

## Mechanical Ventilation in Patients With Guillain-Barré Syndrome

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**BACKGROUND:** Patients with Guillain-Barré syndrome are commonly exposed to prolonged mechanical ventilation. Specific data on ventilatory management of these patients have been limited. **OBJECTIVE:** To describe the practice of mechanical ventilation in patients with Guillain-Barré syndrome and evaluate risk factors for morbidity and mortality. **METHODS:** We describe a historical cohort of mechanically ventilated patients with Guillain-Barré syndrome in a tertiary-care center. We extracted database information on demographics, severity of illness, pulmonary function, and ventilatory management for the period 1976 to 1996. Primary outcomes were development of pulmonary complications, duration of ventilatory support, and mortality. **RESULTS:** Fifty-four patients met the inclusion criteria. After 1990, lower tidal volume ( $p = 0.031$ ) and higher positive end-expiratory pressure ( $p = 0.003$ ) were used than during the 1976 to 1990. Outcomes did not change significantly during the studied period. Forty-six patients (85%) survived to hospital discharge, and 39 (72%) were alive at 1-year follow-up. Ventilator-associated pneumonia was the most frequent complication (56%) and was associated with prolonged mechanical ventilation ( $p < 0.01$ ). Atelectasis developed in 49%, and acute lung injury in 13%. All but 6 patients (89%) received tracheostomy. In 14 patients (30%) tracheostomy was placed  $\geq 14$  days after intubation. When adjusted for atelectasis and severity of illness in a stepwise logistic regression analysis, delayed tracheostomy was associated with the development of ventilator-associated pneumonia (odds ratio 8.2,  $p = 0.029$ ). **CONCLUSIONS:** Changes in ventilator practice did not affect outcomes of mechanically ventilated patients with Guillain-Barré syndrome. The majority of patients received tracheostomy, which should be considered early in the course of respiratory failure. *Key words:* neuromuscular disease, respiratory insufficiency, respiration, weaning, atelectasis, tidal volume. [Respir Care 2006;51(12):1403–1407. © 2006 Daedalus Enterprises]

### Introduction

Guillain-Barré syndrome is an acute, monophasic, symmetrically progressive, peripheral neuropathy that fre-

quently involves respiratory muscles and results in respiratory failure. The mortality rate ranges from 2% to 12%, despite technological advances in supportive care, and 15% of Guillain-Barré syndrome patients have persistent disability.<sup>1</sup> Respiratory failure is a relentless problem among patients with Guillain-Barré syndrome, and mechanical ventilation is required in 20–30% of these patients.<sup>2–5</sup> In many patients with Guillain-Barré syndrome, prolonged ventilatory support is needed because of continuing de-

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## MECHANICAL VENTILATION IN PATIENTS WITH GUILLAIN-BARRÉ SYNDROME

Table 1. Trends in Mechanical Ventilation Practice and Outcomes of Patients With Guillain-Barré Syndrome: 1976 to 1996

	1976 to 1980 ( <i>n</i> = 12)	1980 to 1990 ( <i>n</i> = 31)	1990 to 1996 ( <i>n</i> = 11)	<i>p</i>
Age (median and range y)	55 (36 to 70)	63 (53 to 71)	39 (19 to 58)	0.058
Female ( <i>n</i> and %)	7 (58)	14 (45)	4 (36)	0.561
SAPS II (median and IQ range score)	23 (7 to 29)	24 (13 to 33)	17 (8 to 27)	0.147
P <sub>aO<sub>2</sub></sub> /F <sub>IO<sub>2</sub></sub> (median and IQ range mm Hg)	229 (213 to 357)	291 (174 to 350)	348 (306 to 440)	0.071
Vital capacity (median and IQ range L)	1.3 (0.8 to 2.1)	1.9 (1.2 to 2.6)	2.2 (1.7 to 3.4)	0.074
Ventilation mode ( <i>n</i> and %)				0.335
Assist-control	5 (50)	11 (41)	2 (20)	
SIMV	5 (50)	16 (60)	8 (80)	
V <sub>T</sub> (median and IQ range mL/kg)	12.8 (11.1 to 13.6)	12.0 (10.2 to 14.0)	10.9 (9.5 to 11.4)	0.031
PEEP (median and IQ range cm H <sub>2</sub> O)	0 (0 to 5)	0 (0 to 5)	5 (5 to 5)	0.003
Peak airway pressure (median and IQ range cm H <sub>2</sub> O)	24 (18 to 30)	25 (22 to 35)	24 (20 to 29)	0.309
Atelectasis ( <i>n</i> and %)	4 (33)	15 (60)	4 (30)	0.258
Acute lung injury ( <i>n</i> and %)	1 (8)	6 (19)	0	0.141
Time to tracheostomy ( <i>n</i> and IQ range d)	5 (3 to 15)	10 (7 to 15)	6 (6 to 16)	0.053
VAP ( <i>n</i> and %)	8 (73)	14 (52)	5 (50)	0.453
Duration of mechanical ventilation ( <i>n</i> and IQ range d)	49 (18 to 82)	40 (26 to 88)	38 (11 to 46)	0.314
ICU stay (median and IQ range d)	56 (26 to 87)	41 (27 to 64)	38 (16 to 54)	0.216
Hospital mortality ( <i>n</i> and %)	2 (20)	4 (15)	1 (10)	0.819
12-month mortality ( <i>n</i> and %)	3 (27)	9 (33)	2 (20)	0.722

SAPS II = Simplified Acute Physiology Score II

IQ = interquartile

F<sub>IO<sub>2</sub></sub> = fraction of inspired oxygen

SIMV = synchronized intermittent mandatory ventilation

V<sub>T</sub> = tidal volume

PEEP = positive end-expiratory pressure

VAP = ventilator-associated pneumonia

ICU = intensive care unit

cline in neuromuscular respiratory function and, ultimately, superimposed pulmonary infections increase morbidity and mortality.<sup>6,7</sup> Though 2 small studies<sup>6,7</sup> have described the outcomes of patients with Guillain-Barré syndrome who required mechanical ventilation, specific ventilator management and the timing of tracheostomy have not been reported.

Given the existing evidence that requirement for mechanically assisted ventilation correlates closely with poor outcome, we aimed to describe practice trends in mechanical ventilation, pulmonary complications, and mortality in a historical cohort of mechanically ventilated patients with Guillain-Barré syndrome.

### Methods

From a database of patients with Guillain-Barré syndrome<sup>8</sup> we retrospectively identified consecutive patients admitted to the neurologic intensive care unit (ICU) at the Mayo Clinic in Rochester, Minnesota, who had the diagnosis of Guillain-Barré syndrome and required mechanical ventilation. We collected data from 1976 to 1996. Our neurologic ICU is a 24-bed unit staffed by neurologists, neurosurgeons, and critical care anesthesiologists. Stan-

dard criteria for diagnosis of Guillain-Barré syndrome were used.<sup>9,10</sup> Patients under the age of 16 years and those with atypical variants of Guillain-Barré syndrome were excluded. We also excluded patients who were intubated for more than 24 hours and were transferred from an outside facility, and those who had a tracheostomy in place at the time of admission. The study was approved by our institutional review board.

We collected data on demographics, comorbidities, pre-intubation arterial blood gas values, pulmonary function tests, ventilator settings, and pulmonary complications as primary outcome variables. Simplified Acute Physiology Score (SAPS II) was calculated from data collected at the time of ICU admission.<sup>11</sup> Ventilator settings were extracted from the respiratory therapy flow sheet, and included ventilation mode, tidal volume (V<sub>T</sub>), positive end-expiratory pressure (PEEP), and peak airway pressure. The dominant ventilator setting during the first 3 days was chosen as the initial ventilation mode. The largest V<sub>T</sub> used during days 1–3 was recorded. The PEEP and peak airway pressure were selected from the information collected simultaneously with the V<sub>T</sub>. Tracheostomy was considered delayed if performed more than 14 days after initiation of mechanical ventilation.

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Table 2. Comparison of Patients Who Did or Did Not Require Tracheostomy

	Tracheostomy ( <i>n</i> = 48)	No Tracheostomy ( <i>n</i> = 6)	<i>p</i>
Age (median and range y)	58 (41 to 70)	49 (30 to 62)	0.386
Female ( <i>n</i> and %)	23 (48)	2 (33)	0.675
SAPS II (median and IQ range score)	24 (12 to 31)	12 (6 to 26)	0.110
Vital capacity (median and IQ range L)	1.75 (1.05 to 2.4)	1.88 (1.35 to 4.23)	0.418
P <sub>I</sub> max (median and IQ range cm H <sub>2</sub> O)	-32 (-45 to -21)	-40 (-70 to -28)	0.482
P <sub>E</sub> max (median and IQ range cm H <sub>2</sub> O)	40 (25 to 57)	38 (25 to 70)	0.931
P <sub>aO<sub>2</sub></sub> /F <sub>IO<sub>2</sub></sub> (median and IQ range mm Hg)	285 (214 to 361)	343 (198 to 400)	0.633
pH (median and IQ range)	7.44 (7.40 to 7.48)	7.40 (7.39 to 7.46)	0.390
P <sub>aCO<sub>2</sub></sub> (median and IQ range mm Hg)	38 (34 to 44)	39 (33 to 41)	0.952
VAP ( <i>n</i> and %)	26 (61)	1 (20)	0.106
Hospital mortality ( <i>n</i> and %)	7 (15)	1 (17)	0.894
Duration of mechanical ventilation (median and IQ range d)	42 (27 to 72)	11 (4 to 16)	< 0.001
ICU stay (median and IQ range d)	46 (30 to 64)	20 (8 to 23)	0.002

SAPS II = Simplified Acute Physiology Score II

IQ = interquartile

P<sub>I</sub>max = maximum inspiratory pressure

P<sub>E</sub>max = maximum expiratory pressure

VAP = ventilator-associated pneumonia

ICU = intensive care unit

The primary outcome measures were the duration of mechanical ventilation, ICU stay, hospital mortality, 12-month mortality, and respiratory complications during the ICU course, including ventilator-associated pneumonia (VAP), acute lung injury (ALI), and atelectasis. VAP was clinically defined as the presence of a new and persistent radiographic infiltrate in conjunction with one of: positive pleural/blood culture results for the same organism as that recovered in the tracheal aspirate or sputum; radiographic cavitation; or histopathologic evidence of pneumonia; or with two of: fever, leukocytosis, or purulent tracheal aspirate.<sup>12</sup> ALI was defined according to the definition of the American European Consensus Conference.<sup>13</sup> New atelectasis was defined as no report of atelectasis on the first chest radiograph but evidence of atelectasis on day 2, 3, or 4 after initiation of mechanical ventilation.<sup>14</sup>

We integrated the patient's history, physical examination, data from invasive monitoring, nursing and respiratory therapy flow sheets, laboratory tests, and radiologist's interpretation of daily chest radiographs to determine the presence or absence of respiratory complications.

Continuous and categorical variables were compared using the Kruskal-Wallis or Student's *t* test and chi-square or Fisher's exact tests, as appropriate. Stepwise logistic regression models were developed to evaluate independent associations between predictors and outcome. The data were analyzed with statistics software (JMP 5, SAS Institute, Cary, North Carolina).

## Results

Of 60 patients with Guillain-Barré syndrome who required mechanical ventilation during the period 1976 to 1996, medical records with ventilator data were available for 54 patients admitted to the neurologic ICU. Complete data sets were available for 47 patients (87%). None of the patients were tried on noninvasive mechanical ventilation. Forty-six patients (85%) survived to hospital discharge, and 39 (72%) were alive at 1-year follow-up. One-year nonsurvivors were more likely to be older (median 63 y vs 53 y, *p* = 0.017), to have a higher SAPS II score (median 31 vs 22, *p* = 0.016), to have evidence of pneumonia at the time of ICU admission (43% vs 15%, *p* = 0.050), to have a lower ratio of P<sub>aO<sub>2</sub></sub> to fraction of inspired oxygen (median 229 mm Hg vs 326 mm Hg, *p* < 0.001), and to have lower pre-intubation maximum inspiratory pressure (-25 cm H<sub>2</sub>O vs -40 cm H<sub>2</sub>O, *p* = 0.042). The median ICU stay was 42 days (range 24-62 d). The median duration of mechanical ventilation was 40 days (range 22-64 d).

Table 1 describes the trends in ventilator practice and outcomes during the studied period. Assist control and synchronized intermittent mandatory ventilation were the only ventilation modes used. After 1990, synchronized intermittent mandatory ventilation was used more frequently, as were lower V<sub>T</sub> and higher PEEP settings (see Table 1). During the studied period there was no change in the incidence of atelectasis, ALI, VAP, or mortality, no change in the use of therapeutic plasma exchange or in-

Table 3. Comparison of Patients Who Received Tracheostomy Before or After 2 Weeks After Intubation

	Tracheostomy in ≥ 14 d (n = 14)	Tracheostomy in < 14 d (n = 33)	p
Age (median and range y)	66 (53 to 78)	58 (30 to 65)	0.098
Female (n and %)	5 (35%)	18 (54%)	0.237
SAPS II (median and IQ range score)	28 (22 to 38)	23 (9 to 31)	0.201
Vital capacity (median and IQ range L)	1.5 (1.07 to 2.55)	1.85 (0.99 to 2.42)	0.418
P <sub>I</sub> max (median and IQ range cm H <sub>2</sub> O)	-30 (-35 to -17)	-40 (-48 to -24)	0.189
P <sub>E</sub> max (median and IQ range cm H <sub>2</sub> O)	30 (19 to 60)	40 (30 to 60)	0.311
P <sub>a</sub> O <sub>2</sub> /F <sub>I</sub> O <sub>2</sub> (median and IQ range mm Hg)	317 (174 to 375)	290 (219 to 357)	0.663
pH (median and IQ range)	7.45 (7.40 to 7.5)	7.42 (7.39 to 7.45)	0.222
P <sub>a</sub> CO <sub>2</sub> (median and IQ range mm Hg)	37 (31 to 45)	38 (34 to 44)	0.530
PEEP (median and IQ range cm H <sub>2</sub> O)	0 (0 to 5)	3 (0 to 5)	0.478
V <sub>T</sub> predicted by body weight (median and IQ range mL/kg)	11.6 (10 to 14)	11.5 (10 to 13)	0.623
Acute lung injury (n and %)	4 (28%)	3 (9%)	0.100
Atelectasis (n and %)	3 (21%)	17 (51%)	0.043
VAP (n and %)	11 (78%)	15 (45%)	0.084
Hospital mortality (n and %)	3 (21%)	3 (9%)	0.275
Duration of mechanical ventilation (median and IQ range d)	63 (44 to 112)	39 (25 to 58)	0.005
ICU stay (median and IQ range d)	61 (30 to 64)	45 (28 to 60)	0.098

SAPS = Simplified Acute Physiology Score II

IQ = interquartile

P<sub>I</sub>max = maximum inspiratory pressure

P<sub>E</sub>max = maximum expiratory pressure

F<sub>I</sub>O<sub>2</sub> = fraction of inspired oxygen

PEEP = positive end-expiratory pressure

V<sub>T</sub> = tidal volume

VAP = ventilator-associated pneumonia

ICU = intensive care unit

travenous immunoglobulin, and no formal sedation or ventilator weaning protocols were used.

All but 6 patients (89%) required tracheostomy. Patients who did not require tracheostomy tended to have lower SAPS II scores and shorter duration of mechanical ventilation (Table 2). In 14 patients (30%) tracheostomy was delayed > 14 days after initiation of mechanical ventilation (Table 3).

New atelectasis developed in 49% of the patients. The risk of atelectasis was not affected by the initial choice of V<sub>T</sub> (p = 0.936) or PEEP (p = 0.751). Seven patients developed ALI. There were no significant differences in V<sub>T</sub> (median 10.6 mL/kg predicted body weight vs 11.7 mL/kg predicted body weight, p = 0.331) and PEEP (median 5 cm H<sub>2</sub>O vs 2.5 cm H<sub>2</sub>O, p = 0.189) between patients with or without ALI.

The most common complication was VAP, observed in 27 patients (56%). Patients who developed VAP required longer ventilatory support (median 42 d vs 27 d, p = 0.01) and longer ICU stay (48 d vs 34 d, p = 0.03). To evaluate risk factors associated with development of VAP, the following variables were entered in a stepwise logistic regression model: age, sex, SAPS II score, atelectasis, and timing of tracheostomy. Delayed tracheostomy (odds ratio

8.2, p = 0.029) and atelectasis (odds ratio 4.3, p = 0.069) were associated with the development of VAP.

## Discussion

In this retrospective cohort study we described the ventilator management of and pulmonary complications in a population of patients with Guillain-Barré syndrome who required mechanical ventilation, in an academic medical center during the period 1976 to 1996. Lower V<sub>T</sub> and higher PEEP were used in recent years, but that change was not associated with a significant change in mortality, incidence of VAP, duration of mechanical ventilation, or ICU stay. All but 6 patients received tracheostomy for prolonged ventilatory support. Receiving tracheostomy more than 2 weeks after initiation of mechanical ventilation was associated with a longer duration of mechanical ventilation and a higher VAP rate.

Consistent with recommendations from the literature, the initial ventilation mode was either synchronized intermittent mandatory ventilation or assist control.<sup>15</sup> Trends in ventilator management during the studied period paralleled changes described by others, with lower V<sub>T</sub> and higher PEEP, in accordance with the concept of lung-protective mechanical

ventilation.<sup>14</sup> Although  $V_T$  was decreased, we did not observe an increase in the incidence of atelectasis.<sup>14</sup>

Patients with Guillain-Barré syndrome usually have normal lung mechanics and oxygen requirements. The major reason for mechanical ventilation is respiratory muscle weakness and inability to clear secretions. The general recommendation is to intubate these patients when the vital capacity falls to approximately 15 mL/kg or if there is difficulty clearing secretions.<sup>8</sup> Tracheostomy is frequently performed for prolonged ventilator weaning and to facilitate secretion clearance.<sup>3</sup> Similar to a recent study from India,<sup>7</sup> only a minority of the patients in the present study did not receive tracheostomy. In another small series, tracheostomy was performed less often (32%), despite a mean duration of mechanical ventilation of 21 days.<sup>6</sup> Of note, the incidence of VAP in that study was very high (75%).<sup>6</sup> Apart from a trend toward lower initial SAPS II score and shorter duration of ventilatory support, we did not identify factors associated with successful extubation and avoidance of tracheostomy. In a previous study, tracheostomy was needed more frequently in elderly patients, those with pre-existing pulmonary disease, and in those with severe axonal involvement, by electromyography criteria (absent motor responses, widespread fibrillations).<sup>3</sup>

A recent multicenter survey of ventilator practice noted that a major determinant of the need for tracheostomy is neurologic disease that causes respiratory failure.<sup>16</sup> In a recent randomized trial in patients predicted to need mechanical ventilation for more than 14 days, early tracheostomy allowed for less sedation and was associated with lower incidence of VAP, shorter mechanical ventilation, shorter ICU stay, and dramatically lower hospital mortality.<sup>17,18</sup> In our study, delayed tracheostomy (> 14 d after intubation) was associated with higher incidence of VAP and longer duration of mechanical ventilation.

Several limitations need to be recognized. The study was performed in single tertiary-care center, and the severity of illness and complication rates may be different than what would be expected in a population-based cohort. The observational nature of the study and possible multiple confounding factors do not allow us to infer a cause-and-effect relationship between potential risk factors and outcomes. In particular, we did not record the exact time of VAP onset, so we could not determine a causal relationship between the timing of tracheostomy and the development of VAP. Finally, during the 20-year studied period there were changes in equipment and personnel, and inconsistent charting.

### Conclusion

When patients with Guillain-Barré syndrome require mechanical ventilation, this support is frequently required for an

extended period. In the setting of prolonged intubation and poor secretion clearance, these patients are at high risk of complications, especially VAP. Given the median duration of mechanical ventilation (> 3 weeks), it is reasonable to consider early tracheostomy in most patients with Guillain-Barré syndrome who require mechanical ventilation.

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