Management of Pediatric Acute Hypoxemic Respiratory Insufficiency With Bilevel Positive Pressure (BiPAP) Nasal Mask Ventilation*

James D. Fortenberry, MD; Jorge Del Toro, MD; Larry S. Jefferson, MD; Lee Evey, RRT; and Doug Haase, RRT

Objectives: To evaluate the efficacy and complications of noninvasive nasal mask bilevel continuous positive airway pressure ventilation in pediatric patients with hypoxemic respiratory insufficiency.

Design: Retrospective chart review.

Setting: Intensive care unit, university affiliated tertiary care children’s hospital.

Patients and methods: The study reviewed all patients admitted to the pediatric ICU with acute hypoxemic respiratory insufficiency who received bilevel noninvasive continuous nasal mask positive airway pressure delivered by a bilevel positive airway pressure system (BiPAP; Respironics Inc; Murrysville, Pa).

Results: Bilevel nasal mask positive pressure ventilation was utilized in 28 patients. Median patient age was 8 years (range, 4 to 204 months). The most common primary diagnosis was pneumonia. Nine patients demonstrated severe underlying neurologic disease or immunocompromise. Median duration of nasal mask ventilation was 72 h (range, 20 to 840 h). Clinical and laboratory variables immediately prior to bilevel nasal mask positive airway pressure and approximately 1 h after institution were evaluated. Respiratory rate decreased significantly with nasal mask ventilation (45±18 breaths per minute to 33±11, mean±SD, p<0.001). Arterial blood gas PaO₂ (71±13 mm Hg to 115±55), PaCO₂, pulse oximetry saturation, and pH all improved significantly (p<0.01). Using standard estimates for inspired oxygen, calculated alveolar-arterial gradients (271±157 to 117±65, p=0.001), and PaO₂/ FIO₂ ratios (141±54 to 280±146, p<0.001), both improved significantly with nasal mask ventilation. Only 3 of 28 patients required intubation or reintubation.

Conclusions: We conclude that noninvasive nasal positive pressure mask ventilation can be safely and effectively used in pediatric patients to improve oxygenation in mild to moderate hypoxemic respiratory insufficiency. It may be particularly useful in patients whose underlying condition warrants avoidance of intubation. (CHEST 1995; 108:1059-64)

A-a=alveolar-arterial

Key words: children; nasal mask ventilation; positive airway pressure; respiratory insufficiency

Intubation and mechanical ventilation are frequently necessary to treat the critically ill infant or child who develops hypoxemia and respiratory failure. Placement of an endotracheal tube and initiation of mechanical ventilation predisposes to potential complications such as nosocomial infection and tracheal injury, as well as difficulties with sedation of the intubated child.1,2 If therapeutic, noninvasive alternative ventilatory support in selected patients could minimize these complications.

Experience in adult patients has demonstrated that assisted continuous positive airway pressure ventilation can be provided by a tight-fitting nasal mask.3,4 Nasal mask ventilation was initially used for treatment of adults with sleep apnea, neuromuscular disease with chronic alveolar hypoventilation, and chronic obstructive pulmonary disease.5,6 Mask continuous positive airway pressure ventilation has also been applied for intermittent use in adults with mild to moderate respiratory distress.7 Recently, a portable noninvasive bilevel positive airway pressure (BiPAP; Respironics Inc; Murrysville, Pa) system has been developed that combines inspiratory pressure support ventilation and expiratory positive airway pressure administered through a nasal mask. This system provides therapy similar to continuous positive pressure devices but may offer additional benefits, such as inspiratory pressure support and correction for mask airleak, over continuous positive airway pressure for both hyperventilation syndromes and hypoxemic respiratory failure.9,10

Bilevel positive pressure mask ventilation could prove useful for management of hypoxemic respiratory

For editorial comment see page 894

*From the Division of Critical Care, Department of Pediatrics, Emory University School of Medicine, Atlanta; Critical Care Section, Department of Pediatrics, and Department of Respiratory Therapy, Baylor College of Medicine, Texas Children’s Hospital, Houston.

Manuscript received December 21, 1994; revision accepted March 29, 1995.

Reprint requests: Dr. Fortenberry, Critical Care Division, Department of Pediatrics, Emory University School of Medicine, Egleston Children’s Hospital, 1405 Clifton Road NE, Atlanta, GA 30322
failure in infants and children if the system were tolerated. However, experience with its use for pediatric patients in acute respiratory distress and failure is limited.11,12 We report herein our experience with use of bilevel positive pressure nasal mask ventilation to minimize the need for intubation or reintubation in pediatric patients with mild to moderate hypoxemic respiratory insufficiency.

### Materials and Methods

**Patient Selection**

We used billing records from the Department of Respiratory Therapy to identify and review medical records of all children who received nasal mask ventilation for 17 months from January 1990 to May 1991. All patients included in this review received nasal mask ventilation for treatment of clinical signs of respiratory distress after being described by an attending critical care physician as likely to require intubation, with nasal mask ventilation utilized as an alternative means of support based on attending preference. Patients also received nasal ventilation for postextubation respiratory distress. Patients who received nasal mask ventilation exclusively for management of obstructive sleep apnea or hypventilation associated with chronic neuromuscular disease were excluded from evaluation, as were all patients who received noninvasive ventilation outside the pediatric ICU.

### Data Analysis

All patients had clinical data available for comparison before and after initiation of bilevel mask ventilation. Radiographic interpretations were based on written reports from radiologists who were unaware of presence or absence of nasal mask ventilation. Clinical and laboratory results were obtained from data collected within 2 h prior to nasal mask ventilation. Oxygenation data were evaluated only from patients who had arterial blood gas determinations performed both before and after initiation of this modality (17 patients). Utilizing blood gas data, alveolar-arterial (A-a) PaO2 gradients were calculated from a standard formula.13 Inspired oxygen fraction (FIO2) was estimated in patients receiving liter flow oxygen by use of the following formula: FIO2=0.02×O2 flow [LPM]×0.4.14 Using similar estimates, PaO2/FIO2 was also calculated. This ratio avoids the overestimation of severity of lung injury at higher FIO2 concentrations that occurs with calculation of A-a gradients.15 Mild to moderate hypoxemic respiratory insufficiency was defined as an A-a oxygen gradient greater than 100 or PaO2/FIO2 ratio less than 200 mm Hg. Severe hypoxemic respiratory insufficiency was defined as an A-a gradient greater than 250 mm Hg or PaO2/FIO2

### Table 1—Clinical Summary of Pediatric Patients Receiving Bilevel Nasal Mask Ventilation as Therapy*

<table>
<thead>
<tr>
<th>Age</th>
<th>Diagnosis</th>
<th>Days Therapy</th>
<th>Maximal Settings (IPAP/EPAP)</th>
<th>Reason for Therapy</th>
<th>Required Intubation</th>
<th>CXR Imam</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 yr</td>
<td>Interstitial pneumonia</td>
<td>7</td>
<td>12/8</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>14 yr</td>
<td>Status asthmaticus</td>
<td>2.5</td>
<td>10/5</td>
<td>R</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>8 mo</td>
<td>Aspiration pneumonia/seizures</td>
<td>2</td>
<td>10/6</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>17 mo</td>
<td>Near drowning aspiration pneumonia</td>
<td>1</td>
<td>10/5</td>
<td>R</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>7 yr</td>
<td>Cerebral palsy (cp)pneumonia</td>
<td>1</td>
<td>12/6</td>
<td>R</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>11 yr</td>
<td>Hepatic failure/pneumonia</td>
<td>10</td>
<td>12/6</td>
<td>R</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>5 yr</td>
<td>Subaortic stenosis/pneumonia</td>
<td>2</td>
<td>8/5</td>
<td>R</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>3 yr</td>
<td>Reactive airway disease (RAD)/pneumonia</td>
<td>2</td>
<td>10/6</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>23 mo</td>
<td>Pneumonia</td>
<td>5</td>
<td>10/5</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>8 yr</td>
<td>CP/seizures pneumonia</td>
<td>2</td>
<td>16/6</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>2 yr</td>
<td>Interstitial pneumonia</td>
<td>10</td>
<td>14/6</td>
<td>I</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>19 mo</td>
<td>Liver transplant</td>
<td>1</td>
<td>10/6</td>
<td>R</td>
<td>Yes</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>15 yr</td>
<td>Status asthmaticus</td>
<td>2</td>
<td>12/6</td>
<td>I</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>8 yr</td>
<td>Pulmonary atresia/RAD</td>
<td>3</td>
<td>8/5</td>
<td>R</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>5 yr</td>
<td>Hurler's syndrome/pneumonia/MI</td>
<td>1</td>
<td>10/6</td>
<td>I</td>
<td>Yes</td>
<td>No</td>
<td>Died</td>
</tr>
<tr>
<td>8 yr</td>
<td>Pneumonia/CP</td>
<td>2</td>
<td>12/5</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>4 yr</td>
<td>Pneumonia</td>
<td>6</td>
<td>10/5</td>
<td>R</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>12 yr</td>
<td>Ruptured aortic aneurysm/pneumonia</td>
<td>2</td>
<td>10/5</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>12 yr</td>
<td>Pneumonia/RAD</td>
<td>2</td>
<td>15/8</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>17 yr</td>
<td>RAD/pneumonia</td>
<td>3</td>
<td>14/6</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>15 yr</td>
<td>Pneumonia/Hodgkin’s disease</td>
<td>3</td>
<td>12/6</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>4 mo</td>
<td>Pulmonary atresia/chronic atelectasis</td>
<td>35</td>
<td>10/5</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived1</td>
</tr>
<tr>
<td>14 yr</td>
<td>Pneumonia</td>
<td>11</td>
<td>16/6</td>
<td>I</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>2 yr</td>
<td>Pneumonia/congenital anomalies</td>
<td>3</td>
<td>10/5</td>
<td>R</td>
<td>Yes</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>4 yr</td>
<td>Pneumonia/lonsular hypertrophy</td>
<td>5</td>
<td>14/6</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>2 yr</td>
<td>Pneumonia/congenital anomalies</td>
<td>1</td>
<td>10/5</td>
<td>R</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
<tr>
<td>16 yr</td>
<td>Pneumonia</td>
<td>3</td>
<td>14/8</td>
<td>I</td>
<td>No</td>
<td>Yes</td>
<td>Survived</td>
</tr>
<tr>
<td>13 yr</td>
<td>Mediastinal teratoma</td>
<td>3</td>
<td>12/6</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>Survived</td>
</tr>
</tbody>
</table>

*1=avoidance of initial intubation; R=avoidance of reintubation; CXR Imam=chest radiograph significantly improved based on radiologist’s report; IPAP=inspiratory positive airway pressure; EPAP=expiratory positive airway pressure.

1Patient discharged home with nocturnal mask ventilation due to chronic hypoventilation and recurrent atelectasis.

---

*Table 1—Clinical Summary of Pediatric Patients Receiving Bilevel Nasal Mask Ventilation as Therapy*
ratio less than 100. Statistical analysis was performed utilizing paired
two-tailed t tests for significance to compare clinical and laboratory
variables prior to and after initiation of nasal mask ventilation.

Continuous bilevel nasal mask positive pressure ventilation was
provided in all patients with a ventilatory support system (BiPAP).
This device is based on a standard continuous positive airway pres¬
sure flow generator. Inspiratory positive airway pressure and
expiratory positive airway pressure levels are chosen in the sponta¬
neous mode setting and maintained by a pressure-controlling valve.
Inspiratory positive pressure is produced when the patient’s sponta¬
neous inspiratory flow exceeds 40 mL/s for more than 30 s.
Cycling to expiratory positive pressure occurs when inspiratory flow
decreases below a threshold level, expiratory flow is detected, or
inspiratory flow lasts more than 3 s. A backup rate can also be added
to assist with inadequate minute ventilation or apnea. Initial inspira¬
tory and expiratory pressure settings were selected at the
attending physician’s discretion, as was the decision to terminate use
of mask ventilation.

The standard nasal masks consist of a conforming triangular sil¬
cone rubber mask attached to a hard rubber shell. An infant mask
was available for use in three of the patients. In older patients, the
mask was secured by straps (Velcro). In younger patients, a form¬
fitting cap attached to the straps allowed easier control of the mask.
Most patients received nasal mask ventilation continuously and masks
were not routinely removed.

RESULTS

Thirty-nine children who received bilevel nasal mask ventilation for respiratory insufficiency were
identified by thorough review of all respiratory therapy billing records. Eleven of these patients were excluded
from review because intervention with mask ventilation was specifically documented for neuromuscular
weakness and hypoventilation or for cystic fibrosis, leaving 28 patients for subsequent review and data
analysis (Table 1). Complete data were not available for all patients. No records were found in which nasal mask
ventilation was initiated but withdrawn due to poor tolerance. Median patient age was 8 years (range, 4
months to 17 years). The most common primary diagnosis was pneumonia. Nine patients had underlying
severe neurologic deficits or immunocompromised states, including one patient with human immuno¬
deficiency virus-associated pneumonia. Twenty-two pa¬
tients (79%) demonstrated mild to moderate respira¬
tory insufficiency as previously defined, and 6 patients
(21%) exhibited severe respiratory insufficiency. Twenty-six of 28 patients received oxygen by face mask prior
to nasal mask ventilation, and no patient younger than 3 years old was receiving oxygen via nasal cannula.
Sixteen of 28 patients had arterial blood gases obtained both before and after mask ventilation. Clinical data,
but not blood gas or oxygenation parameters, for the 12 patients without dual blood gas determinations were
included in statistical calculations for this study.

Median duration of nasal mask ventilation use was 72 h, with a range of 20 to 840 h. Mask ventilation
was provided on a continuous rather than intermittent ba¬
is in all these patients. Median inspiratory pressure
was used was 12 cm H2O (range, 8 to 16) and median ex¬
piratory pressure utilized was 6 cm H2O (range, 5 to 8).
In most cases, these settings were only minimally increased during the course of nasal mask ventilation
(range, 2 to 4 cm H2O).

Vital signs and laboratory findings before and after initiation of nasal mask ventilation are shown in Table
2. A significant decrease in respiratory rate was found after beginning therapy (p<0.001). Although mean
heart rate and mean arterial pressure decreased, these changes were not statistically significant. Mean
PaCO2 decreased and serum pH increased significantly with institution of therapy. Arterial oxygen tension
decreased significantly after beginning mask ventilation, while estimated inspired oxygen fraction decreased.
This improvement was associated with a significant increase in oxygen saturation as measured by pulse oximetry (p<0.001).
Mean fractional inspired oxygen concentration decreased from 0.51±0.20 to
0.37±0.07 (p<0.001) after initiation of nasal mask ventilation. Radiographs before and after institution of
treatment showed improvement in 12 of 28 patients (41%).

Calculated estimates of oxygenation deficits also demonstrated benefits of bilevel mask ventilation. Al¬
veolar-arterial gradients were significantly decreased after initiation (p<0.001). As demonstrated in Figure 1,
 improvement was seen in almost all patients. A signif,

| Table 2—Clinical and Laboratory Variables Prior to Institution of Ventilation and Approximately 1 h After Institution
n=28 for Clinical Variables; Number of Patients Listed in Parentheses for Laboratory Variables)* |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretherapy</td>
<td>Posttherapy</td>
<td>p Value</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>45±18</td>
<td>33±11</td>
<td>0.002</td>
</tr>
<tr>
<td>Heart rate</td>
<td>139±25</td>
<td>134±20</td>
<td>0.076</td>
</tr>
<tr>
<td>Mean arterial pressure, mm Hg (kPa) (21)</td>
<td>85±9 (11.2±1.2)</td>
<td>85±10 (11.2±1.3)</td>
<td>0.852</td>
</tr>
<tr>
<td>ABG PCO2 mm Hg (kPa) (21)</td>
<td>45±11 (6.0±1.5)</td>
<td>39±8 (5.2±1.1)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>ABG PO2 mm Hg (kPa) (21)</td>
<td>71±13 (10.0±2.7)</td>
<td>125±65 (16.6±8.7)</td>
<td>0.005</td>
</tr>
<tr>
<td>ABG pH (21)</td>
<td>7.40±0.07</td>
<td>7.44±0.05</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Pulse oximetry O2 saturation, % (28)</td>
<td>94±25</td>
<td>97±2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Alveolar-arterial gradient (16)</td>
<td>271±157</td>
<td>117±65</td>
<td>0.001</td>
</tr>
<tr>
<td>PaO2/FIO2 ratio (16)</td>
<td>141±54</td>
<td>250±146</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Mean±standard deviation (kPa in parentheses). ABG=arterial blood gas.
significan
t decrease was seen if patients with initial A-a gra
dients greater than either 100 (271±157 to 117±65,
p=0.001) or 250 (507±132 to 121±117, p=0.003) were analyzed separately. Using PaO2/FIO2 ratios to avoid underestimation of ventilation/perfusion mismatch in patients receiving 100% oxygen, significant improvement was noted after onset of therapy (p<0.001). Significant changes were again seen in almost all patients (Fig 2). When evaluating only patients with PaO2/FIO2 less than 200 (n=13), ratios increased from 127±45 to 266±158 (p<0.01).

Three patients did not respond adequately to nasal mask ventilation and required intubation. One of these patients died later due to ischemic heart disease and myocardial infarction associated with Hurler’s syndrome. Death was not associated with respiratory failure.

Complications were minimal, although early com-
lications could be underestimated due to the retro-
spective nature of this review. No cases of barotrauma were described. Neither aspiration events nor signifi-
cant gastric distention was reported, even though sev-
eral patients were fed by nasogastric tubes (and orally in one patient) during nasal mask ventilation. Although agitation with initial mask placement was reported in several infants, no patient required discontinuation due to poor tolerance. We did not record sedation usage prior to and after initiation of nasal mask ventilation. Three older patients developed ulcerations of the nasal bridge associated with mask abrasion, a complica-
tion noted in previous adult studies. These oc-
curred early in our experience, and no further incidents were reported after beginning routine placement of a patch (Duoderm, ConvaTec, Bristol-Myers) over the nasal bridge prior to mask placement.

DISCUSSION

Our results, although limited by their retrospective nature, show that pediatric patients with moderate to severe acute hypoxemic respiratory insufficiency can tolerate bilevel nasal mask ventilation with clinical improvement in respiratory distress. Respiratory rates decreased, and blood gas exchange improved. Clinical evidence of response was associated with improvement in calculated indices of oxygenation.

Noninvasive nasal mask therapy may also signifi-
cantly improve ventilation, and it is possible that the conditions of some of our patients improved because of support for respiratory muscles or due to “stenting” of upper airways or large bronchi. This mechanism could account for the reduction in hypercarbia seen in our patients with mask ventilation. Many of these pa-
tients also have had underlying acquired neu-
romuscular deficits related to critical illness or prolonged use of neuromuscular blockade, in which positive pressure delivery after extubation could improve minute ventilation. Nasal mask positive pressure ven-
tilation has shown benefits in preliminary data from children with type 2 respiratory failure associated with neuromuscular weakness.16 Noninvasive positive airway pressure ventilation has demonstrated efficacy in adults with alveolar hypoventilation and hypercapnia related to neuromuscular disorders6 and restrictive thoracic disease.17 Continuous positive airway pressure has become a mainstay in the long-term management of chronic obstructive
sleep apnea. The face mask continuous positive pressure has also proved effective in uncontrolled trials for hypoxic respiratory failure. The mechanisms responsible for improvement with noninvasive continuous positive pressure are probably similar to those provided by invasive delivery of positive pressure. It has been hypothesized that gas exchange may be improved in hypercapnic respiratory failure either by resting chronically fatigued respiratory muscles, increasing lung compliance, or by allowing resetting of medullary respiratory center carbon dioxide sensitivity. The mechanisms improving oxygenation are even less well characterized, but they may include increases in lung compliance, improvement of atelectasis, and concurrent alterations in ventilation/perfusion matching associated with restoration of functional residual capacity. Continuous positive airway pressure may also improve diffusion by decreasing cardiogenic pulmonary edema due to an effect of decreasing systemic vascular afterload.

Bilevel nasal mask ventilation offers some theoretical advantages in comparison to noninvasive continuous positive pressure ventilation. Bilevel ventilation allows delivery of inspiratory pressure, which has been shown to markedly reduce work of breathing. The flow-triggered bilevel system decreases expiratory work of breathing and may improve patient comfort. Use of the nasal mask, compared with a full face mask, allows easier access to clear oral secretions and probably improves patient comfort. The ventilatory support system (BiPAP) also offers a backup ventilator mode to provide machine breaths in the event of apnea. This model is also portable and convenient for home use in selected patients.

Clinical studies in adults have shown that bilevel nasal mask ventilation may provide significant respiratory assistance. Sanders and Kern first documented benefit in obstructive sleep apnea at lower levels of expiratory airway pressure compared with conventional continuous nasal mask therapy. Pennock et al prospectively evaluated 31 patients with respiratory failure in need of intubation. Nasal mask administration improved patient comfort, vital signs, and oxygenation, while 76% of patients did not require intubation. A recent randomized controlled trial demonstrated improved respiratory function and decreased mortality with nasal mask ventilation in adults with chronic obstructive pulmonary disease and acute respiratory failure.

Because a formula was used to calculate the amount of oxygen received based on mask flow, it is possible that derived oxygenation variables were overestimated. However, postmask ventilation, all patients received oxygen solely through a nasal mask with variable dilution from mouth breathing, making overestimation of actual inspired oxygen more likely. The formula utilized does not take into account differences in minute ventilation between patients of varying ages, and thus comparisons of derived values cannot be made between patients. However, comparisons premask and postmask ventilation for individual patients remain valid.

We emphasize that conclusions are limited by the retrospective nature of this review. The selection of patients by use of billing records also may lead to underreporting of patients who were briefly tried on nasal mask ventilation but failed too rapidly to warrant formal billing. These findings do suggest that bilevel nasal mask positive airway pressure ventilation may offer an alternative means of noninvasive mechanical ventilation for infants and children with moderate hypoxic respiratory insufficiency and adequate airway protection. Nasal mask ventilation may be considered particularly in children with respiratory insufficiency after extubation and in patients with underlying disorders for whom invasive intubation may not be considered appropriate by family and physicians. While not proven, bilevel ventilation offers theoretical advantages over continuous positive pressure modes. These benefits may be more significant in patients immediately postextubation with residual neuromuscular weakness in which temporary positive airway pressure support could maintain the patient as a bridge to independent respiratory muscle support. Prospective controlled trials will be crucial to confirm the efficacy and cost-effectiveness of bilevel nasal mask ventilation compared with intubation in selected pediatric patients.

References

16 Hertzog JH, Costarino AT. Nasal mask positive pressure ventilation in pediatric patients with type II respiratory failure [abstract]. Read before the Annual Meeting of the American Academy of Pediatrics, October 1992