Sleep-disordered breathing (SDB), particularly periodic breathing patterns such as repeated central sleep apnea (CSA) and hypopnea, is encountered frequently in patients with heart failure (HF) and is associated with increased mortality and cardiac events, including fatal cardiac arrhythmias. Hypocapnia and circulation delays with elevated central chemoreceptor sensitivity contribute to CSA during sleep in HF patients. Decreased lung inflation and hypoxic stress caused by the abnormal breathing could enhance cardiac sympathetic nerve activity, leading to malignant arrhythmia, which is closely associated with the prognosis of patients with HF. Obstructive sleep apnea (OSA) coexists in approximately one-third of all patients with HF and a reduced ejection fraction, and could be associated with the prognosis of HF patients. Repeated fluctuations in the intrathoracic pressure, increased inflammation caused by hypoxic stress, and increased sympathetic nerve activity because of OSA might be associated with the deteriorated cardiac function and occurrence of malignant arrhythmias, resulting in the poor prognosis of HF patients. Accordingly, various noninvasive positive airway pressure therapies have become an important therapeutic option to prevent SDB events in HF patients (Figure 1).

The Central Sleep Apnea and Heart Failure Trial (CANPAP) showed that continuous positive airway pressure (CPAP) therapy is an effective therapeutic option in HF patients with CSA, with an apnea-hypopnea index (AHI) score <15/h after CPAP therapy. However, it is possible that CPAP therapy could cause several adverse hemodynamic effects because of the continuously increased intrathoracic pressure in nonresponders to CPAP therapy. Adaptive servo-ventilation (ASV) was introduced to treat CSA, because the ASV adjusts its pressure support according to the patient’s breathing effort and maintains a stable minute ventilation and low-grade positive end-expiratory pressure. Therefore, ASV therapy was developed to treat SDB in HF patients without causing hemodynamic disadvantages. Many studies have shown that nocturnal ASV therapy can improve the cardiac function and clinical status of HF patients with SDB via multifactorial mechanisms. Very recently, however, the SERVE-HF study showed that ASV therapy may increase the risk of cardiovascular mortality in patients with HF and an ejection fraction ≤45%, when compared with a control group. Although it is not clear why ASV therapy would increase the risk of cardiovascular diseases, one important reason might be the high pressure induced by ASV therapy. The automatic increase in pressure support by the ASV device to eliminate apnea events could worsen the hemodynamics of HF patients. Accordingly, we must reconsider how we choose noninvasive positive airway pressure therapy (Figure 1), and how we identify the responders to respiratory interventions among HF patients.

In this issue of the Journal, Satake et al report that home oxygen therapy (HOT) and CPAP therapy normalized the AHI score in HF patients with CSA and OSA patients, respectively. Furthermore, there were significantly fewer fatal arrhythmic events in the responder group compared with the nonresponder group. Satake et al used HOT and CPAP therapy with low positive airway pressures to preclude the use of excessively high pressure, which could have negative effects in HF patients. This approach suggests a method of introducing respiratory intervention safely in HF patients. Initially, if OSA requires treatment in HF patients with systolic dysfunction,
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a low, fixed positive airway pressure (4 or 5 cmH2O) might be effective at reducing not only the preload in congestive HF but also apnea events. Furthermore, a low positive airway pressure could avoid the adverse effects related to positive airway pressure therapy. If the SDB events are not suppressed by the initial CPAP therapy, the airway pressure provided by CPAP should be increased gradually based on the results of repeated polysomnography analysis (Figure 2). As Satake et al. show, HF can be treated successfully using relatively low positive airway pressure. If CSA requires treatment in HF patients, HOT may be an effective therapeutic option before initiation of CPAP or ASV therapy (Figure 2).

Nevertheless, there are serious problems that need to be resolved in the respiratory treatment of patients with HF. First, whether the AHI score should be normalized by respiratory interventions needs to be clarified. If the AHI score after respiratory intervention cannot be normalized with low positive airway pressures, should the positive airway pressure be increased gradually? Second, if the target AHI in HF patients with CSA cannot be reached, should HOT or low positive airway pressure be continued? Third, the upper limit of positive airway pressure needs to be examined to avoid the adverse effects of CPAP therapy. Finally, several parameters need to be analyzed to predict worsening HF after respiratory intervention.

Studies have shown that respiratory interventions such as CPAP and ASV are an effective therapeutic option in some HF patients with reduced ejection fraction. Some HF patients respond well to positive airway pressure, resulting in a dramatic improvement in cardiac function. Therefore, the effective therapeutic strategies for respiratory interventions to avoid adverse effects must be determined.

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