Impact of mechanical ventilation time on functional capacity and muscular strength of patients under intensive care

Impacto do tempo de ventilação mecânica na capacidade funcional e força muscular de pacientes em terapia intensiva

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Abstract

Introduction: A prolonged assisted ventilation (AV) period might induce complications. **Objective:** To compare functional capacities and muscle strength of patients under AV. **Methods:** This is a prospective cohort observational study. The patients selected were under mechanical ventilation in any given moment, and they were evaluated only at the time of discharge from the intensive care unit (ICU). The convenience sample of 103 was selected and divided into a group with up to six days of AV (G6) and another with seven days or more of AV (G7). The protocol proposed was: application of the Medical Research Council (MRC) scale, dynamometry, Barthel index, ability to ambulate at ICU discharge. A call was made to the patients six and 12 months after hospital discharge for the application of the Barthel index. **Results:** We verified that G6 patients obtained better muscular strength measured through right 14 (8–30) and left 18 (8–26) dynamometry and MRC scale 48 (44–56). Only seven (14%) patients from the G7 group were able to ambulate. G7 patients showed greater functional loss at hospital discharge 32 (15–60). After one year of hospital discharge, both groups had recovered their functional capacity 100 (100–100). **Conclusion:** When evaluating the process of AV, it is possible to conclude that the longer the ventilator is used, the greater the loss of strength and functionality. In addition, there is a significant recovery of functionality after one year of hospital discharge.

Keywords: Activities of daily living. Intensive Care Units. Mortality. Muscle weakness. Survival.

Resumo

Introdução: *Um período prolongado de ventilação assistida (VA) pode induzir complicações.* ***Objetivo:*** *Comparar as capacidades funcionais e a força muscular de pacientes sob VA.* ***Métodos:*** *Trata-se de um estudo observacional de coorte prospectivo. Os pacientes selecionados encontravam-se em ventilação mecânica em qualquer momento, sendo avaliados apenas no momento da alta da unidade de terapia intensiva (UTI). A amostra de conveniência de 103 foi selecionada e dividida em um grupo com até seis dias de VA (G6) e outro com sete dias ou mais de VA (G7). O protocolo proposto foi: aplicação da escala MRC, dinamometria, índice de Barthel, capacidade de deambulação na alta da UTI. Foi feito um chamado aos pacientes seis e 12 meses após a alta hospitalar para aplicação do índice de Barthel.* ***Resultados:*** *Verificamos que os pacientes do G6 obtiveram melhor força muscular medida através da dinamometria direita 14 (8–30) e esquerda 18 (8–26) e escala do MRC 48 (44–56). Apenas sete (14%) pacientes do grupo G7 conseguiram deambular. Os pacientes do G7 apresentaram maior perda funcional na alta hospitalar 32 (15–60). Após um ano da alta hospitalar, ambos os grupos recuperaram sua capacidade funcional 100 (100–100).* ***Conclusão:*** *Ao avaliar o processo de AV, é possível concluir que quanto maior o tempo de uso do ventilador, maior a perda de força e funcionalidade. Além disso, há uma recuperação significativa da funcionalidade após um ano da alta hospitalar.*

Palavras-chave: *Atividades de vida diária. Unidades de Terapia Intensiva. Mortalidade. Fraqueza muscular. Sobrevivência.*

Introduction

Intensive care units (ICU), aimed to treat patients with severe conditions, are going through important evolutions since their origin.[1,2] With scientific advances and a new epidemiological profile, there has been an increase in the life expectancy of the population and, therefore, an increase in the number of critical patients that evolve to the necessity of assisted ventilation or prolonged mechanical ventilation, when the patient fails the first spontaneous breathing test and requires up to three tests or seven days after the first test to wean off the ventilator.[3-6]

A long period under assisted ventilation might cause post-traumatic disorder, anxiety and depression, reduction in quality of life, loss of functionality, and muscular weakness.[7,8] Only 24 hours after the start of treatment in intensive care patients lose 11% of the degree of strength, with the possibility of going up to 24%-55% if the subject remains hospitalized from seven to ten days. The patient's functionality might not be completely recovered even in 12 months after being discharged from the hospital.[9]

Mortality is an important aspect to be evaluated after ICU discharge. There are indicators that the mortality rate is correlated with the duration of the assisted ventilation, sex, diagnosis on admission, hospitalization time, and polyneuropathy of the critical patient.[9,10] From this perspective, the evaluation of the patient's muscular strength is important not only at the time of ICU discharge but on the long term, in order to determine possible complications inherent to this period and the causes of mortality on this population.

This study compares functional capacities, muscular strength, and survival rate of patients who were discharged from ICU after six days and seven days or more of assisted ventilation.

Methods

This prospective cohort observational study was conducted in a public university hospital in São Paulo, Brazil, from July 2014 to April 2015 in accordance with the Ethics Committee n. 709,052 of June 24, 2014.

The patients selected were under mechanical ventilation in any given moment on the ICU, whether they were clinical or surgical patients. The individuals were included in the study only after signing an agreement term. A total of 128 patients were selected by convenience sampling. The individuals selected were evaluated only at the time of discharge from the ICU and re-evaluated six months and one year after hospital discharge. The patients had to be hemodynamically stable and cooperative, which means Glasgow ≥ 10. Individuals with hemodynamic instability, fever (over 37.8 °C), heart arrhythmia, any factor that prevents ambulation, such as fractures, amputation of inferior limbs, usage of external fixator or calcaneus injuries, hemiplegic patients, and patients with post traumatic spinal cord injury or neuromuscular diseases were excluded from the study. From the initial sample, 19 patients passed away during data collection. Two

patients did not present the appropriate level of conscience for the study according to the criteria, one patient was discharged from the hospital while using assisted ventilation, and three patients who entered palliative care were also excluded from the study.

The convenience sample of 103 patients and the assisted ventilation time determined to which of both groups the patient would be recruited. The physical therapists who assessed the patients were not blinded during the study. Study patients were divided into two groups: a group with up to six days of mechanical ventilation (G6) and a group with seven days or more of ventilation (G7). These two groups were divided in this way because, according to the Brazilian Directive on Mechanical Ventilation,[11] weaning from mechanical ventilation is difficult when, within seven days, extubation attempts are not successful. The evaluation protocol was proposed in the following manner: application of the MRC scale, dynamometry, Barthel index, and ability to ambulate at the time of discharge from ICU. Also, medical records were analyzed for evaluation of the use of corticoids and neuromuscular blockers, and a phone call was made to the patients six months and a year after hospital discharge for the application of the Barthel index.

The MRC scale allows bilateral evaluation of muscular strength of superior and inferior limbs through articulate moves, ranging from 0 to 5 degrees, where 0 is the absence of muscular contraction and 5 represents the greatest muscular strength. The evaluated articulate moves are the following: pulse and knee push-ups, shoulder abduction in superior body parts and dorsiflexion, knee extension and hip push-ups in inferior limbs. The maximum score one can obtain is 60 points; the higher the score, the bigger the muscular strength.[12] The strength of palmar prehension was evaluated with a portable hydraulic dynamometer SH - Sahen, Korea. The American Society of Hand Therapists recommends the patients to be placed sitting with their shoulders in a neutral stance, elbows flexed at 90° and fists in neutral position.[12] The patient was asked to tighten the device using maximum strength, keeping the position of the hands, elbows, and shoulders. There were three measurements performed with a gap of one minute between them, where the highest value achieved by the patient was the one considered.[13,14]

The Barthel index is an instrument that evaluates the patient's level of independence when performing ten daily basic activities such as: eating, practicing personal hygiene, usage of toilets, showering, dressing up, controlling sphincters, ambulation, transferring from chair to bed, and going up and down the stairs. Each item is scored according to the patient's execution of these tasks, whether in a dependent or independent manner or in need of any support. The score ranges from 0 to 100, where 0 indicates maximum dependence for all activities and 100, the individuals' independence.[15] Patients were assessed for their ability to walk on the day of ICU discharge.

Those who could move at least around the bed with or without assistance were considered capable of walking. The cardiac frequency and saturation were constantly monitored via a pulse oximeter from the brand SM-100, Germany. The intent of this test was to evaluate the capacity of ambulation or lack thereof in these patients. At the moment of admission to the ICU, the Sequential Organ Failure Assessment (SOFA) score, which quantifies the degree of organic dysfunction, and the Acute Physiologic Assessment and Chronic Health Evaluation (APACHE) II score, which stratifies the patient according to the severity of the disease, were used to evaluate the patient's prognosis.[16,17]

Lastly, after a period of six months and a year after hospital discharge, patients were contacted via telephone for the evaluation of mortality.

The software used to perform the statistical analysis was Microcal Oringin 8.0. To compare the categorical variables in both groups of assisted ventilation, the Chi-square test (or Fisher's exact test) was used. To compare the numerical variables between both groups of assisted ventilation, the Mann-Whitney test was used, due to the absence of the regular distribution of the variables. At last, to analyze factors related to the duration of assisted ventilation, the linear regression analysis, univariate and multiple models with Stepwise criteria for variable selection were used. The significance level adopted for the statistical tests was $p < 0.05$.

Results

For the study, 128 patients who used mechanical ventilation in the ICU were selected. Of the patients initially included, 19 died and six were excluded according to the study criteria. Two patients were excluded for having Glasgow less than 10, one patient for being discharged from the ICU using mechanical

ventilation, and three patients for being included in the institution's palliative care. Of the 103 patients who were extubated and discharged from the ICU, 53 were selected for the G6 group and 50 for the G7 group, according to the total time of mechanical ventilation.

These patients were re-evaluated six months and one year after hospital discharge. After one year of hospital discharge a total of 48 patients were lost to follow-up after three unsuccessful attempts of telephone contact on consecutive days. Fifty-five patients were contacted via telephone, 30 patients from the G6 group and 25 patients from the G7 group. During this period, six patients died, three from the G6 group and three from the G7 group. According to the study criteria, it was not possible to telephone 42 patients, 26 being from G6, and 16 from G7 (Figure 1).

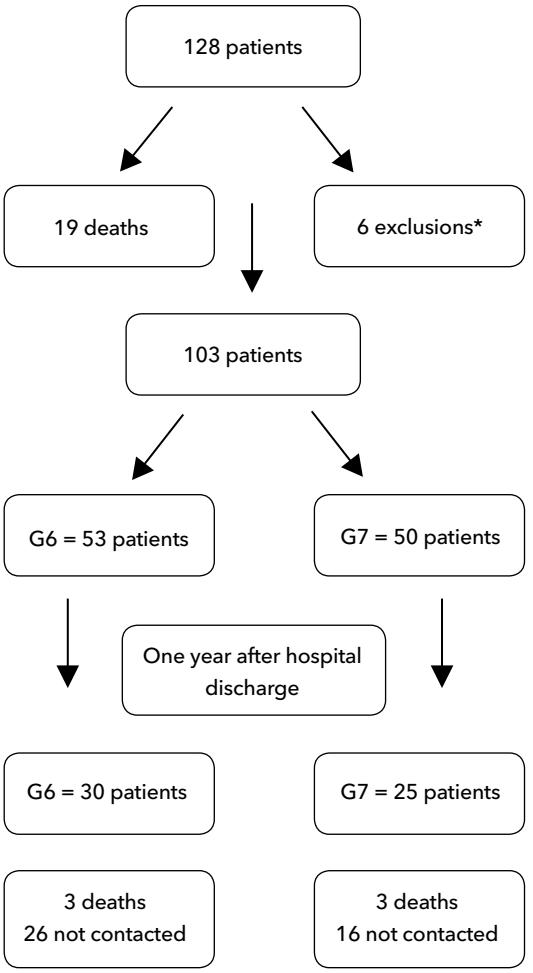

Figure 1 - Data collection.

Nota: *Two patients were excluded for having Glasgow less than 10, one for use of mechanical ventilation, and three for palliative care.

The descriptive analysis of the variables showed that the average age of the patients in this study is 55 (44-67) years old, with 43 (41.75%) women and 60 (58.25%) men. The average period of assisted ventilation were 5 (1-19) days. The mean time between extubation and muscle strength assessment was 4.4 ± 3.36 days in G6 and 6.2 ± 4.42 days in G7. When evaluating the individuals' muscular strength, we observed that the MRC median scored 48 (44-56) points, and both right and left dynamometry scored 14 (8-30) and 18 (8-26), respectively. The functionality evaluated on the moment of discharge from the ICU scored 55 (30-75), and 100 (100-100) points six months and a year after hospital discharge. Of all patients contemplated in the study, (45) 44.12% used corticoids and 17 (16.67%) used neuromuscular blocking. We observed that 62% (60) of hospitalizations was due to surgeries, only 17% (16) was due to a diagnosis of sepsis and 21% (27) due to other diseases (Table 1).

By comparing the numerical and categorical variables of both groups regarding the duration of the assisted ventilation treatment, we verified that G6 patients were able to walk around more frequently. Besides that, they obtained better muscular strength measured through right and left dynamometry and MRC scale, as well as better functionality, observed through the Barthel index, with significant differences between both groups. G7 patients presented extended time on the ICU and hospitalization in general, with a higher SOFA score and significant difference in comparison to G6. Only seven (14%) patients from the G7 group were able to ambulate on the day of discharge while 26 (49%) patients from G6 roamed around, with significant difference (Table 2).

We observed that the more time spent under assisted ventilation, the lower the value of right and left dynamometry, the MRC scale and the Barthel value. In both groups there was a positive correlation between days under assisted ventilation and intensive care treatment/hospital time in general.

The Barthel index at the time of hospital discharge was 5 (30-75). Six months and one year after hospital discharge, it rose to 100 (100-100), showing meaningful comparison, which was also found on different moments of the evaluation. On G6, the mean was 70 (55-85) on the moment of discharge from intensive care unit and 100 (100-100) six months and a year after being discharged from the hospital. On G7, the medians were 32 (15-60) during discharge from intensive care, 100 (100-100) six months and a year later with significant difference.

Table 1 - Sample characterization

		Total Sample (n = 103)			G6 (n = 53)			G7 (n = 50)	
Characteristic	**Q1**	**Median**	**Q3**	**Q1**	**Median**	**Q3**	**Q1**	**Median**	**Q3**
Age	44	55	67	44	55	66	41	54	69
SOFA	6	9	11	6	8	9	8	10	12
APACHE	14	19	24	14	18	24	15	21	26
Characteristic		**n**	**%**		**n**	**%**		**n**	**%**
Sex	Female	43	42		19	35		35	70
	Male	60	58		34	65		15	30
Reason for hospitalization	Surgeries	60	62		41	68		19	32
	Sepsis	16	17		7	43		9	57
	Other diseases	27	21		9	33		18	67

Note: G6 = group with up to six days of mechanical ventilation; G7 = group with seven days or more of ventilation; SOFA = Sequential Organ Failure Assessment; APACHE = Acute Physiologic Assessment and Chronic Health Evaluation.

Table 2 - Comparison of numerical variables between groups

	Total sample (n =103)			G6 (n = 53)			G7 (n = 50)		
Characteristic	**Median**	**Q1**	**Q3**	**Median**	**Q1**	**Q3**	**Median**	**Q1**	**Q3**
MRC	48	44	56	48	46	58	46	38	53
Dynamometry right	14	8	30	28	14	34	9	4	40
Dynamometry left	8	18	26	24	14	32	8	4	19
Barthel	55	30	75	70	55	85	32	15	60
Barthel 6 months	100	100	100	100	100	100	100	100	100
Barthel 1 year	100	100	100	100	100	100	100	100	100

Note: G6 = group with up to six days of mechanical ventilation; G7 = group with seven days or more of ventilation; MRC = Medical Research Council.

When analyzing the deaths during the data collection phase, there was not any significant difference between both groups (p = 0.11). Through the descriptive regression analysis of this study in relation to the survival of patients six months and a year after being discharged from the hospital, we observed that six (5%) of all patients died by the end of the study period. The comparison of categorical variables between the period under assisted ventilation and their deaths was not significant, with three (5%) from the G6 and three (6%) from the G7.

Discussion

This study showed that patients who remain on mechanical ventilation for a long period may lose muscle strength and important functionality upon discharge from the ICU. The study results demonstrate that after six months of hospital discharge, the patient's functionality is recovered.

Through a comparative analysis, it was observed that patients from the G7 obtained a higher loss of muscular strength compared with the G6. These findings corroborate the studies of Dantas et al.[5] and Yosef-Brauner et al.,[18] who have shown that patients who remained for a period longer than seven days under assisted ventilation ended up being diagnosed with peripheral muscle weakness. Still from this perspective, we observed that the longer the period of time under assisted ventilation, the lower the muscle strength. All the same, Ali et al.[19] and Lee et al.,[20] observed that patients who remained under assisted ventilation for a longer time presented a lower MRC value.

In our study, of all 50 patients on G7, only seven were capable of ambulating at hospital discharge. Nydahl et al.[21] and Chiang et al.[22] also observed that, from the patients under assisted ventilation, only 4% and 29,4%, respectively, were capable of wandering.

Van der Schaaf's et al.[23] and Chiang et al.[22] found in their studies that patients who were longer under assisted ventilation suffered significant functional losses. These results corroborate the ones in this study, where it was observed that a longer time under assisted ventilation equals a lower value of Barthel. There was greater functional loss in the G7 compared to the G6.

We also observed that the functional capacities of individuals from G7 decreased in the moment they were discharged from ICU and improved six months and twelve months after being discharged from the hospital. This decrease can be observed in both G6 and G7, a fact which endorses findings from other studies. Sacanella's et al.,[24] however, despite showing a decrease in autonomy levels seen through the Barthel index after hospital discharge, believe that this autonomy is not recovered until twelve months after discharge.

Wieske et al.[25] have observed that mortality is correlated to polyneuropathy on the critical patient, which is correlated to the mortality of patients up to six months after hospital discharge. Cabral et al.[26] highlighted that patients who were longer than seven days under assisted ventilation showed a higher mortality rate and that this was related to the polyneuropathy of the critical patient. In this study, G7 presented a lower MRC score and a higher SOFA. However, our study did not find a significant correlation between assisted ventilation time and mortality on G6 and G7 after hospital discharge, with a survival rate of 94.17%. We can assume that the results found are due to the high value of MRC scale, dynamometry, and Barthel index found on the population of the study, making their recovery post-hospitalization easier.

Some of the limitations of this study include the sample being obtained by convenience and without blinding the evaluators. In addition, the study was performed in a single center, with a small sample and with great loss to follow-up after six months of hospital discharge. Another significant limitation is the variation in time between extubation and patient assessment. These limitations do not invalidate the work performed, requiring further studies to corroborate our findings.

Besides that, in face of the information provided, we reflect on the real goal that should be reached during treatment and recovery, not only on the short term, but considering the return of these patients to life in society after their period under intensive care. The complications presented by these patients greatly affect economy, society, their families and, obviously, themselves.

Conclusion

When evaluating the process of assisted ventilation on ICU, it is possible to conclude that the longer the ventilator is used, the greater the loss of muscle strength and functionality at the time of hospital discharge. Among the most important functional limitations is the ability to ambulate. Despite the considerable functional loss in the moment of discharge from intensive care, there is still a significant recovery regardless of the time spent under ventilation a year after hospital discharge. Furthermore, prolonged mechanical ventilation time correlates with the use of corticosteroids and neuromuscular blockers.

It can also be concluded that time of assisted ventilation did not interfere significantly in mortality during hospital stay and a year after discharge. In addition, it is important that the work of early mobilization is done together with a multiprofessional team to ensure the patient's full recovery.

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Authors' contribution

MC: conceptualization, data curation, formal analysis, investigation, methodology, writing. MS: conceptualization, investigation, methodology, writing. LCF: formal analysis, methodology, project administration. LCM: conceptualization, formal analysis, methodology, supervision, writing.

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