American Review of Respiratory Medicine
Revista Americana de Medicina Respiratoria

ORIGINAL ARTICLE

ISSN 1852-236X

Mortality in Patients Requiring Prolonged Mechanical Ventilation: A Retrospective Cohort Study with Propensity Score Analysis

Mortalidad de pacientes en ventilación mecánica prolongada: Estudio de cohorte retrospectiva con análisis de propensión

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Received: 04/11/2024
Accepted: 06/16/2024

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ABSTRACT

Background: An increase has been observed in the number of patients requiring specialized care in mechanical ventilation weaning and rehabilitation centers (MVWRCs).
Methods: An observational study with propensity score analysis was conducted on a 13-year cohort of patients in a MVWRC in Argentina. Predictors of mortality were analyzed.
Results: Mortality assessed using the inverse probability of treatment weighting was associated with age [OR=1.037 (95% CI: 1.023-1.052), p<0.001], weaning from mechanical ventilation (MV) [OR=0.398 (95% CI: 0.282-0.560), p<0.001], decannulation [OR=0.059 (95% CI: 0.038-0.091), p<0.001], history of cardiovascular disease [OR=1.684 (95% CI: 1.146-2.474), p<0.001], pneumonia in non-chronic obstructive pulmonary disease (non-COPD) [OR=2.649 (95% CI: 1.631-4.302), p<0.001], and COPD [OR=0.477 (95% CI: 0.298-0.762), p=0.002].
Multiple logistic regression analysis in the propensity score-matched sample indicated that weaning from MV [OR=0.313 (95% CI: 0.137-0.715), p=0.006] and decannulation [OR=0.057 (95% CI: 0.021-0.155), p=<0.001] remained associated with lower mortality, whereas age [OR=1.056 (95% CI: 1.026-1.087), p=<0.001] remained a predictor associated with higher mortality.
Conclusion: Mortality in patients requiring MV in a MVWRC was independently associated with older age, failed weaning from MV, and non-decannulation. It is very important to identify such predictors in order to plan attainable treatment goals.

Key words: Critical Care; Assisted ventilation; Tracheostomy

RESUMEN

Introducción: Se ha observado un aumento en el número de pacientes que requieren ser derivados a centros de desvinculación de ventilación mecánica y rehabilitación.

Rev Am Med Resp 2024;24:85-94
https://doi.org./10.56538/ramr.MXDB9423

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Material y métodos: Se realizó un estudio observacional con análisis por puntaje de propensión en el que se analizaron los predictores de mortalidad en una cohorte de trece años internados en un centro de desvinculación de ventilación mecánica y rehabilitación.
Resultados: La mortalidad analizada mediante ponderación por el inverso de la probabilidad de tratamiento se asoció a edad [OR = 1,037 (IC95 % 1,023-1,052), p < 0,001], desvinculación de la ventilación mecánica (VM) [OR = 0,398 (IC95 % 0,282-0,560), p < 0,001], decanulación [OR = 0,059 (IC95 % 0,038-0,091), p < 0,001], antecedentes cardiovasculares [OR = 1,684 (IC95 % 1,146-2,474), p < 0,001], neumonía en no en fermedad pulmonar obstructiva crónica [OR = 2,649 (IC95 % 1,631-4,302), p < 0,001] y la presencia de enfermedad pulmonar obstructiva crónica [OR = 0,477 (IC95 %0,298-0,762), p = 0,002] El análisis de regresión logística múltiple de la muestra emparejada mantuvo la aso ciación entre la desvinculación de la ventilación mecánica [OR = 0,313 (IC95 % 0,137- 0,715), p = 0,006] y la decanulación [OR = 0,057 (IC95 % 0,021-0,155), p ≤ 0,001] como variables asociadas a una menor mortalidad y a la edad [OR = 1,056 (IC95 % 1,026-1,087), p ≤ 0,001] como predictora asociada a mayor mortalidad.
Conclusión: La mortalidad en pacientes con ventilación mecánica en un centro de desvinculación de ventilación mecánica y rehabilitación se asoció de manera independiente a una mayor edad, imposibilidad para la desvinculación de la ventilación mecánica y la no decanulación. Es importante contar con dichos predictores para poder planificar objetivos de tratamiento reales.

Palabras claves: Cuidados críticos; Ventilación asistida; Traqueostomía

INTRODUCTION

In recent decades, greater interest has been observed in patients with physical, psychological, and cognitive sequelae who were discharged from the Intensive Care Unit (ICU) requiring prolonged mechanical ventilation (PMV), that is to say, using mechanical ventilation for more than 21 days, more than 6 hours a day.[1] These patients are often referred to as "chronic critical patients" due to their clinical condition overlapping with a state of persistent inflammation and high catabolism.[2] Functional dependence, the need for skilled care, and high mortality justify the implementation of measures to try to improve clinical practice in order to achieve the best possible outcomes in the shortest period of time.

In our country, this population of patients discharged from the ICU can be treated in mechanical ventilation weaning and rehabilitation centers (MVWRCs). It is difficult to compare outcome descriptions, as there is a great diversity of admission and discharge criteria in different countries. However, better percentages of mechanical ventilation weaning and higher survival rates have been described in patients admitted to MVWRCs compared to those who remained in the ICU.[3-6]

Identifying and recognizing predictors of mortality in chronic critical patients would facilitate decision-making for the patient, the physician, and the family. Advanced age, number of comorbidities, the etiology of the acute respiratory failure, and failed weaning from mechanical ventilation (MV) have been recognized in various studies as predictors of mortality.[1, 3-6] In our country, there is limited information on the population of patients on PMV (prolonged mechanical ventilation). [7, 8]

The objective of this study was to analyze the relationship between overall mortality and weaning in patients on PMV in a MVWRC and to identify factors associated with mortality.

MATERIALS AND METHODS

A retrospective observational cohort study was conducted using propensity score analysis from January 2007 to December 2019 at Clínica Basilea, a privately funded mechanical ventilation weaning and rehabilitation center with 60 beds located in Buenos Aires, Argentina.

The study included all patients recorded in a database who were admitted during the study period and had signed the consent for the use of anonymized data for epidemiological research.

Exclusion criteria: patients admitted to the MVWRC without a tracheostomy cannula, not requiring MV, with missing data in their medical records, or those who were discharged from the MVWRC for reasons other than death or medical discharge (i.e., patients discharged because they were transferred to the ICU, by decision of the health coverage, or the family).

The primary variable of analysis was mortality during hospitalization at the MVWRC. Weaning from MV was considered an independent variable.

The institution's weaning protocol stipulates that a patient on MV can begin a nocturnal spontaneous ventilation (SV) test after having ventilated spontaneously for 12 hours during the day, for the previous three days. Additionally, we used the definition established at the 2005 consensus conference,[1] where a patient is considered successfully weaned from MV after being without it for seven consecutive days.[9] Patients were considered "unweaned from MV" if they required continuous or partial MV at the time of discharge from the MVWRC.

The following predictive variables were collected: pre-ICU history (age, gender, medical history); ICU admission data (reason for admission: medical, surgical, or polytrauma; diagnosis at ICU admission; days in ICU; and days on MV in the ICU); MVWRC hospitalization data (days on MV and days hospitalized in the MVWRC; decannulation; recannulation); and reason for discharge (discharge to home or death).

Statistical analysis

A description of the complete sample was performed. Continuous variables that assumed a normal distribution were reported as mean and standard deviation (SD); otherwise, the median (Med) and interquartile range (IQR) were used. Categorical variables are reported as frequency and percentage. The Kolmogorov-Smirnov test was used to determine the distribution of the sample.

Baseline comparison of the cohort

Clinical and demographic variables were compared between patients who achieved weaning and those who failed. The Mann-Whitney test was used for numerical variables, while Pearson's Chi-square test or Fisher's exact test, as appropriate, were used for categorical variables in the distribution of the double entry table.

Calculation of propensity score (PS), inverse probability of treatment weighting, and PS matching

Given the observational, uncontrolled nature of the study and the suspected differences between the groups to be compared, a propensity score (PS) for weaning was calculated as an independent variable. This aimed to minimize differences between weaned and non-weaned patients and create comparable groups.

The PS was calculated using a binary logistic regression model that included variables related to weaning and mortality, namely: age, gender, successful decannulation, recannulation, total days on MV in the ICU, total days on MV in the MVWRC, total days of ICU hospitalization, total days of hospitalization in the MVWRC, medical history (cardiological, respiratory, neurological, metabolic, or oncological), and reason for admission (medical, surgical, or polytrauma). The sample size considered was 10 cases of the dependent variable per variable included in the binary logistic regression model for the construction of the propensity score.

The PS should be considered as the individual probability of each subject being weaned according to the predictive variables. The PS was used in two ways: as inverse probability of treatment weighting (IPTW) applied to the entire cohort, and outcomes between the weaned and not-weaned groups were compared. The weight was defined as the inverse of the propensity score for the exposed group (weaned) and the inverse of one minus the propensity score for the unexposed group (not-weaned).[10, 11]

On the other hand, in order to confirm the obtained result, a tolerance of 0.05 standard deviation of the logit of the PS was used without replacement to generate PS matching through the radius method.

Multivariate analysis for mortality

A sensitivity analysis was conducted on the sample both before and after matching to identify factors related to the development of adverse events. To do that, a logistic regression model with stepwise selection was used, using the maximum likelihood method. The goodness of fit of both final predictive models was verified using the Hosmer-Lemeshow test. Additionally, the discriminatory power was evaluated through the ROC (Receiver Operating Characteristic) curve analysis. The area under the curve (AUC) was used to determine the level of precision. The AUC ranges from 0 to 1; an AUC < 0.5 indicates that the model's performance is worse than chance, while an AUC$=1$ indicates perfect performance. AUC values > 0.7 and > 0.9 are considered to represent acceptable and excellent performance, respectively.

Power analysis

A sample size of 421 subjects was calculated, which were sufficient to detect a 17% difference in mortality between the two exposure groups (weaned and unweaned), based on previous publications, considering the lower limits of the confidence intervals for mortality in this population according to the exposure factor (46% in unweaned and 29% in unstable weaned patients).[12] The parameters used for the sample size calculation were set at a 95% power to detect differences between the two groups and a probability of type I error or alpha of 5%.

Matching was performed using the PS and statistical analysis with SPSS software, version 25 (SPSS, Chicago, USA), and R Version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria; available through https://cran.r-project.org/mirrors.html). For the power calculation, G*power software was used, version 3.1.9.2 (University of Düsseldorf, Düsseldorf, Germany).[13] A p-value < 0.05 was considered statistically significant.

RESULTS

Characteristics of the entire sample

During the study period, 1,103 patients were admitted. 76 patients were excluded due to missing data, 65 for not having a tracheostomy, 280 for not requiring MV upon admission to the MVWRC, and 5 for still being hospitalized at study closure (Figure 1). 223 patients who were discharged from the MVWRC for reasons other than death or medical discharge were also excluded. 454 patients were analyzed. The median age was 72 years (IQR 61-78); 55.1% were men. The median number of hospitalization days in the ICU was 33 (IQR 25 - 45). 87% (395) of the patients were admitted to the ICU for medical reasons, 11% (51) for surgical reasons, and the remaining 2% (8) for polytrauma

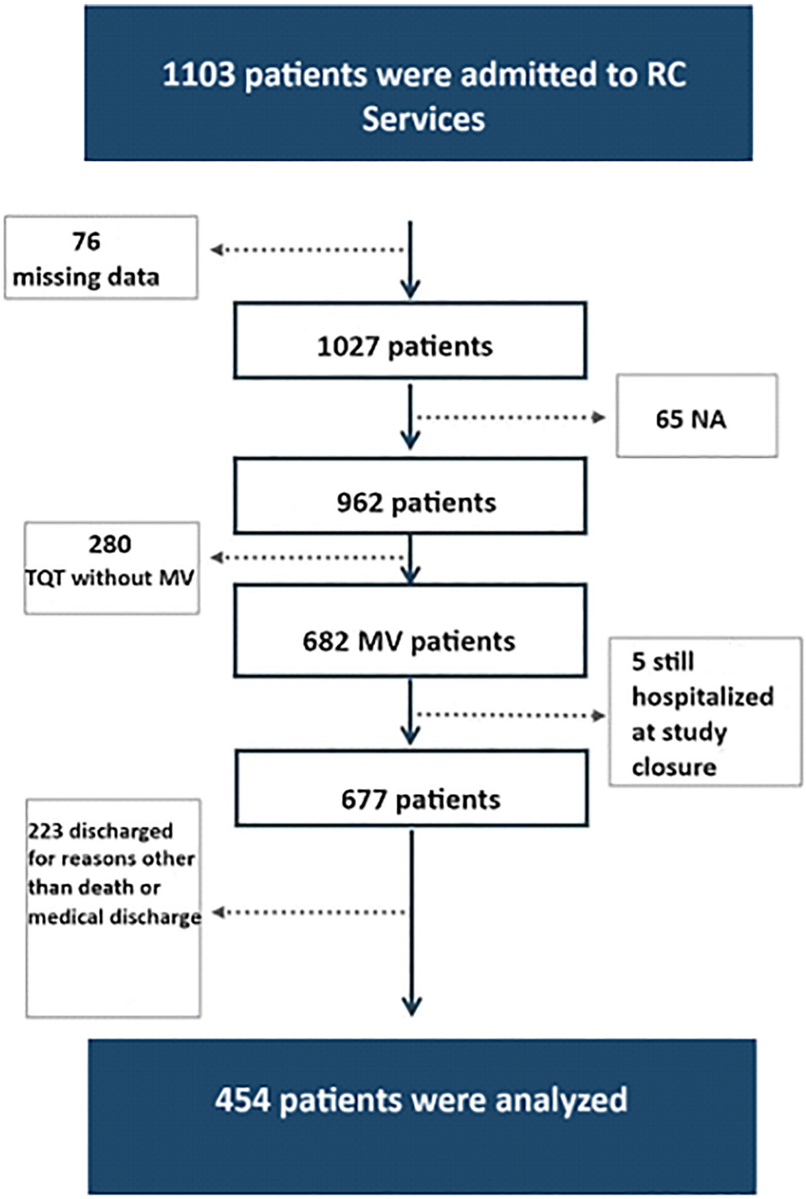


Figure 1. Sample selection. RC: respiratory care, NA: natural airway, MV: mechanical ventilation

Baseline comparison of the entire cohort

The comparison of the entire cohort between patients weaned and unweaned from MV showed differences in the median age [56 years (45 - 70) versus 64 years (51 - 73); p=0.003]. With regard to the reasons for ICU admission, weaning was less frequent among patients with exacerbated COPD and more frequent among patients with stroke and Guillain-Barré syndrome. Unweaned patients had a median of 31.5 days on MV in the MVWRC (IQR 13.5-38), and 61 total days including both ICU and MVWRC (IQR 61-94), compared to weaned patients who had a median of 14 days (IQR 13.5-63.2), and 49 days (IQR 37-76.5), respectively. Also, a higher proportion of weaned patients achieved decannulation compared to not weaned patients. Mortality in the MVWRC was significantly higher in the not weaned group compared to the weaned group [70.9 vs. 27.5%; p<0.001] (Table 1).

Mortality analysis of the entire cohort

Overall mortality was independently associated with older age [OR=1.042 (95% CI: 1.023-1.062), p<0.001] and a history of cardiovascular disease [OR=1.748 (95% CI: 1.035-2.951), p=0.037].

Conversely, the presence of a history of respiratory disease [OR=0.588 (95% CI: 0.356-0.971), p=0.038], mechanical ventilation weaning [OR=0.439 (95% CI: 0.247-0.777), p=0.005], and decannulation [OR=0.096 (95% CI: 0.051-0.178), p<0.001] decreased the chances of death in our sample (Table 2).

TABLE 1. Baseline comparison of the entire cohort based on whether or not they were weaned from mechanical ventilation

	Unweaned N = 265	Weaned N = 189	*p*
Age	64 (51-73)	56 (45-70)	0.003†
Masculine gender	147 (55.5)	103 (54.5)	0.837‡
History of cardiovascular disease	173 (65.3)	108 (57.1)	0.078‡
History of respiratory disease	108 (40.8)	61 (32.3)	0.065‡
History of neurological disease	89 (33.6)	51 (27)	0.113‡
History of metabolic disease	98 (37)	68 (36)	0.827‡
History of cancer	35 (13.2)	35 (18.5)	0.122‡
Reason for admission: medical	233 (87.9)	162 (85.7)	0.490‡
Reason for admission: surgical	28 (10.6)	24 (12.7)	0.482‡
Reason for admission: polytrauma	5 (1.9)	3 (1.6)	1.000¶
Sepsis	24 (9.1)	14 (7.4)	0.471‡
Reason for admission: pneumonia in non-COPD patient	54 (20.4)	26 (13.8)	0.068‡
Reason for admission: exacerbated COPD	54 (20.4)	23 (12.2)	0.022‡
Reason for admission: POP abdominal complications	7 (2.6)	8 (4.2)	0.350‡
Reason for admission: POP cardiovascular complications	9 (3.4)	8 (4.2)	0.643‡
Reason for admission: Pop thoracic-pulmonary complications	2 (0.8)	3 (1.6)	0.280¶
Reason for admission: POP central nervous system complications	2 (0.8)	4 (2.1)	0.240¶
Reason for admission: heart failure	8 (3.0)	3 (1.6)	0.328‡
Reason for admission: acute myocardial infarction	3 (1.1)	4 (2.1)	0.457¶
Reason for admission: cardiopulmonary arrest	13 (4.9)	5 (2.6)	0.224‡
Reason for admission: exacerbated asthma	1 (0.4)	0 (0)	0.999¶
Reason for admission: traumatic brain injury	9 (3.4)	8 (4.2)	0.643‡
Reason for admission: upper cervical spine injury (C3 to C7)	3 (1.1)	7 (3.7)	0.102¶
Reason for admission: stroke	31 (11.7)	47 (24.9)	<0.001‡
Reason for admission: Guillain-Barré syndrome	2 (0.8)	7 (3.8)	0.037¶
Days of MV in the ICU	33 (31-37.5)	33 (30-33.5)	0.095†
Days of MV in the MVWRC	31.5 (13.5-38)	14 (13.5-63.2)	<0.001†
Days of MV in the ICU and the MVWRC	61 (61-94)	49 (37-76.5)	<0.001†
Total inpatient days in the ICU	33 (25-48.5)	32 (25-40.5)	0.073†
Total inpatient days in the MVWRC	78 (26-191)	93 (50-194.5)	0.004†
Total inpatient days in the ICU and the MVWRC	121 (85-225)	121 (85-215)	0.116†
Successful decannulation	25 (9.4)	132 (69.8)	<0.001‡
Recannulation due to failure	3 (1.1)	5 (2.6)	0.286¶
Mortality at MVWRC discharge	188 (70.9)	5 (27.5)	<0.001‡

COPD: chronic obstructive pulmonary disease, POP: postoperative, MV: mechanical ventilation, ICU: Intensive Care Unit, MVWRC: mechanical ventilation weaning and rehabilitation center.
†: Mann-Whitney Test; ‡: Chi-Square Test; ¶: Fisher's exact Test.

Mortality analysis of the entire cohort by inverse probability of treatment weighting (IPTW)

Mortality analyzed using IPTW yielded results consistent with those observed in the initial unweighted cohort analysis. In addition to the previously mentioned variables, the presence of pneumonia in non-COPD patients was added as an independent factor for higher mortality. Besides the same factors as in the unweighted model, lower mortality was associated with MV weaning [OR=0.398 (95% CI: 0.282-0.560), p<0.001], tracheostomy decannulation [OR=0.059 (95% CI: 0.038-0.091), p<0.001], and the presence of COPD instead of any respiratory history [OR=0.477 (95% CI: 0.298-0.762), p=0.002] (Table 3).

Mortality analysis of the matched sample using the propensity score (PS)

The probability of weaning before and after matching by propensity score is shown in Figures 2A and 2B, respectively.

The performance of the PS in matching weaned and unweaned patients and creating comparable groups is illustrated in Figure 3. All variables included in the PS exhibit a mean difference of less than 0.2.

The characteristics of the sample after matching are detailed in Table 4.

The multiple logistic regression analysis of the matched sample maintained the association between MV weaning [OR=0.313 (95% CI: 0.137-0.715), p=0.006] and tracheostomy decannulation [OR=0.057 (95% CI: 0.021-0.155), p<0.001] as variables associated with lower mortality and age [OR=1.056 (95% CI: 1.026-1.087), p<0.001] as a predictor associated with higher mortality. (Table No. 5)

DISCUSSION

In recent decades, there has been a substantial increase in both the number of patients on prolonged mechanical (PMV) and in mechanical ventilation

TABLE 2. Multiple logistic regression analysis of the entire cohort for overall mortality

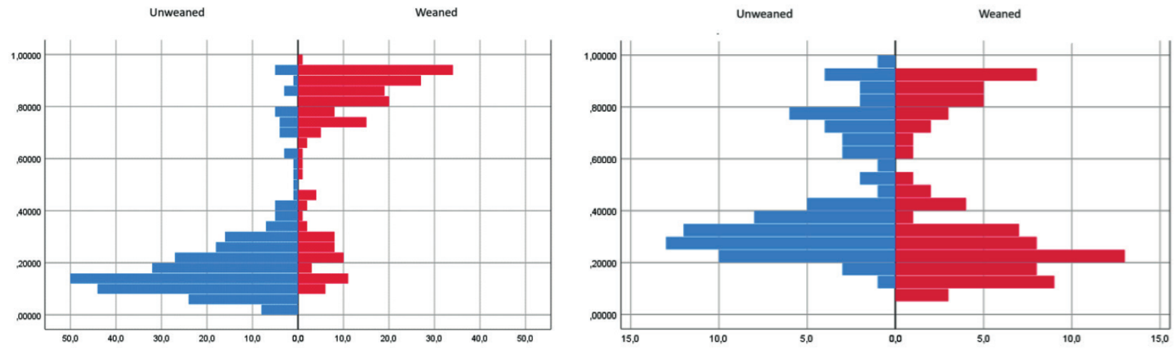
		95 % IC		
	OR	Lower limit	Upper limit	*p*
Age	1.042	1.023	1.062	<0.001
Weaning from MV	0.439	0.247	0.777	0.005
Decannulation	0.096	0.051	0.178	<0.001
History of cardiovascular disease	1.748	1.035	2.951	0.037
History of respiratory disease	0.588	0.356	0.971	0.038

OR: odds ratio; MV: mechanical ventilation; CI: confidence interval

TABLA 3. Análisis de regresión logística múltiple de toda la cohorte para mortalidad ponderada por probabilidad inversa de tratamiento

		95 % IC		
	OR	Límite inferior	Límite superior	*p*
Age	1.037	1.023	1.052	<0.001
Weaning from MV	0.398	0.282	0.560	<0.001
Tracheostomy decannulation	0.059	0.038	0.091	<0.001
History of cardiovascular disease	1.684	1.146	2.474	0.008
Pneumonia in non-COPD patients	2.649	1.631	4.302	<0.001
COPD	0.477	0.298	0.762	0.002

MV: mechanical ventilation; COPD: chronic obstructive pulmonary disease; OR: odds ratio; CI: confidence interval.
IPTW= inverse probability of treatment weighting; OR=odds ratio; Lower CI= lower confidence interval; Upper CI= upper confidence interval. P < 0.05



Histogram A **Histogram B**

Figure 2. Comparison between the histograms of the propensity score for the probability of mechanical ventilation weaning before matching (histogram A) and after matching (histogram B).

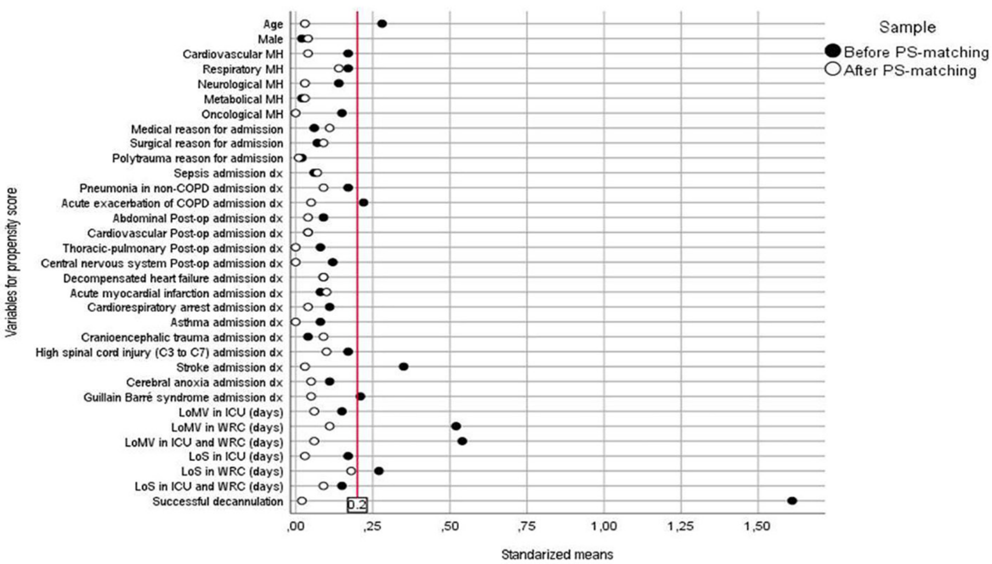


Figure 3. Graph showing difference in means between the variables included in the propensity score.

weaning and rehabilitation centers (MVWRCs) in our country. A variable number of patients achieve complete recovery and are subsequently discharged, but there is also a significant group of patients who do not succeed and die during hospitalization in the MVWRCs. [3-9] In Argentina, patients who cannot be weaned from mechanical ventilation do not have access to institutions for their hospitalization, nor is there home hospitalization available for MV-dependent patients. As a result, they usually remain hospitalized until their death.

Being able to predict which patients have a higher or lower chance of being discharged could benefit both the planning of patient recovery processes and family organization.

We have been able to analyze 13 years of follow-up data from our MVWRC database and apply the propensity analysis in order to balance the groups of weaned and unweaned patients, with a significant sample of patients. Three factors were related to mortality.

In all the models we used, age remained an independent predictor associated with mortality. The

TABLE 4. Comparison of the propensity score-matched sample

Variables	Unweaned n = 81	Weaned n = 81	*p*
Age	71 (58,5-76,5)	73 (56-78)	0,863†
Males	46 (56,8)	43 (53,1)	0,636‡
History of cardiovascular disease	48 (59,3)	45 (55,6)	0,634‡
History of respiratory disease	16 (19,8)	24 (29,6)	0,145‡
History of neurological disease	28 (34,6)	30 (37)	0,743‡
History of metabolic disease	24 (29,6)	26 (32,1)	0,734‡
History of cancer	13 (16)	13 (16)	1,000‡
Reason for admission: medical	68 (84)	73 (90,1)	0,242‡
Reason for admission: surgical	12 (14,8)	8 (9,9)	0,339‡
Reason for admission: polytrauma	2 (2,5)	0 (0)	0,497¶
Reason for admission: sepsis	4 (4,9)	3 (3,7)	1,000¶
Reason for admission: pneumonia in non-COPD patient	9 (11,1)	13 (16)	0,369‡
Reason for admission: exacerbated COPD	8 (9,9)	10 (12,3)	0,617‡
Reason for admission: postoperative abdominal complications	3 (2,5)	3 (3,7)	1,000¶
Reason for admission: POP cardiovascular pain	3 (3,7)	2 (2,5)	1,000¶
Reason for admission: POP thoracic-pulmonary pain	0 (0)	0 (0)	NC
Reason for admission: POP central nervous system complications	2 (2,5)	2 (2,5)	1,000¶
Reason for admission: decompensated heart failure	0 (0)	1 (1,2)	1,000¶
Reason for admission: acute myocardial infarction	1 (1,2)	3 (3,7)	0,620¶
Reason for admission: cardiopulmonary arrest	3 (3,7)	4 (4,9)	1,000¶
Reason for admission: exacerbated asthma	0 (0)	0 (0)	NC
Reason for admission: traumatic brain injury	4 (8,6)	4 (4,9)	0,349‡
Reason for admission: upper cervical spine injury (C3 to C7)	1 (1,2)	3 (3,7)	0,620¶
Reason for admission: stroke	20 (24,7)	22 (27,2)	0,720‡
Reason for admission: brain anoxia	2 (2,5)	1 (1,2)	1,000¶
Reason for admission: Guillain-Barré syndrome.	2 (2,5)	1 (1,2)	1,000¶
Days of MVA in the ICU	33 (31,5-38,5)	33 (31-39)	0,715†
Days of MVA in the MVWRC	24 (9-40)	20 (6,5-48,5)	0,501†
Days of MVA in the UCI and the MVWRC	61 (50-65)	61 (43-86,5)	0,716†
Total inpatient days in the ICU	33 (24,5-45,5)	33 (26-42,5)	0,847†
Total inpatient days in the MVWRC	90 (45-264,5)	106 (70,5-257)	0,247†
Total inpatient days in the ICU and the MVWRC	133 (83,5-312)	141 (97,5-291)	0,576†
Successful decannulation	25 (30,9)	26 (32,1)	0,866‡
Recannulation due to failure	3 (3,7)	1 (1,2)	0,299‡
Mortality at MVWRC discharge	49 (60,5)	35 (43,2)	0,28‡

COPD: chronic obstructive pulmonary disease, POP: postoperative, MV: mechanical ventilation, ICU: Intensive Care Unit, MVWRC: mechanical ventilation weaning and rehabilitation center.
†: Mann-Whitney Test, ‡: Chi-Square Test. ¶: Fisher's exact Test.

older the age, the higher the mortality. This finding aligns with numerous published studies.[1, 1-7,22]

On the other hand, achieving MV weaning and decannulation in the MVWRC are protective factors against mortality. Considering the tracheostomy decannulation as a protective factor against mortality is consistent with the findings of Scrigna et al (p = 0.0001, OR 7.51; CI: 2.77 – 20.38). In this study, 80% of the 44% of patients who were decannulated were medically discharged, while only 15% of patients in the non-decannulated group were discharged. Additionally, follow-up

TABLE 5. Logistic regression analysis post-propensity score matching

		95 % IC		
	OR	Lower limit	Upper limit	*p*
Weaning from MV	0.313	0.137	0.715	0.006
Age in years	1.056	1.026	1.087	<0.001
Tracheostomy decannulation	0.057	0.021	0.155	<0.001

OR= odds ratio; MV: mechanical ventilation. CI = confidence interval

after discharge showed that the median survival among decannulated patients was 45 months (CI: 15.1 to 75.1) compared to 11 months (CI: 2.1 to 19.6) for non-decannulated patients ($p = 0.004$).[20]

The study by Jubran et al found that one-year survival was 66.9% for patients disconnected from MV and 16.4% for those still on MV, which is consistent with our findings that MV weaning is a protective factor against mortality. [21]This study followed a cohort of patients discharged from a weaning center for one year and highlighted in its discussion that "instead of limiting (or abandoning) weaning efforts based on the perception of a poor prognosis, physicians should adopt a more aggressive approach and assess the patient's performance in the total absence of ventilator support, which facilitates early ventilator discontinuation. This approach minimizes the risk of failing to identify patients who can be separated from the ventilator." All of this knowing that patients who are successfully weaned off have a higher chance of being discharged. This method of carrying out the weaning process is similar to the protocol at our institution, where patients are tested during spontaneous ventilation (SV) without MV support, based on prior work by the same group.[23]

It is not possible to assert that the higher mortality observed in the group dependent on MV and non-decannulation of the tracheostomy is solely dependent on these two conditions. It may, perhaps, reflect an overall poorer health status of the patients associated with worse prognosis and survival. Patients who do not achieve MV weaning and tracheostomy decannulation do not get medically discharged, thereby prolonging their stay in the MVWRC.

Some countries have intermediate care centers or home hospitalization systems for patient referral in cases where the patient doesn't improve within a certain period, facilitating the discharge of patients with artificial airways and need for MV. This could be the reason why such centers report higher survival rates and certainly do not attribute their mortality rates to weaning and decannulation failure.

Another reason preventing the discharge of tracheostomized patients is the inability to provide home support, depending on the geographic area where they live and their family's capacity to accommodate home hospitalization. If this is the reason for prolonged hospitalization, it is possible that mortality is more associated with the length of stay than with the patient's severity or instability.

Knowing the patient's probabilities based on their characteristics at admission to the MVWRC and their progress there (success in MV weaning and decannulation) allows for better decision-making and improving communication with the patient and/or their family. This helps avoid creating false expectations and prioritizes the best quality of life.

The main limitation of this work is that it is a retrospective analysis, where only data obtained from medical records were analyzed. However, including a propensity analysis allowed for a balanced sample concerning the variable of MV weaning, leading to a better analysis of mortality within the MVWRC. As the study was conducted in a single institution, it also limits the extrapolation of the results.

CONCLUSION

This study showed that mortality in patients requiring MV in a MVWRC was independently associated with older age, failure to wean from MV, and non-decannulation. It is vitally important to have these predictors in order to plan achievable treatment goals in collaboration with the patient and their family.

Conflict of interest
None to declare

REFERENCES

1. MacIntyre NR, Epstein SK, Carson S, Scheinhorn D, Christopher K, Muldoon S. Management of patients requiring prolonged mechanical ventilation - report of a NAMDRC consensus conference. Chest 2005;128:3937-54. https://doi.org/10.1378/chest.128.6.3937
2. Carson SS, Bach PB. The epidemiology and costs of chronic critical illness. Crit Care Clin. 2002;18:461-76. https://doi.org/10.1016/S0749-0704(02)00015-5
3. Mauri T, Pivi S, Bigatello L. Prolonged mechanical ventilation after critical illness. Minerva Anestesiol. 2008;74:297-301.
4. Mamary A, Kondapaneni S, Vance G, Gaughan JP, Martin UJ, Criner GJ. Survival in Patients Receiving Prolonged Ventilation: Factors that Influence Outcome. Clin Med Insights Circ Respir Pulm Med. 2011;5:17-26. https://doi.org/10.4137/CCRPM.S6649
5. Scheinhorn DJ, Artinian B, Catlin J. Weaning from prolonged mechanical ventilation: the experience at a regional weaning center. Chest 1994;105:534-9. https://doi.org/10.1378/chest.105.2.534
6. Lone N, Walsh T. Prolonged mechanical ventilation in critically ill patients: epidemiology, outcomes and modelling the potencial cost consequences of establishing a regional weaning unit. Critical Care 2011;15: R102. https://doi.org/10.1186/cc10117
7. Ambrosino N, Goldstein R. Ventilatory Support for Chronic Respiratory Failure. Informa Healthcare. 2008. https://doi.org/10.3109/9781420020229
8. Villalba D, Plotnikow G, Feld V, RiveroVairo N, Scapellato J, Díaz Nielsen E. Weaning from prolonged mechanical ventilation at 72 hours of spontaneous breathing. Medicina (B Aires). 2015;75:11-7.
9. Villalba D, Gil Rossetti G, Scrigna M, et al. Prevalence of and Risk Factors for Mechanical Ventilation Reinstitution in Patients Weaned from Prolonged Mechanical Ventilation. Respir Care. 2020;65:210-6. https://doi.org/10.4187/respcare.06807
10. Schafer JL, Kang J. Average causal effects from nonrandomized studies: a practical guide and simulated example. Psychol Methods. 2008;13:279-313. https://doi.org/10.1037/a0014268
11. Newgard CD, Hedges JR, Arthur M, Mullins RJ. Advanced statistics: the propensity score--a method for estimating treatment effect in observational research. Acad Emerg Med. 2004;11:953-61. https://doi.org/10.1197/j.aem.2004.02.530
12. Schönhofer B, Euteneuer S, Nava S, Suchi S, Köhler D. Survival of mechanically ventilated patients admitted to a specialised weaning centre. Intensive Care Med 2002;28:908-16. https://doi.org/10.1007/s00134-002-1287-5
13. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39:175-91. https://doi.org/10.3758/BF03193146
14. Rose L, Fraser IM. Patient characteristics and outcomes of a provincial prolonged-ventilation weaning centre: a retrospective cohort study. Can Respir J 2012;19:216-20. https://doi.org/10.1155/2012/358265
15. Scheinhorn DJ, Hassenpflug MS, Votto JJ, et al. Ventilator dependent survivors of catastrophic illness transferred to 23 long-term care hospitals for weaning from prolonged mechanical ventilation. Chest 2007;131:76-84. https://doi.org/10.1378/chest.06-1079
16. Rojek-Jarmuła A, Hombach R, Gierek D, Krzych ŁJ. A single centre seven-year experience with mechanical ventilation weaning. Anaesthesiol Intensive Ther 2015;47:204-9. https://doi.org/10.5603/AIT.2015.0033
17. Mifsud Bonnici D, Sanctuary T, Warren A, et al. Prospective observational cohort study of patients with weaning failure admitted to a specialist weaning, rehabilitation and home mechanical ventilation centre. BMJ Open 2016;6:e010025. https://doi.org/10.1136/bmjopen-2015-010025
18. Hong-Joon Shin, Jin-Sun Chang, SeongAhn, et al Clinical factors associated with weaning failure in patients requiring prolonged mechanical ventilation. J Thorac Dis. 2017;9:143-50. https://doi.org/10.21037/jtd.2017.01.14
19. Bigatello LM, Stelfox HT, Berra L, Schmidt U, Gettings EM. Outcome of patients undergoing prolonged mechanical ventilation after critical illness. Crit Care Med 2007;35:2491-7. https://doi.org/10.1097/01.CCM.0000287589.16724.B2
20. Scrigna M, Plotnikow G, Feld V, et. al. Decannulation after the ICU Stay. Analysis of 181 Tracheostomized Patients. Rev Am Med Resp 2013;2:58-63.
21. Jubran A, Grant B, Duffner LA, et. al. Long-Term Outcome after Prolonged Mechanical Ventilation. A Long-Term Acute-Care Hospital Study.Am J RespirCrit Care Med. 2019;199:1508-16. https://doi.org/10.1164/rccm.201806-1131OC
22. Engoren M, Arslanian-Engoren C, Fenn-Buderer N. Hospital and long-term outcome after tracheostomy for respiratory failure. Chest. 2004;125:220-7. https://doi.org/10.1378/chest.125.1.220
23. Jubran A, Grant BJ, Duffner LA, et al. Effect of pressure support vs unassisted breathing through a tracheostomy collar on weaning duration in patients requiring prolonged mechanical ventilation: a randomized trial. JAMA. 2013;309:671-7. https://doi.org/10.1001/jama.2013.159