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Comparative Study of Different Intensity Rehabilitation Training on the Off-line Time and Success Rate of Severe Pneumonia Patients

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Abstract: *Objective:* To see how different levels of rehabilitation training affect weaning time and success in severe pneumonia patients on mechanical ventilation. *Methods:* Patients were divided into three groups (high, medium, low intensity). All received standard care plus their assigned rehabilitation. We compared weaning and other outcome measures. *Results:* The high-intensity group did better in reducing weaning time, improving success rate, lowering complications, and improving function. *Conclusion:* Higher-intensity rehabilitation can help patients wean sooner, but it should be tailored to each patient with close monitoring.

Keywords: Severe pneumonia; Rehabilitation training; Time off line; Success rate of off line; Mechanical ventilation; Prognosis

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1. Introduction

Severe pneumonia is caused by pathogen infection and often leads to respiratory failure. It is one of the main reasons for mechanical ventilation in the ICU. Even though treatment techniques continue to make progress, problems such as the difficulty of weaning from the ventilator, long hospital stays, and numerous complications remain prominent. Long-term bedridden and immobile conditions It can cause atrophy of respiratory muscles, a decrease in lung compliance, and also increase the risks of VAP, DVT and ICU-AW, prolonging the duration of mechanical ventilation. In recent years, early rehabilitation training has gradually gained attention in the ICU. Studies have shown that it can improve respiratory muscle function, promote sputum expulsion, enhance endurance, shorten the duration of mechanical ventilation and hospital stay, and reduce the incidence of complications. However, there is a lack of systematic research on the impact of rehabilitation training of different intensities on weaning effects. This study mainly compares the effects of different intensities of rehabilitation training on the weaning time, success rate and prognosis of patients with severe pneumonia, providing corresponding basis for clinical rehabilitation strategies.

2. Materials and methods

2.1. General information

A retrospective analysis was conducted on 95 patients with severe pneumonia admitted to the ICU of our hospital from January 2022 to December 2024.

2.1.1. Inclusion criteria

(1) Comply with the "Guidelines for the Diagnosis and Treatment of Community-Acquired Pneumonia in Chinese Adults (2016 Edition)" or the diagnostic criteria for severe cases of hospital-acquired pneumonia [1]

(2) Mechanical ventilation is required for at least 48 hours [1]

(3) Vital signs are relatively stable (systolic blood pressure ≥ 90 mmHg, heart rate 60–130 beats per minute, oxygenation index ≥ 150 mmHg) [1]

(4) The patient or their family members sign the informed consent form [1].

2.1.2. Exclusion criteria

(1) Combined with severe neurological diseases, unable to cooperate with rehabilitation training;

(2) Severe coagulation dysfunction or active bleeding;

(3) Acute myocardial infarction or unstable angina pectoris;

(4) Limb fractures or severe bone and joint diseases that affect movement;

(5) The expected survival period is less than 72 hours.

2.1.3. Grouping situation

They were divided into three groups according to the intensity of rehabilitation training:

(1) High-intensity group (32 cases)

18 males and 14 females, with an average age of (56.8 ± 10.2) years and an APACHEII score of (18.6 ± 4.3) points

(2) Moderate-intensity group (32 cases)

17 males and 15 females, with an average age of (58.2 ± 9.6) years and an APACHEII score of (19.2 ± 4.5) points

(3) Low-intensity group (31 cases)

16 males and 15 females, with an average age of (57.5 ± 10.8) years and an APACHEII score of (18.9 ± 4.7) points

There was no statistically significant difference among the three groups of patients in terms of gender, age, underlying diseases (hypertension, diabetes, coronary heart disease, etc.), APACHEII score, etc. ($p > 0.05$), and they were comparable.

2.2. Treatment methods

2.2.1. All patients were given

(1) Anti-infection treatment

Sensitive antibiotics are selected based on etiological and drug sensitivity results. Empirical treatment is given when the pathogenic bacteria are not identified.

(2) Mechanical ventilation

Synchronous intermittent ventilation (SIMV) or pressure support ventilation (PSV) mode is adopted, and parameters are adjusted according to the patient's oxygenation condition.

(3) Symptomatic support

This include nutritional support (enteral nutrition first, parenteral nutrition when necessary), maintaining water, electrolyte and acid-base balance, controlling blood sugar, and preventing stress ulcers, etc.

2.2.2. Rehabilitation training program

High-intensity group: Twice a day, 30 to 40 minutes each time. The content includes:

(1) Turning over and sitting up in bed for 5 minutes each time;
(2) Bedside standing training (5 to 10 minutes each time);
(3) Walking training in the ward (10 to 20 meters away, gradually increasing according to tolerance);
(4) Respiratory muscle training (Using a respiratory load trainer with a higher resistance setting, for 10 minutes each time).

During the training, vital signs should be continuously monitored. If the heart rate increases by more than 20 beats per minute or the systolic blood pressure drops by more than 20 mmHg, the training should be paused.

Moderate-intensity group: Twice a day, 20 to 30 minutes each time. The content includes:

(1) Turning over and sitting up in bed for 5 minutes each time;
(2) Stand by the bedside for a short time (3 to 5 minutes each time);
(3) Respiratory muscle training (moderate resistance, 8 to 10 minutes each time).

Low-intensity group: 1-2 times a day, 10-20 minutes each time. The content includes:

(1) Passive activities on the bed (limb joint activities, 5 to 10 minutes each time);
(2) Respiratory muscle training (low resistance, 5 to 8 minutes each time).

All rehabilitation training is conducted by ICU rehabilitation therapists or trained nurses at the bedside, and necessary rescue equipment is provided.

2.3. Observation indicators

(1) Weaning time
The period from the initiation of mechanical ventilation to successful weaning (spontaneous breathing ≥ 48 hours);
(2) Weaning success rate
The proportion of patients who successfully weaned from the ventilator within 28 days;
(3) Length of stay in the ICU;
(4) Incidence of VAP: Meets the VAP diagnostic criteria of the US CDC;
(5) 28-day survival rate;
(6) 6-minute walking distance (6MWD)
Measured 28 days after treatment;
(7) Maximum inspiratory pressure (MIP)
Assesses the strength of the respiratory muscles;
(8) APACHEII score
Compare the changes in the severity of the disease before and after treatment.

2.4. Statistical methods

The correlation analysis was performed using SPSS 25.0 statistical software. Quantitative data were presented as mean ± standard deviation ($\bar{x} \pm s$), with between-group comparisons conducted via one-way ANOVA and pairwise comparisons performed using LSD-*t* test. Categorical data were expressed as percentages, and between-group comparisons were analyzed using χ^2 test. A p value < 0.05 indicated statistically significant differences.

3. Results

3.1. Offline time and success rate

The high-intensity group demonstrated significantly shorter off-ventilator time compared to the moderate and low-intensity

groups ($p < 0.05$), with a markedly higher success rate in achieving off-ventilator status ($p < 0.05$). These findings indicate that moderately increasing rehabilitation training intensity during mechanical ventilation therapy for severe pneumonia patients can effectively promote respiratory function recovery, reduce ventilator dependence duration, and improve off-ventilator success rates. The underlying mechanisms may include enhanced respiratory muscle strength and endurance from high-intensity training, improved ventilation-perfusion balance, enhanced clearance of airway secretions, and accelerated weaning from mechanical ventilation [2]. (see **Table 1**).

Table 1. Effect of different intensity rehabilitation training on the off-line time and success rate of severe pneumonia patients

Group	Number of cases	Offline time (day, $\bar{x} \pm s$)	Offline success rate (%)
High strength group	**32**	8.6 ± 2.3	93.8
Moderate-intensity group	32	11.4 ± 2.8	81.3
Low-intensity group	31	14.7 ± 3.5	64.5

3.2. ICU hospitalization time and VAP incidence

The high-intensity group demonstrated significantly shorter ICU stays compared to the other two groups, with a markedly lower incidence of ventilator-associated pneumonia (VAP). Intensive rehabilitation training not only shortened mechanical ventilation duration but also reduced both ICU hospitalization days and the risk of ventilator-associated pneumonia. This effect may stem from early mobilization, which enhances sputum drainage, minimizes aspiration risks, improves systemic circulation, and strengthens immune function, all contributing to reduced nosocomial infection rates [3]. (see **Table 2**).

Table 2. Effects of rehabilitation training with different intensities on ICU length of stay and VAP incidence

Group	ICU length of stay (day, $\bar{x} \pm s$)	VAP incidence (%)
High strength group	12.3 ± 3.1	6.3
Moderate-intensity group	15.6 ± 3.8	18.8
Low-intensity group	19.2 ± 4.5	32.3

3.3. 28-day survival rate

Statistically significant differences were observed among the three survival groups, with the high-intensity group demonstrating the highest survival rate. This finding indicates that for severe pneumonia patients, intensive rehabilitation training not only facilitates recovery but also indirectly improves short-term survival rates by reducing complications and enhancing overall health. Furthermore, such training helps preserve muscle strength and functional reserves, thereby boosting the patient's overall disease resistance [4]. (see **Table 3**).

Table 3. Effects of different intensity rehabilitation training on 28-day survival rate

Group	Number of survival cases	Number of deaths	Survival rate (%)
High strength group	31	1	96.9
Moderate-intensity group	28	4	87.5
Low-intensity group	24	7	77.4

3.4. Changes in functional indicators

After 28 days of treatment, all three patient groups demonstrated significant improvements in 6-minute walk distance

(6MWD) and maximal isometric power (MIP) compared to baseline levels, with *p*-values below 0.05. The APACHE II score also showed marked reduction ($p < 0.05$). Notably, the high-intensity group outperformed both moderate and low-intensity groups in improvement magnitude ($p < 0.05$). These findings strongly indicate a positive correlation between rehabilitation training intensity and functional recovery. High-intensity training proved particularly effective in enhancing exercise endurance, strengthening respiratory muscles, and alleviating disease severity. In clinical practice, training intensity should be progressively increased under close monitoring based on patients' tolerance to achieve optimal rehabilitation outcomes [5]. (see **Table 4**).

Table 4. Effects of rehabilitation training intensity on functional outcomes ($\bar{x} \pm s$)

Group	Time point	6MWD (meter, $\bar{x} \pm s$)	MIP (cmH_2O, $\bar{x} \pm s$)	APACHEII (score, $\bar{x} \pm s$)
High strength group	Before treatment	125 ± 35	45 ± 8	18.6 ± 4.3
	Treatment for 28 days	345 ± 48	62 ± 10	8.2 ± 3.1
Moderate-intensity group	Before treatment	128 ± 36	46 ± 9	19.2 ± 4.5
	Treatment for 28 days	302 ± 45	56 ± 9	10.5 ± 3.4
Low-intensity group	Before treatment	126 ± 34	44 ± 8	18.9 ± 4.7
	Treatment for 28 days	258 ± 42	51 ± 8	12.8 ± 3.8

4. Discussion

The results obtained from this study indicate that relatively high-intensity rehabilitation training can significantly shorten the time for patients with severe pneumonia to be weaning from ventilators, increase the success rate of weaning and the 28-day survival rate, reduce the occurrence probability of VAP, and also improve respiratory muscle function and exercise endurance. This is consistent with the conclusions of early rehabilitation studies at home and abroad. The underlying mechanisms may include enhancing respiratory muscle strength, promoting sputum expulsion, improving pulmonary perfusion, reducing ICU-AW, and improving psychological state, etc [6]. The intensity needs to be adjusted under close monitoring based on the patient's tolerance. For patients with unstable conditions, it should start from a low intensity. This study adopted a single-center retrospective design with a limited sample size, lacking long-term follow-up and quality of life assessment. In the future, multi-center randomized controlled studies can be conducted, and objective indicators such as diaphragmatic ultrasound and electromyography can be introduced for verification. Combined with intelligent monitoring technology, the safety and efficacy of training are dynamically evaluated to provide more sufficient evidence for individualized rehabilitation strategies [7,8].

5. Conclusion

In patients with severe pneumonia, appropriately intense rehabilitation training can improve weaning outcomes and prognostic indicators, such as shortening the time required for weaning, increasing the success rate and survival probability of weaning, reducing the occurrence probability of complications such as ventilator-associated pneumonia, and promoting the recovery of respiratory muscle function and exercise endurance. In clinical practice, On the basis of close monitoring and thorough assessment of the patient's vital signs, oxygenation status and tolerance, rehabilitation training should be gradually implemented in a certain order. The intensity and content should be dynamically adjusted according to the changes in the condition to achieve individualized treatment. For patients with unstable hemodynamics or critical conditions, it is necessary to start with low-intensity training and gradually increase the load when conditions permit. Under the premise of ensuring safety, the best rehabilitation effect can be achieved. With the help of scientific and

reasonable rehabilitation intervention, patients can get rid of mechanical ventilation earlier, shorten the length of stay in the ICU, and also improve their long-term quality of life. Provide key support for the comprehensive treatment of severe pneumonia.

Disclosure statement

The author declares no conflict of interest.

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