



Prevention of extubation failure in high-risk patients with neuromuscular disease ☆,☆☆,★

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Abstract

Background: A substantial proportion of patients with neuromuscular disease (NMD) who undergo positive pressure ventilation via endotracheal intubation for acute respiratory failure fail to pass spontaneous breathing trials and should be considered at high risk for extubation failure. In our study, we prospectively investigated the efficacy of early application of noninvasive ventilation (NIV) combined with assisted coughing as an intervention aimed at preventing extubation failure in patients with NMD.

Methods: This study is a prospective analysis of the short-term outcomes of 10 patients with NMD who were treated by NIV and assisted coughing immediately after extubation and comparison with the outcomes of a population of 10 historical control patients who received standard medical therapy (SMT) alone. The participants were composed of 10 patients with NMD who were submitted to NIV and assisted coughing after extubation (group A) and 10 historical control patients who were administered SMT (group B), who were admitted to a 4-bed respiratory intensive care unit (RICU) in a university hospital. Need for reintubation despite treatment was evaluated. Mortality during RICU stay, need for tracheostomy, and length of stay in the RICU were also compared.

Results: Significantly fewer patients who received the treatment protocol required reintubation and tracheostomy compared with those who received SMT (reintubation, 3 vs 10; tracheostomy, 3 vs 9; $P = .002$ and $.01$, respectively). Mortality did not differ significantly between the 2 groups. Patients in group A remained for a shorter time in the RICU compared with group B (7.8 ± 3.9 vs 23.8 ± 15.8 days; $P = .006$).

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☆ All authors declare to have no financial or personal relationships with people or organizations that could have inappropriately influenced (biased) the study.

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Table 2 Anthropometric, clinical, pulmonary function, and blood gas data at admission to RICU in patients submitted to NIV plus assisted coughing (group A) and to SMT (group B)

	Group A	Group B	<i>P</i>
No. of subjects	10	10	–
Age (y)	23 ± 12.19	35 ± 20	.12
BMI (kg/m ²)	21.9 ± 5.87	19.1 ± 6.0	.30
Sex (male; female)	5; 5	7; 3	.240
Diagnosis related to ARF, n			
Pneumonia	7	5	.64
Bronchitis	2	3	.64
Heart failure	–	1	1
Other	1	1	1
APACHE II	12 ± 4.99	11 ± 5	.659
Comorbidities, n	1.5 ± 1.17	1 ± 0.42	.219
GS	1.2 ± 1.31	1.6 ± 1.26	.56
Hospitalizations in 2 y, n	1 ± 0.63	1 ± 1.05	1
Patients previously administered HMV, n	6	7	.74
HMV use (h/d)	5.3 ± 5.1	6.8 ± 6.1	.35
FVC (L)	0.73 ± 0.41	0.84 ± 0.36	.53
PCEF (L/min)	1.79 ± 1.23	1.81 ± 0.99	.96
Pao ₂ (mm Hg)	97 ± 33.83	79 ± 36.33	.26
Paco ₂ (mm Hg)	74 ± 28.22	64 ± 26	.42
pH	7.27 ± 0.12	7.34 ± 0.13	.22
Oxygen saturation (%)	95 ± 2.58	95 ± 3	1

Values are expressed as mean ± SD.

92%. In all cases, nocturnal ventilation via nasal mask was continued until discharge from the RICU.

2.2.2. Assisted coughing

The following techniques were used to improve ability to clear secretions, depending on the patient's clinical status and level of cooperation:

1. Manually assisted coughing, to provide an optimal insufflation followed by an abdominal thrust in conjunction with the patient's coughing efforts. The ICU ventilator was used for delivering the deep insufflations. Patients were taught to maximally expand their lungs by "air stacking" (retaining consecutive) ventilator delivered volumes; once air stacked, the abdominal thrust was provided [24].

2. Mechanically assisted coughing (Mech-AC), delivered in the presence of stiffness of the chest wall (ie, severe thoracic deformity or obesity) and to uncooperative patients unable to fully perform air stacking. A mechanical device (Pegaso Cough; DIMA Italia, Bologna, Italy) was applied via a face mask, based on the simple principle of releasing alternating positive and negative pressure across the airway opening. It consists of a 2-stage axial compressor that provides positive pressure to the airway then rapidly shifts to negative pressure, thereby generating a forced expiration. The insufflation and exsufflation pressures and timing were independently adjusted according to efficacy and patient

Table 3 Clinical and blood gas data at the time of extubation and outcomes of patients submitted to NIV plus assisted coughing (group A) and to SMT (group B)

	Group A	Group B	<i>P</i>
Reason to be considered at risk for reintubation, n			
>1 consecutive extubation failure	3	5	.48
Ineffective cough	4	5	.61
Swallowing impairment	5	3	.65
Hypercapnia (Paco ₂ >45 mm Hg)	7	2	.07
Respiratory rate (breaths/min)	17.0 ± 4.1	17.6 ± 4.6	1
Heart rate (beats/min)	104.7 ± 11	117.3 ± 8.7	.01
Pao ₂ (mm Hg)	88 ± 31	97 ± 44	.60
Paco ₂ (mm Hg)	50 ± 13.5	41 ± 13	.14
pH	7.43 ± 0.04	7.43 ± 0.09	1
Oxygen saturation (%)	96 ± 3.8	96 ± 3	1
Reintubation, n	3	10	.002
Tracheostomy, n	3	9	.010
Death, n	0	2	.235
ICU stay (d)	7.8 ± 3.9	23.8 ± 15.8	.0061

Values are expressed as mean ± SD.

tolerance; generally, pressures between +30 and –40 cm H₂O were applied [25]. Although the Pegaso device has not been widely studied, its comfortable and successful application has been reported in the scientific literature [26].

Typically, a session of assisted coughing was provided whenever the Sao₂ level decreased, ventilator peak inspiratory pressure increased, or the patient had an increase in dyspnea or sense of retained secretions. Treatments were usually repeated until 1 or more of the following were observed: reduction in dyspnea, reduction in respiratory rate, sputum elimination, improved breathing sounds, increased percussion resonance, and increased Sao₂ level. Manually assisted coughing and Mech-AC were usually administered by a respiratory therapist except during weekends, when only trained nonprofessional caregivers (ie, patient's home care attendant, a family member, residents) were available. The daily treatment frequency was recorded on a diary by nurses.

2.2.3. Criteria for reintubation

The decision to perform ETI was made by the patient's treating physician, according to the criteria usually used for patients developing postextubation respiratory failure; in particular, patients were reintubated if they met at least 1 of the following criteria: (a) respiratory acidosis (pH <7.35 with a Paco₂ >45 mm Hg or, in the presence of hypercapnia at the time of extubation, a Paco₂ increase of >15%); (b) hypoxemia (ie, Sao₂ to <85%, despite the use of a high fraction of inspired oxygen); (c) a significant increase in respiratory rate; (d) changes in mental status, rendering the patient unable to tolerate NIV; (e) clinical signs of respiratory muscle fatigue (use of accessory muscles, inward movements of the abdomen