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Importance of ventilator mode in long-term noninvasive positive pressure ventilation

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KEYWORDS
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Summary
Background: Long-term noninvasive positive pressure ventilation (NPPV) is associated with an excellent survival rate, especially in post-tuberculosis patients. Nothing is currently known on which method of ventilatory support is associated with a better continuation of long-term NPPV, which itself might lead to longer survival.
Methods: One hundred and eighty four post-tuberculosis patients, who started NPPV at the Kyoto University Hospital group and the National Tokyo Hospital from June 1990 to August 2007, were examined retrospectively. Ventilator mode (an assisted mode or a pure controlled mode) and potential confounders were examined with the discontinuation of NPPV as the primary outcome.
Results: Patients treated with a pure controlled mode had significantly better continuation rates (hazard ratio, 3.09; 95% confidential interval, 1.75–5.47; $p = 0.0001$) and better survival rates (Log-rank test; $p = 0.0031$) than those treated with an assisted mode. Female gender and no pulmonary lesions were also associated with a significantly better probability of continuing NPPV. The five- and ten-year probabilities of continuing NPPV for 106 patients with a pure controlled mode were 68.3% and 41.4%, respectively, while those for 76 patients with an assisted mode were 46.7% and 12.7%, respectively.

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Conclusions: Patients treated with pure controlled ventilation had significantly better continuation rates and survival rates than those treated with assisted ventilation. Prospective randomized controlled trials are needed to verify the effectiveness of a pure controlled mode in patients with not only restrictive thoracic disease but also other diseases including chronic obstructive pulmonary disease.
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Introduction

Noninvasive positive pressure ventilation (NPPV) has been widely used in the treatment of patients with chronic hypercapnic respiratory failure.[1–6] Recently, better survival has been reported for post-tuberculosis patients treated with home mechanical ventilation (HMV) than with long-term oxygen therapy (LTOT) alone.[7]

In chest wall disorders, either pressure or volume preset ventilation is known to be effective.[8,9] Ventilation triggered by the patient's breath (an assisted mode) is thought to be preferable to pure controlled ventilation.[1,10] However, this choice of ventilator mode is not based on any clinical evidence.

During NPPV, ventilator settings are commonly adjusted in order to achieve better synchrony between the patients and the ventilator. Most bilevel positive airway pressure (PAP) devices have sensitive triggers that enhance synchrony. However, when triggers have difficulty in sensing a patient's inspiration in the face of unexpected leaks, end-expiratory lung hyperinflation, upper airway obstruction, and/or an extremely weak respiratory effort or output on the part of the patient, the efficacy of ventilatory assistance can become seriously compromised.[11] The setting of the expiratory trigger is also important. In patients with obstructive ventilatory defects, setting the expiratory trigger at a higher percentage of peak inspiratory flow has been reported to improve patient–ventilator synchrony and to reduce inspiratory muscle effort.[12]

On the other hand, a pure controlled mode could accomplish truly passive ventilation[9,13–19] and has been described as the treatment of choice in patients with more advanced respiratory disorders.[17] Recently, controlled NPPV using a timed (T) mode in bilevel PAP devices has been demonstrated as feasible in patients with hypercapnic chronic obstructive pulmonary disease (COPD).[18] However, another recent report of patients with chronic respiratory failure showed no significant differences between an assisted mode and a pure controlled mode with volumetric ventilators, in a relatively short-term evaluation.[19] Therefore, we wanted to clarify the most suitable mode for long-term NPPV in post-tuberculosis patients.

We hypothesized that patients receiving NPPV with a pure controlled mode would have better continuation and survival than those receiving NPPV with an assisted mode. The effect of the two modes was retrospectively examined.

Methods

Patients

All post-tuberculosis patients who had started NPPV at the Kyoto University Hospital group (six hospitals) and the National Tokyo Hospital over the period from June 15, 1990 to August 2, 2007, were included in this retrospective study. All patients had suffered from chronic hypercapnic ventilatory disorders. Patients started on NPPV therapy either after an acute episode or at a chronic state. The decision for initiation of NPPV was based on clinical symptoms such as morning headache, persistent daytime hypercapnia ($PaCO_2 > 6.0$ kPa) and/or nocturnal hypoventilation, and clinical instability with recurrent hospitalizations. Patients with other causes of chronic respiratory failure, such as idiopathic kyphoscoliosis (KS), neuromuscular disorders or COPD were excluded. The patients were followed up until November 30, 2007. Clinical surveys had been performed at the end of every year from 1995 to 2002, in December 2004 and in December 2007.

Measurements

Age at the start of NPPV, gender, body-mass index (BMI), vital capacity (percentage of predicted), forced expiratory volume in 1 s over forced vital capacity (FEV_1/FVC), presence of pulmonary lesions, duration of LTOT before start of NPPV, hospitalization rate due to acute episodes per year before start of NPPV, status on introduction of NPPV (i.e., acute or chronic state), the institution where NPPV was introduced (the Kyoto University Hospital group or the National Tokyo Hospital), type of ventilator at the start of long-term NPPV (pressure or volume preset ventilator), concurrent use of LTOT after the start of NPPV and ventilator mode (an assisted mode or a pure controlled mode), were all examined and/or documented for risk factors. Arterial blood gases were measured during spontaneous breathing with prescribed supplemental oxygen before and three months after the start of long-term NPPV.

All data and information on the clinical course of each patient were collected from outpatient and inpatient clinical records.

Clinical protocol for introducing long-term NPPV

Patients who started NPPV at a chronic state were carefully instructed in the use of the ventilator and in the way of fitting the mask during daytime. Most patients learnt how to handle the NPPV devices within the first week. After this was achieved, patients started to receive NPPV nocturnally, and most were able to receive NPPV throughout the night within a week. Patients were discharged from hospital only after they were comfortable with NPPV, were able to tolerate nocturnal NPPV, and were confident of dealing with the NPPV devices.

For patients who started NPPV at an acute state, the need to continue NPPV was estimated carefully after they had recovered thoroughly from their acute episode.

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