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Case Report

The Usefulness of Non-invasive Ventilation for Acute Respiratory Failure in Elderly Patients: Case Reports

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급성호흡부전 고령 환자에서 비침습적 호흡법의 유용성: 증례보고

정석영, 장찬웅, 강성웅, 김명상, 최원아, 조한얼

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Abstract

In this case report, we introduce on two unusual cases in which Non-invasive ventilation (NIV) was applied to elderly patients with respiratory failures. The first case needed ventilatory support because of acute respiratory failure. Although patient's situation was not “end-of-life”, but “curative”, surrogates did not agree to intubate since the patient had previously declared “do not intubate (DNI)”. The use of NIV allowed the patient to overcome the disease. The latter case, we introduce a patient with underlying tuberculosis-destroyed lung who showed dyspnea and chronic hypercapnia respiratory failure after influenza infection. This patient could manage hypercapnia and dyspnea through using NIV, and finally, she could wean the ventilator. Like our cases, if NIV can be used properly, treatment choices can be significantly expanded for patients with acute respiratory failure. We expected that these cases would widen the range of NIV use in elderly patients.

Key Words

Aged, Non-invasive ventilation, Respiratory insufficiency

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Introduction

People worldwide are living longer. The development of cutting-edge medical technology has put the world into an aging society. The number of people over the age of 60 is expected to reach 2 billion by 2050, while the average lifespan worldwide is predicted to climb to 76.2 years.[1,2] As the population ages, there are a growing number of older people with comorbid conditions,[3] which inevitably leads to an increase in the number of elderly patients admitted to the hospital for respiratory failure. As a result, physicians have had the opportunity to deal with more diverse situations than in the past, such as when a tracheostomy cannot be performed for any reason or when the symptoms are mild enough for intubation. This raised the requirement for updated treatment protocols for elderly with respiratory

failure.

Non-invasive ventilation (NIV) becomes a potential alternative option whose aim is to avoid the need for invasive mechanical ventilation, as well as to prevent its life-threatening complications.[4] Also, NIV can prevent various complications caused by intubation or tracheostomy,[5,6] allowing adequate NIV use to be especially beneficial for the elderly population. As a result, NIV has recently become the first choice for ventilatory technique in some diseases with a high prevalence, such as chronic obstructive pulmonary disease, cardiogenic pulmonary edema, immunosuppression of various origins, neuromuscular disease without severe bulbar impairment, obesity hypoventilation syndrome, and chest wall deformity in the elderly.[4]

In this case report, we introduce two unusual cases in which NIV was applied to elderly patients with respiratory failures. For our first case, we introduce a case in which NIV was applied for patients who refused an invasive procedure because the patient has previously declared 'do not intubate (DNI). This case showed for the palliative use of NIV. The other was a patient who needed ventilatory support after influenza infection due to tuberculosis sequelae. We expected that these diverse cases would widen the range of NIV use in elderly patients.

Cases Report

Case 1

A 76-year-old female patient visited emergency room of a tertiary hospital for ongoing general weakness, fever, cough, sputum, and dyspnea for 7 days on April 10, 2021. She had a medical history of hypertension, dyslipidemia, and rheumatoid arthritis.

Initial laboratory test showed elevated C-reactive protein (CRP) to 75.6 mg/L and Chest CT showed diffuse bronchial wall thickening, multiple calcified granulomas, patchy ground glass opacities, and nodular lesions in both lungs. The patient showed unstable vital signs with hypotension and desaturation; initial blood pressure was 53/38 mmHg and arterial blood gas analysis (ABGA) showed oxygen saturation of 85.3% and Partial pressure of oxygen (PaO_2) of 56.5 mmHg. The patient was diagnosed with community-acquired pneumonia with septic shock and was admitted to intensive care unit. Intravenous norepinephrine, antibiotics (Piperacillin/Tazobactam), steroid infusion, and applying oxygen (O_2) via nasal cannula were started.

However, pneumonia in both lungs aggravated on April 17, 2021. O_2 demand increased; WBC count was 10,250/μL (neutrophil 90.8%), CRP increased to 232.7 mg/L, and chest x-ray showed further aggravation of pneumonia. The patient showed 91% oxygen saturation (SpO_2) after applying 6L/min of O_2. High flow nasal cannula (HFNC) was urgently applied (40 L/min of O_2). O_2 was restored in the following ABGA; however, hypercapnia became the new issue (ABGA showed pH 7.231, PaO_2 177.1 mmHg, with partial pressure of carbon dioxide ($PaCO_2$) 84.2 mmHg, and HCO_3- 35.0 mmol/L) and the patient showed altered consciousness. Medical staffs in charge informed families of the patient that urgent endotracheal intubation and invasive mechanical ventilation could improve the patient's condition by regulating airway secretion and improving ventilation status. However, they refused intubation since the patient had previously declared DNI at the end-of-life. The in-charge medical team emphasized that the patient's situation was not 'end-of-life', but rather 'curative', and that a patient urgently required ventilatory treatment. However, differences of opinion among the family members prevented a decision regarding intubation.

Through consultation with the pulmonary rehabilitation center in our hospital, NIV, instead of endotracheal intubation and invasive mechanical ventilator, was chosen as a method for the ventilation. On April 19, NIV was applied to the patient via nasal mask with bilevel positive airway pressure mode with O_2 4 L. Transcutaneous monitoring (SENTEC AG, Basel, Switzerland) was used to continuously monitor the patient's ventilatory status. Before applying NIV, SpO_2 was 94% and transcutaneous CO_2 ($TcCO_2$) was 63.6 mmHg under HFNC 40 L/min. After 8

hours after applying NIV, decreased $TcCO_2$ of 38.2 mmHg on average was identified, suggesting improvement in hypercapnic respiratory failure.

On April 27, the patient recovered from pneumonia (Fig. 1); CRP was normalized to 5.0 mg/L, and the patient did not show severe hypercapnia even without applying NIV during the daytime (ABGA results; pH 7.375, PaO_2 86.1 mmHg, $PaCO_2$ 46.5 mmHg, HCO_3- 27.4 mmol/L). Considering pulmonary hypertension and overnight hypercapnia ($TcCO_2$ max 50.2 mmHg and average 44.6 mmHg), the patient was recommended to continue using the NIV only the night.

The patient did not report any respiratory complications after using NIV. The patient continued using NIV for another year because a regular check-up revealed that her nighttime hypercapnia was not fully resolved. On May 17, 2022, the patient was fully weaned off the ventilator.

Case 2

On November 22, 2018, a 70-year-old female patient was admitted to the Department of respiratory medicine due to

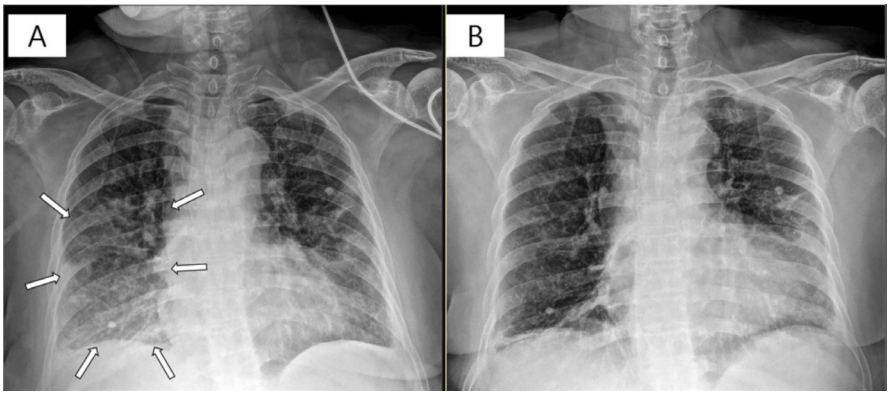

Fig. 1. Change of chest X-ray of case 1.
(A) Before using non-invasive ventilation (April 15th, 2021)
(B) After using non-invasive ventilation (April 27th, 2021)
Ground glass opacity and nodular lesions (white arrows) was improved after using non-invasive ventilation.

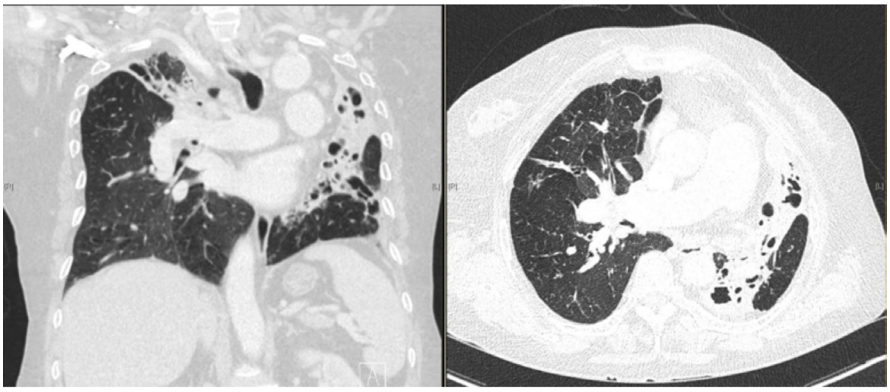

Fig. 2. Chest CT of a case 2.
Chest CT showed post-inflammatory lesions in both lungs.

aggravated dyspnea, cough, sputum, and mild fever. She had a history of hypertension, hypothyroidism, and pulmonary tuberculosis (TB). Because of tuberculosis-destroyed lung, the patient had been using 1L of O_2 by nasal cannula since recovering from tuberculosis 30 years ago.

Initial laboratory test showed WBC 22,780 /μL (neutrophil 90.0%), CRP 145.7. ABGA showed hypercapnic respiratory failure (pH 7.411 $PaCO_2$ 58.1 mmHg, PaO_2 96.7 mmHg, and HCO_3- 37.2 mmol/L). Chest CT showed almost destroyed left upper lobe, fibrosis, and bronchiectasis in left lower lobe and right upper lobe, with bronchitis in both lungs (Fig. 2). Influenza antigen test revealed that the cause of respiratory distress in the patient was influenza A infection.

After the use of peramivir and intravenous antibiotics (Piperacillin/Tazobactam and Lexofloxacin), chest x-ray and laboratory test improved; however, the patient suffered from continuous dyspnea and hypercapnia. The patient was referred for consultation for pulmonary rehabilitation. Considering the patients had only needed O_2 therapy with previous tuberculosis-destroyed lung before influenza infection, we assumed that the patient's respiratory muscle weakness had deteriorated due to other factors such as deconditioning.

In a pulmonary function test, forced vital capacity was 1,320 ml (42.3% of predicted value) in a sitting position and 1,290 ml (41.3% of predicted value) in a supine position. Peak cough flow was checked as 170 L/min. Considering the patient's discomfort, respiratory muscle weakness, and hypercapnia, we decided to use NIV. Before using NIV, overnight transcutaneous monitoring showed hypercapnia (average SpO_2 96%, max $TcCO_2$ 68.8 mmHg, and average $TcCO_2$ 58.7 mmHg). After one week of using NIV, the patient showed improvement in hypercapnia; overnight transcutaneous monitoring with average SpO_2 96%, max $TcCO_2$ 45.5 mmHg, and average $TcCO_2$ 42.7 mmHg.

The patient was continuously managed through regular checkup, and her pulmonary function showed gradual improvement. On August 1, 2011, her vital capacity was checked as 1,530 mL (52.4% of predicted value) in sitting and 1,520 mL (52.0% of predicted value) in a supine position. Peak cough flow was 230 L/min. Even though she had not used the ventilator for more than a week, there was no sign of overnight hypercapnia (average SpO_2 96% max $TcCO_2$ 43.6 mmHg, average $TcCO_2$ 39.0 mmHg on transcutaneous monitoring performed on August 7, 2022). After not using a ventilator for two months, a follow-up examination was done on October 7th, 2022. She finally decided to wean off the ventilator since she did not show hypercapnia or respiratory problems.

Discussion

NIV has proven to be a highly effective treatment for the elderly population.[7] Prior to the introduction of NIV, invasive mechanical ventilation with a close monitoring system was the only available therapeutic option for elderly patients with acute respiratory failure. Although ICU admission and mechanical ventilation are not necessarily indications of a bad prognosis in older patients,[8] the development of NIV as a novel treatment option has allowed some patients who cannot or will not apply invasive mechanical ventilation to continue getting treatments.

The first case is related to palliative use of NIV, which has been actively discussed in recent years. The "Society of Critical Care Medicine palliative non-invasive positive ventilation task force" proposed categorizing NIV usage in acute respiratory failure (ARF) patients into three groups; Category 1) NIV Without Preset Limits on the Provision of Advanced Life Support; Category 2) NIV for Patients Who Decline Endotracheal Intubation and Invasive Mechanical Ventilation; and Category 3) NIV as a Comfort Measure for Patients Who Decline Endotracheal Intubation.[9] Although our case falls under category 2, it is not as ideal as the task force's ideal scenario. In a task force scenario, patients and caregivers understand the potential consequences of this decision. However, the lack of a clear distinction between "curative", "palliative", and "end-of-life" care worsen the matters. In our case, the patient was unconscious, and the

caregivers' decisions were clouded by the patient's abrupt onset of the patient and deterioration of the disease. Non-invasive ventilatory support was introduced to put a stop on the delay in decision-making process, which was jeopardizing the patient's chance of survival. It is notable that the problem was resolved with the proper use of the NIV.

In the latter case, the patient did not need ventilatory support for more than 30 years after being treated for TB. However, because of the sequelae of TB, the patient might be vulnerable to respiratory complications,[10] which led to the need for ventilatory support after influenza infection. Korea has the highest TB incidence among the member countries of the Organization for Economic Cooperation and Development.[11] It seems obvious that there would be numerous people with severe lung sequelae similar to this patient. These individuals may experience a temporary decline in lung function, such as vital capacity, as a result of deconditioning, critical-illness polyneuromyopathy,[12] and/or critical illness-associated diaphragm weakness.[13] In this case, hypercapnia persisted for a long period even after the patient recovered from pneumonia, necessitating the continued use of NIV. Without NIV, the patient would have undergone a tracheostomy, which would cause discomfort and had a negative impact on her quality of life.

We introduced the effective application of NIV in elderly patients. Like our cases, if NIV is used properly, treatment choices for the medical staffs and patients can be significantly expanded. In conclusion, we emphasize the value of NIV as an alternative option of invasive mechanical ventilation in elderly patients through these cases.

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