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CASE REPORT

Severe *Legionella* pneumonia successfully treated by independent lung ventilation with intrapulmonary percussive ventilation

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Abstract: A case of severe *Legionella* pneumonia was successfully treated by independent lung ventilation (ILV) with intrapulmonary percussive ventilation (IPV). A 57-year-old man with lobar pneumonia was intubated and mechanically ventilated because of his deteriorating respiratory status. The diagnosis of *Legionella* pneumonia was made on the fourth day after admission and appropriate antibiotic therapy was commenced. On the fifth hospital day, ILV was commenced because the right unaffected lung was over-distended, his haemodynamic state was unstable and his left lung was producing copious amounts of purulent sputum. His right lung was ventilated and his left lung was treated with IPV owing to the existence of massive atelectasis. After treatment with antibiotics and ILV combined with IPV, his respiratory and haemodynamic status gradually improved. On the tenth day after admission, ILV was changed to conventional bilateral ventilation. The patient was extubated on the sixteenth hospital day and discharged from the intensive care unit 30 days after admission. The combination of ILV and IPV was therapeutically effective during the acute phase of unilateral severe *Legionella* pneumonia.

Key words: independent lung ventilation, intrapulmonary percussive ventilation, *Legionella* pneumonia, methylprednisolone, pulmonary organizing change.

INTRODUCTION

Severe *Legionella* pneumonia is a life-threatening respiratory disease,[1,2] and unilateral involvement of the lungs may make respiratory care difficult. Although intrapulmonary percussive ventilation (IPV) has been reported to be effective in ARDS, smoke inhalation, compressive atelectasis and acute exacerbation of COPD,[3–8] there have been no reports on the combined use of IPV and independent lung ventilation (ILV). This report describes a patient with severe *Legionella* pneumonia that was successfully treated with concurrent ILV and IPV.

CASE REPORT

A 57-year-old male gardener with a 5-day history of dyspnoea and general fatigue had an infiltrating shadow on the left lower lung field of the CXR and was diagnosed with pneumonia. He subsequently developed respiratory failure.

On admission, he had a diminished level of consciousness (Glasgow Coma Scale 11). Vital signs were relatively stable with a blood pressure of 110/70 mm Hg, pulse of 82 beats/min, and core body temperature of 35.6°C; however, his respiratory rate was 32 breaths/min and bilateral coarse crackles were heard on lung auscultation. The laboratory data on admission, which indicated hypoalbuminaemia, liver dysfunction, rhabdomyolysis and hyponatraemia, are

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Table 1 Laboratory data on admission

Blood gas analysis (under 5 L/min O_2)	
pH	7.48
PaO_2 (mm Hg)	89.5
$PaCO_2$ (mm Hg)	35.0
HCO_3^- (mmol/L)	27.2
BE (mmol/L)	2.7
Peripheral blood	
WCC ($\times 10^9$/L)	7.79
RCC ($\times 10^9$/L)	393
Hb (g/L)	123
Haematocrit (%)	37.7
Platelets ($\times 10^9$/L)	127
Biochemistry	
Total Protein (g/L)	51
Alb (g/L)	20
T-Bil (mg/L)	13
AST (IU/L)	346
ALT (IU/L)	150
LDH (IU/L)	640
CK (IU/L)	5306
ChE (IU/L)	90
CRP (mg/L)	467
Na (mmol/L)	130
K (mmol/L)	3.9
Cl (mmol/L)	97

shown in Table 1. The WCC was within normal limits, but the level of CRP was high. CXR on admission revealed shadowing of the left mid and lower zones; CT scans showed atelectasis of the left lower lobe with a surrounding infiltrating shadow.

The patient's clinical course is shown in Figure 1. He was initially transfused with a large volume of fluid (1500 mL per 8 h) and catecholamine was administered for septic shock. His worsening respiratory status required intubation and mechanical ventilation with an inspired oxygen fraction (FiO_2) of 1.0, respiratory rate of 12 breaths/min (synchronized intermittent mandatory ventilation mode), tidal volume of 500 mL, and PEEP of 5 cm H_2O. An antibiotic regimen of meropenem and minocycline was chosen, in order to treat the lobar pneumonia according to the Japanese Respiratory Society guidelines for the management of community-acquired pneumonia in adults. Sputum toileting by bronchoscopy was performed owing to the massive amount of sputum emanating from the left lung. Intrapleural drainage was performed on the left lung because of an intermediate sized pleural effusion. On the fourth day after admission, *Legionella* antigen was detected in the urine, the diagnosis of *Legionella* pneumonia was confirmed and the antibiotic regimen was switched to ciprofloxacin, erythromycin and rifampicin. On the fifth hospital day, sputum from the left affected lung flowed into the right unaffected lung during bronchoscopy. The right unaffected lung was over-distended on CXR and a shadow subsequently appeared on the dorsal aspect of the right lung CT scan. The PaO_2/FiO_2 (P/F) ratio of 153 did not improve and PEEP was increased to 9 cm H_2O. The patient's haemodynamic state became unstable and infusion of 0.1 μg/kg/min of noradrenalin was commenced. ILV was performed after changing the single lumen endotracheal tube to a double lumen tube, as it was felt that conventional ventilation (FiO_2 of 0.8, respiratory rate of 15 breaths/min, tidal volume of 500 mL and PEEP of 9 cm H_2O) was detrimental to the right lung and haemodynamic state. The left lung was treated with IPV (Spanker, Percussionaire, Bird Space Technologies, Sandpoint, ID, USA) and CPAP to maintain a high mean airway pressure in the left lung, and to drain the sputum from the region of massive atelectasis. The IPV setting was at a high frequency of 300 beats/min. The driving pressure was 138 kPa (20 psi). The right lung was ventilated with an FiO_2 of 1.0, respiratory rate of 18 breaths/min (synchronized intermittent mandatory ventilation mode), positive inspiratory pressure of 15 cm H_2O, and PEEP of 9 cm H_2O. Following the change of antibiotics and combined ILV and IPV, the respiratory and haemodynamic status gradually improved. On the eighth hospital day, noradrenalin was tapered off. On the tenth hospital day, ILV with IPV was discontinued and the patient was returned to conventional bilateral ventilation.

Methylprednisolone (mPSL, 120 mg) was administered intravenously on the tenth hospital day, as signs of pulmonary organization had appeared on the chest CT. The intravenous dosage of mPSL was tapered and switched to oral mPSL. The patient was extubated on the sixteenth hospital day. Bacteriological examination of sputum disclosed *Legionella pneumophila* serogroup 1. The antibiotic regimen was continued for 3 weeks, and mPSL was continued for 4 weeks. The patient was discharged from the intensive care unit on the thirtieth day after admission.

DISCUSSION

Unilateral lung pneumonia poses several difficulties for respiratory treatment. Decreased compliance of the affected lung induces over-distension and increasing pulmonary resistance in the unaffected lung. Blood flow consequently shifts towards the affected lung.[9] This shift leads to a V/Q mismatch and disruption of oxygenation. In the present case, the pneumonia progressed mainly in the left lung, and the patient was treated with a high PEEP because the P/F ratio worsened. The resulting over-distension of the right lung and haemodynamic instability led to the decision to utilize ILV with a double lumen tube. After ILV, the patient's haemodynamic state recovered and oxygenation status gradually improved.

Independent lung ventilation was also used to prevent intrapulmonary cross-contamination. Severe *Legionella* pneumonia displays pyogenic and destructive progression and the patient's left-sided pneumonia could have spread to his right lung via the sputum. A post-ILV CXR demonstrated no infection of the right lung, possibly owing to the ILV (Fig. 1).

In this patient, ILV was combined with IPV. During ILV, the affected lung is generally treated with CPAP, which improves the V/Q ratio. However, in the present

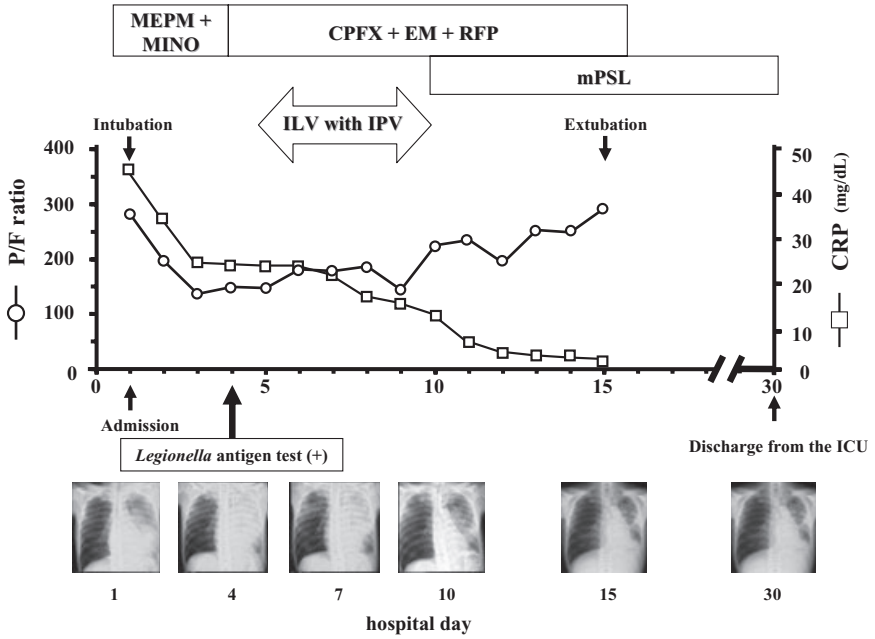

Figure 1 Clinical course in a patient with severe *Legionella* pneumonia. The changes in PaO_2/FiO_2 (P/F) ratio, CRP and CXR following treatment are shown. The circle indicates the P/F ratio and the square indicates the CRP level. MEPM, meropenem; MINO, minocycline; CPFX, ciprofloxacin; EM, erythromycin; RFP, rifampicin; ILV, independent lung ventilation; IPV, intrapulmonary percussive ventilation; mPSL, methylprednisolone.

case, CPAP to the left lung did not provide sufficient oxygenation or address the massive atelectasis that was present. Furthermore, the patient's haemodynamic state was unstable and he required noradrenalin to maintain normal blood pressure. ILV with IPV is considered superior to ILV with CPAP because IPV has been reported to improve oxygenation without haemodynamic change in ARDS,[3,4] smoke inhalation,[5,6] compression atelectasis[7] and acute exacerbation of COPD.[8] IPV can increase the mean airway pressure with reduced peak airway pressure, can recruit compressed alveoli, improve oxygenation, does not affect the haemodynamic state and can reduce the risk of barotrauma.[3]

The percussive wave of IPV is thought to improve the clearance of pulmonary secretions.[3,7,8] Velmahos *et al*.[3] reported that IPV dramatically mobilized secretions and lung infiltrations cleared after the treatment. Antonaglia *et al*.[8] described two mechanisms for facilitated mucus clearance by IPV. IPV could increase the mucus/flow interaction, thus leading to a decrease in mucus viscoelasticity, and the transient changes in air flow with each high frequency cycle could produce shearing at the air–mucus interface and thereby provide a cough-like force to the mucus layer.[8] In the present case, massive atelectasis and sputum overflow existed in the patient's left lung, which did not improve with conventional ventilation with suction, bronchoscopic toileting and physical therapy. However, IPV accelerated the drainage of the pyogenic sputum and improved the atelectasis, so contributing to improved oxygenation.

There are no available data comparing the efficacy of ILV and IPV with conventional therapy, and further studies may be needed to clarify the effect of ILV with IPV in severe pneumonia.

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