Noninvasive ventilatory support in morbid obesity

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Abstract

Background: In the conventional management of the morbidly obese that normalizes the apnea-hypopnea index (AHI), CO2 levels often remain elevated.

Methods: A retrospective review of morbidly obese patients using volume preset settings up to 1800 ml to positive inspiratory pressures (PIPs) of 25–55 cm H2O, or pressure control at 25–50 cm H2O pressure via noninvasive interfaces up to continuously (CNVS).

Results: Twenty-six patients, mean 55.6 ± 14.8 years of age, weight 108–229 kg, mean BMI 56.1 (35.5–77) kg/m², mean AHI 69.0 ± 24.9, depended on up to CNVS for 3 weeks to up to 66 years. There were eleven extubations and seven decannulations to CNVS despite failure to pass spontaneous breathing trials. Thirteen were CNVS dependent for 92.2 patient-years with little to no ventilator free breathing ability (VFBA). Six used NIVS from 10 to 23 h a day, and others only for sleep. Fifteen patients with cough peak flows (CPF) less than 270 L/m had access to mechanical ventilation-insufflation-exsufflation (MIE) in the peri-extubation/decannulation period and long-term. The daytime end-tidal (Et)CO2 of 14 who were placed on sleep NIVS without extubation or decannulation to it decreased from mean EtCO2 61.0 ± 9.3–38.5 ± 3.6 mm Hg and AHI normalized to 2.2. Blood gas levels were normal while using NIVS/CNVS. Pre-intubation PaCO2 levels, when measured, were as high as 183 mm Hg before extubation to CNVS.

Conclusions: Ventilator unweanable morbidly obese patients can be safely extubated/decannulated and maintained indefinitely using up to CNVS rather than resort to tracheotomies.

KEYWORDS

Obesity associated respiratory failure; Morbid obesity; Noninvasive ventilator support; Noninvasive ventilation; Mechanical insufflation-exsufflation

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Introduction

Morbid obesity is defined by having a body mass index (BMI) of 40 kg/m² or more, and is associated with a number of comorbid conditions which can adversely impact survival. Increased work of breathing and ‘resetting’ of hypoalamic respiratory drive can result in hypoventilation and in cor pulmonale.¹² Morbidly obese individuals, with or without complicating conditions, can become continuously ventilator dependent, that is, dependent on noninvasive ventilatory support (CNVS) or on tracheostomy mechanical ventilation (CTMV).

’’NIV’’ has come to be synonymous with continuous positive airway pressure (CPAP) and bi-level PAP at spans that can normalize AHI without providing full NVS to normalize CO₂ and optimally rest inspiratory muscles.² Bi-level PAP became available in 1990 and often better normalized AHIs than CPAP but it has not been used at full ventilatory support settings aimed at normalization of CO₂ in patients with ventilatory pump failure.³ Mokhlesi et al. reported that eight of 34 patients (23%) who used sleep bi-level PAP did not have a significant improvement in their PaCO₂ despite normalization of their AHIs from 44 ± 45.⁴ Likewise, Bouloukaki et al.³ evaluated CPAP and typical bi-level therapy and reported that around 20% of individuals had a CO₂ > 45 mm Hg after two years of therapy. Greater than the usual bi-level spans can be needed to normalize CO₂.

The positive inspiratory pressures (PIPs) of mechanical ventilation during general anesthesia and neuromuscular blockade for patients with normal BMI are 17–25 cm H₂O as are PIPs for any patients with little or no measurable vital capacity (VC) but normal pulmonary compliance.⁶ However, patients with poor lung and chest wall compliance may require much higher pressures to normalize ventilation. The aim of this study is to demonstrate that NVS can at times be required to pressures over 50 cm H₂O for the morbidly obese to normalize CO₂ levels and avoid the need for O₂ therapy and tracheotomy. Ventilator dependent patients can also be extubated or decannulated to it. This study was approved by the Rutgers University Institutional Review Board as No. Pro2018001071.

Methods

This is a retrospective study describing the use of NVS with high PIPs for morbidity obese patients presenting to two NVS centers over a 12 year period who required NVS support due to ongoing hypercapnic respiratory failure despite NIV use. Patients 1–17 presented to Center A and patients 18–26 to Center B. Vital capacity (VC) (measured to correlate with weight but not reported here), cough peak flows (CPF), End-tidal (Et)CO₂, and oximetry were measured at every visit. Thirteen of the 17 patients of center A underwent bariatric surgery but subsequently regained weight. All were offered ketogenic diets and exercise programs, but none continued these therapies long-term. Introduction of NVS was indicated by symptomatic hypoventilation with decreased VC.

The therapeutic goals were: (1) normalization of PaCO₂ and/or end-tidal carbon dioxide (EtCO₂) or transcutaneous CO₂ (TcCO₂) tensions and oxyhemoglobin saturation (SpO₂) during wakefulness and sleep to relieve symptoms of hypoventilation; (2) to extubate and/or decannulate those failing ventilator weaning parameters and spontaneous breathing trials to CNVS.

We define NVS as the use of portable ventilators, volume or pressure preset or bi-level machines, at at least full ventilatory support settings to normalize CO₂ levels as opposed to ”NIV” settings to only normalize AHI. Although volumes were initially prescribed for the patient to choose over a range from 700 to 1500 ml, one patient increased his to 1800 ml. Pressure support/control for drive pressures of 20–55 cm H₂O were used for patients with abdominal dis-tension. The goal was to normalize PaCO₂ around the clock. Patients used sleep-only NVS, sleep plus daytime NVS for up to 23 h/day, or CNVS with little or no VFBA.

All patients were prescribed NVS, which was preferen-tially volume preset with physiologic back-up rates, that is, normal respiratory rates for age or about 12–16. Portable ventilators were used with active ventilator circuits with or without minimal EPAP/PEEP. Volume preset was preferred since lung volume recruitment cannot be performed when using pressure preset ventilation.⁶ Intubated patients and those using tracheostomy mechanical ventilation (TMV) were extubated/decannulated to up to CNVS with weaning, as possible.

Sleep NVS users who continued to gain weight tended to become dyspnic upon discontinuing NYS in the morning and developed fatigue, somnolence, and dyspnea when daytime hypercapnia was associated with decreases in SpO₂ below 95% during the day, especially late in the day. As previously described, increased daytime use of mouthpiece/nasal NYS at that point was facilitated by using oximetry feedback. This renormalized blood gases and relieved dyspnea. Nasal or oronasal interfaces were used for sleep, although patients who required daytime as well sleep NYS used oronasal interfaces with straps tightly applied during sleep for a more ”closed system” to maintain normal blood gases. With nasal NYS during sleep large leak resulted in difficulty maintaining adequate PIPs and normal SpO₂.⁴ Any supplemental O₂ and sedating medications were discontinued to avoid increased NYS leakage out of the mouth.⁵ Patients’ cough peak flows (CPF) were measured and when less than 270 L/m mechanical insufflation-exsufflation (MIE) was made available to decrease the risk of intercurrent pneumonias.⁹,¹²

Although pre-NYS AHI measurements were by polysomnography, subsequent measurements were estimated by ventilator flow and pressure sensors that store the data for analysis on personal computers. Compliance, average tidal volume, minute ventilation, respiratory rate, leaks, percent of spontaneous inspirations, and indices of residual apnea and hypopnea were monitored during sleep. However, only SpO₂ and EtCO₂ or TcCO₂ levels were used as indications to adjust ventilator settings and interfaces, for example, whether to use nasal or oronasal interfaces. The reliability of the AHI by ventilator software has been reported to be sufficient for monitoring subjects on long-term NIV/NVS.¹¹,¹³,¹⁴

Results and outcomes

The patients’ demographics, anthropometric data, any complicating neurological conditions, and whether extubated
Table 1 Demographic Data, Extubations and Decannulations for Patients with Morbid Obesity.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>BMI</th>
<th>Complicating conditions</th>
<th>BiPAP to intubation</th>
<th>Required Extubation/Decannulation to CNVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1⁰</td>
<td>71</td>
<td>M</td>
<td>77</td>
<td>None</td>
<td>1 year 3 intubations</td>
<td>Extubation &amp; Decannulation</td>
</tr>
<tr>
<td>2⁰</td>
<td>24</td>
<td>M</td>
<td>54.4</td>
<td>Spina bifida paraplegia</td>
<td>2 years 3 intubations</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>F</td>
<td>41.4</td>
<td>None</td>
<td>NVS to intubation</td>
<td>Extubation x 2</td>
</tr>
<tr>
<td>4</td>
<td>72</td>
<td>F</td>
<td>43.9</td>
<td>Post-poliomyelitis</td>
<td>No</td>
<td>Extubation to CNVS for Surgery</td>
</tr>
<tr>
<td>5⁰</td>
<td>32</td>
<td>F</td>
<td>75</td>
<td>None</td>
<td>2 years 2 intubations</td>
<td>Extubation &amp; Decannulation</td>
</tr>
<tr>
<td>6⁰</td>
<td>59</td>
<td>F</td>
<td>57.5</td>
<td>None</td>
<td>2 years 2 intubations</td>
<td>Extubation &amp; Decannulation</td>
</tr>
<tr>
<td>7</td>
<td>71</td>
<td>M</td>
<td>35.5</td>
<td>Diabetic neuropathy</td>
<td>No</td>
<td>Extubation</td>
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<td>8⁰</td>
<td>53</td>
<td>F</td>
<td>53.1</td>
<td>None</td>
<td>1 intubation</td>
<td>Extubation x 2 &amp; Decannulation</td>
</tr>
<tr>
<td>9⁰</td>
<td>62</td>
<td>F</td>
<td>48.1</td>
<td>None</td>
<td>14 years 2 intubations</td>
<td>Decannulation</td>
</tr>
<tr>
<td>10⁰</td>
<td>81</td>
<td>F</td>
<td>54</td>
<td>None</td>
<td>8 years</td>
<td>No</td>
</tr>
<tr>
<td>11⁰</td>
<td>59</td>
<td>F</td>
<td>46.3</td>
<td>None</td>
<td>2 intubations</td>
<td>Decannulation</td>
</tr>
<tr>
<td>12</td>
<td>58</td>
<td>F</td>
<td>N/A</td>
<td>None</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>13</td>
<td>37</td>
<td>F</td>
<td>44</td>
<td>diabetic neuropathy</td>
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<td>No</td>
</tr>
<tr>
<td>14</td>
<td>30</td>
<td>F</td>
<td>47</td>
<td>Hypopituitarism, Cushingoid</td>
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<td>No</td>
</tr>
<tr>
<td>15</td>
<td>53</td>
<td>F</td>
<td>61.8</td>
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</tr>
<tr>
<td>16</td>
<td>71</td>
<td>M</td>
<td>48</td>
<td>MND</td>
<td>4 years</td>
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</tr>
<tr>
<td>17</td>
<td>52</td>
<td>F</td>
<td>68</td>
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</tr>
<tr>
<td>18</td>
<td>64</td>
<td>F</td>
<td>75</td>
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</tr>
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<td>66</td>
<td>F</td>
<td>58</td>
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<td>No</td>
</tr>
<tr>
<td>20</td>
<td>61</td>
<td>M</td>
<td>49</td>
<td>Post-Polio</td>
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<td>No</td>
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</tr>
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<td>66</td>
<td>F</td>
<td>56.3</td>
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<td>No</td>
<td>No</td>
</tr>
<tr>
<td>23</td>
<td>69</td>
<td>M</td>
<td>58.6</td>
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<td>24</td>
<td>42</td>
<td>M</td>
<td>74</td>
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<td>No</td>
</tr>
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<td>25</td>
<td>37</td>
<td>F</td>
<td>66.8</td>
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<td>No</td>
<td>No</td>
</tr>
<tr>
<td>26</td>
<td>59</td>
<td>M</td>
<td>55</td>
<td>Polyneuropathy</td>
<td>No</td>
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</tr>
</tbody>
</table>

CNVS — continuous noninvasive ventilatory support; BMI — body mass index.

BiPAP to intubation—"No" denotes patients who were placed on NVS settings from outset, otherwise patients developed acute on chronic respiratory failure with or without using bi-level PAP with seven requiring intubation then extubation to CNVS and five of the seven failing a total of nine extubation attempts at other hospitals before transfer for successfully extubation to CNVS and mechanical insufflation-exsufflation (MIE). One local patient required extubation to CNVS and MIE twice.

Required extubation/decannulation to CNVS — except where noted, all intubations were for acute on chronic respiratory failure and extubation attempts to CPAP, bi-level PAP, and O2 failed or were not attempted do to inability to pass ventilator weaning parameters and spontaneous breathing trials. The patients had to be extubated to CNVS and MIE.

⁰ Denotes patients who had been successfully extubated to low span bi-level PAP and O2 but remained extremely hypercapnic despite sleep bi-level PAP until being transitioned to NVS settings, in 5 cases, after being intubated again, undergoing tracheotomies, then being decannulated to CNVS in our center. Patient 9, however, only required sleep NVS post-decannulation.

Patients’ initial presentation, clinical management, and transition to NVS are described in a flow diagram in Fig. 1. Diurnal CO2 and SpO2 levels, mean sleep SpO2 levels, and AHI for those undergoing polysomnograms before introduction to NVS are noted in Table 2. Extent of NVS dependence (VFBA) between NVS to CNVS varied with patients’ weight (Table 2).

Table 3 denotes extent of daytime use of NVS. Five intubated patients were transferred, including two on two occasions, from other critical care units after failing weaning and a total of 15 extubation attempts. Two intubated
Figure 1  Patients’ Initial Presentation, Management, and Transition to Noninvasive Ventilatory Support (NVS).

NIV - noninvasive ventilation; ARF - acute respiratory failure; CNVS - continuous noninvasive ventilatory support.

Table 2  Pre-Noninvasive Ventilatory Support (NVS) Assessment.

<table>
<thead>
<tr>
<th>Case</th>
<th>Pre-NVS</th>
<th>Daytime O2 Sat</th>
<th>Daytime EtCO2/TcCO2</th>
<th>Sleep mean O2 Sat</th>
<th>AHI</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>88−94%</td>
<td>51</td>
<td></td>
<td>81</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>92%</td>
<td>71</td>
<td></td>
<td>90</td>
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<td>3</td>
<td></td>
<td>88−94%</td>
<td>63</td>
<td></td>
<td>93</td>
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<td>4</td>
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<tr>
<td>5</td>
<td></td>
<td>79−83</td>
<td></td>
<td></td>
<td>93</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>85−91%</td>
<td>59</td>
<td></td>
<td>93</td>
</tr>
<tr>
<td><strong>7</strong></td>
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<td>**</td>
<td></td>
<td></td>
<td><strong>7</strong></td>
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<tr>
<td>8</td>
<td></td>
<td>96−98%</td>
<td>47</td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>94−95%</td>
<td>44</td>
<td></td>
<td>94</td>
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<td>10</td>
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<td>83−85%</td>
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<td>11</td>
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<td>86−88%</td>
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<td>48</td>
<td>89%</td>
<td>94</td>
</tr>
<tr>
<td>17</td>
<td></td>
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<td>103</td>
<td>89%</td>
<td>94</td>
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<tr>
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<td></td>
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<tr>
<td>26</td>
<td></td>
<td>90−94%</td>
<td>94</td>
<td>84%</td>
<td>94</td>
</tr>
</tbody>
</table>

EtCO2 — End-tidal carbon dioxide in mm Hg; TcCO2 — transcutaneous CO2 mm Hg; Daytime O2 sat and EtCO2 — O2 sat and EtCO2 while stable; AHI — apnea hypopnea index; NVS settings — ** indicates pre-hospitalization blood gases unknown; the patient was transferred for extubation to CNVS after failing two extubation attempts and passing no ventilator weaning parameters; post-extubation was discharged using sleep NVS.
<table>
<thead>
<tr>
<th>Case</th>
<th>NVS extent and duration</th>
<th>NVS outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sleep only NVS</td>
<td>Night NVS + Day</td>
</tr>
<tr>
<td>3^1</td>
<td>None</td>
<td>5 years</td>
</tr>
<tr>
<td>4^2</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>5^3</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>6^4</td>
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<td>7^5</td>
<td>None</td>
<td>1 year</td>
</tr>
<tr>
<td>8^6</td>
<td>8 years</td>
<td>None</td>
</tr>
<tr>
<td>9^7</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>10^8</td>
<td>4 years</td>
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<td>None</td>
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</tr>
<tr>
<td>12^10</td>
<td>9 years</td>
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</tr>
<tr>
<td>13^11</td>
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<td>6.4 years</td>
</tr>
<tr>
<td>14^12</td>
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</tr>
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</tr>
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</table>

(C)NVS — (continuous) noninvasive ventilatory support; EtCO2 — end-tidal carbon dioxide in mm Hg; TcCO2 — transcutaneous CO2 mm Hg; NVS extent and duration — the total duration of use of sleep-only NVS, NVS use up to 23 h a day, and CNVS with little or no ventilator free breathing ability, however, patients often varied from one category to another as their weights and vital capacities increased or decreased.

^a Indicates patients who used volume preset NVS with a range of 800–1800 ml, mean 1280 ml, that resulted in the positive inspiratory pressures (PIPs) noted for both daytime and sleep NVS, others used pressure control NVS.
patients were local. All seven unweanable patients were
successfully extubated to CNVS and MIE, including Cases 3
and 8 on two occasions, and discharged home. Three of
the seven eventually weaned, at least temporarily, to nighttime-
only NVS. Their CPF averaged 208 L/m (70 L/m Case 8) and
only one patient had flows over 270 L/m (Case 15) so 15
needed access to MIE long-term as well as for extubation
and/or decannulations.\textsuperscript{15-17}

All six patients who presented using up to continuous
TMV (CTMV) were successfully decannulated to NVS/CNVS
and MIE including 3 CTMV users who had no VFBA. All six
subsequently weaned to at least some daytime VFBA. Two
patients who were decannulated to CNVS but then used
sleep-only NVS, subsequently developed pneumonia and
required re-intubation but were successfully re-extubated
to CNVS (Table 1: Cases 1, 5). One patient who was extu-
bated to CNVS developed sepsis from a hand infection,
underwent tracheotomy, and was subsequently decannu-
lated to CNVS.

Dyspnea was relieved and blood gases normalized for all
patients. For the eleven who used only sleep NVS the initial
daytime ETCO\textsubscript{2} of 61.5 ± 6.3 decreased to 39.9 ± 3.3 mm Hg,
and SpO\textsubscript{2} normalized before increasing weight resulted in
their need to extend NVS into daytime hours. The ETCO\textsubscript{2}
and SpO\textsubscript{2} were always normal while using NVS during the day at
PIPs of 25–55 cm H\textsubscript{2}O. The mean pre-NVS AH\textsubscript{I} of 69.0 ± 24.9
decreased to 2.3 ± 1.4 during sleep NVS. Four required CNVS
only for days to months following extubation or decannula-
tion before weaning to less than full-time NVS was achieved.
Using oximetry as feedback, all patients were able to main-
tain normal daytime SpO\textsubscript{2} in ambient air by using NVS and
MIE.\textsuperscript{17}

For Center A, the 17 patients’ mean VC was 1409 ± 871
(range 200–2680)ml when sitting, and 1029 ± 764 (range
200–2060)ml when supine with a mean decrease of 27% from
sitting to supine for these patients who could not tolerate
reclining supine without using NVS. In the overall group, 18
patients used nasal and eight patients used oronasal inter-
faces for sleep NVS (Table 2). Four patients died; three
predominantly from diabetes, hypertension, and renal fail-
ure including one with sickle cell anemia and aortic stenosis.
Contact was lost with Case 8 who had liver cirrhosis and
severe diabetes mellitus, and with case 13.

No patients were intubated due to failure of CNVS, how-
ever, two using less than CNVS, because of its inconvenience
while walking, developed CO\textsubscript{2} narcosis, required hospitali-
zation and intubation for ARF, and had to be extubated back
to CNVS.

Fourteen patients were CNVS dependent for 7.3 ± 16.1
(range from 3 months to 66 years) years with little to no
VFBA for a total of 92.2 patient-years. Six others predomi-
nantly used NVS day and night with some VFBA and the others
predominantly for sleep-only (Table 2).

Discussion

These results demonstrate that: (1) volume or pressure
preset NVS settings can normalize blood gases day and
night and AH\textsubscript{I}s without EPAP or PEEP; (2) ventilator
unweanable patients with morbid obesity can be extu-
bated/decannulated to, and depend on, CNVS for years
to maintain normal blood gases without supplemental O\textsubscript{2}
despite having little or no autonomous ability to breathe,
(3) CNVS can be safely provided day and night to PIPs over
40 and even over 50 cm H\textsubscript{2}O for the morbidly obese, (4) mor-
bidly obese patients are good candidates for mouthpiece
and nasal CNVS because of intact bulbar-innervated muscula-
ture that permits them to comfortably use NVS settings, (5) and
morbidly obese patients with respiratory orthopnea can use
NVS for sleep reeling.

In many studies on managing morbid obesity, supplemental
O\textsubscript{2} and bi-level PAP at less than NVS settings are used
rather than correcting SpO\textsubscript{2} and CO\textsubscript{2} levels by using NVS
settings.\textsuperscript{18-24} Residual hypercapnia can be symptomatic and
cause morbidity.\textsuperscript{3,25} Outside of academic circles, CO\textsubscript{2}
levels are often not routinely monitored during polysomnogra-
phy. None of the patients we switched to active ventilator cir-
cuits with 0 ml of PEEP had CO\textsubscript{2} monitored during their
sleep studies. While morbidly obese patients can obstruct
inspiration during sleep and they may not exhale to atmo-
spheric pressures, the air delivered at PIPs of 30–50 cm H\textsubscript{2}O
was unobstructed on flow signals from the ventilator down-
load. Increasing the IPAP to compensate for the EPAP to
achieve the same support as with EPAP increases mean tho-
racic pressures and possibly discomfort sometimes without
obvious clinical benefit. Although the airway obstruction of
patients with bulbar amyotrophic lateral sclerosis (ALS) is
certainly pathologically distinct from that of the morbidly
obese, Crescimanno et al. titrated the AH\textsubscript{I}s of patients with
ALS then repeated the studies with 0 EPAP and reported
that even 4 cm H\textsubscript{2}O produced more leak than no EPAP, along
with poorer sleep quality, more arousals, and a higher occur-
rence of patient-ventilator dysynchrony without improving
oxygen saturation.\textsuperscript{3,26} Thus, EPAP may also be unnecessary
to treat the morbidly obese when NVS settings are used,
since airflow was unobstructed, blood gases normalized, and
symptoms relieved. Future studies will be needed to confirm
this observation.

Pressure preset CNVS at 18–50 cm H\textsubscript{2}O and volume preset
CNVS at 700–1800 ml have now been used to sustain life for
over 65 years for some of the 257 post-poliomyelitis mouth-
piece CNVS users described in 1993, when for up to 28 years for
59 high level traumatic tetraplegics,\textsuperscript{28} for over 30 years for
patients with Duchenne muscular dystrophy,\textsuperscript{15} for over 25
years for severe spinal muscular atrophy (SMA) type \textsuperscript{15,33} for
up to 13 years for ALS,\textsuperscript{30} and others. None received EPAP, PEEP, or supplemental O\textsubscript{2}. Likewise, many
morbidly obese patients with no VFBA and immediate apnea
when unaided, may also be managed by NVS without EPAP
or PEEP.

Six patients were decannulated despite dependence on
up to CTMV with limited VFBA. Although these patients could
not be weaned from ventilatory support, this is not unprece-
dented. Perhaps the first decannulated CTMV dependent
patient was a 17 year old high level spinal cord injured
patient with 420 ml of VC seated but 0 ml supine. He had
had a C1 fracture in March of 1967. He was decannulated to
CNVS using a mouthpiece during the day. The ostomy closed
in April 1969. He was euthanized after 38 years of CNVS in
2006. Another 91 TMV dependent patients, including two
with 0ml of VC, were subsequently decannulated to CNVS
in reports in 1988 and 1990.\textsuperscript{17,28,31} Seven remained CNVS
dependent for 12.4 ± 6.3 (range 1–22) years. Another 61
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