Literature Review

The PSV mode has worse weaning outcomes when compared to other ventilatory modes in patients with an acute exacerbation of chronic obstructive pulmonary disease: systematic review

O modo PSV apresenta piores desfechos em relação ao desmame quando comparado com outros modos ventilatórios de pacientes com exacerbação aguda da doença pulmonar obstrutiva crônica: revisão sistemática

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ABSTRACT | INTRODUCTION: Chronic Obstructive Pulmonary Disease (COPD) is a chronic and progressive disorder that evolves with the decline in lung function. Despite its chronicity, periods of exacerbation accompanied by hypercapnic Acute Respiratory Failure are common, requiring a stay in Intensive Care Units (ICU) and Invasive Mechanical Ventilation (IMV) to reverse respiratory failure. Weaning in COPD occupies up to 58% of the MV, therefore, specific strategies are needed to optimize this process, using ventilatory modes and adjustments that promote early and effective weaning. **OBJECTIVE:** To verify the effects of Pressure Support Ventilation when compared with different modes and strategies in weaning patients with COPD. **METHODS:** Systematic review, constructed following PRISMA criteria, registered at PROSPERO (CRD42022362228). Randomized controlled clinical trials that evaluated the PSV mode in comparison with different modes and strategies, in patients diagnosed with COPD, on IMV, without delimitation of year/language, were considered eligible. Incomplete, duplicate and unavailable articles were excluded. Outcomes of interest were: duration of weaning, length of stay in the ICU and mortality. The strategy was applied in the bases: PubMed, Cochrane, SciELO, and Biblioteca Virtual em Saúde. The PEDro Scale and RevMan Web tools were used to analyze study quality and risk of bias, respectively. **RESULTS:** Included 8 articles. 6 showed statistical significance, showing shorter weaning time in the ASV group (24 (20–62) h versus 72 (24–144) h PSV) (p=0.041), and more days in the ICU when compared to the PAV mode (p<0.001). PSV was more effective on the same outcomes when compared with the T-tube strategy. There were differences in the mortality rate with the NAVA mode. **CONCLUSION:** It is evident that the PSV mode, when compared to assisted ventilation modes, has the potential to provide worse outcomes associated with the process of weaning from invasive ventilation in patients with COPD.

KEYWORDS: Chronic Obstructive Pulmonary Disease. Artificial Respiration. Weaning. Intermittent Positive-Pressure Ventilation. Intensive Care Unit.

RESUMO | INTRODUÇÃO: A Doença Pulmonar Obstrutiva Crônica (DPOC) é um distúrbio crônico e progressivo, que evolui com o declínio da função pulmonar. Embora sua cronicidade, são comuns períodos de agudização acompanhados de Insuficiência Respiratória Aguda hipercápnica, requisitando permanência nas Unidades de Terapia Intensiva (UTI) e Ventilação Mecânica Invasiva (VMI) para reversão da falência respiratória. O desmame na DPOC ocupa até 58% da VM, logo, se faz necessário estratégias específicas para otimização desse processo, com a utilização de modos e ajustes ventilatórios que promovam um desmame precoce e efetivo. **OBJETIVO:** Verificar os efeitos da Ventilação com Pressão de Suporte quando comparado com modos e estratégias distintas no desmame de pacientes com DPOC. **MÉTODOS:** Revisão sistemática, construída seguindo critérios do PRISMA, registrada na PROSPERO (CRD42022362228). Considerados elegíveis ensaios clínicos controlados randomizados que avaliaram o modo PSV em comparação com modos e estratégias distintas, em pacientes com diagnóstico de DPOC, em VMI, sem delimitação de ano/idioma. Foram excluídos artigos incompletos, duplicados e indisponíveis aos recursos de recuperação. Desfechos de interesse foram: duração do desmame, tempo de permanência na UTI e mortalidade. A estratégia foi aplicada nas bases: PubMed, Cochrane, SciELO, e Biblioteca Virtual em Saúde. As ferramentas Escala PEDro e *RevMan Web* foram utilizadas para análise da qualidade dos estudos e risco de viés, respectivamente. **RESULTADOS:** Incluídos 8 artigos. 6 mostraram significância estatística, apresentando menor tempo de desmame no grupo ASV (24 (20–62) h versus 72 (24–144) h PSV) (p=0,041); mais dias na UTI quando comparado com o modo PAV (p<0,001). PSV foi mais eficaz nos mesmos desfechos quando comparado com a estratégia Tubo-T. Houve diferenças quanto a taxa de mortalidade com o modo NAVA. **CONCLUSÃO:** Fica evidente que o modo PSV quando em relação a modos ventilatórios assistidos, tem potencial de fornecer piores desfechos associados ao processo de desmame da ventilação invasiva de pacientes com DPOC.

PALAVRAS-CHAVE: Doença Pulmonar Obstrutiva Crônica. Respiração Artificial. Desmame. Ventilação com Pressão Positiva Intermitente. Unidade de Terapia Intensiva.

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Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a disorder recognized for its chronic, progressive nature, which evolves slowly with the decline in lung function. COPD is characterized by airway obstruction, with a reduction of up to 80% in Forced Expiratory Volume in one second (FEV1).[1] Although COPD is chronic, periods of disease exacerbation are common. However, there is difficulty in conceptualizing this exacerbation, since each patient has a symptomatology and their individual perceptions regarding the subjective sensations of respiratory distress. Acute Exacerbation of Chronic Obstructive Pulmonary Disease (COPD) can be defined as a sustained aggravation of the disease, in addition to normal daily variations, demanding a change in the medication of the patient with underlying COPD.[2]

According to the latest report Global Burden of Disease by The Lancet, COPD will be one of the main causes of early death by 2040, followed by cardiovascular diseases.[3] Exacerbation commonly accompanies episodes of Acute Respiratory Failure (ARF) of the hypercapnic type (II), promoting an unfavorable prognosis and increased mortality rates. In addition, it may require the need to stay in the Intensive Care Units (ICU) and Invasive Mechanical Ventilation (IMV).[4]

IMV is a ventilatory support resource that partially or fully replaces spontaneous breathing, through an endotracheal tube (ETT) or tracheostomy tube, indicated mainly for cases of ARF, or acute chronic to minimize efforts of the respiratory muscles, in the increment of gas exchanges and reversal of the mechanical failure of the respiratory system.[5] This support can include the programming of several modes, Pressure Support Ventilation (PSV) is one of the conventional ventilatory modes, which uses positive pressure in the airways, where the patient triggers each breath. This mode can be offered invasively or non-invasively, and is considered a strategy that offers great respiratory comfort to intubated patients, in addition to being generally the mode used to evolve with IMV weaning.[6,7]

However, new modes are being considered for this proposal, such as Proportional Assisted Ventilation (PAV), which aims to reduce the work of the respiratory muscles by offering a pressure proportional to the patient's effort, and the Adjusted Assisted Ventilation mode Neurally (NAVA), which captures the electrical activity of the diaphragm and reduces the risk of asynchrony.[8]

Weaning comprises the transition between artificial ventilation and spontaneous ventilation, in patients with more than 24 hours of IMV. This process occupies up to 41% of the total mechanical ventilation time, being even greater in patients with COPD, reaching 58%. Therefore, an adequate and individualized ventilatory strategy is necessary, considering the alterations present in this profile of patients, so that the process can be streamlined, and the consequent suppression of the injuries that would occur with Prolonged Mechanical Ventilation (PMV).[9,10]

Prolonged weaning is characterized by consecutive failure of >3 days in the Spontaneous Breathing Test (SBT), and is directly related to the occurrence of numerous complications in the clinical course of the patient, including the evolution of critically ill polyneuropathy, metabolic and nutritional alterations, hydroelectrolytes, increased incidence of MV-associated pneumonia (VAP) and the need for tracheostomy. Difficult/prolonged weaning is also associated with the appearance of neuropsychiatric disorders and post-ICU physical dependence.[11-13] Furthermore, a longer weaning time corresponds to an extension of the hospital stay, requiring resources and intensive care, generating a great impact on hospital costs.[14]

Currently, in the literature, there are few studies that evaluate the effects of different modes in the described population, in addition to the fact that there is no consensus on which modality could be the most suitable for effective weaning. The present study can help with the establishment of more specific care, taking into account the particular changes in this patient profile. In view of this, this article sought to verify the effects of the PSV mode when compared with different ventilatory modes at the time of weaning of patients with an acute exacerbation of COPD.

Methods

This is a systematic review study, which followed the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Checklist (PRISMA)[15], registered with PROSPERO (CRD42022362228).

Eligibility criteria

Randomized controlled clinical trials (RCTs) that evaluated Pressure Support Ventilation in comparison with ventilatory modes and different strategies (T-tube) at the time of weaning, in patients diagnosed with COPD, mechanically ventilated via intubation orotracheal, nasotracheal or tracheostomy, without delimitation of year and language were considered eligible for this review. Duplicate, incomplete and/or unavailable articles were excluded. The outcomes of interest were: duration of weaning, length of stay in the ICU and mortality.

Research strategy

Searches were performed using the PICO acronym strategy: Patients with exacerbation of COPD on IMV (population); Ventilatory Mode/Strategy (intervention); Pressure Support Ventilation Mode (control); Duration of weaning (Primary outcome) and Length of stay in ICU/Mortality (Secondary outcome).

The strategy produced (Chart 1) was used until January 2023 in the search for articles indexed in the following databases: US National Library of Medicine (PubMed), Cochrane, Scientific Electronic Library Online (SciELO) and Biblioteca Virtual em Saúde (BVS). The terms and descriptors for Health Sciences Descriptors (DECS) and Medical Subject Headings (Mesh) were used: “Acute exacerbation of chronic obstructive pulmonary disease”, “Chronic obstructive pulmonary disease” “Pressure Support Ventilation”, “Intermittent Positive- Pressure Ventilation", "Artificial respiration", "Weaning", "Intensive unit care" and "Ventilation modes" with their respective terms, in addition to the Boolean operators AND and OR at the intersection of descriptors, aiming at greater sensitivity in the selection of articles.

Chart 1. Search strategy used in PubMed and Cochrane databases

PubMed (first search): ((Chronic obstructive pulmonary disease) AND (Weaning) AND (Pressure support ventilation)) AND (Ventilation modes))
PubMed (second search): ((((((((((((((((((((((((Chronic obstructive pulmonary disease) OR (Acute exacerbations of chronic obstructive pulmonary disease)) OR (COPD)) AND (Pressure support ventilation)) AND (Respiration Artificial)) OR (Artificial Respirations)) OR (Respirations, Artificial)) OR (Ventilation, Mechanical)) OR (Mechanical Ventilations)) OR (Ventilations, Mechanical)) OR (Mechanical Ventilation)) AND (Weaning)) OR (Ventilator weaning)) AND (Intensive Care Unit)) OR (Unit, Intensive Care)) OR (ICU Intensive Care Units)) AND (Ventilation modes)) AND (Clinical Trial[Publication Type])) AND (Intermittent Positive-Pressure Ventilation)) OR (BIPAP Biphasic Intermittent Positive Pressure Ventilation)) OR (IPPV)) OR (Biphasic Intermittent Positive Airway Pressure BIPAP)) OR (Inspiratory Ventilation with Positive Pressure)) OR (Inspiratory Positive Pressure Ventilation)) OR (Biphasic Intermittent Positive Pressure Ventilation)) OR (Biphasic Intermittent Positive Pressure Ventilation BIPAP)
Cochrane (first search): Pressure support ventilation* COPD* Weaning*
Cochrane (second search): Pressure support ventilation* Intermittent Positive-Pressure Ventilation* COPD* Weaning*

Source: The authors (2023).

Collection

The extraction of articles was performed by two independent researchers. The articles were selected primarily by their titles, seeking to identify possible studies relevant to the topic. Then the selection took place by reading the abstracts, to identify the inclusion criteria and analyzed outcomes. After this step, the selected articles were read in full to be included or not in the analysis.

The unavailable articles were recruited through the ResearchGate search and downloaded, when full text was available, through the researcher's personal profile in the database. When the file was unavailable, direct contact by sending an e-mail to the corresponding author was considered for recovery, however, there was no response.

Methodological quality

The PEDro scale was used to assess the quality of each study included in the review. The purpose of the PEDro quality scale is to help users of the PEDro database, as well as other databases, regarding methodological quality (internal validity) and the presence of minimal statistical information so that the results can be interpreted. PEDro does not assess the external validity of the study, generalization of the results, or whether there was a minimal clinically important difference.[16]

Risk of bias analysis was performed using the RevMan Web[17] tool of the Cochrane collaboration, by two independent reviewers. The tool was created to integrate other systematic review software and has on its platform the resources for analyzing the risk of bias based on 8 domains with 3 possible answers ("Low risk", "Unclear risk" or "High risk"). The results and graphs were generated in the same program.

Data summary and synthesis measures

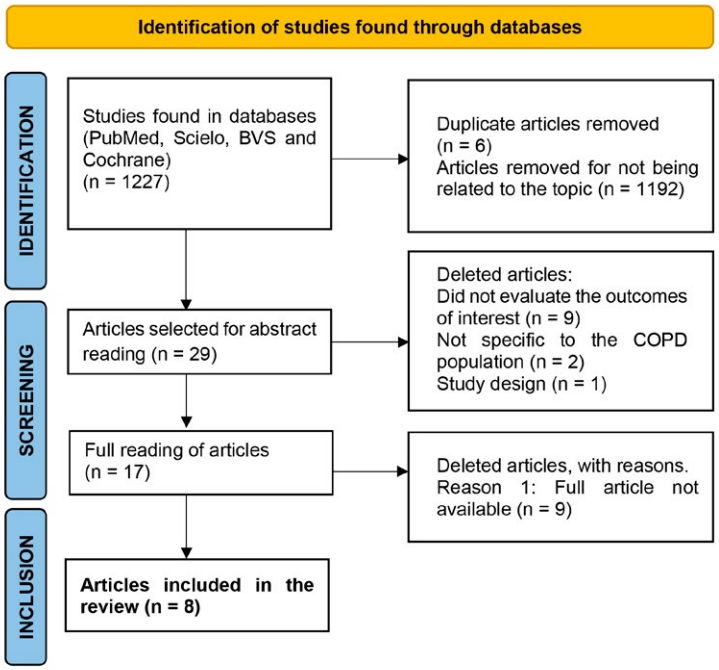
Data regarding the outcomes of choice were synthesized in a table in Microsoft Excel 2019 software, in order to compare the articles included based on a logical sequence including the year of publication, intervention, sample size, mean and standard deviation (SD) of age of the groups, parameters used in weaning and main results.

A narrative summary was presented for the outcomes of duration of weaning, length of stay in the ICU and mortality.

Results

1227 articles were identified in the databases selected for the research, 6 articles were removed for being duplicates and 1192 for not being related to the topic of interest. After that, the abstracts of 29 articles were read, from which 12 were excluded for not meeting the eligibility criteria (evaluation of the listed outcomes and type of study). Finally, after excluding 9 articles due to incomplete text and impossibility of recovery, 8 randomized clinical trials were read in full and included in this review (Figure 1).

Figure 1. Study search and selection flowchart



Source: Adapted from PRISMA Statement (https://www.prisma-statement.org).

Methodological quality

The scores of each randomized clinical trial were gathered according to the PEDro evaluation scale, as well as the identification of each criterion. With a maximum possible score of 10, scores ranged from 4 to 8 (Table 1).

Table 1. PEDro scale score for each item included

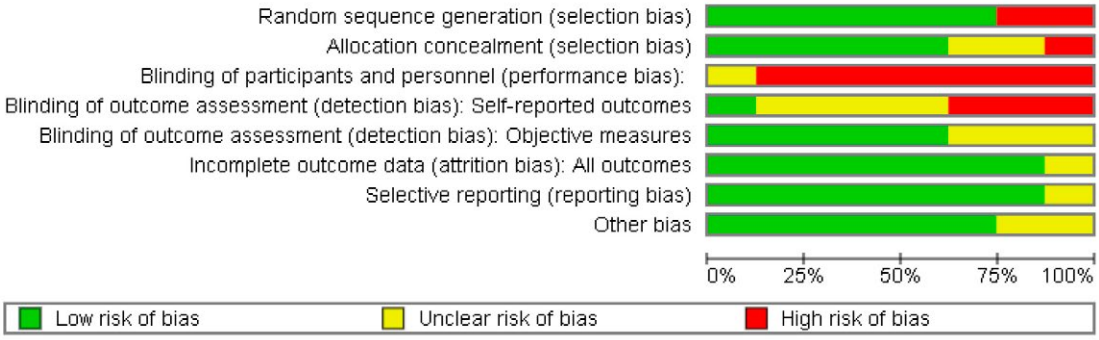
Study	Criteria										
	2	3	4	5	6	7	8	9	10	11	Total
Kirakli et al. (2011)[18]	X	X	X						X	X	5/10
Fayed et al. (2016)[19]	X	X	X				X	X	X		6/10
Mohamed; Kamal El Maraghi. (2014)[20]	X	X	X				X	X	X	X	7/10
Matić et al. (2007)[21]	X	X	X	X			X	X	X	X	8/10
Pellegrini et al. (2018)[22]	X	X	X				X	X	X	X	7/10
Elganady; Beshey; Abdelaziz. (2014)[23]	X	X	X				X	X	X	X	7/10
Kuo et al. (2016)[24]	X		X	X			X	X	X	X	7/10
Jounieau; Duran; Levi-Valensi. (1994)[25]	X		X						X	X	4/10

Subtitle: (2) Random allocation; (3) Hidden allocation; (4) Baseline comparability; (5) Blind subjects; (6) Blind therapists; (7) Blind raters; (8) Adequate follow-up; (9) Intention-to-treat analysis; (10) Comparisons between groups; (11) Point estimates and variability.
Source: The authors (2023).

Risk of bias analysis

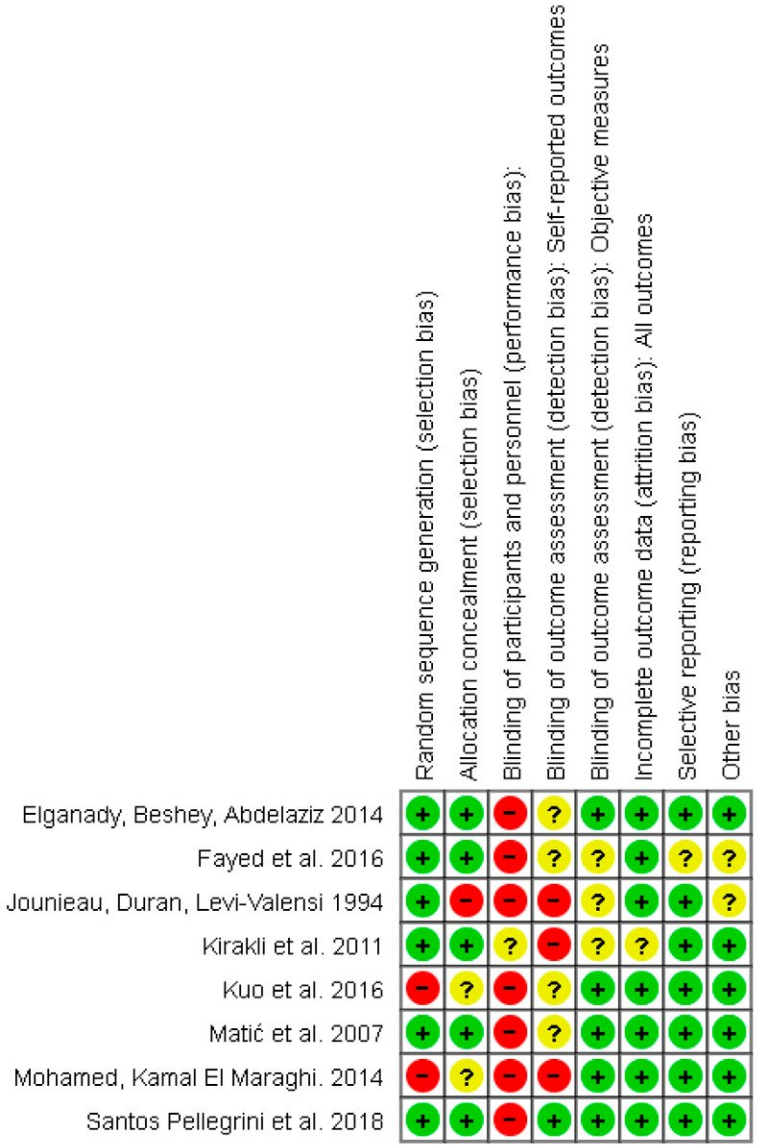
The analysis showed that the studies did not present sufficient methodological description regarding the blinding of the team and patients (Figure 2), characterizing "High risk of bias" for seven articles and "Unclear risk" for one article. Three studies presented "High risk" for the random sequence generation domain due to the lack of explicit information used for randomization and for the allocation concealment domain, according to the individual analysis described in the generated graphs (Figure 3).

Figure 2. Classification of degrees of risk of bias in each domain



Source: RevMan Web Cochrane Collaboration.

Figure 3. Risk of bias ranking by domain in each study



Source: RevMan Web Cochrane Collaboration.

General characteristics of the studies

The sample of the trials that were analyzed ranged from 19 to 190 patients, of both sexes, with a predominance of males. The most used ventilation mode in the control group was Adaptive Support Ventilation (ASV). Data on the sample and outcomes are shown in Table 2.

PSV Versus Adaptive Support Ventilation (ASV) Mode

Of the articles included in the review, three compared the PSV mode with the ASV mode during weaning of a total of 207 patients with AECOPD. All studies presented similar findings regarding the outcomes of weaning time/success and length of stay in the ICU.

Kirakli et al.[18] found a difference in the duration of weaning, which was significantly shorter with ASV (median (IQR) 24 (20–62) h versus 72 (24–144) h) and in the length of stay in the ICU, which was shorter in weaned by ASV, but without statistical significance.

Fayed et al.[19] also found significant differences. Weaning duration (ASV 24 (12-48) h versus 72 (24-144) h) and ICU days (ASV 4 (2.5-9) days versus 6 (3-11) days) were shorter. Mohamed and Maraghi[20] similarly identified a statistically significant difference in the outcomes mentioned above, with better outcomes concentrated in patients in the ASV group, with a reduction in weaning time (27.3 ± 12.3 h vs. 62 ± 14.1 h) and a shorter length of stay (7.3 ± 2.6 days vs 11.7 ± 4.2 days).

In evaluating the mortality of these patients, although an overall mortality of 8% was observed (3 patients), where 2 patients were in the PSV group and 1 in the ASV[20] group, there were no statistically significant differences when comparing the groups. The same was observed in the study by Kirakli et al.[18], where the same rate was found for both groups (9 (18)).

T-tube and PSV as a weaning strategy

Matić and Santos Pellegrini et al.[21,22] compared the effects of the strategy with T-tube versus PSV in a total of 253 patients with AECOPD. Both studies investigated the same outcomes and also presented similar results regarding the length of the weaning process and ICU stay.

Patients in the T-tube group had a longer mean weaning time (63 (51-69) h vs 43 (35-49) h).[21] The same group was also associated with a significantly longer weaning time for patients in the difficult/prolonged weaning subgroup (n = 71) in the study by Santos Pellegrini et al.[22], reaching approximately twice the time of patients in the PSV group (8.36 ± 11.04 days vs 4.06 ± 4.94 days). The trials found no statistically significant differences when comparing the groups in terms of mortality.

However, the findings differ in relation to the length of stay in the ICU. Matić et al.[21] found a longer time in the ICU in the T-tube group (241 (211-268) h vs 210 (186-241) h) while Santos Pellegrini et al.[22] did not observe differences between groups in this variable.

PSV versus Proportional Assisted Ventilation (PAV)

Elganady, Beshey and Abdelaziz[23] compared Assisted Proportional Ventilation (PAV) mode versus PSV in 60 patients, finding patients in the VAP group associated with a shorter time in the ICUs both in the success subgroup (3.70 ± 0.94 vs 5.45 ± 1.43 days) and in the failure subgroup (8.33 ± 0.58 vs 10.0 ± 1.05 days). However, no statistically significant differences were observed regarding 28-day mortality.

PSV versus Neurally Adjusted Assisted Ventilation (NAVA)

Kuo et al.[24] evaluated the outcome of mortality and time in the ICU (n = 33), finding statistical significance for the 90-day mortality rate when comparing the groups, concentrating a lower value in the NAVA group (28.6% vs 31.6% (p=0.85)). Regarding ICU stay, there were no differences between the groups.

Synchronized Intermittent Mandatory Ventilation (SIMV) with and without PSV

Comparing the SIMV mode with and without PSV (n = 19) in assessing the duration of weaning in these patients. Jounieau, Duran and Levi-Valensi[25] found a shorter time in the SIMV/PSV group (4.2±0.8 days vs 5.3±1.0 days), but no statistical significance was observed (p=0.0545).

Table 2. General characteristics of the included studies (to be continued)

AUTHOR, YEAR	INTERVENTION	SAMPLE	WEANING PARAMETERS	OUTCOMES	RESULTS
Matić et al. (2007)[21]	T-tube	N = 63 CG = 32 (52.01 ± 27.93 years) IG = 31 (56.86 ± 23.31 years)	**IG =** The weaning procedure was initiated by a 5-minute SBT trial. If this attempt was successful, a 2-hour SBT was performed. **CG =** Initial positive pressure support was 18 cmH_2O. This support was then reduced by 2-4 cmH_2O based on lung mechanics, biochemistry and circulation parameters; patients were extubated with a pressure support of 5 cmH_2O.	Duration of weaning Time in ICU Mortality	IG = Mean time to weaning (63 (51-69) vs 43 (35-49) h) and in the ICU (241 (211-268) vs 210 (186-241) h) were significantly longer. There were no differences in mortality.
Kirakli et al. (2011)[18]	ASV	N = 97 CG = 48 (63.58 ± 10.69 years) IG = 49 (62.58 ± 12.22 years)	**IG =** Inspiratory trigger sensitivity at -1 cmH_2O; pressure trigger in 0.1s (P0.1); high pressure alarm for 45 cmH_2O; minute volume at 100mL/kg of ideal weight, reduced to 50mL/kg after 1h and to 30mL/kg after 2h, expected to be associated with an inspiratory pressure level of 10 cmH_2O, similar to PSV; SBT with minute volume support of 30mL/kg for 2h. **CG =** Inspiratory trigger sensitivity at -1 cmH_2O; pressure trigger in 0.1s (P0.1); initial pressure support level (above PEEP) at 15 cmH_2O, assessed every 30min and titrated to maintain RR 35irpm and, if possible, gradually decrease to 7 cmH_2O at 2 cmH_2O intervals; SBT with pressure support level of 7 cmH_2O for 2h.	Duration of weaning Time in ICU Mortality	IG = Weaning time (24 (20–62) versus 72 (24–144) h) (p=0.041) was significantly shorter. Time in ICU was shorter (11 (6-15) versus 13 (8–14) days, p=0.5), but this difference was not statistically significant and there was no difference in mortality.
Elganady; Beshey; Abdelaziz. (2014)[23]	PAV	N = 60 CG = 30 (61.20 ± 6.01 years) IG = 30 (58.13 ± 7.74 years)	**IG =** Maximum airway pressure limit of 40 cmH_2O; initial PEEP and FiO2 adjustments were made by the usual criteria; assistance percentage from 70%; if there was no respiratory distress, assistance was reduced by 10-20% every 2h with respiratory distress monitoring. **CG =** Attempted SBT with a low level of continuous positive airway pressure (eg, 5 cmH_2O) and low level of pressure support (eg, 5-8 cmH_2O); if there were no signs of discomfort within 120min, extubation was considered.	Time in ICU Mortality	IG = ICU time was shorter in both subgroups, success (3.70 ± 0.94 vs 5.45 ± 1.43 days) and failure (8.33 ± 0.58 vs 10.0 ± 1.05 days). There were no differences in mortality (p=1000).

Table 2. General characteristics of the included studies (continuation)

AUTHOR, YEAR	INTERVENTION	SAMPLE	WEANING PARAMETERS	OUTCOMES	RESULTS
Mohamed; Kamal El Maraghi. (2014)[20]	ASV	N = 50 CG = 25 (66.9 ± 7.8 years) IG = 25 (63.5 ± 9.4 years)	**IG =** Minute volume was reduced to 30% to achieve lower levels of pressure support, as in the PSV group, and to prepare the patient for extubation. Patients were ventilated for 2 hours and then extubated. **CG =** The initial level of pressure support (above PEEP) was set at 15 cmH_2O; the pressure support level was assessed at least every 30min and titrated to maintain the RR<35 cycles/min and, if possible, gradually decreased to 7 cmH_2O by 2 cmH_2O; patients were ventilated for 2 hours and then extubated.	Duration of weaning Time in ICU Mortality	IG = Weaning time (27.3 ± 12.3 vs 62 ± 14.1 h) and ICU time (7.3 ± 2.6 vs 11.7 ± 4.2 days) were significantly shorter. There were no differences in overall mortality at the 28-day follow-up.
Fayed et al. (2016)[19]	ASV	N = 60 CG = 30 (61.35 ± 17.90 years) IG = 30 (59.63 ± 19.46 years)	**IG =** Minute volume 100 ml/kg of ideal weight; ASV detected patient exertion and automatically weaned off the mandatory RR when the patient was ready to assume a portion of the MV requirement; if the patient does not breathe spontaneously, and blood gas analysis is ideal, a 10-20% %MV reduction was attempted to encourage spontaneous breathing; when extubation criteria were met, extubation was attempted directly without SBT. **CG =** From the maximum level of PSV (level that reaches FR <20 with a TV of 8 ml/kg); Reduction of PSV by 5 cmH_2O; if no signs of intolerance were evident for 4 hours of testing, the PSV was reduced by an additional 5 cmH_2O for another 4 hours; at any sign of intolerance, the patient was returned to the previous level for the next 4 hours; once the patient was able to sustain 7 cmH_2O PSV without signs of intolerance for 4 hours, extubation was attempted.	Duration of weaning Time in ICU	IG = Weaning duration (24 (12-48) versus 72 (24-144) h) and ICU stay (4 (2.5-9) days versus 6 (3-11) days, p<0.001) were significantly smaller.
Pellegrini et al. (2018)[22]	T-tube	N = 190 CG = 91 (67.30 ± 9.83 years) IG = 99 (67.99 ± 11.37 years)	**IG =** The tracheal tube was disconnected from the ventilator and connected to a "T" connector, which continuously supplied humidified oxygen to reach a saturation of at least 92% in the absence of positive pressure; the SBT was performed in 30 minutes in the semi-sitting position. **CG =** The support pressure of the patients was adjusted to 10 cmH_2O, keeping the previously adjusted PEEP and FiO2 – the latter could be adjusted when necessary to reach an arterial saturation of at least 92%; the SBT was performed in 30 minutes in the semi-sitting position.	Duration of weaning Time in ICU Mortality	IG = In the difficult weaning group, there was an association with a weaning time of approximately twice as much (8.36 ± 11.04 vs 4.06 ± 4.94 days). There were no differences in the other outcomes.

Table 2. General characteristics of the included studies (conclusion)

AUTHOR, YEAR	INTERVENTION	SAMPLE	WEANING PARAMETERS	OUTCOMES	RESULTS
Kuo et al. (2016)[24]	NAVA	N = 33 CG = 19 (76.9±9.3 years) IG = 14 (79.3 ± 6.2 years)	**IG =** An SBT with PSV 8 cmH_2O and unchanged PEEP was performed every 24 hours if the patient met the following criteria: 1) absence of fever or infection, 2) hemodynamic stability, 3) FiO2 50% and 4) PEEP 8 cmH_2O. If successful, the patient was evaluated for extubation and non-invasive ventilation. If the SBT failed, it was returned to assisted ventilation with a NAVA setting corresponding to 50% of the peak Edi level during the SBT. **CG =** An SBT with PSV 8 cmH_2O and unchanged PEEP was performed every 24 hours if the patient met the following criteria: 1) absence of fever or infection, 2) hemodynamic stability, 3) FiO2 50% and 4) PEEP 8 cmH_2O. If successful, the patient was evaluated for extubation and non-invasive ventilation. If the SBT fails, the PSV group returns to a PSV level determined by the conventional weaning protocol.	Time in ICU Mortality	IG = The mortality rate in the 90 days was significantly lower (28.6% vs 31.6% (p=0.85)), in the outcome of total time in the ICU there were no differences between the groups.
Jounieau; Duran; Levi-Valensi. (1994)[25]	SIMV	N = 19 CG = 9 (67.2 ± 8.4) IG = 10 (67.1 ± 8.3 years)	**IG =** The SIMV rate was gradually reduced by 2 cycles/min once or twice a day according to the patient's tolerance. When it reached 6 cycles/min, short periods of spontaneous breathing of 1h were performed through the ventilator circuit. If SBT attempts appeared clinically well tolerated, a spontaneous breathing period of at least 10 hours was performed. When patients underwent this procedure successfully, they were extubated. **CG =** PSV was added throughout weaning and four decreasing levels, arbitrarily chosen, were used in conjunction with decreasing SIMV rate: 15 cmH_2O at 10 cycles/min step; 12 cmH_2O at 8 cycles/min step; 9 cmH_2O at 6 cycles/min step; and 6 cmH_2O during SBT and SB until extubation.	Duration of weaning	IG = Weaning duration was longer (4.2 ± 0.8 vs 5.3 ± 1.0 days), but the difference did not reach the significance level (p=0.0545).

ASV: Adaptive Support Ventilation; FiO2: Fraction of Inspired Oxygen; RR: Respiratory Rate; NAVA: Neurally Adjusted Ventilatory Support; PAV: Proportional Assisted Ventilation; PEEP: Positive End-Expiratory Pressure; PSV: Pressure Support Ventilation; SIMV: Synchronized Intermittent Mandatory Ventilation; SB: Spontaneous Breathing. SBT: Spontaneous Breathing Trial; ICU: Intensive Care Unit; TV: Tidal Volume; MV: Mechanical Ventilation.
Source: The authors (2023).

Discussion

In most of the articles that made up this systematic review, the PSV Mode was associated with unfavorable outcomes (increased time to weaning and ICU stay) in patients with AECOPD. In the comparison, the ASV, NAVA and PAV modes showed better results, on the other hand, better values were observed in the PSV mode only when compared to the T-Tube strategy. In general, the majority of randomized clinical trials showed no difference between the modes in terms of mortality.

Similar results were observed in the clinical trial by Liu et al.[26], where the NAVA mode in patients with difficult weaning improved clinical outcomes and promoted an improvement in patient-ventilator synchrony when compared to PSV. In contrast to the present study, they found better values regarding the duration of weaning. Vasconcelos et al.[27] found the most frequent asynchrony in patients with airflow limitation to be late cycling, which represents the neural-mechanical time correlation and is common during PSV mode. Furthermore, it was shown that respiratory mechanics directly affects this correlation and the degree of asynchrony, mainly impacting patients with an obstructive profile, the target group of the current study.

In the evaluation of the NAVA vs PSV mode in patients with Acute Respiratory Distress Syndrome, it was possible to observe that the modes generated similar breathing patterns, despite the neural adjustment mode having optimized gas exchanges in protective MV.[28] The study by Leites et al.[29] that evaluated the PAV mode in the weaning of 14 tracheostomized patients, concluded that despite having observed a reduction in weaning time and a higher success rate of the process, the data were not statistically significant, and the small sample size did not support the best choice mode.

In the analysis of the T-tube as the main weaning strategy, the authors identified a good ability to identify patients eligible for MV interruption, however a high rate of re-intubation was found, which was associated by the authors with excessive efforts of the musculature due to the time used for the test.[30] Assunção et al.[31], evaluating the same strategy for weaning patients with and without heart disease, concluded that in the comparison, PSV improves oxygenation and respiratory parameters.

Despite the importance of using an adequate ventilation mode, there are other factors associated with weaning failure that potentially cause worse outcomes, and that may have influenced the results of the studies, as well as age, admission profile, causes of OTI, presence of pneumonia or other injuries and the strategy used for the SBT, in addition to the time it was performed.[32]

Evidence also already suggests an alternative for patients with hypercapnic COPD ($PaCO_2$ > 45mmHg) who fail SBT, when the clinical picture is sufficient to perform it. The facilitating NIV in these individuals favors early weaning from IMV, reducing the time in the ICU and preventing the decline of clinical outcomes.[33,34] It is noteworthy that the majority of studies had the physician as the main figure involved in the entire process, from the ventilation prior to handling in the weaning process. However, the importance of the physiotherapist during this transition is already widely known, since it is the professional who can accelerate the weaning process, consequently reducing the time on MV, thus avoiding several subsequent injuries. José et al.[35] evaluated the effect of physiotherapy in this process and observed that the time on MV.

Some characteristics added limitations to this study, which may have influenced the results, such as the heterogeneity of the samples, as well as a reduced number of patients in the groups of some of the included studies, in addition to the risk of bias analysis that identified possible threats to the reliability of the trials, which may have reduced the quality of the articles and limited the analysis in this review. In addition, a considerable number of studies were excluded in the selection process because they were unavailable to all possible resources, reducing the number of RCTs for investigation in the present review.

The meta-analysis for this study was considered, however, discarded due to the high heterogeneity of the few studies that were considered eligible, therefore, the reported result would not present an ideal level of reliability.

Conclusion

Based on the analyzes carried out from each study, it is evident that the PSV mode in mechanically ventilated patients with AECOPD, when compared to assisted ventilation modes, favors worse outcomes associated with the weaning process, including the duration of weaning and affecting the time of stay in the ICU. However, there is still not much evidence regarding the mortality of patients ventilated by this mode.

Author contributions

Alves BBC participated in the design of the research question, methodological design, search and statistical analysis of research data, interpretation of results and writing of the scientific article. Silva CMS participated in the design of the research question, methodological design, data interpretation, interpretation of the results of the scientific article. All authors reviewed and approved the final version and are in agreement with its publication.

Conflicts of interest

No financial, legal or political conflicts involving third parties (government, companies and private foundations, etc.) have been declared for any aspect of submitted work (including, but not limited to, grants and funding, advisory board participation, study design, preparation manuscript, statistical analysis, etc.).

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