Predicting the success of noninvasive positive pressure ventilation in emergency room for patients with acute heart failure

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KEYWORDS
Acute heart failure syndrome; Noninvasive ventilation; Bilevel positive airway pressure; Endotracheal intubation

Summary
Background: Non-invasive positive pressure ventilation (NPPV) for acute heart failure (AHF) is increasingly used to avoid endotracheal intubation (ETI). We therefore reviewed our experience using respirator management in the emergency room for AHF, and evaluated the predictive factors in the success of NPPV in the emergency room.
Methods and results: Three-hundred forty-three patients with AHF were analyzed. The AHF patients were assigned to either BiPAP-Synchrony® (B-S; Respironics, Merrysville, PA, USA) period (2005—2007, n = 176) or BiPAP-Vision® (B-V; Respironics) period (2008—2010, n = 167). The rate of carperitide use was significantly increased and dopamine use was significantly decreased in the B-V period. The total length of hospital stay was significantly shorter in the B-V period. AHF patients were also assigned to a failed trial of NPPV followed by ETI (NPPV failure group) or an NPPV success group in the emergency room for each period. NPPV was successfully used in 48 cases in the B-S period, and in 111 cases in the B-V period. Fifty-seven ETI patients included 45 direct ETI and 11 NPPV failure cases in the B-S period, and 16 ETI patients included 10 direct ETI and 6 NPPV failure cases in the B-V period. The pH values were significantly lower in the NPPV failure than in the NPPV success for both periods (7.19 ± 0.10 vs. 7.28 ± 0.11, B-S period, p < 0.05; 7.05 ± 0.08 vs. 7.27 ± 0.14, B-V period, p < 0.001). A pH value of 7.20 produced the optimal balance in the B-S period, while that of 7.03 produced the optimal balance in B-V periods by
Introduction

Patients with acute heart failure (AHF) present with a form of hypoxemic acute respiratory failure caused by acute pulmonary edema. Standard therapy for patients with AHF includes conservative medical therapy and respiratory management. Patients with severe AHF often require endotracheal intubation (ETI), and standard respiratory management previously called for mechanical ventilation. The potential benefit of non-invasive positive pressure ventilation (NPPV), in which pressure support and positive end expiratory pressure are delivered via face mask or nasal mask, was recognized over the previous decades as a new mode of ventilator management which dispensed with ETI [1–6]. Meta-analysis studies have specifically reported on NPPV in patients with AHF [7–11] and NPPV significantly decreased mortality when compared to rates in patients who receive standard medical treatment and mechanical ventilation [7]. The European Society of Cardiology presented in guidelines that continuous positive airway pressure was the first line of treatment before mechanical ventilation and conservative therapy including diuresis, nitroglycerin, and dobutamine [12]. NPPV therefore is increasingly used as a means to avoid ETI and its attendant complications in patients with AHF.

Thus, NPPV has garnered attention for the treatment of hypoxemic AHF. However, there are institutions which have not implemented NPPV because physicians lack experience with this method [13]. Despite recent evidence, the rate of NPPV use as an acute respiratory strategy was 69.5% in patients who required mechanical ventilation according to the ADHERE registry [14] and approximately 20% in all patients with AHF from the ongoing Japanese ATTEND registry [15].

The success of NPPV is due to the skill of the medical team and the experience of the physician in the emergency setting. In some studies NPPV management success predictors were identified in patients with acute respiratory failure including chronic obstructive pulmonary disease [16,17]. These studies indicated that patients with a better neurologic status and who have not developed severe acid–base or gas exchange derangements are more likely to succeed. However, the recommended guidelines for NPPV use according to clinical and blood gas criteria have not been well studied in patients with AHF. We herein found that the frequency of NPPV increased rapidly in recent years through the use of the BiPAP Visor® (B-V) system (Respironics, Middletown, PF, USA) in which the inspired oxygen concentration could be enriched to 100%. The aims of our study were to evaluate the efficiency of the B-V system in comparison to the BiPAP Synchrony® (B-S) system (Respironics), and to evaluate the predictive factors for the success of NPPV in emergency room in patients with AHF based on the use of each system.

Methods

Subjects

We analyzed 343 patients with AHF who were admitted to the intensive care unit of Chiba Hokusoh Hospital, Nippon Medical School between January 2005 and September 2010. AHF was defined as either new-onset HF or decompensation of chronic HF with symptoms sufficient to warrant hospitalization [18]. HF was diagnosed based on the Framingham criteria for a clinical diagnosis of HF, based on the satisfaction of 2 major criteria or 1 major and 2 minor criteria [19]. All patients had a New York Heart Association (NYHA) functional class of either Class III or IV. Patients with HF caused by acute coronary syndrome were excluded. The patients who had already undergone ETI prior to admission or who had immediately received NPPV management in the emergency room before any examinations were also excluded. Any patients who were changed to respiratory management because of a worsening respiration after leaving the emergency room were excluded as well. The specific strategy of respiratory management and the medical treatment were chosen by each individual doctor participating.

Devices

The B-S and B-V systems were used for pressure support and positive end-expiratory pressure, delivered via face mask or nasal mask for NPPV. The continuous positive airway pressure mode (only positive end-expiratory pressure) or bi-level positive airway pressure mode (pressure support and positive end-expiratory pressure) could be selected with both systems. However, the inspired oxygen concentration could be increased to 100% with the B-V system, but not the B-S system. The inspired oxygen concentration could be increased to 60% using the B-S system. The B-S system was in use for NPPV in emergency rooms from 2005 to 2007, and the B-V system has been in use from 2008 to 2010. The bi-level positive airway pressure mode or the continuous positive airway pressure mode was chosen by each of the doctors to suit each individual patient’s condition. There were no limitations for the selection conditions according to the mode for NPPV and the selection of mask management.

Almost all patients underwent transthoracic echocardiography upon admission and after HF stabilization (Sonos 5500, Hewlett Packard, Palo Alto, CA, USA or Vivid I, GE

the ROC curve analysis. The cutoff value of pH was lower in the B-V period than in the B-S period.

Conclusions: This predictive value provides successful estimates of NPPV with a high sensitivity and specificity, and the aortic blood gas level was above 7.03 pH when using the B-V system.

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Table 1 Comparison of the patient backgrounds.

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<tr>
<td>Age (years)</td>
<td>71.9 ± 10.7</td>
<td>72.1 ± 11.7</td>
<td>72.0 ± 11.2</td>
<td>n.s.</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>120/56</td>
<td>122/45</td>
<td>242/101</td>
<td>n.s.</td>
</tr>
<tr>
<td>NYHA (III/IV)</td>
<td>43/133</td>
<td>36/131</td>
<td>79/264</td>
<td>n.s.</td>
</tr>
<tr>
<td>LVEF (%) on admission</td>
<td>35.7 ± 17.5</td>
<td>36.7 ± 16.4</td>
<td>36.0 ± 16.8</td>
<td>n.s.</td>
</tr>
<tr>
<td>BNP (pg/ml)</td>
<td>1281.1 ± 1566.1</td>
<td>1027.4 ± 1083.8</td>
<td>1146.3 ± 1335.5</td>
<td>n.s.</td>
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<tr>
<td>SBP (mmHg)</td>
<td>161.8 ± 36.7</td>
<td>164.5 ± 39.0</td>
<td>163.1 ± 37.8</td>
<td>n.s.</td>
</tr>
<tr>
<td>Pulse (beats/min)</td>
<td>118.5 ± 30.6</td>
<td>108.7 ± 30.0</td>
<td>114.3 ± 29.6</td>
<td>&lt; 0.001</td>
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Etiology of heart failure (cases)

- Ischemic heart disease: 73 vs. 75 vs. 148
- Cardiomyopathy: 34 vs. 30 vs. 64
- Hypertensive heart disease: 31 vs. 28 vs. 59
- Valvular disease: 35 vs. 28 vs. 63
- Others: 3 vs. 6 vs. 9

Past medical history

- Hypertension (y/n): 121/55 vs. 137/30 vs. 258/85, p-value = 0.007
- Diabetes mellitus (y/n): 102/74 vs. 97/70 vs. 198/145, n.s.
- Hyperlipidemia (y/n): 95/81 vs. 83/84 vs. 178/165, n.s.

Amount of O2 inhalation (L)

- 8.56 ± 3.24 vs. 8.55 ± 3.32 vs. 8.55 ± 3.27, n.s.

pH

- 7.28 ± 0.15 vs. 7.28 ± 0.16 vs. 7.28 ± 0.15, n.s.

PCO2 (mm Hg)

- 51.4 ± 19.1 vs. 50.3 ± 22.6 vs. 50.9 ± 20.9, n.s.

PO2 (mm Hg)

- 98.1 ± 52.1 vs. 107.7 ± 66.3 vs. 102.8 ± 59.6, n.s.

SaO2 (%)

- 91.5 ± 7.8 vs. 91.7 ± 10.0 vs. 91.6 ± 8.9, n.s.

NYHA, New York Heart Association; LVEF, left ventricular ejection fraction measured by echocardiogram at emergency room; BNP, brain natriuretic peptide; SBP, systolic blood pressure; B-S, BiPAP Synchrony; B-V, BiPAP-Vision; p-value; B-S period (2005–2007) vs. B-V period (2008–2010).

Yokokawa Medical, Tokyo, Japan). Left ventricular ejection fraction (LVEF) was calculated using the Teicholz method or Simpson’s methods.

Procedures

From the information collected, we examined (1) the frequency of NPPV usage as a respiratory strategy in the emergency room between the two periods (B-S period: 2005–2007, n = 176; B-V period: 2008–2010, n = 167), and also examined (2) any differences in the patients’ characteristics and treatments between the two time periods.

The AHF patients who needed mechanical ventilation were also divided to a failed trial of NPPV followed by ETI (NPPV failure group), direct ETI group, and an NPPV success group according to the differences in the respiratory management in the emergency room for each period. We examined (3) the differences in the clinical information including the vital signs [blood pressure (BP), heart rate, body temperature, respiratory rate], and arterial blood gases (pH, PCO2, PO2, SaO2) before determining the appropriate respiratory management between the NPPV failure groups and the NPPV success groups in each period.

Statistical analysis

All numerical data are expressed as the means ± standard deviation. Variables were compared using the chi-square test, and a p-value of less than 0.05 was defined as statistically significant. The significant factors for distinguishing between the ETI and NPPV groups were determined based on a multivariate logistic regression model. Receiver-operating characteristic (ROC) curves were calculated to predict the cutoff value. The sensitivity, specificity, and area under ROC curves (AUC) were computed using the SPSS 14.0J software package (SPSS Japan Institute, Tokyo, Japan).

All data were statistically analyzed using the StatView 5 software package (SAS Institute, Cary, NC, USA), and SPSS 14.0J.

Results

Patient characteristics

Table 1 shows that patient cohort was composed of 70.6% males with a mean age of 72.0 ± 11.2 years. One hundred and forty-eight (43.1%) patients had ischemic heart disease, and 195 (56.9%) patients had non-ischemic heart diseases including cardiomyopathy (n = 64), hypertensive heart disease (n = 59), valvular disease (n = 63), and other heart diseases (n = 9). Most patients were in the NYHA class IV (77.0%), and the average LVEF values upon admission were 36.0%. Average arterial blood gas was as following: O2, 8.55 L; pH, 7.28; PCO2, 50.9 mm Hg; PO2, 102.8 mm Hg; SaO2, 91.6%. Almost all of these clinical values were not statistically different between the B-S and B-V periods.
Time-dependent changes in respiratory management in the emergent room for patients with AHF. The rate of NPPV use at emergency room increased yearly, and ETI decreased. The ETI group had 57 patients (32.4%), the NPPV group 48 patients (27.2%) and O₂ inhalation group 71 patients (40.4%) in the BiP AP-Synchrony period. The ETI group contained 16 patients (9.6%), the NPPV group 111 cases (66.5%) and O₂ inhalation group 40 patients (23.9%) in the BiP AP-Vision period. ETI, endotracheal intubation; NPPV, non-invasive positive pressure ventilation.

Respiratory management

Fig. 1 shows the rate of patients under respiratory management, including ETI, NPPV, and O₂ inhalation while in our institution. The frequency of NPPV use in the emergency room increased yearly. The ETI group included 57 patients (32.4%), NPPV 48 patients (27.2%) during the B-S period. In the B-V period, the rate of ETI decreased in 16 cases (9.6%), and the rate of NPPV increased for 111 patients (66.5%).

Patient characteristics and medications during hospitalization

Table 2 illustrates the differences in the patients’ characteristics during hospitalization between the two periods. The total hospitalization was significantly shorter in the B-V period (29.8 ± 37.8 days) than in the B-S period (38.4 ± 39.9 days) (p < 0.05). The majority of patients (93.3%) received intravenous loop diuretics during the acute phase. Nitroglycerin and carperitide were administered in 77.6% and 69.7% of patients, respectively. In contrast, dopamine and dobutamine were used in 20.4% and 22.2% of patients, respectively. Angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers were administered to 232 patients (67.6%), spironolactone was administered to 179 (52.2%) patients, and β-blockers were administered to 187 (54.5%) patients. The administration of nitroglycerin significantly (p < 0.001) decreased, while the administration of nicorandil significantly (p < 0.001) increased during the B-V period in comparison to the B-S period. Furthermore, the administration of carperitide significantly (p < 0.05) increased and the administration of dopamine significantly (p < 0.05) decreased during the B-V period in comparison to the B-S period.

Table 2  Comparison of patient characteristics and medications during hospitalization.

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<thead>
<tr>
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<tr>
<td>LVEF (%) before discharge</td>
<td>42.3 ± 16.2</td>
<td>45.3 ± 16.5</td>
<td>n.s.</td>
</tr>
<tr>
<td>ICU hospitalization (days)</td>
<td>6.3 ± 8.9</td>
<td>5.6 ± 7.1</td>
<td>n.s.</td>
</tr>
<tr>
<td>Total hospitalization (days)</td>
<td>38.4 ± 39.9</td>
<td>29.8 ± 37.8</td>
<td>0.044</td>
</tr>
<tr>
<td>Respirator management in ER (cases)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilator</td>
<td>57</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>NPPV</td>
<td>48</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>O₂ inhalation</td>
<td>71</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Duration of ventilator (h)</td>
<td>69.1 ± 62.1</td>
<td>84.7 ± 109.5</td>
<td>n.s.</td>
</tr>
<tr>
<td>Duration of NPPV (h)</td>
<td>15.7 ± 14.9</td>
<td>20.9 ± 16.3</td>
<td></td>
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<tr>
<td>Medication (cases)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(Acute phase)</td>
<td></td>
<td></td>
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<tr>
<td>Furosemide (y/n)</td>
<td>166/10</td>
<td>154/13</td>
<td>n.s.</td>
</tr>
<tr>
<td>Nitroglycerin (y/n)</td>
<td>153/23</td>
<td>113/54</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nicorandil (y/n)</td>
<td>8/168</td>
<td>35/132</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Carperitide (y/n)</td>
<td>111/65</td>
<td>128/39</td>
<td>0.009</td>
</tr>
<tr>
<td>Dopamine (y/n)</td>
<td>46/130</td>
<td>24/143</td>
<td>0.011</td>
</tr>
<tr>
<td>Dobutamine (y/n)</td>
<td>45/131</td>
<td>31/136</td>
<td>n.s.</td>
</tr>
<tr>
<td>(Acute-chronic phase)</td>
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<tr>
<td>ACE-I/ARB (y/n)</td>
<td>127/49</td>
<td>105/62</td>
<td>n.s.</td>
</tr>
<tr>
<td>Spironolactone (y/n)</td>
<td>100/76</td>
<td>79/88</td>
<td>n.s.</td>
</tr>
<tr>
<td>β-Blocker (y/n)</td>
<td>104/72</td>
<td>78/89</td>
<td>n.s.</td>
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<tr>
<td>Prognosis (cases)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Alive/dead</td>
<td>168/8</td>
<td>162/5</td>
<td>n.s.</td>
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LVEF, left ventricular ejection fraction; ICU, intensive care unit; ER, emergency room; NPPV, non-invasive positive pressure ventilation; ACE-I, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; B-S, BiPAP Synchrony; B-V, BiPAP Vision; p-value, B-S period (2005–2007) vs. B-V period (2008–2010).
Information before deciding respiratory management

Fifty-seven ETI patients included 45 in the direct ETI group, 11 in the NPPV failure group, and 1 with O2 inhalation failure in the B-S period. Sixteen ETI group patients were also divided into 10 direct ETI group and 6 NPPV failure group in the B-V period. Success rate of NPPV increased from 81.4% to 94.9%. Table 3 shows the value of vital signs and arterial blood gas before respiratory management was started.

The BP was significantly higher in the NPPV failure group compared with the NPPV success group in the B-S period. Other vital signs were not significantly different between the NPPV failure group and NPPV success group in either period. The arterial blood gas value for pH was significantly lower in the NPPV failure group than in the NPPV success group for both periods (7.19 ± 0.10 vs. 7.28 ± 0.11, B-S period, p < 0.05; 7.05 ± 0.08 vs. 7.27 ± 0.14, B-V period, p < 0.001). The PCO2 values were significantly higher in the NPPV failure group than in the NPPV success group for

![Graph A](image1.png)

![Graph B](image2.png)

Figure 2  Receiver-operating characteristic (ROC) curves for pH. (A) pH value of 7.20 produced the optimal balance between sensitivity and specificity (81.2% and 64.5%) in the BiPAP-Synchrony period. (B) However, a pH value of 7.03 produced the optimal balance between sensitivity and specificity (92.8% and 66.7%) in the BiPAP-Vision period. AUC, area under receiver-operating characteristic (ROC) curves.
both periods (62.4 ± 13.9 mm Hg vs. 49.8 ± 15.3 mm Hg, B-S period, p < 0.05; 82.0 ± 51.4 mm Hg vs. 51.2 ± 19.3 mm Hg, B-V period, p < 0.001). The cutoff value for pH was determined according to an ROC curve analysis to distinguish the values of NPPV failure group and NPPV success group for both periods. A pH value of 7.20 produced the optimal balance between sensitivity and specificity (81.2% and 64.5%; AUC 0.725, p < 0.05) in the B-S period (Fig. 2A). Moreover, a pH value of 7.03 produced the optimal balance between sensitivity and specificity (92.8% and 66.7%; AUC 0.910, p < 0.001) in the B-V period (Fig. 2B).

Discussion

The rate of NPPV use increased rapidly after the introduction of the B-V system, during which the inspired oxygen concentration could be increased to 100%. Moreover, the success rate of NPPV also increased by the use of B-V system. The administration of carperitide which was reported to lead to better prognosis in AHF [20] significantly increased, and the administration of dopamine which was associated with poor prognosis in AHF [21] significantly decreased. This finding indicated that we might be able to successfully maintain the BP levels because we did not need to administer any excessive sedation due to the reduction of ETI. Nicorandil has been approved for use since 2007 in Japan for patients with AHF; therefore, the administration of nitroglycerin significantly decreased and the administration of nicorandil significantly increased, however, the use rate of a vasodilator did not significantly differ between the two periods. The total length of hospital stay was shorter when increasing the NPPV, namely from 81.4% to 94.9% with ventilator support. Our data therefore suggest that NPPV is an effective strategy for the treatment of AHF.

The present study indicates that patients who have not developed either severe acid–base or gas exchange derangements are more likely to be successfully treated under NPPV management. We suggest that the management of NPPV would be successful with high sensitivity and specificity for patients whose aortic blood gas pH levels lie above 7.03 with the use of the B-V system. There have been a few reports that attempted to establish recommended guidelines according to the blood gas criteria for the initial use of NPPV in patients with AHF.

Evidence of NPPV in AHF as respiratory management

AHF patients present with a form of hypoxemic acute respiratory failure caused by acute pulmonary edema (verified by chest X-ray), which is accompanied by severe respiratory distress, including crackles over the lung and orthopnea. Oxygen saturation is usually lower than 90% of ambient air prior to treatment. NPPV, which is the combination of pressure support and positive end-expiratory pressure delivered via face mask or nasal mask, has in recent years increased in usage to avoid ETI and its attendant complications in patients with AHF. ETI is associated with a considerable risk of morbidity, including upper airway trauma, nosocomial pneumonia, and sinusitis. This procedure may prolong intensive care unit and hospital stays, as additional time may be necessary for weaning from ventilation and the treatment of additional complications.

The guidelines on the diagnosis and treatment of AHF from the European Society of Cardiology consider the strategy of ventilator support without ETI in the treatment of patients with AHF resistant to standard medical therapy [12]. The efficiency of continuous positive airway pressure was reported by a randomized controlled trial in patients with cardiogenic pulmonary edema [1,2,4,5,22]. The investigators measured PaO2/FiO2 ratio as an indicator of oxygenation, aortic blood gas, and hemodynamics, which were all improved by continuous positive airway pressure [1,2,4,5], and the rate of ETI was decreased by positive airway pressure [1,5,6]. Takeda et al. reported that the pulmonary artery wedge pressure was significantly lower, and the cardiac index was higher in comparison to patients treated with oxygen [4]. In more recent studies, it was also reported that the efficiency of bi-level positive airway pressure was improved, as demonstrated by clinical information including blood pressure, heart rate, respiratory rate, and arterial blood gases (pH, PCO2, PO2, SaO2). The rates of ETI also decreased by the use of bi-level positive airway pressure [23,24]. Therefore, NPPV, which is a ventilator support without ETI and which uses bi-level positive airway pressure and continuous positive airway pressure, has proven its use in clinical situations.

The improvement in mortality by the use of NPPV and the death rates in the intensive care unit and hospital were decreased due to an increased use of NPPV in patients with acute exacerbation of chronic obstructive pulmonary disease [25]. Some meta-analysis has reported on NPPV in AHF patients, and these studies also demonstrated the efficiency of NPPV, defined as the effect of improvement of the patients’ prognosis [7—11].

The use of NPPV in emergency settings

In spite of mounting evidence demonstrating NPPV efficacy, the opportunity for NPPV use was unexpectedly low with use of the AHF registry, such as the ongoing Japanese ATTEND registry [15]. This is one reason that physicians were inexperienced with this method. If patients developed signs of discomfort or noncooperation, physicians can misunderstand that these patients are non-responders and immediately reconciled these patients to continue NPPV [13]. In other cases, if physicians only slowly implement NPPV, then physicians may thus miss an opportunity to use NPPV effectively since respiratory failure is well known to advance rapidly in the emergency setting. NPPV success is largely due to the skill of the medical team in treating patients. Physicians must consider many factors, including a patient’s diagnosis, the reversibility of the respiratory failure, the patient’s clinical characteristics, and the risk of failure; the judgment depends largely on physician experience.

In the field of acute respiratory failure including chronic obstructive pulmonary disease, some predictors of success for NPPV have been identified by several studies. These predictors include synchronous breathing, intact dentition, a lower APACHE score, and a good initial response to NPPV (correlation of pH, reduction in respiratory rate, and reduc-
tion in PaCO2) [26,27]. Patients with better neurologic conditions and who are more cooperative, who can protect their airways without severe acid–base or gas exchange derangement together have a higher chance of success following NPPV treatment. However, a report predicting the success of NPPV in patients with AHF in emergency departments appeared to be rare. In the present examination, we demonstrated the success of NPPV use to increase by introducing the B-V system, in which the inspired oxygen concentration could be set to 100%. In a previous study, it was pointed out that the use of NPPV, in which the inspired oxygen concentration could not be set to 100% leads, had no effect on the short-term mortality [28]. Our findings suggest that it might be able to avoid ETI in patients with a pH greater than 7.03, and with a statistically high sensitivity and specificity, by using the B-V system. In our institution, continuous positive airway pressure was tried on all patients. While patients were not cooperative for face mask attachment, it was strongly attached by many physicians or bi-level positive airway pressure was achieved with a small amount of sedation. If a patient exhibited severe neurologic conditions with acidosis, bi-level positive airway pressure was attempted first.

Several studies also have found that a patient’s initial response to NPPV following 1 h of treatment (as demonstrated by improvements in pH, PaCO2, and levels of consciousness) are associated with greater rates of success. These studies also indicated that there is a window of opportunity for initiating NPPV [16,25,29]. Data are not shown in the present study, but non-responders of NPPV continued to demonstrate a severely acidemic state. We therefore recommend that NPPV should be used first by means of a B-V system if the pH levels lie above 7.03; however, if the patient becomes severely acidemic despite receiving NPPV therapy, then the patient should be immediately switched to ETI.

Study limitations

There are several limitations associated with this study. First, the main limitation was the small number of patients included in each of the groups. Therefore, the conclusion that NPPV should be used first by means of a B-V system if the pH levels lie above 7.03 is a relatively premature one. Second, this is a retrospective study, the device for respiratory management was decided by each physician, and there were no limitations as to the decision of respiratory management. There is a natural physician’s bias. Third, the present study was a single center study, the patients’ bias might exist. For example, systolic BP was relatively high compared with other HF registries and the rate of new-onset HF was high at 60.7%.

Conclusions

The frequency and success of NPPV use increased rapidly with use of the B-V system at our institution. Distinguishing whether to utilize NPPV or ETI before determining on the optimal respiratory management was mainly based on the pH levels. NPPV will be successful with both a high sensitivity and specificity if the aortic blood pH gas levels are above 7.03 before using the B-V system.

References


