Association of Noninvasive Ventilation With Nosocomial Infections and Survival in Critically Ill Patients

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Noninvasive ventilation (NIV) has been shown to reduce the need for endotracheal intubation in patients with acute respiratory failure11,12 and to re-

Context
Invasive life-support techniques are a major risk factor for nosocomial infection. Noninvasive ventilation (NIV) can be used to avoid endotracheal intubation and may reduce morbidity among patients in intensive care units (ICUs).

Objective
To determine whether the use of NIV is associated with decreased risk of nosocomial infections and improved survival in everyday clinical practice among patients with acute exacerbation of chronic obstructive pulmonary disease (COPD) or hypercapnic cardiogenic pulmonary edema (CPE).

Design and Setting
Matched case-control study conducted in the medical ICU of a French university hospital from January 1996 through March 1998.

Patients
Fifty patients with acute exacerbation of COPD or severe CPE who were treated with NIV for at least 2 hours and 50 patients treated with mechanical ventilation between 1993 and 1998 (controls), matched on diagnosis, Simplified Acute Physiology Score II, Logistic Organ Dysfunction score, age, and no contraindication to NIV.

Main Outcome Measures
Rates of nosocomial infections, antibiotic use, lengths of ventilatory support and of ICU stay, ICU mortality, compared between cases and controls.

Results
Rates of nosocomial infections and of nosocomial pneumonia were significantly lower in patients who received NIV than those treated with mechanical ventilation (18% vs 60% and 8% vs 22%; P<.001 and P = .04, respectively). Similarly, the daily risk of acquiring an infection (19 vs 39 episodes per 1000 patient-days; P = .05), proportion of patients receiving antibiotics for nosocomial infection (8% vs 26%; P = .01), mean (SD) duration of ventilation (6 [6] vs 10 [12] days; P = .01), mean (SD) length of ICU stay (9 [7] vs 15 [14] days; P = .02), and crude mortality (4% vs 26%; P = .002) were all lower among patients who received NIV than those treated with mechanical ventilation.

Conclusions
Use of NIV instead of mechanical ventilation is associated with a lower risk of nosocomial infections, less antibiotic use, shorter length of ICU stay, and lower mortality.

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roduce mortality in selected groups of patients with chronic obstructive pulmonary disease (COPD).11,13,15 The beneficial impact of this technique on nosocomial infections has been suggested by several prospective randomized trials,10,11,13 although the low event rates did not result in a significant difference. More importantly, the results of carefully conducted clinical trials in limited groups of patients could differ from everyday practice. This is partly because the optimum use of this technique requires specific staff training and patient monitoring to achieve its potential efficiency.16,17 This may also explain why results vary among centers.18,19

In the medical ICU of Henri Mondor hospital, Crétel, France, NIV has been progressively implemented over the last decade, especially for patients with COPD or severe hypercapnic cardiogenic pulmonary edema (CPE).13 During these years, some of the patients did not receive this technique despite a clinical status making them potentially eligible for NIV, either because they had received endotracheal intubation before the ICU admission, because the policy of out-of-hospital emergency teams or of other departments was not to use NIV, or because the nurses and physicians in charge of the patients were not yet familiar with this technique. Because of this progressive implementation, we had the unique opportunity to compare the different effects of NIV and endotracheal intubation on the infection and survival rate out of the context of a randomized clinical trial. We therefore performed a retrospective matched case-control study to compare outcomes for similar patients admitted for acute exacerbation of COPD or severe CPE who were treated with NIV or received endotracheal intubation and conventional mechanical ventilation (MV).

**METHODS**

**Setting**

The study was conducted in the medical ICU of Henri Mondor university hospital, a 26-bed ICU that receives patients from the community, from several other wards and specialized ICUs in the hospital, and from ICUs of other hospitals.

**Study Design**

We performed a pairwise, retrospective case-control study with 1:1 matching. The study period for cases extended from January 1, 1996, to March 31, 1998, during which 2441 patients were admitted to the ICU.

Eligible patients were those who were admitted for acute exacerbation of COPD or severe CPE and who received NIV for at least 2 hours as first-time ventilatory support. We chose a minimum of 2 hours of NIV treatment to define cases to exclude patients in whom the need for ventilatory support was questionable because of quasi-immediate improvement and patients who rapidly required endotracheal intubation after a brief attempted treatment of NIV because of associated contraindications, such as refractory shock, or because of the inability of the staff to adequately deliver NIV.

In addition, the following exclusion criteria were applied: patients having a do-not-resuscitate order; patients with cancer or hematologic malignancy with a poor short-term prognosis or who declined or were denied intubation; patients having acute lung injury and COPD (presence of bilateral lung infiltrates on a chest radiograph, a \( \text{PaO}_2/\text{FiO}_2 \) ratio <300 mm Hg, and the absence of confirmed or suspected left cardiac failure); patients having a contraindication to NIV; and patients receiving NIV during weaning from mechanical ventilation. Noninvasive ventilation primarily was applied intermittently, usually for periods of 2 to 6 hours, with several periods delivered per day. Ventilatory settings during NIV delivery included pressure support ventilation and positive end-expiratory pressure. The usual settings were 15 to 20 cm H\(_2\)O of pressure support and 0 to 5 cm H\(_2\)O of positive end-expiratory pressure. Noninvasive ventilation was started exclusively in the ICU and always within the first 72 hours of patient admission to the ICU.

Control patients had to be admitted for exacerbation of COPD or severe CPE and treated with conventional MV within the first 72 hours of ICU admission. Postoperative patients, patients with asthma, and patients with metastatic cancer or hematologic malignancy with a poor short-term prognosis or with acute lung injury were excluded from the control group as well as patients having potential contraindications for NIV as explained below.

A computer-generated list of potential controls was obtained from a database that included 6264 patients during a 6-year period (from 1993-1998). Controls were selected over a longer period than cases because the use of NIV was less frequent 5 or 6 years ago compared with the most recent period when most eligible patients were treated with NIV. Controls were chosen according to the following matching criteria: same diagnosis on admission, age (±5 years), and Simplified Acute Physiology Score (SAPS) II20 (±6 points) and Logistic Organ Dysfunction score33 (±3 points), which evaluate the severity of illness and both were calculated within the first 24 hours of ICU admission. In addition, controls had to have no contraindication for being treated with NIV, such as coma with swallowing dysfunction, severe shock, or acute lung injury. Severe shock was defined by the administration of epinephrine or nor-epinephrine within the first 48 hours of ICU admission. Coma was defined by a Glasgow Coma Scale score28 of less than 10 on admission. The list of potential controls was reviewed for the best possible match, giving a ranking of priority to diagnosis, absence of contraindication to NIV, SAPS II, Logistic Organ Dysfunction score, and age. When multiple possible controls existed to match one case, the patient with the date of ICU admission closest to that of the case patient was selected.

The following variables were collected: age, sex, dates of admission and of discharge from the ICU, location before ICU admission, worst value of the \( \text{PaO}_2/\text{FiO}_2 \) ratio within the first 72 hours of ventilatory support, and primary di-
agnosis on admission. Arterial pH and Pco2 values were recorded before implementation of mechanical ventilation in COPD patients when available. The total duration of ventilatory support, including the days when NIV was delivered, was recorded. Therapeutic activity was evaluated using the Omega score\(^2\) at discharge. The Omega score is composed of therapeutic items, and it is divided into 3 categories accorded 1 to 10 points each as follows: category 1, items entered only at the time of their first application; category 2, items entered at each application; and category 3, items entered every day of application. The total score, which covers the entire length of stay, is calculated by adding the points obtained in the 3 categories.

The sites and dates of diagnosis of each nosocomial infection were recorded as well as antibiotic regimens given during the ICU stay. Pneumonia, urinary tract infection (UTI), primary bacteremia, and central venous catheter–related infection, occurring at least 48 hours after ICU admission, were collected according to the following definitions. Patients with new and persistent lung infiltrates on chest radiographs, with a temperature greater than 38°C, and with macroscopically proven purulent tracheal secretions were suspected of having nosocomial pneumonia acquired while receiving either conventional MV or NIV.

In such patients who received conventional MV, a diagnosis of ventilator-associated pneumonia was ascertained by the positivity of a quantitative protected plugged catheter culture, defined as at least 1 microorganism recovered at a significant concentration (\(\geq 10^3\) colony-forming units [CFU]/mL).\(^3\) In patients clinically suspected of having pneumonia but treated with NIV, the positivity of a quantitative protected plugged catheter culture at the same significant threshold as described above, when available, or the sole administration of new antibiotics in the absence of other sites of infection was used to characterize the presence of NIV-associated pneumonia. A different definition was used in both groups, since the rationale for obtaining protected bacteriological sampling of the lungs with quantitative cultures is based on the presence of colonization in the airways of patients who were intubated. This does not strictly apply to patients who were not intubated, in whom treatment can be administered based on clinical, radiological, and laboratory criteria, without bacteriological sampling of the lung.

A UTI was defined by the association of the 2 following criteria: pyuria (\(\geq 10^3\) white blood cells/\(\mu\)L) and a urine culture growing \(1 \times 10^5\) CFU/mL in patients with clinical signs of infection (temperature \(>38^\circ\)C, leukocytosis, abnormal macroscopic appearance of urine, and presence of urinary nitrites). Catheter-related infection was defined by a positive quantitative tip culture with a significant threshold of \(1 \times 10^3\) CFU/mL\(^2\) in the presence of localized signs of infection at the access site and/or systemic signs of infection, such as fever or elevated white blood cell count. Primary bacteremia was defined by at least 1 positive blood culture result (2 or more blood cultures when coagulase-negative staphylococci were isolated) in the absence of infection focus growing the same microorganism or the isolation of the same organism from a catheter segment quantitative culture and from a peripheral blood culture. Surveillance was performed prospectively by a physician (C.B.-B.) who reviewed all clinical and microbiological information weekly for each patient.

**Statistical Analysis**

Categorical variables were expressed as percentage and continuous variables as mean (SD). A \(P\) value \(\leq .05\) in a 2-tailed test was considered to indicate statistical significance. Percentages were compared with use of the \(\chi^2\) test and means with the \(t\) test. Nonparametric tests were used when the conditions for parametric tests were not fulfilled (ie, Mann-Whitney test for continuous variables). Failures of NIV treatment were retained in the NIV group and analyzed as cases. Kaplan-Meier curves were used to determine the probabilities of remaining free of nosocomial infection during the ICU stay in the 2 groups of patients; curves were compared using the log-rank test. The statistical analysis was performed using the Statistica 4.5 software (Statsoft, Inc, Tulsa, Okla).

**RESULTS**

During the study period, 134 patients received NIV (12.9 per 100 patients needing ventilatory support). Of these 134 patients potentially eligible as cases, 77 were excluded as indicated in Figure 1. Of the 57 case-patients enrolled in the study, matching was possible for only 50 (88%) of them because of an insufficient number of suitable control patients available in our database.

The results of matching for the criteria listed above were as follows: All control patients were matched to cases for diagnosis on admission and contraindication to NIV. Forty-nine (98%) of the 50 case-control pairs were matched for SAPS II, 43 (86%) for age, and 45 (90%) for the Logistic Organ Dysfunction score. Overall, matching was suc-
cessful for 237 (94.8%) of 250 variables used. Several other variables also were compared in the 2 patient groups on admission, and no difference was found between cases and controls, except for the number of patients who received antibiotics on admission (P < .001) (Table 1). All patients were hypercapnic on admission except 2 pairs of patients with CPE. In the NIV group, 6 patients (12%) eventually required endotracheal intubation and CMV.

As shown in Table 2, the 50 case-patients developed significantly fewer infections (P = .006) during their ICU stay than controls and received fewer antibiotics for nosocomial infection (P = .01). The sites of infection in cases were 4 pneumonia (among which 3 were diagnosed in patients requiring endotracheal intubation), 3 UTIs, 1 primary bacteremia, and 1 central venous catheter–related infection. The sites of infection in controls were: 11 pneumonia, 10 UTIs, 5 primary bacteremia, and 4 central venous catheter–related infections. For each site of infection, the rates were significantly lower (P = .04, P = .03, and P = .002, respectively) in NIV patients than in controls (Figure 2). Figure 3 shows the percentage of patients who remained free of nosocomial infection during the ICU stay. The probability of remaining free of infection was significantly higher in patients receiving NIV than in those receiving conventional MV (P = .04). The mean (SD) delay before onset of infection was 8 (3) days (median, 10 days) in the NIV group and 11 (10) days (median, 10 days) in the conventional MV group (P = .52). Incidence densities, which reflect the daily risk of acquiring an infection or receiving antibiotics, also were significantly lower in cases than in controls (P = .05 and P < .001, respectively; Table 2). There was no significant difference in incidence densities for nosocomial pneumonia (P = .40; Table 2).

The ICU mortality rate was significantly lower in patients treated with NIV (2 deaths [46%] vs 13 deaths [26%]; P = .002). Durations of ICU stay and of ventilation also were significantly shorter in NIV patients (P = .02 and P = .01, respectively; Table 2).

To ensure that the 7 nonmatched NIV patients were similar to the paired cases, we compared their clinical characteristics with those of the 50 matched cases and found no significant difference (data not shown). Moreover, when we included them in the analysis together with hypothetical controls assumed to have had no nosocomial infection, no antibiotic therapy, and to have survived, the impact of NIV remained unchanged (data not shown).

**Table 1. Matching Criteria and Clinical Characteristics of the Study Population**

<table>
<thead>
<tr>
<th>Matching criteria</th>
<th>Values</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic respiratory disease, No. (%)</td>
<td>41 (82)</td>
<td>.99</td>
</tr>
<tr>
<td>Acute pulmonary edema, No. (%)</td>
<td>9 (18)</td>
<td>&gt; .99</td>
</tr>
<tr>
<td>SAPS II, mean (SD), points*</td>
<td>35.6 (7.7)</td>
<td>.33</td>
</tr>
<tr>
<td>Logistic Organ Dysfunction score, mean (SD), points†</td>
<td>3.7 (1.9)</td>
<td>.99</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>71.9 (10.7)</td>
<td>.22</td>
</tr>
</tbody>
</table>

**Characteristics**

<table>
<thead>
<tr>
<th>Variables</th>
<th>NIV Cases (n = 50)</th>
<th>Conventional MV Controls (n = 50)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital</td>
<td>15 (30)</td>
<td>22 (47)</td>
<td>.09</td>
</tr>
<tr>
<td>Community</td>
<td>35 (70)</td>
<td>25 (53)</td>
<td>.99</td>
</tr>
<tr>
<td>pH before ventilation, mean (SD)§</td>
<td>7.30 (0.09)</td>
<td>7.30 (0.11)</td>
<td>.66</td>
</tr>
<tr>
<td>PaO₂/FiO₂ before ventilation, mean (SD), mm Hg‡</td>
<td>70.0 (12.2)</td>
<td>73.1 (19.3)</td>
<td>.40</td>
</tr>
<tr>
<td>Patients infected on admission, No. (%)*</td>
<td>15 (30)</td>
<td>23 (46)</td>
<td>.10</td>
</tr>
<tr>
<td>Community-acquired pneumonia</td>
<td>5</td>
<td>9</td>
<td>.84</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>9</td>
<td>13</td>
<td>.56</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>4</td>
<td>.56</td>
</tr>
<tr>
<td>Patients receiving antibiotics on admission, No. (%)</td>
<td>20 (40)</td>
<td>39 (78)</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

* NIV indicates noninvasive ventilation; MV, mechanical ventilation; SAPS, Simplified Acute Physiology Score; and ICU, intensive care unit.

† Calculated within the first 24 hours of admission.

‡ No P value was calculated considering the small number of patients in each category of comorbidity.

§ Available only in 29 pairs of patients with chronic obstructive pulmonary disease in whom arterial blood gases were before ventilation.

† On admission, a patient may have had more than 1 infection.

### COMMENT

This study describes the infectious complications associated with intubation and conventional MV in patients who could have been treated by NIV. The results show that the use of NIV is associated with lower rates of nosocomial pneumonia, other acquired infections, and antibiotic administration. This lower nosocomial infection rate is likely to contribute to the reduced mortality in this group of patients.

Because randomized controlled trials have demonstrated the benefits of NIV on intubation and mortality in patients with COPD, the case-control study can be considered an appropriate study design to assess the relation of NIV with nosocomial infections in routine practice. It is of particular relevance to assess the use of NIV treatment in everyday clinical practice and to assess whether the results of randomized controlled trials mirror current practice, for
such a ventilatory technique in which the motivation and the skills of the clinicians applying it are so important. Therefore, different and complementary information is generated by the case-control study than is generated by randomized clinical trials.

We used a careful matching process to avoid selecting more seriously ill patients in the conventional MV group. Patients considered to have contraindication to NIV, those presenting with coma, severe shock, or acute lung injury were not enrolled as controls. Similarly, patients treated with NIV but who had a do-not-resuscitate order or who declined or were denied intubation were not enrolled as cases, since these patients would not have received endotracheal intubation in any case and could not have been matched with controls.

One limitation of this design, however, may come from the lack of sufficient control patients or from the limited number of matching variables. The possibility that the choice of endotracheal intubation was based on a higher possibility that the choice of endotracheal intubation in any case and could not have been matched with controls.

However, this was not apparent when comparing laboratory data or severity indices on admission. The only difference between cases and controls concerned the number of patients receiving antibiotics on admission. This was frequently related to suspected bronchitis, however, and not to documented infection. This lack of difference in severity indices suggests that if any difference in severity still existed, it was modest and largely insufficient to explain most of the major differences in nosocomial infection rates observed in this study and that corroborated the results of previous studies. Lower rates of nosocomial pneumonia in patients receiving NIV has been suggested in several studies. In a randomized controlled trial of patients with COPD, Brochard et al found that treatment with NIV reduced the total number of adverse events associated with mechanical ventilation and length of stay in the ICU and that the rate of nosocomial pneumonia was reduced from 17% to 5%. While this difference in rate of pneumonia was not signifi-

Table 2. Comparison of Outcome Variables in Cases and Controls§

<table>
<thead>
<tr>
<th>Outcome Variables</th>
<th>NIV Cases (n = 50)</th>
<th>Conventional MV Controls (n = 50)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nosocomial infections</td>
<td>7 (14)</td>
<td>19 (38)</td>
<td>.006</td>
</tr>
<tr>
<td>Nosocomial infections, No. (%)</td>
<td>9 (18)</td>
<td>30 (60)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nosocomial infections per patient, mean (SD)</td>
<td>0.2 (0.5)</td>
<td>0.6 (1.0)</td>
<td>.006</td>
</tr>
<tr>
<td>Incidence density of nosocomial infections</td>
<td>19</td>
<td>39</td>
<td>.06</td>
</tr>
<tr>
<td>Nosocomial pneumonia, No. (%)</td>
<td>4 (8)</td>
<td>11 (22)</td>
<td>.04</td>
</tr>
<tr>
<td>Incidence density of nosocomial pneumonia</td>
<td>14</td>
<td>23</td>
<td>.40</td>
</tr>
<tr>
<td>Antibiotics administered for nosocomial infections</td>
<td>4 (8)</td>
<td>13 (26)</td>
<td>.01</td>
</tr>
<tr>
<td>Antibiotics per patient, mean (SD)</td>
<td>0.1 (0.5)</td>
<td>0.5 (1.0)</td>
<td>.01</td>
</tr>
<tr>
<td>Duration of antibiotic therapy, mean (SD), d§</td>
<td>1 (4)</td>
<td>4 (8)</td>
<td>.01</td>
</tr>
<tr>
<td>Incidence density of antibiotics</td>
<td>11</td>
<td>24</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>General outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude ICU mortality, No. (%)</td>
<td>2 (4)</td>
<td>13 (26)</td>
<td>.002</td>
</tr>
<tr>
<td>Length of ICU stay, mean (SD), d</td>
<td>9 (7)</td>
<td>15 (14)</td>
<td>.02</td>
</tr>
<tr>
<td>Duration of ventilation, mean (SD), d¶</td>
<td>6 (6)</td>
<td>10 (12)</td>
<td>.01</td>
</tr>
<tr>
<td>Omega points scored during the ICU stay, mean (SD)</td>
<td>100 (88)</td>
<td>194 (206)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*NIV indicates noninvasive ventilation; MV, mechanical ventilation; and ICU, intensive care unit.
†Number of infectious episodes per 1000 patient-days.
‡Number of pneumonia cases per 1000 ventilation-days (whatever the type of ventilation).
§Number of antibiotics per patient; mean (SD) was calculated by adding the duration of each individual antibiotic.
¶Number of antibiotic-days per 100 patient-days.
‖Duration of ventilation in the NIV group included the time spent receiving mechanical ventilation after NIV failure.
cent, crude mortality was significantly reduced. Nava et al.28 used NIV as a means to shorten the duration of invasive mechanical ventilation by switching to NIV after 48 hours of mechanical ventilation. In the group of 25 patients treated with NIV early on, no patient developed nosocomial pneumonia vs 28% in the group who were weaned from invasive MV; this approach was associated with a reduced mortality at 2 months. Recently, Antonelli et al.10 showed that NIV could be used instead of endotracheal intubation in severely hypoxemic patients. Adverse events were significantly lower in the NIV group. When pooling together nosocomial sinusitis and pneumonia, these infections were significantly reduced by the use of NIV. All these results are consistent with our data on the relation between treatment with NIV and nosocomial pneumonia.

Close monitoring of nosocomial infections through a continuous surveillance system implemented in our ICU since 1993 made it most unlikely that an episode of infection would be missed in this patient population. We used definitions of nosocomial infections routinely applied in ICUs and applied strict criteria to define bacteriologically proven ventilator-associated pneumonia in patients who were treated with invasive mechanical ventilation. Pneumonia acquired during NIV treatment could be based on the administration of new antibiotics in patients with no other documented site of infection and who met the clinical criteria for pneumonia. While this definition was chosen to avoid omitting any possible case of pneumonia in patients treated with NIV, it may have resulted in overestimating the rate of pneumonia in the NIV group.

In addition to pneumonia, infections at all other sites were significantly reduced in patients treated with NIV independent from the patient’s severity of illness. This finding is in accordance with those reported in a recent study.28 This may reflect a less frequent use or shorter duration of invasive devices in those patients.28 Craven et al.28 analyzed risk factors for nosocomial infections in surgical ICU patients. A greater exposure to invasive devices and procedures of all types was found to be associated with a higher incidence of nosocomial infections, independent from the underlying severity of illness. More recently, a case-control study assessing risk factors for nosocomial infections and in which patients were carefully matched on initial severity of illness, showed that a persistent high level of therapeutic activity was associated with the acquisition of nosocomial infection in ICU patients.3 In our study, patients treated with NIV were administered fewer antibiotics for nosocomial infection and had shorter length of ICU stay and duration of ventilation. This might explain the reduced frequency of all types of nosocomial infections observed in the NIV patients.

Noninvasive ventilation cannot be administered to all patients with respiratory failure.8 Patients with acute exacerbation of chronic respiratory failure, especially COPD and CPE, constitute the groups more likely to benefit from NIV treatment.11,14,15 Several randomized controlled studies have shown reductions in mortality in COPD patients.11,13,29 Patients with community-acquired pneumonia also have been shown to benefit from the use of NIV, especially in patients with COPD.30

The other group represented in our study included patients with CPE, a disease that has been shown to respond well to NIV treatment.31-34 especially when associated with hypercapnia and ventilatory failure.31,35 In our study, all but 2 NIV cases with CPE were hypercapnic on admission. Although patients with hypoxemic respiratory failure represent a larger scope of diseases, not all of these patients are good candidates for NIV therapy, and the selection of appropriate patients is still a matter of research. Wysocki et al.35 have shown that among hypoxic patients, only patients with associated ventilatory failure and acute hypercapnia really benefited from treatment with NIV. Antonelli et al.10,36 showed that in selected patients, NIV could be beneficial in patients with severe hypoxemia or in patients with solid organ transplant. Other authors reported that severe hypoxic pneumonia was a poor indication for the technique.9,19

Our study showed a lower mortality associated with the use of NIV. This can be explained in part by the reduction not only of nosocomial infections but also by other complications previously reported to be associated with prolonged length of stay and not reported here.1,4

Our results confirmed the results of trials that showed a reduction in mortality with NIV therapy.11,13 It is important, however, to evaluate whether this observed reduction in mortality is observed in everyday practice, since the results of carefully conducted, concealed but nonblinded studies evaluating selected group of patients may not always be replicated during routine application of the technique.

In conclusion, our study found that critically ill patients treated with NIV were less likely to acquire pneumonia and other nosocomial infections than similar patients treated with conventional MV and that the use of NIV is associated with a shortened stay in the ICU and reduced mortality.

Previous Presentation: This study was presented in part at the American Thoracic Society International Conference, San Diego, Calif, April 23-28, 1999.

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NONINVASIVE VENTILATION

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