Noninvasive vs Conventional Mechanical Ventilation in Acute Respiratory Failure

A Multicenter, Randomized Controlled Trial

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Study objective: Noninvasive mechanical ventilation (NIMV) is beneficial for patients with acute respiratory failure (ARF) when added to medical treatment. However, its role as an alternative to conventional mechanical ventilation (CMV) remains controversial. Our aim was to compare the efficacy and resource consumption of NIMV against CMV in patients with ARF.

Design: A randomized, multicenter, controlled trial.

Setting: Seven multipurpose ICUs.

Patients: Sixty-four patients with ARF from various causes who fulfilled criteria for mechanical ventilation.

Intervention: The noninvasive group received ventilation through a face mask in pressure-support mode plus positive end-expiratory pressure; the conventional group received ventilation through a tracheal tube.

Measurements and results: Avoidance of intubation, mortality, and consumption of resources were the outcome variables. Thirty-one patients were assigned to the noninvasive group, and 33 were assigned to the conventional group. In the noninvasive group, 58% patients were intubated, vs 100% in the conventional group (relative risk reduction, 43%; \( p < 0.001 \)). Stratification by type of ARF gave similar results. In the ICU, death occurred in 23% and 39% \( (p = 0.09) \) and complications occurred in 52% and 70% \( (p = 0.07) \) in the noninvasive and conventional groups, respectively. There were no differences in length of stay. The Therapeutic Intervention Score System-28, but not the direct nursing activity time, was lower in the noninvasive group during the first 3 days.

Conclusions: NIMV reduces the need for intubation and therapeutic intervention in patients with ARF from different causes. There is a nonsignificant trend of reduction in ICUs and hospital mortality together with fewer complications during ICU stay.

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Key words: intratracheal; intubation; mask; randomized controlled trial; respiration, artificial; respiratory insufficiency

Abbreviations: APACHE = acute physiology and chronic health evaluation; ARF = acute respiratory failure; CI = confidence interval; CMV = conventional mechanical ventilation; EMVIRA = Ensayo de Modalidades de Ventilación en Insuficiencia Respiratoria Aguda (Trial on Modalities of Ventilation in Acute Respiratory Failure); \( \text{FiO}_2 \) = fraction of inspired oxygen; NIMV = noninvasive mechanical ventilation; PEEP = positive end-expiratory pressure; PS = pressure support; TISS-28 = Simplified Therapeutic Intervention Scoring System-28

Approximately 30% of patients admitted to an ICU receive mechanical ventilation to treat acute respiratory failure (ARF), and > 90% of them receive ventilation through endotracheal intubation.\(^1\) However, the insertion of an artificial airway can lead to numerous side effects related to sedation, airway damage, and respiratory infections.\(^2\)–\(^4\)

Numerous randomized trials and reviews\(^5\)–\(^18\) have shown benefits from the use of noninvasive mechanical ventilation (NIMV) when compared with conventional medical treatment in the treatment of ARF. The benefit of NIMV in hypoxemic or hypercapnic ARF with criteria for endotracheal intubation as an alternative to conventional mechanical ventilation (CMV) has been widely studied in nonrandomized trials.\(^19\)–\(^22\) Only two randomized trials\(^23,24\) have assessed NIMV as an alternative to CMV in patients with ARF and criteria for endotracheal intubation. They showed NIMV to be as efficacious as CMV in improving gas exchange, reducing complications,\(^23\) and avoiding intubation without changes in mortality.\(^24\)

As NIMV applied through a face mask or nasal
mask may avoid the need for tracheal intubation, it might offer the additional benefits of a lesser need for sedation and a decrease in the risk of airway damage or pneumonia.25 Accordingly, if one assumes that as complications reduce, so do morbidity and mortality, NIMV might improve the outcome of ARF patients who require mechanical ventilation.

For editorial comment see page 3790

We aimed to compare the efficacy of NIMV with CMV in patients with ARF from different causes with criteria for mechanical ventilation. Efficacy was assessed with the avoidance of intubation, medical complications, and the consumption of resources.

**MATERIALS AND METHODS**

**Design, Setting, Subjects**

A multicenter randomized trial was carried out in seven ICUs. These units had sufficient expertise in the use of NIMV measured in terms of both time of use and the number of patients receiving ventilation. Patients with ARF were randomized to receive either NIMV or endotracheal intubation and CMV. The study was approved by the ethics committees of the participating centers. Written informed consent was given by participants or proxy relatives.

The criteria for eligibility were ARF, both hypoxemic and hypercapnic, from causes previously defined26–28 that had deteriorated despite standard medical management and at least three of the following criteria: PaO2/fraction of inspired oxygen (FiO2) ratio ≤ 170; respiratory rate ≥ 35 breaths/min; blood pH < 7.30; a score between 3 and 5 on the Kelly scale of neurologic dysfunction; and a score of three or more points on a modified scale of accessory respiratory muscle use22: 1 = no visible respiratory activity in the neck muscles; 2 = respiratory activity in the neck muscles without active contraction of supraclavicular or intercostal muscles; 3 = vigorous activity of accessory muscles with contraction; and 4 = vigorous activity with contraction of accessory muscles and paradoxical abdominal breathing pattern. Once the patient fulfilled these criteria, the final decision to enroll was made by the attending clinician. A consistency analysis was performed between the above criteria for intubation and the decision to intubate made by a physician. The χ2 index was 0.76 when one of the criteria was either the Kelly scale of neurologic dysfunction or the scale of use of accessory respiratory muscles. The reasons for exclusion were the presence of any condition immediately threatening life (imminent respiratory arrest, deep coma [Kelly score of 6], shock), contraindications to NIMV (coma of an origin other than hypercapnia, facial or digestive tract surgery), previous treatment with any mode of ventilation during the same admission, and decision not to apply mechanical ventilation for other reasons.

**Intervention**

The randomization scheme was stratified by center and made by a computer-based, pseudorandom number generator. Allocations were issued using opaque, sealed, and numbered envelopes.

**NIMV**

NIMV was applied with face mask (ResMed Ltd/North Ryde, New South Wales, Australia; and Respironics; Murrysville, PA). Standard ICU respirators were used (Dräger Evita; Dräger Medical; Lubeck, Germany; and Siemens; Siemens AG; Munich, Germany). The ventilatory mode applied was pressure support (PS) plus positive end-expiratory pressure (PEEP) with increasing PS level adjustment to achieve a baseline tidal volume from 5 to 7 mL/kg. In the subset of hypoxemic patients, PEEP was administered between 5 cm H2O and 10 cm H2O to achieve oxygen saturation > 90% with an FiO2 < 0.6. In hypercapnic patients, PEEP was applied between 5 cm H2O and 7 cm H2O to compensate for auto-PEEP.29 The application was continuous for the first 6 h,6,7 and no limit was set on the duration provided no criteria for failure were achieved. For weaning spontaneous respiration with oxygen for 30 to 60 min was tried and if successful intermittent disconnections were followed.

NIMV was considered to be successful if the patient remained in spontaneous respiration for at least 48 h after the withdrawal of NIMV. The criteria for NIMV failure were as follows: (1) cardiorespiratory arrest or imminent vital risk; (2) hemodynamic impairment that required vasoactive drugs; (3) severe damage at the nose bridge; and (4) impairment of any of the physiologic or gasometric variables with any decrease in the PaO2/FiO2 ratio, increase in PaCO2 > 5 mm Hg, a decrease in pH of at least 0.05, or any increase on the Kelly scale of neurologic dysfunction or the scale of use of accessory respiratory muscles.

**CMV**

CMV was administered following the usual practice in each ICU. Assist-control ventilation was applied in 25 of 33 patients. Sedation was administered in 32 of 33 patients. All patients were intubated orally. Other therapeutic interventions were determined by the attendant physician. The use of weaning protocols was required in advance. T-tube weaning and PS were equally used.

**Outcome Variables**

The primary outcome variable was intubation avoidance in the NIMV group compared with the CMV group. Secondary clinical
variables were mortality in the ICU and at hospital discharge, clinical complications previously defined in the study protocol, and total ventilation time. The lengths of ICU and hospital stay, and the Simplified Therapeutic Intervention Scoring System-28 (TISS-28) scale for 7 days were also measured. Seven measurements were made for the time of nursing activity, the first for 8 h immediately after random assignment, and the other six measurements for 4 h each in every subsequent work shift.

Moreover, we assessed the predictive factors for the failure of NIMV. Potential predictive variables were the primary cause of ARF, APACHE (acute physiology and chronic health evaluation) II score, baseline blood gases, in particular PaCO$_2$, changes in breathing rate, Kelly score, scale of accessory respiratory muscle use, PaO$_2$/FiO$_2$ ratio, PaCO$_2$, and pH at the first hour.

**Statistical Analysis**

A sample of 60 patients per group, for an α value of 0.05 and a power of 0.90, would allow the detection of a reduction in the percentage of intubation of up to 18% in the group assigned to NIMV compared with the CMV group, and a reduction in its length of stay of 47%. However, after 64 patients had been enrolled, the Steering Committee decided to stop the study because of a decrease in the rate of enrollment, which the Steering Committee ascribed to a preference of attending physicians to treat directly with NIMV.

All analyses were made by assigned treatment. Proportions were compared using the Mantel-Haenszel test stratified by center. Mortality was analyzed using Kaplan-Meier curves and log-rank tests. Means were compared using analysis of variance or Mann-Whitney U test. Length-of-stay variables were transformed into their corresponding natural logarithm. The probability of intubation in the NIMV group was analyzed with multiple logistic regression. In the analyses of intubation avoidance, hypothesis testing was one sided and the significance level was set at p < 0.025. In the other analyses, hypothesis testing was two sided, and the significance level was established at p < 0.05. Two-sided 95% confidence intervals (CIs) was used for all analyses.

**RESULTS**

Between November 1999 and September 2001, 64 patients were recruited; 31 were assigned to NIMV, and 33 were assigned to CMV. All randomized patients were included in the statistical analysis; no patients were unavailable for follow-up. Information on the number of potentially eligible patients who were admitted was only obtained in five of the seven centers during the study period (Fig 1). The characteristics of the patients at enrollment are listed in Table 1. Concerning inclusion criteria, all patients but one fulfilled at least one of the scales (3 to 5 points in the Kelly scale, and at least 3 in the scale of use of accessory respiratory muscles). No normocapnic patient had a Kelly score ≥ 3, and three patients had pH between 7.24 and 7.30. Although the number of patients with a previous diagnosis of COPD was quite similar in the two groups, there were a greater number of patients with acute exacerbations of COPD in the CMV group.

![Figure 1. Participant flow through each stage.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/22036/)
of COPD and acute pulmonary edema as the cause for ARF in the NIMV group.

Endotracheal Intubation

In the group assigned to NIMV, 18 patients (58%) were intubated, vs 33 patients (100%) in the group assigned to CMV (relative risk reduction, 43% [95% CI, 22 to 58%; p = 0.00003]; number needed to treat, 2.4 [95% CI, 1.7 to 4.1]; Fig 2). The analysis further stratified by the presence or not of exacerbation of COPD or cardiogenic acute pulmonary edema gave similar results (relative risk reduction,
of death are listed in Table 3. Of ten patients died in ICU, 9 from septic shock with acute respiratory failure and 3 from refractory ARF. The causes of death were pneumonia (four with and four without a history of COPD), NIMV failed in all patients (Fig 2). The reasons for intubation in NIMV patients are shown in Table 2.

Mortality

In the NIMV group, 7 patients died (23%) in the ICU, vs 13 patients (39%) from the CMV group (relative risk reduction, 47%; 95% CI, 12 to 75%; p = 0.09). This tendency toward mortality reduction was homogeneous in all subgroups analyzed (Fig 3). There were no statistically significant differences in the ICU survival time between the two groups (p = 0.60) [Fig 4]. Of the 18 patients assigned to NIMV who required endotracheal intubation, 7 patients died (39%). All patients from the NIMV group who died in the ICU had been intubated.

In the NIMV group, 10 patients (32%) died in the hospital, vs 14 patients (42%) in the CMV group (relative risk reduction, 24%; 95% CI, 34 to 61%; p = 0.30). There were no statistically significant differences in hospital survival time between the two groups (p = 0.43). One patient died of acute exacerbation of chronic renal failure 21 days after ICU discharge without having been intubated. Of 18 patients with baseline diagnosis of pneumonia, 12 patients died in ICU, 9 from septic shock with acute renal failure and 3 from refractory ARF. The causes of death are listed in Table 3.

Complications

At least one complication or comorbidity after the start of ventilation occurred in 16 patients (52%) in the NIMV group, vs 23 patients (70%) in the CMV group (relative risk reduction, 26%; 95% CI, 3 to 47%; p = 0.07). Complications were more frequent in the CMV group, but the differences did not reach statistical significance except for the inability to sustain enteral feeding (Table 4).

Ventilation Times

Geometric means of total ventilation times, adding up the CMV and NIMV times, were 85.9 h and 143.7 h in the NIMV and CMV groups, respectively. The ratio between ventilation times in the NIMV and CMV groups was 0.59 (95% CI, 0.28 to 1.25; p = 0.17). In patients in whom NIMV failed, the median NIMV time prior to endotracheal intubation was 61 h (range, 10 min to 79 h; interquartile range, 2.5 to 24.5 h).

Lengths of Stay

The geometric means of length of stay in the ICU were 8.9 days (SE 2.6) in the NIMV group and 9.7 days (SE 3.0) in the CMV group. The ratio between the lengths of stay in the NIMV and CMV groups was 0.90 (95% CI, 0.54 to 1.50; p = 0.69). No statistically significant differences were found in ICU stay or length of stay in hospital when analyzing only those patients who survived (data not shown).

Nursing Workload

On the first day of ventilation, the TISS-28 score was lower in the NIMV group (median, 27; range, 22 to 60) than the CMV group (median, 32; range, 28 to 46) [p = 0.007]. The average of the first 3 days was also lower in the NIMV group (median, 27.7; range, 15.3 to 56.3) than the CMV group (median, 31.0; range, 23.3 to 46.7) [p = 0.03]. The means of direct nursing activity time measurements during the first 8 h were 191 min (SD 66) in the NIMV group and 205 min (SD 63) in the CMV group (p = 0.48). No differences were found in subsequent measurements.

Predictive Factors for the Failure of NIMV

In the group that received NIMV, the following parameters considerably improved 60 min after commencement ventilation: PaO₂/FIO₂ (a mean increase of 32.3, p = 0.001), respiratory rate (mean decrease of 10.6 breaths/min, p = 0.001), and the scale of accessory respiratory muscle use (mean decrease, 9.2 points, p = 0.001). There was a very small decrease

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**Table 2—Indications for Intubation in the NIMV Group**

<table>
<thead>
<tr>
<th>Indications</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in Kelly score</td>
<td>4 (22)</td>
</tr>
<tr>
<td>Impairment of ventilation*</td>
<td>4 (22)</td>
</tr>
<tr>
<td>Cardiorespiratory arrest or imminent vital risk</td>
<td>4 (22)</td>
</tr>
<tr>
<td>Impairment of oxygenation†</td>
<td>2 (11)</td>
</tr>
<tr>
<td>Agitation</td>
<td>2 (11)</td>
</tr>
<tr>
<td>Intolerance to face mask</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Transfer to other hospital†</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Total</td>
<td>18 (100)</td>
</tr>
</tbody>
</table>

*Increase in PaCO₂ > 5 mm Hg or decrease in pH ≥ 0.05.
†Any decrease in the PaO₂/FIO₂ ratio.
‡For heart catheterization and eventual heart surgery.
in \( P_{aco_2} \) (2.74 mm Hg, \( p = 0.24 \)). When these changes in the subgroup that failed were compared with those in whom intubation was avoided, no statistically significant differences were found.

The following variables were associated with a higher frequency of endotracheal intubation in the unadjusted analysis: pneumonia as the primary diagnosis (indeterminate odds ratio, \( p = 0.001 \)), APACHE II score (odds ratio for every one point increase, 1.20; 95% CI, 1.01 to 1.43; \( p = 0.0009 \)), and a respiratory rate < 35 breaths/min (odds ratio, 7.6; 95% CI, 0.84 to 69.6; \( p = 0.038 \)). In the adjusted analysis, pneumonia as the primary diagnosis (odds ratio indeterminate, \( p = 0.005 \)) and APACHE II score (odds ratio, 1.20; 95% CI, 0.98 to 1.45; \( p = 0.046 \)) jointly predicted the need for endotracheal intubation.

**Discussion**

We found that NIMV avoids intubation in almost 50% of patients with ARF who need mechanical ventilation according to our predefined criteria. This avoidance of intubation might not apply to pneumonia, in which NIMV failed, since all patients were finally intubated. Our results also suggest that NIMV might be associated with lower mortality; however, this could not be confirmed. The extent of therapeutic intervention is lower during the first few days, but nursing workload is equal in the two ventilation modalities.

In our patients, NIMV improves oxygenation and reduces respiratory workload measured by the scale of use of accessory muscles and breathing rate. However, \( P_{aco_2} \) hardly decreases, a finding also observed by
This decrease in respiratory workload would be the cause for the improvement, but does not predict the avoidance of intubation since such improvement was alike in the group in which NIMV succeeded and the one in which NIMV failed.

Several randomized controlled trials have shown that patients with COPD exacerbations, acute pulmonary edema, hypoxemic ARF, and ARF of several etiologies benefit from the addition of NIMV to their usual medical treatment. To date, three meta-analyses comparing NIMV with the usual medical treatment in ARF and COPD exacerbations have demonstrated benefits from NIMV in reducing endotracheal intubation and mortality, but no benefit was observed in patients with ARF due to causes other than COPD exacerbations. The design of our study differs in two respects. The patients included in our study were more severe, as can be seen by the baseline clinical data, gasometric data, and APACHE II scores; and the aim of our study was to assess whether NIMV could replace CMV in patients with ARF who need it. Accordingly, our patients were severe enough to need mechanical ventilation and had to meet strict criteria so that no patient would be intubated without justification. The choice of our criteria is supported by their high consistency with experienced clinician’s decision.

There are only two previous trials that compared NIMV with CMV and endotracheal intubation in acute respiratory failure. The first trial excluded patients with criteria of COPD, and the second trial only included patients with acute exacerbations of COPD in whom conventional treatment had failed. Both studies found that NIMV improved gas exchange. The first trial found fewer complications and shorter lengths of stay in the ICU in NIMV, whereas the second trial did not find any differences in the short-term results. Our trial included patients with ARF without previous COPD and patients with COPD whose causes of ARF were exacerbation and other etiologies. In our stratified analysis, NIMV reduced endotracheal intubation independently of the type of ARF. Mortality in patients in whom NIMV failed was equal to that from patients receiving CMV from the start, which suggests that once strict criteria of NIMV failure are implemented intubation is not dangerously delayed. With regard to nursing workload, our findings of lower therapeutic intervention and similar nursing workload in NIMV compared with CMV support other findings on other tasks in the ICU. Inconsistencies between TISS-28 scores and nursing workloads are more striking in the lowest TISS-28 scores, which despite measuring well the severity and complexity of treatment only explain 43% of nursing direct time.

The main limitation of our study was its small sample size, which decreased its ability to detect differences in mortality and complications. The study was stopped before achieving the planned sample size due to an ever-decreasing rate of enrollment. Although early termination of a trial is commonly justified on ethical reasons, either for a high rate of severe side effects or for a remarking effect of one arm of the trial, there are trials in ICUs that...

### Table 3—Causes of Death

<table>
<thead>
<tr>
<th>Causes</th>
<th>NIMV, No. (%)</th>
<th>CMV, No. (%)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septic shock</td>
<td>3 (30)</td>
<td>7 (50)</td>
<td>0.15</td>
</tr>
<tr>
<td>Refractory respiratory failure</td>
<td>5 (50)</td>
<td>6 (43)</td>
<td>0.62</td>
</tr>
<tr>
<td>ARF</td>
<td>1 (10)</td>
<td>0 (0)</td>
<td>0.34</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>1 (10)</td>
<td>1 (7)</td>
<td>0.97</td>
</tr>
<tr>
<td>Total</td>
<td>10 (100)</td>
<td>14 (100)</td>
<td>0.30</td>
</tr>
</tbody>
</table>

### Table 4—Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>NIMV (n = 31), No. (%)</th>
<th>CMV (n = 33), No. (%)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock</td>
<td>9 (29)</td>
<td>12 (36)</td>
<td>0.42</td>
</tr>
<tr>
<td>Sepsis</td>
<td>8 (26)</td>
<td>10 (30)</td>
<td>0.56</td>
</tr>
<tr>
<td>ARF</td>
<td>6 (19)</td>
<td>11 (33)</td>
<td>0.08</td>
</tr>
<tr>
<td>Mental disorders</td>
<td>5 (16)</td>
<td>7 (21)</td>
<td>0.72</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>3 (10)</td>
<td>7 (21)</td>
<td>0.12</td>
</tr>
<tr>
<td>Inability to sustain enteral feeding</td>
<td>2 (7)</td>
<td>7 (21)</td>
<td>0.05</td>
</tr>
<tr>
<td>Facial skin lesions</td>
<td>4 (13)</td>
<td>1 (3)</td>
<td>0.15</td>
</tr>
<tr>
<td>Neuromuscular disorders</td>
<td>2 (7)</td>
<td>3 (9)</td>
<td>0.63</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>2 (7)</td>
<td>3 (9)</td>
<td>0.62</td>
</tr>
<tr>
<td>Pneumothorax, pneumomediastinum, subcutaneous emphysema</td>
<td>2 (7)</td>
<td>2 (6)</td>
<td>0.90</td>
</tr>
<tr>
<td>Repeat ventilation (after 48 h)</td>
<td>1 (3)</td>
<td>2 (6)</td>
<td>0.51</td>
</tr>
<tr>
<td>Acute myocardial infarction/angina</td>
<td>1 (3)</td>
<td>2 (6)</td>
<td>0.59</td>
</tr>
<tr>
<td>Laryngeal or tracheal lesions</td>
<td>1 (3)</td>
<td>1 (3)</td>
<td>0.97</td>
</tr>
<tr>
<td>Other complications*</td>
<td>1 (3)</td>
<td>6 (21)</td>
<td>0.15</td>
</tr>
</tbody>
</table>

*In the NIMV group, pulmonary infection; in the CMV group, sinusitis, arrhythmia, upper digestive hemorrhage, self-extubation, reintubation, repeat ventilation for systemic inflammatory response syndrome, and acute cholecystitis (seven complications in six patients).*
were terminated before the planned sample size was achieved because of a decrease in the rate of enrollment. In our study, the known benefit of NIMV when compared with the usual medical treatment in acute exacerbations of COPD may have deterred some physicians from enrolling potential participants since they would expect better results from NIMV than CMV. The external validity of our study might be affected since less severe patients would have not been recruited as much as those more severe. However, as both groups were allocated by chance, internal validity would not be affected.

In spite of the fact that our study was a randomized controlled trial and, therefore, the two study groups should have been homogeneous, they were not entirely similar. However, baseline differences between groups did not affect the main results, as can be seen in the stratified analyses. Neither can we rule out the presence of unknown confounders.

As our trial was unmasked, the assessment of the need for intubation in NIMV patients could potentially have been biased or delayed despite the predefined criteria for failure. However, we think this was unlikely since in patients from the NIMV group who eventually were intubated, not only were their ventilation times before intubation short but also their mortality was equal to that from patients assigned to CMV (39%). Another consequence of the trial not being masked is that co-intervention might also have happened, but we think it unlikely that any potential co-intervention could have influenced on intubation. The relative effect of NIMV on mortality, clinical complications, and consumption of resources when compared with CMV are issues that need to be confirmed in further trials.

Our results might be applied to patients with ARF of several etiologies, but their application to conditions sparsely included in our study, such as ARDS, remains to be seen. Our finding that NIMV in patients with pneumonia, with or without COPD, fails to avoid invasive mechanical ventilation should be looked at with caution since subgroup analyses were not preplanned in the design and this finding was unexpected. Its validity will have to be confirmed in further studies.

In conclusion, we found that NIMV reduces the need for intubation in severe ARF with the possible exception of pneumonia. We also found a nonsignificant trend of reduction in ICU and hospital mortality together with fewer complications during ICU stay. The extent of therapeutic intervention is lower during the first few days and does not require longer nursing times.

APPENDIX

EMVIRA (Ensayo de Modalidades de Ventilación en Insuficiencia Respiratoria Aguda) Investigators


REFERENCES