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Background: This study tested the hypothesis that adaptive servo-ventilation (ASV) therapy improves the prognosis of heart failure (HF) patients, regardless of the severity of sleep-disordered breathing (SDB).

Methods and Results: 88 consecutive patients were divided into 4 groups based on ASV therapy and SDB severity. The incidence of HF, brain natriuretic peptide (BNP) levels, and left ventricular ejection fraction (LVEF) were followed for 12 months. Fewer HF events, together with an increase in LVEF and a decrease in BNP, occurred in ASV-treated patients with both non-to-mild and moderate-to-severe SDB.

Conclusions: ASV therapy improves the short-term prognosis in HF-patients, regardless SDB severity. (Circ J 2011; 75: 710–712)

Key Words: Adaptive servo-ventilation; Heart failure; Prognosis; Sleep-disordered breathing

A daptive servo-ventilation (AVS; Autoset CS®, ResMed, Sydney, NSW, Australia) is an effective therapy for heart failure (HF) patients with sleep-disordered breathing (SDB). However, because it is unclear whether ASV therapy improves the prognosis of HF even in patients with non-to-mild SDB, this study was designed to examine this point.

Methods
Between April 2008 and August 2009, 88 consecutive patients diagnosed with HF (NYHA class II or III, left ventricular ejection fraction [LVEF] < 55%) and a hospital admission in the 6 months prior to therapy initiation were enrolled. Patients experiencing decompensated HF or who had recovered from acute HF were excluded.

Polysomnography analysis, echocardiography for evaluating LVEF, and the ASV therapy initiation protocol were performed as reported previously. The LVEF was determined from an apical 4-chamber view using Simpson’s method. Patients with an apnea hypopnea index (AHI) ≥ 20 were defined as having moderate-to-severe SDB and those with an AHI < 20 as non-to-mild SDB. Some patients could not use the ASV device because of the discomfort of either wearing a mask (n=25) or the positive airway pressure (n=12). Patients were divided into 2 categories: receiving ASV treatment (ASV-treated patients) and not receiving ASV treatment (non-ASV-treated patients). The ASV-treated patients were defined as those whose device usage was >4 h per night.

The patients underwent ASV therapy only during the night. Consequently, the patients were divided into 4 groups: (A) moderate-to-severe SDB, ASV-treated patients; (B) moderate-to-severe SDB, non-ASV-treated patients; (C) non-to-mild SDB, ASV-treated patients; and (D) non-to-mild SDB, non-ASV-treated patients (Table). The primary endpoint of the study was the proportion of patients who died or were admitted to hospital because of HF, and the secondary endpoint was the plasma brain natriuretic peptide (BNP) level and LVEF 12 months after ASV initiation. The prevalence of HF-related events during the 12 months after ASV treatment was examined. The prescriptions for the enrolled patients were unchanged during the follow-up period. The compliance data were downloaded from the ASV device and checked monthly.

Student’s t-test and the Mann-Whitney U-test were used to compare the data between groups. Univariate and multivariate Cox regression analyses were used to identify predictors of HF events. All parameters with P<0.10 in the univariate analysis were entered into the multivariate model. The time to a cardiac event was estimated using the Kaplan-Meier method, with comparisons made using the log-rank test. P<0.05 was considered statistically significant. All analyses were performed using SPSS for Windows ver. 16.0 (SPSS, Chicago, IL, USA).

Results
No significant difference in the patients' baseline characteris-
patients was observed between groups A and B or between groups C and D (Table). The prevalence of SDB in this study was 53.4%, slightly lower than in previous studies. ASV-treated patients were able to continue ASV therapy throughout the 12-month follow-up period. The duration of daily ASV use was 5.5±1.4 h in group A and 5.1±1.1 h in group C.

Kaplan-Meier survival analysis showed that the event-free rate at 12 months was greater in groups A and C, when compared with previous studies. The reduction in the plasma BNP level was greater in groups A and C ([group A] 202.6±163.0 to 219.8±154.5, P=0.033) than in groups B and D ([group B] 228.4±220.1 to 219.8±154.5 to 158.2±103.7, P=0.005, [group D] 158.2±103.7 to 139.1±113.4 pg/ml, P=0.448). Using LVEF to evaluate the HF patients, we found that 7.8% of the patients had no response to ASV therapy. Reevaluating the data using plasma BNP levels yielded the same result. In the Cox regression analysis including ASV therapy, NYHA class, and plasma BNP level before treatment, NYHA class, and plasma BNP level after treatment, NYHA class (hazard ratio =3.992, 95%CI = 1.037–15.369, P=0.044) was associated with HF events in...
patients with moderate-to-severe SDB. ASV therapy reduced the number of events in patients with AHI ≥20 (hazard ratio = 0.246, 95% CI = 0.073–0.831; P = 0.024). In patients with AHI <20, ASV therapy (hazard ratio = 0.151, 95% CI = 0.001–3.093; P = 0.048) and a higher LVEF before treatment (hazard ratio = 0.810, 95% CI = 0.668–0.983; P = 0.032) were predictors of a reduced number of HF events, from among NYHA class, body mass index, sinus rhythm, pacemaker rhythm, LVEF before treatment, and ASV therapy.

**Discussion**

This study showed that ASV therapy improved the prognosis of HF patients, together with a reduced plasma BNP level and increased LVEF. The beneficial effects were evident even in those with non-to-mild SDB. ASV therapy contributed to a reduced risk of rehospitalization in these patients. This is the first study showing that ASV improves the prognosis of HF.

Continuous-positive-airway-pressure therapy has several hemodynamic adverse effects in HF patients due to the continuous increase of intrathoracic pressure.

ASV therapy improves HF coexisting with SDB through the positive-airway-pressure and its automatic self-adjustment to the patient’s breathing efforts. These beneficial effects could result not only from the prevention of hypoxic responses, but also from the lower positive-airway-pressure of ASV during respiration. In this study, ASV therapy improved the prognosis of HF-patients with both non-to-mild and moderate-to-severe SDB. These results suggest that in HF patients the lower positive-airway-pressure of ASV could prevent the increase in preload while supine without hemodynamic disadvantage. The hemodynamic support of ASV therapy could be used to improve the prognosis of HF patients.

Some bias and limitations could be present in this study because of it being an observational trial. The beneficial effect was observed only in HF patients who could tolerate the ASV device. Further prospective trials are needed to establish ASV treatment as a therapeutic option for HF.

Because ASV therapy improved the short-term prognosis and cardiac function in HF patients, regardless of SDB severity, it is an important therapeutic option for HF patients.

**Disclosure**

All authors declare no conflicts of interest.

**References**


