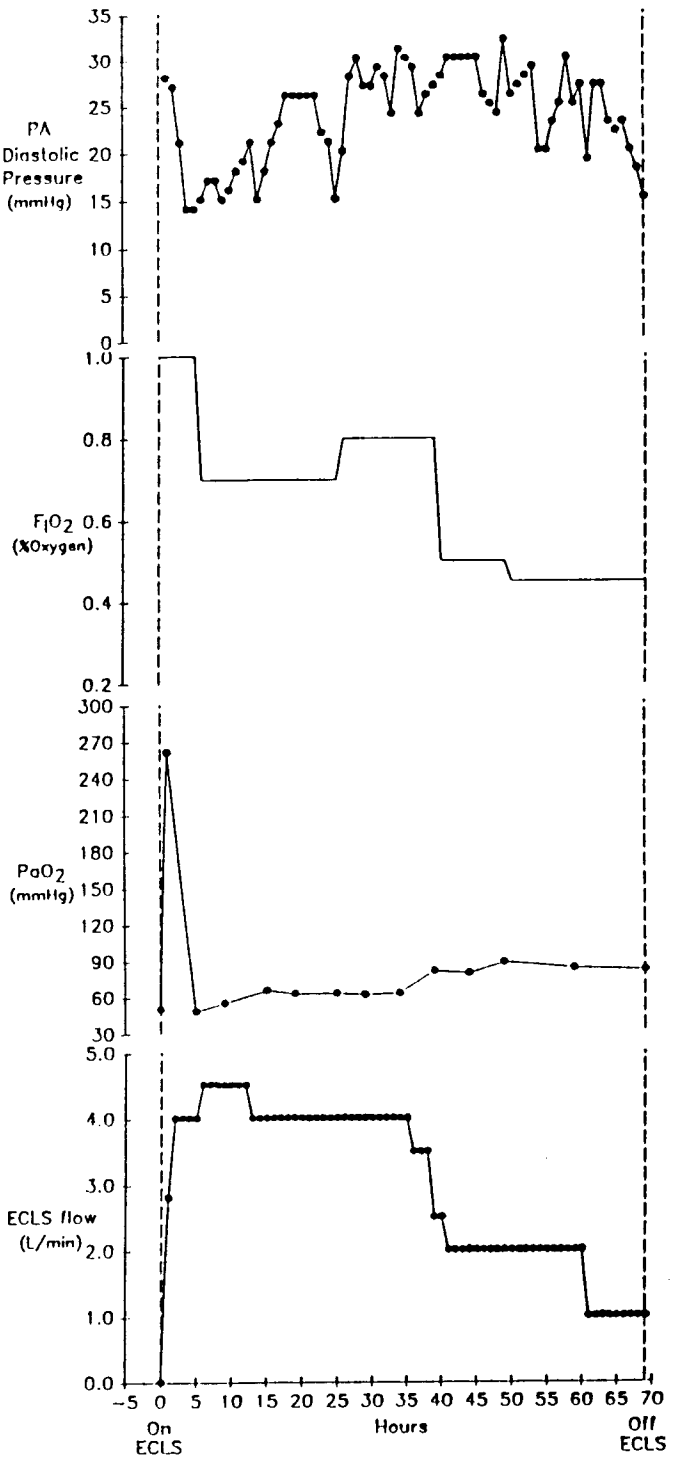
Figure 1
Graphical representation of the patient while on veno-arterial Extracorporeal Life Support (ECLS) for varicella pneumonia.
Arterial oxygen tension (P_aO_2); Fractional inspired oxygen concentration (F_iO_2); Extracorporeal life support flow rate (ECLS) plotted against time; Pulmonary Artery Diastolic Pressure, (PADP).



trial that was sponsored by the National Institute of Health in 1975 (8). In this study of 90 patients, approximately 10% survived in both conventional treatment and ECLS groups. Although there were several problems later identified with this study, based on these results, ECLS and its application in the adult population was virtually abandoned in the United States in 1979 (9). The resurgence of ECLS in adults was brought about by Gattinoni et al, who utilized veno-veno bypass with extracorporeal CO_2 removal in 43 patients with a 49% survival (10).

Since 1985 the Extracorporeal Life Support Organization (ELSO) has kept a registry of participating centers, listing adults placed on ECLS by either respiratory or cardiac diagnosis. Of the 90 patients reported to the registry, as of July 1993, 56 had been diagnosed with respiratory dysfunction, with a 43% survival (11). Patients with a diagnosis of viral pneumonia had a 70% survival rate (Table 2).

Varicella pneumonia is a highly infectious disease caused by the varicella-zoster virus. The clinical course of varicella pneumonia, while usually benign, can be unpredictable (12). Varicella pneumonia, while often self limiting can be associated with significant morbidity and mortality. Other complications of varicella include myocarditis, hepatitis, encephalitis, glomerulonephritis, thrombocytopenia, and arrhythmias (2,13-15). Treatment of varicella pneumonia is primarily directed toward the alleviation of the symptoms. Patients exhibiting tachypnea and hypoxemia may require oxygen therapy while those with refractory hypoxemia, that are intubated and on mechanical ventilation, may benefit from antiviral agents such as acyclovir (16).

This case demonstrates that when conventional therapies fail, ECLS is indicated as a means of cardiopulmonary support. Although, ECLS is not a routine treatment for varicella pneumonia, the process can support a patient facilitating lower airway pressures and oxygen concentrations. This allows the lungs time to heal while avoiding high oxygen tensions and excessive airway pressures.

The criteria used for initiating ECLS in this case was acute deterioration of respiratory function. However, in spite of overall poor prognosis it was felt the lung disease was reversible. The size of the patient, 118 kg, presented problems because venous return was restricted by the 21 french cannula, reducing flow rate. In spite of using flow rates up to 4.5 L/min, initially oxygen tensions greater than 70 mmHg were not possible. This situation may have been corrected by the use of a larger (4.5m^2) oxygenator, but probably was caused by the patient's high output hyperdynamic heart. This resulted in large amounts of desaturated pulmonary blood mixing with the oxygenated blood from the extracorporeal circuit. During the first 24 hours of ECLS our patient developed renal failure and oliguria. This may have exacerbated his lung injury by further increasing extravascular lung water. The addition of CAVH, and the removal of 6 liters of fluid over the next 45 hours, improved hemodynamics and decreased extravascular lung water as reflected by the chest x-ray. This corelated with improvements in lung compliance and

Table 1
Electrolytes and hematologic values before, during, and after ECLS.

	Pre ECLS	1ST Day ECLS	2nd Day ECLS	3rd Day ECLS	1st Day Off ECLS	Discharge
Na^+	136	135	132	129	129	140 mmol/l
K^+	3.6	3.6	4.9	5.7	5.6	4.2 mmol/l
Cl^-	101	97	94	92	91	98 mmol/l
BUN	14	11	54	85	95	16 mg/dl
Creat	.8	1.7	5.5	7.0	7.2	1.8 mg/dl
WBC	-	-	29.8	33.8	30.8	- THO/ul
Hct	48	32	28	26	25	27 %
Hgb	16	11.3	10.1	9.2	8.9	9.3 g/dl
Plt	132	87	102	168	156	446 THO/l

BUN- Blood Urea Nitrogen; CL^-- Chloride; Creat- Creatinine; g/dl- grams per deciliter; Hct- Hematocrit; Hgb- Hemoglobin; K^+- Potassium; mg/dl- milligrams per deciliter; mmol/l- millimoles per liter; Na^+- Sodium; Plt- Platelet; %- Percent; THO/ul- Thousand per microliter; WBC- White Blood Count

Table 2
Adult registry of the Extracorporeal Life Support Organization by respiratory diagnosis since 1985 to July 1993.

Respiratory Diagnosis	Total Treated	Percent Survived
Viral pneumonia	10	70%
ARDS	23	52%
Other respiratory	11	36%
Bacterial pneumonia	7	14%
Aspiration	4	0%
Pulmonary hemorrhage	1	0%

arterial oxygen tensions. Once the ECLS flow rate had been 1 L/min for 9 hours, it was felt that his lung function had improved enough to be taken off ECLS.

The success of this case was attributed to early intervention with ECLS before lung damage became irreversible. Another contributing factor may have been the young age of this patient, who except for having varicella pneumonia, had no other long standing medical problems prior to his admission. The future success of ECLS in adults with respiratory insufficiency is dependent upon continued research, development of defined criteria for its initiation and identifying those disease states that best respond to ECLS. The collaboration of participating centers and collection of data by the ELSO is essential to meeting these goals.

REFERENCES

1. Weser DM, Pelleccia JA. Varicella pneumonia: Study of prevalence in adult men. JAMA 1965; 192: 572-73.
2. Hockenberger RS, Rothstein RJ. Varicella pneumonia in adults: a spectrum of disease. Ann Emerg Med 1986; 15: 931-34.
3. MacFarlane JT, Smith FD, Finch RG. Vidarabine in fulminating chickenpox pneumonia. Thorax 1982; 37: 226-27.
4. Fleischer G, Henry W, McSorley M. Life threatening complications of varicella. Am J Dis Child 1981; 135: 869-99
5. Hicks RE, Kinney TR, Raphaely RC, Donaldson MH, Edmunds HL, Naiman LJ. Successful treatment of varicella

pneumonia with prolonged extracorporeal membrane oxygenation in a child with leukemia. J Thorac Cardiovasc Surg 1977; 73: 297-302.
6. Clark GP, Dobson PM, Thickett A, Turner NM. Chickenpox pneumonia, its complication and management. Anesthesia 1991; 5: 376-80.
7. Hill JD, O'Brien TG, Murray JJ, Dontigny L. Bramson ML, Sborni J, et al. Extracorporeal oxygenation for acute post-traumatic respiratory failure (shock-lung syndrome): use of the Bramson Membrane Lung. N Eng J Med 1972; 286: 629-34.
8. Zapol WM, Snider MT, Hill JD, Fallat RJ, Bartlett RH, Edmunds LH, et al. Extracorporeal membrane oxygenation in severe acute respiratory failure. JAMA 1979; 242: 2193-6.
9. Anderson HL, Delius RE, Sinard JM, McCurry KR, Shanley CT, Chapman RA, et al. Early experience with adult extracorporeal membrane oxygenation in the modern era. Ann Thorac Surg 1992; 53: 553-63.
10. Gattinoni L, Pesenti A, Mascheroni D, Marcolin R, Fumagalli R, Ross F, et al. Low-frequency positive-pressure ventilation with extracorporeal CO_2 removal in severe acute respiratory failure. JAMA 1986; 256: 881-86.
11. Adult ECMO quarterly report. Ann Arbor, MI: Adult ECMO Registry of the Extracorporeal Life Support Organization (ELSO) July 1993.
12. Bullowa JEM, Wishik SM. Complications of varicella: Their occurrence among 2,534 patients. Am J Dis Child 1939; 49 923-32.
13. Fiddler GI, Campell RWF, Pottage A, Goodman MJ. Varicella myocarditis presenting with unusual ventricular arrhythmias. Br Heart J 1977; 39: 1150-3
14. Ey JL, Smith SM, Fulginiti VA. Varicella hepatitis without neurological symptoms or findings. Pediatrics 1981; 67: 285-7.
15. Johnson R, Milbourn PE. Central nervous system manifestations of chickenpox. Can Med Assoc J 1970; 102: 831-4.
16. Lheureux PH, Doutrelepont JM, Akenasi R. Varicella pneumonia in adulthood: acyclovir therapy may benefit. Ann Emerg Med 1987; 16: 1097.