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RESPIRATORY MUSCLE TRAINING AT WEANING FROM IMV: AN INTEGRATIVE REVIEW

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ABSTRACT

Objective: To evaluate the repercussions of respiratory muscle training on weaning IMV. Methodology: The present study is an integrative review study, with a survey carried out in the following databases: the National Library of Medicine, the National Center for Biotechnology Information (PUBMED), and Latin American and Caribbean Literature on Health Sciences (LILACS). The search for articles took place from August to November 2023, with the following descriptors: weaning, respiratory muscle training, and inspiratory muscle training, and used as follows: PUBMED, the descriptors "weaning", "respiratory muscle training"; and in LILACS, the descriptors "inspiratory muscle training", "weaning" were used. On both platforms, he used the Boolean operator "AND". Results: Respiratory muscle training is essential for maintaining and reestablishing the power and strength of the respiratory muscles, especially in patients who remain on invasive mechanical ventilation (IMV) for long periods so that the muscles can perform their function efficiently. The protocols for carrying out the training are varied in load intensity, sets, and repetitions, the 7 selected articles showed consequent benefits of respiratory muscle training in the weaning process, as well as in variables that influence its reduction, such as MIP, improvement of FVC, reduction of SRRI and dyspnea. Conclusion: Given the arguments presented, it can be seen through the study that respiratory muscle training (RMT) promotes positive effects on weaning from invasive mechanical ventilation (IMV) since it promotes the gradual improvement of inspiratory muscle strength, and respiratory patterns, oxygenation, MIP, FVC and reduction of weaning duration.

Keywords: Weaning. Respiratory Muscle Training. Inspiratory Muscle Training.

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INTRODUCTION

Invasive mechanical ventilation (IMV) is the provision of ventilatory support using positive pressure, used in patients who are using any type of artificial airway such as an endotracheal tube or tracheostomy cannula, and who make the connection between the mechanical ventilator and the patient (Da Silva Guimarães *et al*., 2021).

This practice is common in the care of critical patients in Intensive Care Units (ICUs) who are unable to perform gas exchange efficiently to maintain respiratory function and dynamics. Although it has great benefits, its applicability time should be as short as possible, since its prolonged use is associated with sequelae in the respiratory system such as lung injury and dysfunction of the respiratory muscles, characterized by reduced strength, which tends to negatively influence the weaning process (De Lima *et al*., 2023).

The weaning process refers to the transition from mechanical ventilation to spontaneous breathing in patients who remain on mechanical ventilation for more than 24 hours. The earlier this process begins, the greater the chances of success, when started late, there is a significant impairment of the recovery of spontaneous breathing as a result of attempts to interrupt ventilation and muscle weakness (De Souza, 2020).

Patients undergoing prolonged invasive mechanical ventilation (IMV) are subject to developing respiratory muscle weakness, as the diaphragm and accessory muscles of inspiration are compromised. With this, strengthening this muscle can increase the efficiency of the weaning process. Respiratory muscle training aims to reduce the problems resulting from disuse and atrophy caused by the period of permanence on mechanical ventilation (Marinho *et al*., 2018).

The forms of respiratory muscle training (RMT) mentioned in the literature are classified as linear loading, alinear loading, and isokinetic loading, as examples are: P flex, mechanical ventilator sensitivity alteration, spirotiger, Threshold, and Powerbreath (Santos *et al*., 2001).

For the diaphragm and accessory muscles to obtain strength, and endurance and increase their inspiratory capacity, the inspiratory muscles need to be stimulated. As a result, these stimuli can be performed in different ways in the inspiratory muscle training (IMT) of patients in the weaning process (Epaminondas *et al*., 2020).

Given this scenario, the study aims to evaluate the repercussions of respiratory muscle training on weaning from IMV.

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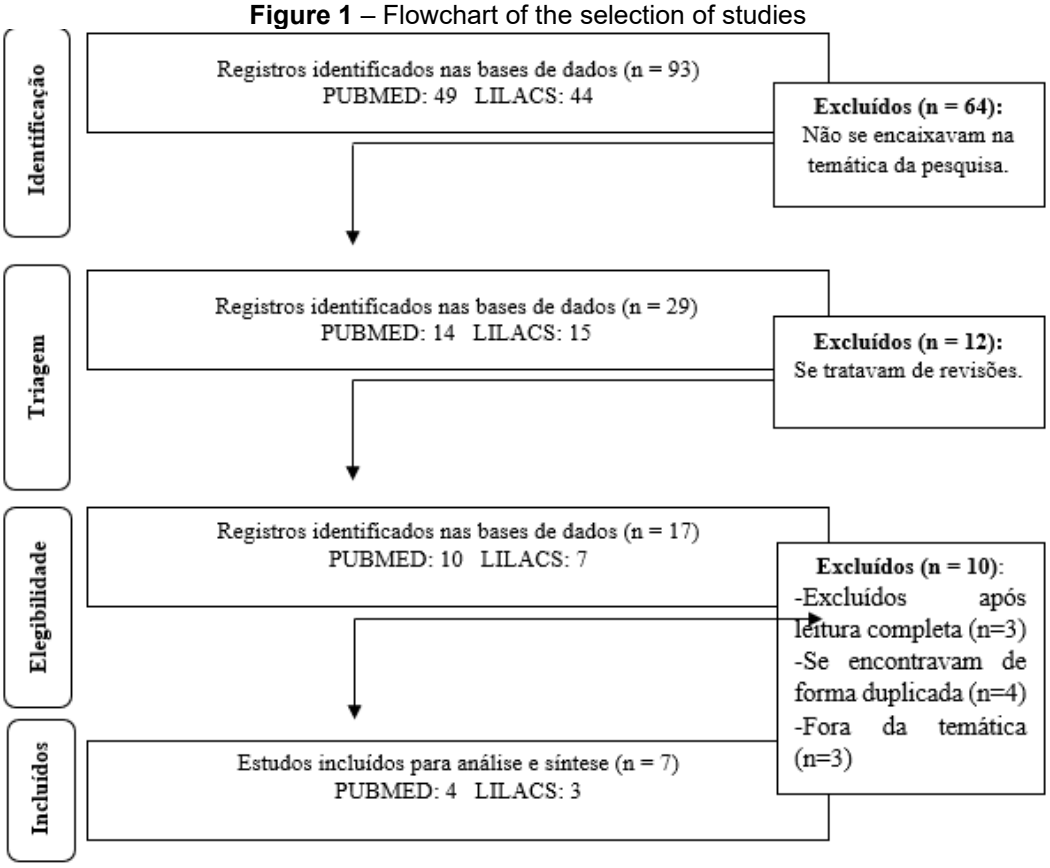
METHODOLOGY

The present study is an integrative review study, with a survey carried out in the following databases: the National Library of Medicine National Center for Biotechnology Information (PUBMED) and the Latin American and Caribbean Literature on Health Sciences (LILACS).

The inclusion criteria were the time of publication of the articles between 2015 and 2022, with the target population being critically ill patients with prolonged time of use of mechanical ventilation. The exclusion criteria were literature review articles, and articles found in duplicate form in the research sites.

The search for articles took place from August to November 2023, with the following descriptors: weaning, respiratory muscle training, and inspiratory muscle training, and used as follows: PUBMED, the descriptors "weaning", "respiratory muscle training"; and in LILACS, the descriptors "inspiratory muscle training", "weaning" were used. On both platforms, he used the Boolean operator "AND". All descriptors were cross-referenced in all languages, and then the titles and abstracts resulting from the search were read to select the articles that were part of this review.

Figure 1 – Flowchart of the selection of studies



Source: 2023 survey data

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RESULTS

In the search carried out in the databases, 93 articles were found, of which 7 were included in this review, the remaining articles were excluded according to the inclusion/exclusion criteria cited: articles that did not fit the theme of the aforementioned work, duplicate articles. The articles found are shown in Table 1.

Table 1 - Articles collected in the LILACS, and PUBMED databases

ARTICLE	METHODOLOGY	GOAL	INTERVENTION	DENOUEMENT
Monsalve *et al*., 2019	Case report	OBJECTIVE: To describe the case of a 65-year-old patient with Fisher III subarachnoid hemorrhage, on prolonged MV and difficulty weaning, submitted to respiratory muscle training.	In the case described, we worked with an intensity of 60% to 80% of the maximum sensitivity reached by the patient, ensuring the fulfillment of three sets of 15 repetitions each session.	The implementation of respiratory muscle training strategies in addition to conventional therapy can contribute to the gradual increase in inspiratory muscle strength in neurocritical patients admitted to intensive care units, as in the case presented here, influencing weaning from invasive mechanical ventilation.
Van Hollebeke *et al*., 2022	Randomized controlled trial	To compare changes in muscle oxygenation parameters of the inspiratory scalene and sternocleidomastoid muscles during a standardized task among patients with weaning difficulties who received high-intensity IMT (intervention) or low-intensity sham IMT (control).	41 patients performed daily IMT sessions (4 sets, 6-10 breaths) until successful weaning or for 28 consecutive days. The training load was progressively adjusted in the intervention group (*n* = 22) for the highest tolerable load, while the control group (*n* = 19) maintained training at 10% of its baseline maximal inspiratory pressure (MIP).	The intervention group improved work and respiratory power; both groups significantly improved the local oxygen saturation index; both groups significantly improved MIP and FVC improved significantly only in the intervention group.
Bissett *et al*., 2021	Randomized trial	To verify whether inspiratory muscle training, initiated while	70 participants (mechanically ventilated ≥7 days) were randomized to receive supervised high-intensity	Quality of life improved significantly more in the training group than in the control

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		ventilator-dependent, would improve outcomes for patients invasively ventilated for 7 days or more.	inspiratory muscle training, once daily, with a mechanical threshold device, in addition to usual care. Or to receive usual care (control).	group. Only the training group demonstrated significant reductions in dyspnea (-1.5 at rest, -1.9 during exercise).
Khodabandelo o *et al*., 2023	Randomized controlled trial	To evaluate the effect of inspiratory muscle training (IMT) threshold on weaning duration in patients admitted to an intensive care unit (ICU).	79 patients admitted to the ICU on MV were randomly divided into intervention groups (*n* = 40) who received threshold IMT and conventional respiratory physiotherapy, and control (n = 39) who received conventional respiratory physiotherapy only once a day. Before and after the end of the intervention, inspiratory muscle strength and weaning duration were measured in both groups.	The duration of weaning was shorter in the intervention group. There was a greater decrease in the RSRI in the intervention group when compared to the control group. There was an increase in respiratory muscle strength and a reduction in weaning duration in both groups.
Tonella *et al*., 2017	Pilot, prospective, randomized study	To evaluate variations in respiratory and hemodynamic parameters with electronic inspiratory muscle training (EIMT) in tracheostomized patients requiring MV and to compare these variations with those of a group of patients undergoing an intermittent nebulization program (IBB).	21 patients were randomized: 11 in the INP group and 10 in the IEMT group. Two patients were excluded from the experimental group due to hemodynamic instability.	In the IEMT group, maximal inspiratory pressure (MIP) after training was significantly higher than before (P = 0.017), there were no hemodynamic changes, and the total weaning time was shorter than in the INP group (P = 0.0192).
Chang *et al*., 2022	Preliminary study	To examine the impact of adjusting ventilator firing sensitivity as inspiratory muscle training on weaning parameters in patients with	A convenience sampling method was used to recruit patients who received prolonged mechanical ventilation for more than 21 days in the control (n = 20) and intervention (n = 22) groups. Adjustment of the ventilator trigger	The magnitude of weaning parameters was significantly higher in the intervention group after the six-week training, including MIP, IRRS, tidal volume, and

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		prolonged ventilator dependence.	sensitivity started at 10% of baseline MIP and increased to 40% after a six-week training period. Weaning parameters were collected for pre- and post-tests.	arterial/inspired oxygen ratio.
Da Silva Guimarães *et al*., 2021	Prospective randomized controlled trial	To test whether the use of an inspiratory muscle training program with an electronic resistive load device is associated with benefits in terms of muscle strength, weaning, and survival in the ICU.	Tracheostomized patients (18-86 years) in prolonged weaning were assigned to IMT (intervention) or a traditional T-piece protocol (control). In the IMT group, they underwent training with an electronic inspiratory training device (POWERbreathe K-5; Technologies Ltd, Birmingham, United Kingdom).	IMT was associated with a substantially greater gain in muscle strength as assessed by MIP and timed inspiratory effort. Outcomes on day 60 in ICU were significantly better in the intervention group in terms of both survival and weaning success.

Few relevant studies were found on the importance of respiratory muscle training (RMT) in the weaning process of patients on mechanical ventilation. Being selected and subdivided into: one case report, one preliminary study type, and five clinical trials, three randomized and two prospective randomized controlled trials.

DISCUSSION

Mechanical ventilation (MV) is a process frequently instituted in patients admitted to intensive care units (ICU). Although its use is temporary, in most cases neurocritical patients need to use MV for prolonged periods due to various conditions that hinder the weaning process.

When the cause of MV prolongation is due to muscle weakness, it is important to institute a respiratory muscle training (RMT) program, which aims to condition the respiratory muscles so that they perform their function with the greatest possible ease and performance.

In his study, Monsalve (2019), when describing the case of a 65-year-old patient with Fisher III subarachnoid hemorrhage, prolonged mechanical ventilation, and difficulty weaning, in which a respiratory muscle training strategy was implemented, where she was subjected to training with the following parameters: intensity of 60% to 80%, fulfilling three

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sets of 15 repetitions each session, highlighted that the implementation of the RMT added to conventional therapy can contribute to the gradual increase in inspiratory muscle strength of neurocritical patients admitted to intensive care units, as in the case presented here, influencing weaning from invasive mechanical ventilation.

In the studies by Khodabandeloo (2023) and Da Silva Guimarães (2021), participants were divided into a control group (CG) and an intervention group (IG), where all participants were evaluated before and after the intervention to quantify the expected results.

Thus, Khodabandeloo (2023), in his study, when evaluating the effect of the inspiratory muscle training (IMT) threshold on weaning duration in 79 patients admitted to the intensive care unit (ICU), mechanically ventilated and divided into 2 groups: intervention group (received threshold IMT and conventional respiratory physiotherapy) and control group (received conventional respiratory physiotherapy once a day), showed that there were changes about weaning in the groups, where the intervention group had a shorter duration in this process; there was a decrease in the IRRS in the intervention group and control group after the intervention and the comparison between groups showed a significantly greater reduction in the intervention group than in the control group, highlighting the positive effect of the threshold IMT in increasing respiratory muscle strength and reducing weaning duration.

Similar results were found in the study by Da Silva Guimarães (2021), where, when testing whether the use of an inspiratory muscle training program with an electronic resistive loading device is associated with benefits in terms of muscle strength, weaning, and ICU survival in 101 tracheostomized patients (18-86 years) under prolonged weaning, with participants assigned to IMT (intervention group) or a traditional T-piece protocol (control group), showed that IMT was associated with a substantially greater gain in muscle strength assessed by MIP and timed inspiratory effort, where the results on the 60th day of ICU were significantly better in the intervention group both in terms of survival and weaning success, presenting results similar to those described in the study by Monsalve (2019) and Khodabandeloo (2023).

Critically ill patients who have difficulties in weaning from the mechanical ventilator are prone to developing respiratory muscle weakness, with this, inspiratory muscle training (IMT), as highlighted in the study by Bissett (2021) can improve respiratory muscle strength, especially through the increase in MIP as evidenced in the study by Da Silva

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Guimarães (2021) and Tonella (2017), In addition, it generates positive impacts on relevant clinical outcomes such as weaning success.

In his study, Tonella (2017), when evaluating variations in respiratory and hemodynamic parameters with electronic inspiratory muscle training (EIMT) in 21 tracheostomized patients who require MV and comparing these variations with those of a group of patients undergoing an intermittent nebulization program (IBP), showed that in the IIMT group, MIP after training was significantly higher than before and the total weaning time was shorter than in the group INP.

The author Bissett (2021), when verifying whether inspiratory muscle training, initiated while ventilator-dependent, would improve outcomes for 70 patients invasively ventilated for 7 days or more, randomized to receive supervised high-intensity IMT, once daily, with a mechanical threshold device, in addition to usual care or to receive usual care (control), showed that quality of life improved significantly more in the training group than in the control group and that only the training group demonstrated significant reductions in dyspnea.

The protocols for carrying out the training are varied in the intensity of the load, series, and repetitions, according to the specificity of each patient, and should be applied individually for each case. In the study by Monsalve (2019), the intensity of 60% to 80%, fulfilling three sets of 15 repetitions each session, generated positive results in the gradual increase of inspiratory muscle strength, influencing the time to wean from ventilation.

In the study by Van Hollebeke (2022), high-intensity IMT generated better results when compared to low-intensity IMT, where, by monitoring changes in muscle oxygenation parameters of the scalene and sternocleidomastoid inspiratory muscles during a standardized task among 41 patients with weaning difficulties who received high-intensity IMT (intervention, with training load progressively adjusted to the highest tolerable load) or low-intensity simulated IMT (control, maintained training at 10% of its baseline MIP), showed that the intervention group improved work and respiratory power; both groups significantly improved the local oxygen saturation index and MIP, FVC improved significantly only in the intervention group.

In his study, Chang (2022), used another form of TMR, being performed by adjusting the sensitivity of the ventilator, where when examining the adjustment of the sensitivity of the ventilator firing as inspiratory muscle training on weaning parameters in 42 patients with prolonged dependence on the ventilator, with the adjustment of sensitivity starting from

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10% of the initial MIP and being increased to 40% after a six-week training period, showed that the adjustment made can help ventilator-dependent patients for a prolonged period to improve their respiratory muscle strength, breathing patterns, and oxygenation.

The studies by authors Van Hollebeke (2022), Monsalve (2019), and Chang (2022) demonstrate that, despite the positive results, the ideal respiratory training parameters have not yet been established, and further studies on the subject are needed.

CONCLUSION

Given the arguments presented, it can be seen through the study that respiratory muscle training (RMT) promotes positive effects on weaning from invasive mechanical ventilation (IMV) since it promotes gradual improvement in inspiratory muscle strength and respiratory patterns, oxygenation, MIP, FVC and reduction of weaning duration.

All respiratory muscle training (RMT) protocols described in the studies show improvements resulting from their application. As a result, information about this modality and its benefits should be disseminated and understood by the multi-professional team, reinforcing the need for more studies and research on the subject, given the low number of studies available in the literature.

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