Impact of noninvasive ventilation (NIV) trial for various types of acute respiratory failure in the emergency department; decreased mortality and use of the ICU

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Received 21 May 2008; accepted 4 August 2008
Available online 18 September 2008

KEYWORDS
Noninvasive Ventilation; Acute respiratory failure; Mortality; Intensive-care-unit; Emergency department

Summary
Background: Trial of noninvasive ventilation (NIV) in the emergency department (ED) for heterogeneous acute respiratory failure (ARF) has been optional and its clinical benefit unclear.

Methods: We conducted a retrospective cohort study comparing between two periods, October 2001—September 2003 and October 2004—September 2006, i.e., before and after adopting an NIV-trial strategy in which NIV was applied in the ED to any noncontraindicated ARF patients needing ventilatory support and was then continued in the intermediate-care-unit. During these two periods, we retrieved cases of ARF treated either invasively or with NIV, and compared the patients’ in-hospital mortalities and the length of ICU and intermediate-care-unit stay.

Results: Compared were 73 (invasive 56, NIV 17) and 125 cases (invasive 31, NIV 94) retrieved from 271 and 415 emergent admissions with proper pulmonary etiologies for mechanical ventilation, respectively. Of their respiratory failures, type (hypercapnic/non-hypercapnic, 0.97 vs. 0.98) and severity (pH 7.23 vs. 7.21 for hypercapnic; PaO2/FiO2 133 vs. 137 for non-hypercapnic) were similar, and the rate of predisposing etiologies was not significantly different. However, excluding those with recurrent aspiration pneumonia for whom NIV was mostly used as “ceiling” treatment, significant reductions in both overall in-hospital mortality (38%—19%, risk ratio 0.51, 95% CI 0.37—0.70) and in both ICU and intermediate-care-unit stay were observed.

Abbreviations: ARF, acute respiratory failure; Bilevel-PAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure; DNI, do-not-intubate; ED, emergency department; NIV, noninvasive ventilation; PEEP, positive end-expiratory pressure.

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doi:10.1016/j.rmed.2008.08.001
Introduction

Noninvasive ventilation (NIV) is now the first-line treatment for acute respiratory failure (ARF) of certain types of pathogenesis such as COPD,1 cardiogenic pulmonary edema,2 and hypoxic respiratory failure associated with immunodeficiency,3,4 and abundant evidence has been presented of decreasing mortality rates,1,2 intubations,1,2 complications and ICU stays.5 The application of NIV for other diagnoses is, however, still equivocal and not recommended routinely, although trials using patients with pneumonia,6,7 hypoxic respiratory failure,8 bronchial asthma,9 other types of hypercapnic failure10 and those with do-not-intubate (DNI) orders11,12 suggest its validity.

Early use of NIV in the emergency department (ED) was revealed to improve physiological variables rapidly, and reduced mortality, ICU admissions for COPD13 and cardiogenic pulmonary edema.14 Likewise, for other etiologies, the immediate provision of continuous positive airway pressure (CPAP) or positive end-expiratory pressure (PEEP) can prevent atelectasis and subsequent V/Q mismatch causing poorer oxygenation, while Bilevel-PAP or pressure support can prevent further fatigue of respiratory muscles. Additionally, in clinical practice, predisposing etiologies of ARF are often complex and not easy to determine in a short time. Therefore, if provided promptly in the ED regardless of etiologies, NIV may produce certain benefits for both ARF patients and acute care hospitals.15

In order to perform NIV in the ED, we have to find somewhere it is possible to continue treatment after the ED. A typical ICU does not seem to be suitable for this, because the capacity of such units is usually insufficient and, furthermore, the cost to treat every patient is too high. Additionally, assignment to the ICU is unnecessary for not a few patients with DNI orders, who, in some cases, are good candidates for NIV. Recently, the number of reports on performing NIV outside the ICU is increasing,16,17 and experience in intermediate-care-units has provided favorable outcomes, as well as being cost-effective.15,18,19 Thus, prompt initiation in the ED with subsequent continuation in intermediate-care-units, which may be quite common in some countries,19 seems to be the optimal location for NIV for ARF.

Based on the above details, we have been initiating NIV (prompt bi-level PAP or CPAP) in the ED and continuing it in the intermediate-care-unit for every possible non-contraindicated patient with ARF needing ventilatory support since 2004. In order to elucidate the benefits of this strategy, we retrospectively compared the mortality rates and the length of ICU or intermediate-care-unit stay among ARF admissions to our hospital with invasive ventilation or NIV during the periods before and after the introduction of the NIV-trial strategy.

Methods

Application and location of noninvasive ventilation

In our 900-bed community teaching hospital, which plays a central role in treating emergent patients from Kobe City’s population of 1,560,000 people, NIV for ARF was fully introduced in the ED in 2004, without additional staffing with nurses and respiratory therapists. Thereafter, bi-level PAP or CPAP by “BiPAP Vision” (Respironics, Inc.), which has a high-flow oxygen blender allowing FiO2 up to 100%, became available at anytime. Before that time, NIV had been performed only in some patients with acute on chronic hypercapnic failure, and most patients who needed mechanical ventilation were intubated. In contrast, after that time, NIV-trial strategy was applied, namely, NIV could be begun at any time in any patients with ARF needing mechanical ventilation, as long as they had no contraindications to NIV such as respiratory arrest, hemodynamic instability and/or urgent need for airway management. All the patients, whether in pre- or in post-NIV trial strategy, to whom NIV had been already applied, or would be applied soon were transferred from emergency room to a preexisting intermediate-care-unit within the ED, which had been providing a 4:1 nurse to patient ratio per shift, adequate continuous non-invasive monitoring and the availability of a physician 24 h a day. In the case of NIV failure, they were intubated and could be transferred to the ICU. However, if they were stabilized by NIV, they would either stay there until the treatment was completed, or were transferred to the general wards if they had no urgent need for intubation or if they had DNI orders. In the case of patients with acute on chronic respiratory failure for whom home NIV had previously been prescribed, we used the same ventilator in hospital as long as they could be managed without a high FiO2 setting.

Data collection and statistics

Data collection and analysis were processed only by our authors without exposing patient’s personal information to other people. As this was a retrospective historical control study, our IRB stated that their approval was not necessary.

For the two 2-year periods, October 2001—September 2003 and October 2004—September 2006, i.e., before and after the introduction of NIV-trial strategy for ARF patients, we screened all the medical records of pulmonary emergent admissions to our hospital and retrieved cases of ARF identified as those needing oxygenation on admission defined as PaO2 < 60 mmHg, or SpO2 < 90% on room air (Fig 1). In the case of acute exacerbation of chronic respiratory failure, we...
adopted those who needed more oxygen than usual to maintain SpO2 > 90%. During the former period, 271 cases were retrieved from a total of 485 cases by excluding those unsuitable for survival analysis or for NIV-candidates; malignancy, cardiopulmonary arrest, those who needed urgent airway management, namely, asphyxia, airway narrowing, inhalation burn, airway trauma, massive hemoptysis, drug overdose, and those in whom prognosis would not be affected by ventilatory management, namely, pneumothorax, massive pleural effusion and pulmonary embolism. Similarly, 415 cases were retrieved from 859 records during the latter period. Finally, excluding cases with no need or intention for mechanical ventilation under the each strategy of the both periods, 73 and 125 cases were used for this study. Their demographic data, types of respiratory failure defined as "hypercapnic" (PaCO2 > 45 torr on admission) and "non-hypercapnic" (P/F < 300 and PaCO2 < 45 torr on admission), predisposing etiologies, in-hospital mortality, length of ICU and intermediate-care-unit stay, and the total number of hospital days were compared between the two periods.

The type of mechanical ventilation applied was defined as follows: (1) invasive: every case in which invasive ventilation was used, (2) NIV: cases, in which NIV was used without changing to invasive ventilation. The cases we retrieved were tentatively classified into six categories depending on their pulmonary etiologies of ARF based on their medical records: (1) pneumonia (recurrent aspiration pneumonia, such as totally bed-ridden, unable to swallow, and having multiple aspiration episodes, were separated from other pneumonia because their indication for mechanical ventilation and ICU stay were generally different from those with other etiologies), (2) interstitial lung disease, (3) other types of non-hypercapnic respiratory failure such as alveolar hemorrhage, congestive heart failure, ARDS, pulmonary vasculitis and their coexistence, (4) bronchial asthma, (5) COPD and (6) other types of hypercapnic respiratory failure such as old pulmonary tuberculosis, deformed thorax, bronchiectasis, sarcoidosis and pulmonary Aspergillosis. Unfortunately, as our data source was limited to the medical records of the department of respiratory medicine, cases with congestive heart failure and extra-pulmonary ARDS were largely excluded. Cases considered to have both COPD and asthma were included under "COPD" when their ARF was hypercapnic, and under "bronchial asthma" when non-hypercapnic. Cases of COPD with pulmonary infiltrates were included under "pneumonia", as were those of ARDS complicated with pneumonia.

In comparing the two periods, we used unpaired-t tests for continuous data: patient's age, pH, PaO2/FiO2 ratio, length of stay in the ICU, intermediate-care-unit and hospital, and chi-square tests for categorical data: gender ratio, diagnosis (df = 5). The risk ratio of in-hospital mortality and that of ICU and intermediate-care-unit use (total days in the ICU and intermediate-care-unit per stay in hospital) were presented with a 95% confidence interval. Discharge rates from the ICU and intermediate-care-unit were expressed by the Kaplan–Meier method and the difference was examined by Logrank test, in which data

**Figure 1** Study profile. *Diseases unsuitable for survival analysis or NIV-candidates were excluded. †Acute on chronic cases in which the same previously prescribed home-NPPV machine was used after admission are included here. ‡Tracheostomy or intubation had been performed before arrival in eight cases. Emergent intubation was needed in other 19 cases: aspiration in the airway (4), cardiovascular instability (3), deep coma (5), and unspecified reasons (7). DNI: do not intubate.
were considered censored when death occurred. All statistical analyses were performed using statistical software (JMP 7.0.2.; SAS Institute Inc.).

Results

The number of cases in which mechanical ventilation, invasive or noninvasive, was administered was 56 and 17 in the period "before introduction" and 31 and 94 cases in the "after introduction", respectively (Table 1). Patient ages were similar overall (68.9 ± 13.0 vs. 71.2 ± 13.6, P = 0.23), but significantly lower in those treated with invasive ventilation than in those with NIV in the period "before introduction" (P = 0.01). Gender ratio (percentages of male; 63.0 vs. 62.4, P = 0.93) and the type of respiratory failure were similar (hypercapnic/non-hypercapnic; 0.97 vs. 0.98). Mean pH in hypercapnic failures indicating their severity, was not statistically different between the two periods (7.23 ± 0.14 vs. 7.21 ± 0.12, P = 0.47), but significantly lower in those treated with invasive ventilation than in those with NIV in the period "after introduction" (P < 0.0001). The ratio of PaO2/FiO2 in non-hypercapnic failures was not different between the two periods (133 ± 69 vs. 137 ± 66, P = 0.83). In terms of the rate of pulmonary etiologies causing ARF, no statistical difference existed between the two periods (pneumonia 39.7% vs. 34.4%, bronchial asthma 13.7% vs. 9.6%, other hypercapnic respiratory failure 24.7% vs. 24.0%, interstitial lung disease 9.6% vs. 15.2%, COPD 8.2% vs. 16.0%, other non-hypercapnic failure 4.1% vs. 0.8%) (P = 0.07). The rate of patients who died after refusing invasive ventilation and underwent NIV as "ceiling" treatment, was similar (4/17; 23.5% vs. 23/94; 24.5%) but their types of respiratory failure shifted from hypercapnic to non-hypercapnic (hypercapnic/non-hypercapnic; from 2/1 to 5/14) and their predisposing etiologies from "other hypercapnic failure" to "recurrent aspiration pneumonia" and "interstitial lung disease".

Overall in-hospital mortality rates decreased from "before introduction" to "after introduction" (38%–25%, risk ratio 0.65; 95% CI 0.42–0.99) (Table 2), in which hypercapnic failures favored the tendency more than non-hypercapnic failures. The reduction in mortality rates slightly differed among the etiologies, with those of "bronchial asthma", "other hypercapnic respiratory failure", "interstitial lung disease" and "COPD" showing a conspicuous risk ratio of 0.20–0.60 and statistical significance existed in "other hypercapnic failure" and "interstitial lung disease" despite including not a few patients with DNI orders. As for "pneumonia", which was the most frequent etiology, the in-hospital mortality rate did not improve after the introduction of NIV-trial, especially in "recurrent aspiration pneumonia". Had we excluded cases in this category from the overall analysis, the mortality rate would have been 25/66 (38%) and 20/104 (19%) before and after "introduction", respectively, and the risk ratio between them would have been 0.51 (95% CI 0.31-0.84), in spite of a similar degree of severity in their respiratory failure (pH 7.23 ± 0.14 vs. 7.23 ± 0.11, P = 0.86 for hypercapnic; and PaO2/FiO2 123 ± 62 vs. 142 ± 64, P = 0.23 for non-hypercapnic).

Although the total length of hospital stay, excluding those of recurrent aspiration pneumonia, was almost the same for the two periods (17.8 ± 14.8 vs. 17.7 ± 15.4, P = 0.91), the length of ICU and intermediate-care-unit stays decreased (8.0 ± 9.1 days vs. 5.6 ± 4.4 days, P = 0.01). Discharge rates from the ICU and intermediate-care-unit (Fig. 2) were significantly higher in the period "after introduction" than in the period "before introduction" (median length of stay; 12 vs. 5 days, P < 0.0001), and the rate of ICU and intermediate-care-unit use (total days in the ICU and intermediate-care-unit per stay in hospital) decreased overall from 620/1306 (47.5%) to 583/2485 (23.5%), risk ratio 0.49 (95% CI 0.45-0.54).

Discussion

In association with the introduction of NIV-trial strategy, both an overall significant reduction in in-hospital mortality and use of the ICU and intermediate-care-unit were seen in emergent admissions to our hospital of patients with ARF of various pulmonary etiologies. To the best of our knowledge, this is the first report indicating the overall benefits obtained after introduction of NIV in treating ARF regardless of etiologies in clinical practice.

Reduction in mortality by NIV has been reported for several diagnoses; relative risk of 0.52 for acute exacerbation of COPD and 0.55 for acute cardiogenic pulmonary edema from meta-analysis, and 0.46 (ICU mortality, 18% vs. 39%) for heterogeneous severe hypoxemic failure and 0.11 (ICU mortality, 6% vs. 53%) for early ARDS in experienced hospitals. Nevertheless, for other etiologies such as pneumonia, interstitial lung disease, bronchial asthma, mortality reduction by NIV has not yet been presented. Therefore, our data showing an overall reduction in mortality of heterogeneous predisposing etiologies is both noteworthy and also useful in promoting NIV in the clinical practice of the ED, where the etiologies of ARF are not always easy to determine in a short period of time, and where no time should be lost.

The overall reduction in mortality could have been due to the common beneficial factors of NIV for all etiologies, such as early administration of PEEP or pressure support, which could have prevented further worsening of ARF by increasing pulmonary gas exchange and/or reducing the work of breathing. The application of NIV for patients with DNI orders might also have been a contributing factor in decreased mortalities as seen in our study in "interstitial pneumonia"; however, the actual percentage of rescued DNI patients could not be obtained from this retrospective study. Conversely, patients with DNI orders for whom NIV was performed as "ceiling" treatment, should have diminished the effect of mortality reduction, because those who were in the same unfavorable condition had not been included in the period "before introduction of NIV-trial". This seems to be the main reason why overall mortality reduction was conspicuous after excluding those with recurrent aspiration pneumonia.

Although NIV itself has the potential to reduce ICU stay by lowering the rate of intubation and complications such as ventilator associated pneumonia, the strategy of performing NIV in the intermediate-care-unit instead of the ICU can reduce ICU stay further. Similarly, the subsequent transfer of low-risk patients, such as intermittent users of NIV, from the intermediate-care-unit to the general ward will reduce the length of their stay. These patient-flows,
Table 1  Baseline characteristics of cases that underwent mechanical ventilation in the two periods.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Invasive</td>
<td>NIV</td>
</tr>
<tr>
<td>No. of cases</td>
<td>56</td>
<td>17 (4)</td>
</tr>
<tr>
<td>Age, mean ± SD years</td>
<td>66.8 ± 12.7a</td>
<td>75.8 ± 11.9</td>
</tr>
<tr>
<td>M/F ratio (male %)</td>
<td>66.1</td>
<td>52.9</td>
</tr>
<tr>
<td>Types of respiratory failures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypercapnic failure (PaCO₂ &gt; 45 torr)</td>
<td>18</td>
<td>14 (2)</td>
</tr>
<tr>
<td>pH</td>
<td>7.22 ± 0.17</td>
<td>7.26 ± 0.11</td>
</tr>
<tr>
<td>Non-hypercapnic failure (P/F &lt; 300 and PaCO₂ &lt; 45 torr)</td>
<td>31</td>
<td>2 (1)</td>
</tr>
<tr>
<td>PaO₂/FiO₂</td>
<td>133 ± 69</td>
<td>–</td>
</tr>
<tr>
<td>Others not specifiedc</td>
<td>7</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia, total</td>
<td>25</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Recurrent aspiration pneumonia</td>
<td>5</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Other pneumonia</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Bronchial asthma</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Other hypercapnic failure</td>
<td>8</td>
<td>10 (3)</td>
</tr>
<tr>
<td>Interstitial lung disease</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>COPD</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Other non-hypercapnic failure</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

() Denotes the number of patients who died after refusing invasive ventilation and undergoing NIV as "ceiling" treatment.

a Mean age of those who had invasive ventilation was significantly lower than those who underwent NIV in the period "before introduction of NIV-trial" (P = 0.01).

b Mean pH of hypercapnic failures was significantly lower in those who had invasive ventilation than in those who underwent NIV in the period "after introduction of NIV-trial" (P = 0.0007).

c Types of respiratory failure were not specifically defined by the patient's medical record.
based on the idea that the appropriate site for NIV should be decided according to the situation in each country and each hospital, it seems to be realistic when it comes to performing NIV widely as the first-line treatment for ARF. Conversely, strict adherence to the ICU for NIV might limit its immediate application, loses the chance to avoid intubation and thereby increase ICU use.

In terms of the rate of classified etiologies, which was tentatively done according to medical records, COPD was unexpectedly low. This might have been due to the classification of complicated cases; for example, acute exacerbation with lung infiltration was included under "pneumonia", while those with other coincidental disease such as chest wall deforming or old pulmonary tuberculosis were allocated to "other hypercapnic failure". Similarly, ARDS, which was to be included under "other non-hypercapnic failure", was remarkably low, probably because most of the patients with extrapulmonary ARDS were originally excluded from the medical records of our department, and a considerable number of cases of pulmonary ARDS were included in the category "interstitial lung disease" or "pneumonia".

Once we had introduced the NIV-trial strategy, the rate of NIV in the total mechanical ventilation increased remarkably from 20 to 30%, comparable to the usual level reported to almost 80%. This rapid increase of NIV seems to have been caused by several components of our strategy: (1) the ready availability of NIV machines with a high oxygen blender, which enabled immediate pressure support and PEEP with high FiO₂; (2) the presence of a physician at initiation and observation of NIV during the acute phase; and (3) smooth transfer of the patients from the ICU and intermediate-care-unit to general wards. In addition, although no extra nursing staff or respiratory therapists were provided, an associated accumulation of experience and confidence makes the indication wider and produces a favorable outcome as reported. We think these factors are prerequisites for introducing NIV in the ED successfully into the clinical practice of a community hospital.

There were certain limitations in this study. As this was a retrospective historical control study, differences existed in the background of the cases in the two periods. Several confounding factors such as changes in the number of patients, drugs, members of staff and monitoring equipment from 2001–2003 to 2004–2006 may possibly have influenced the results, although the rate of the type of respiratory failure and each category of the predisposing etiology were not significantly different. Another limitation in this study was the highly selected study populations. Although many patients were excluded for various reasons until the study population consisted of 15% and 14% of patients with acute respiratory failure in the pre- and post-NIV trial strategy groups, respectively, this population comprised most of the pulmonary etiologies that could be rescued by mechanical ventilation without caring for

### Table 2  In-hospital mortality rates of retrieved cases of ARF that underwent invasive ventilation or NIV.

<table>
<thead>
<tr>
<th></th>
<th>Before introduction of &quot;NIV-trial&quot; (Oct 2001–Sep 2003)</th>
<th>After introduction of &quot;NIV-trial&quot; (Oct 2004–Sep 2006)</th>
<th>Risk ratio (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall (%)</td>
<td>28/73 (38)</td>
<td>31/125 (25)</td>
<td>0.65 (0.42–0.99)</td>
</tr>
<tr>
<td>Hypercapnic failures (%)</td>
<td>7/32 (22)</td>
<td>7/58 (12)</td>
<td>0.55 (0.21–1.43)</td>
</tr>
<tr>
<td>Non-hypercapnic failures (%)</td>
<td>16/33 (49)</td>
<td>20/59 (34)</td>
<td>0.70 (0.42–1.15)</td>
</tr>
<tr>
<td>Pneumonia, total (%)</td>
<td>11/29 (38)</td>
<td>16/43 (37)</td>
<td>0.98 (0.54–1.78)</td>
</tr>
<tr>
<td>Recurrent aspiration pneumonia (%)</td>
<td>3/7 (43)</td>
<td>11/21 (52)</td>
<td>1.22 (0.47–3.15)</td>
</tr>
<tr>
<td>Other pneumonia (%)</td>
<td>8/22 (36)</td>
<td>5/22 (23)</td>
<td>0.63 (0.24–1.61)</td>
</tr>
<tr>
<td>Bronchial asthma (%)</td>
<td>2/10 (20)</td>
<td>1/12 (8)</td>
<td>0.38 (0.04–3.67)</td>
</tr>
<tr>
<td>Other hypercapnic failure (%)</td>
<td>6/18 (33)</td>
<td>2/30 (7)</td>
<td>0.20 (0.05–0.89)</td>
</tr>
<tr>
<td>Interstitial lung disease (%)</td>
<td>7/7 (100)</td>
<td>9/19 (47)</td>
<td>0.47 (0.29–0.76)</td>
</tr>
<tr>
<td>COPD (%)</td>
<td>1/6 (17)</td>
<td>2/20 (10)</td>
<td>0.60 (0.07–5.53)</td>
</tr>
<tr>
<td>Other non-hypercapnic failure (%)</td>
<td>1/3 (33)</td>
<td>1/1 (100)</td>
<td>3.00 (0.61–14.9)</td>
</tr>
<tr>
<td>Overall excluding recurrent aspiration pneumonia (%)</td>
<td>25/66 (38)</td>
<td>10/104 (19)</td>
<td>0.51 (0.31–0.84)</td>
</tr>
</tbody>
</table>

Figure 2  Discharge rates from the ICU and Intermediate-care-unit. Discharge rates were significantly higher in the period “after introduction of NIV-trials” than in the period “before introduction” (median length of stay; 5 vs. 12 days, P < 0.0001). This statistical analysis was performed excluding cases of recurrent aspiration pneumonia.
airway patency. The small numbers might inhibit the reliability of our results; however, this grouping of the patients would be presumably justifiable in the urban clinical situation in one hospital. Although we could not include congestive pulmonary edema, the result would not be affected much because NIV is considered to be favorable for this etiology. In our NIV-trial strategy, we tried NIV in every patient by physician’s decision as needing mechanical ventilation without definite contraindication, however, if the more accurate definition of the NIV-indications, i.e., pCO2 of 45–55, 55–65 etc. or pH 7.35–7.3, 7.3–7.25 etc. could be obtained, it would be better and helpful for applying this strategy. In terms of ICU use, the increased number of patients admitted emergently might have affected the results, as the increased numbers might have created other pressures to expel simple ARF patients from the ICU.

In conclusion, the NIV-trial strategy for ARF including quick and broad application of NIV in the ED, based on an on-site physician’s decision and subsequent continuation in the intermediate-care-unit, could have the effect of reducing mortality and ICU use, especially if those with debilitating conditions such as recurrent aspiration pneumonia are excluded. Obviously, cases needing cardiovascular support or complicated ventilator settings should be managed in the ICU with invasive ventilation; however, the numerous remaining cases with simple pulmonary etiology could be managed promptly and simply with NIV outside the ICU such as in the ED, intermediate care unit and general wards. This separation of roles can save more lives, save space, and also, presumably, cost, especially in hospitals where ICU resources are always limited.

Conflict of interest statement

None of the authors have a conflict of interest to declare in relation to this work.

Acknowledgements

We greatly appreciate the contribution of the physicians in our emergency department, Shinichi Sato, Kouichi Ariyoshi, Takuro Hayashi and Huh Ji-Young; our clinical engineering technologist, Ichiro Sakachi; and also of the nursing staff of our emergency and respiratory medicine departments.

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