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Analysis of functionality and ventilatory mechanics indicators of patients hospitalized in an Intensive Care Unit

Análisis de indicadores de funcionalidad y mecánica ventilatoria de pacientes hospitalizados en una Unidad de Cuidados Intensivos

Análise de indicadores de funcionalidade e mecânica ventilatória de pacientes internados em Unidade de Terapia Intensiva

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ABSTRACT

Objective: To analyze the functionality milestones and ventilatory mechanics data of patients admitted to an Intensive Care Unit (ICU). **Methods:** This is an observational, prospective and quantitative study, with an active search in the medical records of patients over 18 years old and with more than 24 hours of mechanical ventilation after admission to the ICU, to record demographic, clinical, epidemiological, ventilatory mechanics and functionality. **Results:** 51 records were included, with a mean severity of 68.9 ± 20.3 in SAPS 3. 49% performed bedside sitting, while 4% progressed to walking. Mortality rate of 72.5% and 84.3% of patients remained with a mean Driving Pressure (SD) below 15, in addition to the weak correlation coefficient for MV time (r 0.025; p > 0.05), for length of stay (r 0.000; p > 0.05), for severity (r 0.01; p > 0.05) and for the outcome (r 0.265; p > 0.05), which is included in discharge or death in the ICU. **Conclusion:** Functionality and ventilatory mechanics milestones did not present a statistically significant association with MV duration, hospitalization, severity and mortality of patients.

Keywords: Ventilatory mechanic, Funcionalidad, Intensive Care Unit.

RESUMO

Objetivo: Analisar os marcos de funcionalidade e dados de mecânica ventilatória de pacientes internados em uma Unidade de Terapia Intensiva (UTI). **Métodos:** Trata-se de um estudo observacional, prospectivo e quantitativo, com busca ativa nos prontuários de pacientes maiores de 18 anos e com mais de 24 horas de ventilação mecânica após admissão na UTI, para registro de dados demográficos, clínicos, epidemiológicos, de mecânica ventilatória e funcionalidade. **Resultados:** Foram incluídos 51 prontuários, com gravidade média de 68,9 ± 20,3 no SAPS 3. 49% realizaram a postura sentada à beira do leito, enquanto 4% evoluíram para a deambulação. Taxa de mortalidade de 72,5% e 84,3% dos pacientes permaneceram com Driving Pressure (DP) média abaixo de 15, além do coeficiente de correlação fraco para o tempo de VM (r 0,025; p > 0,05), para o tempo de internação (r 0,000; p > 0,05), para a gravidade (r 0,01; p > 0,05) e para o desfecho (r 0,265;

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p > 0,05), que está incluído na alta ou óbito na UTI. **Conclusão:** Os marcos da funcionalidade e da mecânica ventilatória não apresentaram associação estatisticamente significativa com a duração da VM, internação, gravidade e mortalidade dos pacientes.

Palavras-chave: Mecânica ventilatória, Funcionalidade, Unidade de Terapia Intensiva.

RESUMEN

Objetivo: Analizar los hitos de funcionalidad y datos de mecánica ventilatoria de pacientes ingresados en una Unidad de Cuidados Intensivos (UCI). **Métodos:** Se trata de un estudio observacional, prospectivo y cuantitativo, con una búsqueda activa en las historias clínicas de pacientes mayores de 18 años y con más de 24 horas de ventilación mecánica después del ingreso a la UCI, para registrar datos demográficos, clínicos, epidemiológicos, ventilatorios. Mecánica y funcionalidad. **Resultados:** Se incluyeron 51 registros, con una gravedad media de 68,9 ± 20,3 en SAPS 3. El 49% realizó sentada junto a la cama, mientras que el 4% progresó a caminar. La tasa de mortalidad del 72,5% y el 84,3% de los pacientes permanecieron con una presión de conducción (DE) media inferior a 15, además del débil coeficiente de correlación para el tiempo de VM (r 0,025; p > 0,05), para el tiempo de estancia (r 0,000; p > 0,05), para la gravedad (r 0,01; p > 0,05) y para el resultado (r 0,265; p > 0,05), que se incluye en el alta o muerte en la UCI. **Conclusion:** Los hitos de funcionalidad y mecánica ventilatoria no presentaron asociación estadísticamente significativa con la duración de la VM, la hospitalización, la gravedad y la mortalidad de los pacientes.

Palabras clave: Ventilación mecánica, Funcionalidad, Unidad de Cuidados Intensivos.

INTRODUCTION

In ICUs, patients are susceptible to the installation of Acquired Muscle Weakness (AMF), which is understood as a loss of muscle performance associated with long periods of immobility, with structural muscle changes, micro-circulatory disorders, bioenergetic failure, activation of the inadequate autophagy, membrane and ion channel dysfunction, and central nervous system involvement. Therefore, AMF is one of the main factors for the increase in the mortality rate and hospitalization, in addition to drastically reducing the functionality of this population (VANHOEBEEK I, et al., 2020).

Aiming at improving the functionality of this population, sitting at the bedside and walking are part of the activities carried out in intensive care environments and can be performed by patients with different levels of functionality, and it is of paramount importance that such mobilizations be carried out in a strategic manner. , as the benefits of such activities may include not only an improvement in functional capacity and quality of life, but also an increase in peripheral and respiratory muscle strength, a reduction in the length of hospital stay and in the time of Invasive Mechanical Ventilation (SILVA VS, et al., 2014).

In addition, ventilatory monitoring is of fundamental importance for patients admitted to the ICU, since this prevents ventilation-induced lung injury (VILI), classically known as barotrauma, volutrauma, atelectrauma and biotrauma, which in turn are intrinsically related with the mortality rate (BEITLER JR, et al., 2016). Thus, since the study by ARDS Network, Brower RG, et al. (2000), it is known that the limitation of plateau pressure (Pplateau) ≤ 30 cmH2O and tidal volume (Vt) of 6 ml/kg of predicted weight, presents a close relationship with the increase survival of critically ill patients.

In the study by Amato and his team, Amato MB et al. (2015), this increase in survival was better elucidated, since the limitation of the aforementioned parameters causes a reduction in the alveolar distending pressure, known as driving pressure (DP), which consists of the difference between the plateau pressure and the positive end expiratory pressure (PEEP), being altered by other respiratory mechanics data, such as static compliance (Cest).

In addition, DP is currently the main mechanical ventilation (MV) indicator of mortality risk (YANG Q, et al., 2019; PATON M et al., 2018; ORBAN et al., 2017). Despite the great scientific evolution in the management of critically ill patients in almost 70 years after the creation of ICUs, early optimization of functionality and increased survival of these patients is still one of the main objectives within this intensive care setting.

Therefore, functionality indicators, such as bedside sitting and walking, as well as protective ventilatory management, through ventilatory monitoring of mechanically ventilated patients, constitute major safety indicators within the ICUs, which are support for the desire of the aforementioned objectives (YANG Q, et al., 2019; PATON M et al., 2018; ORBAN et al., 2017). In this sense, the present study aimed to analyze the functionality indicators and ventilatory mechanics data of patients hospitalized in a general ICU.

METHODS

Kind of study and Ethical aspects

This is an observational, prospective and quantitative study, approved by the Ethics and Research Committee (CEP), under opinion number 5,264,806.

Sample and Project development

Data collection was performed on medical records of patients admitted to a general ICU. The active search was carried out using the information contained in the shift change sheet of the sector's Physiotherapy team from April 2022 to September 2022, including the medical records of patients over 18 years old and with more than 24 hours of MV and excluded those with incomplete information and who were extubated in less than 24 hours.

Information regarding age, gender, severity, impression and diagnostic profile, length of stay, date and time of orotracheal intubation, data regarding ventilatory mechanics (DP and plateau pressure) of patients on Invasive MV were collected; period and number of bedside sittings and walks performed in the unit. The information was computed daily, throughout the patient's hospitalization period in the unit and while he was able to perform such an evaluation.

Regarding the information on ventilatory mechanics, the values of the evaluations made by the team on duty in the morning shift were considered, with standardization of the Tidal Volume (Vt) in 6 ml/kg of the predicted weight, inspiratory pause of 0.5 seconds and flow = 0 L/min to obtain the plateau pressure, always respecting the protective ventilation parameters previously used by the patient. In addition, it is guaranteed that the conditions of the patients are optimal for the evaluation, therefore, there is no patient-ventilator asynchrony, ensuring adequate positioning in the bed and avoiding excess secretion in the Oro-Tracheal Tube (OTT), in the tracheostomy cannula or in Upper Airways (UAS).

Data analysis

The collected data were organized and stored in Excel® 2013 software (Microsoft Corporation, USA), and subsequently statistical analysis was performed in SPSS 16.0 software. Initially, the normality of data distribution was evaluated using the Shapiro-Wilk test, which revealed normality only for the severity variable. Therefore, non-parametric correlation tests were performed, such as Spearman's Correlation test, correlating the DP variable with MV time and length of hospital stay, while for the severity variable, the Pearson Correlation parametric test was performed.

The chi-square test was also performed to analyze the nominal outcome variable. Adopting a significance alpha of 5% ($p<0.05$). For the correlation tests, the reference values of Callegari-Jacques (2003) were used, stipulating: 0.00 to 0.19 a very weak correlation; 0.20 to 0.39 a weak correlation; 0.40 to 0.69 a moderate correlation; 0.70 to 0.89 a strong correlation; and 0.90 to 1.00 a very strong correlation. The funders played no role in the design, conduct, or reporting of this study.

RESULTS

51 medical records were analyzed and included, after successfully passing the inclusion criteria. Among these, the predominance was male (66.6%), with a mean age of 68.2 ± 15.4 years and severity measured by the SAPS 3 score of 68.9 ± 20.3. Among the organic systems most related to the diagnostic impression of patients, the Cardiological (19.6%) and the combination of commitments in the Cardiological and Respiratory

systems (39.2%) stand out, both representing more than half of the incidence among the included patients (**Table 1**).

Table 1 - Characteristics of the individuals participating in the present study represented by average, standard deviation and percentage.

Variables	Participants (N=51)	
	Average	SD
Age	68.2	15.4
Gravity	68.9	20.3
-	**N**	**%**
Sex		
Feminine	17	33.4
Male	34	66.6
Diagnostic Profile		
Cardiological	10	19.6
Cardiology and Respiratory	20	39.2
Respiratory	2	4
Renal	1	1.9
Respiratory and Renal	2	3.9
Cardiology and Renal	4	7.8
Cardiac, respiratory and renal	3	5.8
Cardiology, Renal and Gastric	2	3.9
Cardiology, Respiratory and Gastric	1	1.9
Cardiology and Urology	1	1.9
Neurological	1	1.9
Cardiology and Neurology	2	3.9
Respiratory and Immunological	1	1.9
Cardiological, Renal, Neurological and Metabolic	1	1.9

Note: (SD): Standard deviation, (%): percentage.
Source: Fonseca EC, et al., 2025.

With regard to clinical parameters, there was an average of 6 (3 – 12.5) days on MV and 8 (5-15) days of hospitalization in the general ICU. Furthermore, the mortality rate was 72.5%, corresponding to 37 patients, 43 (84.3%) patients remained with an average SD below 15 and, referring to functionality, 24 (49%) patients performed the sedation bedside, while 2 (4%) progressed to ambulation (**Table 2**).

Table 2- Characteristics of the individuals participating in the studies regarding length of stay, outcome, DP and functionality, represented by average, standard deviation and percentage.

Variables	Participants (N=51)	
	Average	SD
VM Time (Days)	6	3-12.5
Hospitalization Time (Days)	8	5-15
-	**N**	**%**
Outcome		
High	14	27.5
Death	37	72.5
Driving Pressure		
< 15	43	84.3
> 15	8	15.7
Functionality		
Sitting	24	49
No Sedestation	26	51
Ambulation	two	4
No Ambulation	49	96

Note: (SD): Standard deviation, (%): percentage.
Source: Fonseca EC, et al., 2025.

Regarding the assessment of ventilatory mechanics, represented by DP, a very weak correlation coefficient was found for the duration of MV (r 0.025; p > 0.05), for the length of stay (r 0.000; p > 0, 05), for severity (r 0.01; p > 0.05) and a weak correlation coefficient for the outcome (r 0.265; p > 0.05), which is understood as discharge or death from the unit (**Table 3**).

Table 3- Correlations between ventilatory mechanics and the variables duration of mechanical ventilation, length of stay, severity and outcome.

Variables	r	p-value
DP x VM Time	0.025	0.8
DP x Hospitalization Time	0.000	0.9
DP x Gravity	0.01	0.9
DP x Outcome	0.265	0.058

Note: (DP): Driving Pressure, (r): correlation coeficiente, (p-value): 5% significance alpha (p<0.05).
Source: Fonseca EC, et al., 2025.

DISCUSSION

The individuals had a mean age of 68.2 ± 15.4 years and were mostly men (66.6%), data similar to the findings of a systematic review with meta-analysis that aimed to evaluate randomized clinical trials that measured the effects of early mobilization in patients who underwent cardiac surgery, with a mean age within the range of 60 years and mostly men (70%) (CHEN B, et al., 2021).

Regarding severity, the score used was the Simplified Acute Physiology Score (SAPS) 3 with a mean finding of 68.9 ± 20.3, a high value in relation to the study by Godinjak A et al. (2016), where the authors determined and compared the SAPS 2 scores and the Acute Physiology and Chronic Health Evaluation (APACHE) 2 scores in patients admitted to the ICU with means of 48.4 ± 17.0 and 21.6 ± 10, 3 respectively.

This scenario attests to the high degree of severity of the patients included in this study. Becerra-Muñoz et al. (2021) carried out a clinical and epidemiological survey among patients with COVID-19 and found, in relation to the diagnostic profile in addition to Sars-Cov-2 infection, a higher prevalence of cardiovascular system impairments, similar to the findings of this study in that there was a higher prevalence of the cardiovascular and respiratory systems (39.2%). This fact can be suggested by the reference profile in cardiology of the hospital where the patients were hospitalized.

Regarding the days of ICU stay and days on MV, the findings of this study were 8 (5-15) and 6 (6-12.5) days, respectively, data that are lower than the findings of a prospective cohort study, which verified whether diaphragmatic atrophy caused by MV would prolong the length of stay on the device, with 12.5 (7-21) days for ICU stay and 9 (5-17) days on MV (GOLIGHER EC, et al., 2018). The high mortality presented among the patients in this study (72.5%) is in contrast with the findings by Lim ZJ et al. (2021) (45%), who performed a systematic review with meta-analysis verifying the mortality of positive COVID-19 patients on MV.

A scenario that draws attention, as in the review of this Australian group, they point out that some patients in the analyzed studies were still hospitalized at the time of publication, with a high mortality rate of 64%, a value still below that found in the present study. DP is an important measure for monitoring protective ventilation used in this study, which can be calculated by subtracting PEEP from the plateau pressure and, among the results, the patients included in this study who remained with values below 15 cmH2O (84.3%), data that are in line with the findings of Guérin C et al. (2016) who showed an average below 15 (13 ± 4) of DP in patients with Acute Respiratory Distress Syndrome (ARDS).

McWillams D, et al. (2021) carried out an observational study describing the demographic, clinical and functional profile of patients with COVID-19 admitted to an ICU, with findings of: 14% rested at the bedside, 17% walked, at least, with some type of external assistance and 9% walked without assistance for at least 30 meters, data that differs from the findings of this study, given that 49% of the patients sat by the bed and only 4% were able to walk. With a high gravity in the sample, the study raises a challenging question for functionality in this type of scenario, a fact that can be reflected with the aforementioned numbers.

In the study by Mao JY, et al. (2020) investigated the relationship between high ranges of DP values in the first 72 hours of ventilation and the prognosis of patients with hypoxia, finding an independent relationship between high ranges of DP and longer MV and ICU stay. Such results differ from data found in the present study, since a statistically significant relationship between DP and duration of MV and ICU stay was not established.

However, the information in the current work coincides with other studies in the literature. Ramin S, et al. (2022) performed a retrospective study to assess the relationship of DP in victims of thoracic trauma, who were divided into two groups, with ARDS and without ARDS, thus, even with DP values above 14 cmH2O in the group with ARDS, the The relationship between DP and duration of MV was not significant, which may be related to a low mean DP in the ARDS and non-ARDS groups, 11.6 cmH2O and 10.9 ± 1.9 cmH2O, respectively. Thus, taking into account that 84.3% of the patients in the present study also maintained values considered safe by the literature, that is, below 15 cmH2O, the hypothesis arises that DP is not the only or the best predictor of time of VM.

Furthermore, it is important to mention that the great diversity of the population studied may have contributed to the establishment of a non-significant relationship between DP and duration of MV and ICU stay. A meta-analysis performed by Li Y, et al. (2022) compared the effects of MV management guided by DP and the management of MV by other parameters, despite having found an important relationship between DP and mortality, the same did not apply to the duration of MV and hospitalization, which which was attributed, among several factors, to the heterogeneity of the study population.

Equally, analyzing the factors that influenced the severity of ARDS, Laffey JG et al. (2016) noticed that DP was one of the modifiable factors that directly influenced the severity of ARDS, while advanced age was the non-modifiable factor that stood out the most. Although the average age of the public in the current study was 68.2 years, the same relationship between DP and severity did not show a statistically significant association, which may also be related to the great diversity of underlying diseases of the patients, while the aforementioned study had ARDS as the underlying disease of its work.

Furthermore, since 2015, Amato MB, et al. (2015) demonstrated that among the various protective ventilation strategies to reduce mortality in ARDS such as low plateau pressure, higher PEEP and lower tidal volume, the relationship between tidal volume and static compliance, that is, DP, showed the variable that most influences the mortality of these patients, especially from a DP of 15 cmH2O. Thus, such an association encouraged further studies on the subject, such as the systematic review and meta-analysis carried out by Aoyama H, et al. (2018), which confirmed that DP is related to mortality in adult patients with ARDS, indicating a safety range of up to 13 or 15 cmH2O. Also, Chen Z et al. (2019) identified the same relationship between DP and mortality in ARDS patients, however, in moderate to severe ARDS, DP did not have the same performance in predicting the prognosis.

Thus, it is clear that the literature already has a more delimited definition of DP and mortality in ARDS, however, the public of the present study is without ARDS, and the impact of DP on mortality is still not well defined in these patients. Outside the scope of ARDS, studies studying the aforementioned relationship are more frequent in thoracic surgeries. Blank RS, et al. (2016) performed a retrospective study with 1,019 patients to analyze the effects of DP in the postoperative period of thoracic surgery, and found that the risk of morbidity increases by 3.4% for each increase of 1 cmH2O in DP.

In addition, 3 other studies were carried out and observed the relationship between DP and complications in the postoperative period of thoracic surgery. In the meta-analysis by Neto AS, et al. (2016) 17 randomized clinical trials were analyzed, totaling 2250 patients, investigating the effects of postoperative tidal volume, PEEP and DP.

Park M, et al. (2019) performed a randomized and controlled study with 292 patients scheduled for elective thoracic surgery, who were divided into two groups, where both were ventilated with the same tidal volume, however, the intervention group used an individualized PEEP for lower DP, while whereas the control group used a fixed PEEP of 5 cmH2O. Mathis MR, et al. (2019) retrospectively evaluated 4694 patients undergoing

cardiac surgery, and observed the effects of ventilatory management during the intraoperative and postoperative periods. All these 3 studies reported that DP influenced postoperative complications, such as pneumonia and ARDS.

Likewise, Sahetya SK, et al. (2019) observed patients without ARDS from 59 ICUs in the United States, which included medical, surgical, and mixed medical-surgical ICUs. Thus, this study demonstrated that higher DP values are associated with increased mortality in individuals without ARDS, concluding that DP can be a target of protective ventilation adopted with all patients.

However, these results do not coincide with the findings of the present study, because although 84.3% of the patients maintained a DP lower than 15 cmH2O, the DP did not present a statistically significant relationship with mortality in the current study, where 72.5% of patients evolved to death. Such results may be related to the severity of the study population, given that, according to the Simplified Acute Physiology Score III (SAPS 3) prognosis system, 68.6% already had a high chance of death.

Furthermore, the great heterogeneity of underlying diseases in the working population may have contributed to a less accurate analysis of the effects of DP on mortality, as in other studies in the literature. Lanspa and collaborators28 performed a retrospective analysis of critically ill patients without ARDS, finding that DP was not associated with a higher 30 day mortality. As in the present work, the population of the work by Lanspa MJ, et al. (2019) presented different pathophysiology, originating from medical, cardiac, trauma and surgical ICUs.

However, studies with specific subgroups also reached the same conclusions. In a prospective observational study with patients with external trauma, DP had no influence on increased mortality (SILVEIRA JÚNIOR JCD, et al., 2021). Therefore, there is no doubt that the relationship between DP and mortality in patients without ARDS still needs further study. As limitations of this study, we can list the great variability of underlying pathologies that influenced the high severity and mortality of the patients involved, in addition to also influencing the indicators of functionality and ventilatory mechanics.

Therefore, the indicators of functionality and ventilatory mechanics, represented by DP, did not present a statistically significant association with duration of invasive mechanical ventilation, length of hospital stay, severity and mortality of patients. It is worth emphasizing the importance of this initial study for verifying such findings among a population whose majority is cardiological. However, to the detriment of the great heterogeneity of the work population and the great severity of these, the need for more studies approaching this theme is undeniable, analyzing specific subgroups to obtain more reliable results.

CONCLUSION

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