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STRATEGIES FOR WEANING FROM INVASIVE MECHANICAL VENTILATION: INTEGRATIVE REVIEW

ESTRATÉGIAS PARA O DESMAME DA VENTILAÇÃO MECÂNICA INVASIVA: REVISÃO INTEGRATIVA

ESTRATEGIAS PARA EL DESTETE DE LA VENTILACIÓN MECÁNICA INVASIVA: REVISIÓN INTEGRATIVA

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ABSTRACT

Introduction: Our objective was to identify strategies used by healthcare professionals, which promote the success of ventilatory weaning of the critical patient under invasive mechanical ventilation (IMV), hospitalized in Intensive Care Unit (ICU).

Methods: Integrative literature review, with research on B-On®. Studies included focused on the ventilatory weaning of critical patients, aged 18 years or older, hospitalized in ICU. Data was extracted according to the previous defined tools. The levels of evidence and methodological quality of the studies were evaluated.

Results: After the selection process, seven studies were analyzed. The main strategies identified were the use of weaning plans that included sedation interruption and daily patient assessment against predictive criteria for weaning success, spontaneous breathing trial (SBT), and assessment of SBT success/failure criteria before extubating.

Conclusion: The strategies identified promoted favorable results on the critical patient, among which are evidenced, the timely ventilatory weaning and the decrease of the duration of IMV, fostering the improvement of the quality of care.

Keywords: Critical Care; Intensive Care Units; Mechanical Ventilation; Ventilator Weaning.

RESUMO

Introdução: O nosso objetivo foi identificar estratégias utilizadas pelos profissionais de saúde, promotoras do sucesso do desmame ventilatório do doente crítico sob ventilação mecânica invasiva (VMI), internado em Unidade de Cuidados Intensivos (UCI).

Métodos: Revisão integrativa da literatura, com pesquisa na Biblioteca do Conhecimento Online (B-On®). Incluíram-se estudos sobre desmame ventilatório do doente crítico, adulto, internado em UCI. Extraídos os dados, mediante instrumentos definidos previamente. Procedeu-se à avaliação dos níveis de evidência e qualidade metodológica dos estudos.

Resultados: Após processo de seleção, foram analisados 7 estudos. As principais estratégias identificadas foram a utilização de planos de desmame, que incluam a interrupção da sedação e avaliação diária do doente face aos critérios preditores do sucesso do desmame, realização de teste de respiração espontânea (TRE) e avaliação dos critérios de sucesso/insucesso do TRE antes da extubação.

Conclusão: As estratégias identificadas promoveram resultados favoráveis ao doente crítico, nomeadamente, o desmame ventilatório oportuno e o decréscimo da duração da VMI, fomentando o sucesso do desmame ventilatório e consequente melhoria da qualidade dos cuidados.

Palavras-chave: Cuidados Críticos; Desmame do Respirador; Ventilação Mecânica; Unidades de Terapia Intensiva.

RESUMEN

Introducción: Nuestro objectivo es identificar las estrategias utilizadas por los profesionales de salud, promotoras del éxito del destete ventilatorio, del paciente crítico sometido a ventilación mecánica invasiva (VMI) internado en Unidad de Cuidados Intensivos (UCI).

Métodos: Revisión integrativa de la literatura, con investigación en la B-On®. Se incluyeron estudios sobre el destete ventilatorio del paciente crítico, adulto, internado en UCI. Extraídos los datos, mediante instrumentos definidos previamente. Se procedió a la evaluación de los niveles de evidencia y calidad metodológica de los estudios.

Resultados: Tras el proceso de selección, se analizaron 7 estudios. Las principales estrategias identificadas fueron el uso de planes de destete que incluían la interrupción de la sedación y la evaluación diaria del paciente frente a los criterios predictivos para el éxito del destete, el ensayo de respiración espontánea (ERE) y la evaluación de los criterios de éxito/fracaso del ERE antes de la extubación.

Conclusion: Las estrategias identificadas promovieron resultados favorables al paciente crítico, entre los cuales, el destete ventilatorio oportuno y el decrecimiento de la duración de la VMI, fomentando la mejora de la calidad del cuidado.

Descriptores: Cuidados Críticos; Desconexión del Ventilador; Ventilación Mecánica; Unidades de Cuidados Intensivos.

INTRODUCTION

Critically ill patients can be defined as those in situations of imminent organ failure that condition their survival; needs continuous and highly qualified care, which requires healthcare professionals to carry out methodical and systemic data collection in order to ensure early intervention in the prevention and detection of complications and to ensure rigorous, efficient and timely intervention[1].

Invasive mechanical ventilation (IMV) is a ventilatory support therapy commonly used to treat critically ill patients with compromised ventilation. In Europe, 990 000 to 1 500 000 patients/year are ventilated in intensive care[2]. Although IMV has multiple life-saving benefits, it is associated with side effects, including: decreased cardiac output and renal perfusion, ventilator-associated pneumonia (VAP), and ventilator-induced lung injury[3]. Critically ill patients should remain under IMV as long as necessary, and timely and successful ventilatory weaning is recommended[3,4].

Weaning from IMV is the process of gradually reducing the ventilatory support provided to the patient until it is replaced by spontaneous ventilation and removal of the artificial airway[5]. In order for ventilatory weaning to be successful, extubation and absence of ventilatory support should be provided within 48 hours after extubation, since failure of ventilatory weaning consists of failure in spontaneous breathing trial (SBT), need for reintubation or to resume ventilatory support after planned extubation, or death within 48 hours after extubation[5].

Over the past 20 years, weaning from IMV has been the focus of clinical research in an effort to reduce ventilation time and the harmful effects that may result from it[4]. Protocol-guided ventilatory weaning reduces the average duration of IMV by 26%, the duration of ventilatory weaning by 70%, and the average length of Intensive Care Unit (ICU) stay by 11%[4].

International guidelines recommend protocol-guided ventilatory weaning[6], however, they do not specify the strategies that IMV weaning protocols should understand. The Directorate General of Health issued Standard No. 021/2015, which defines the "Intervention Beam" for the Prevention of Intubation-Associated Pneumonia, including the daily assessment of the possibility of ventilatory weaning and/or extubation, with formulation of weaning plan recorded in the clinical file[7], this measure is strongly recommended and supported by well-designed epidemiological, clinical and experimental studies[7].

Thus, the importance of implementing ventilatory weaning plans is recognized, and the identification and adoption of strategies that promote timely and successful weaning is a research priority designed to increase evidence-based practice and improve of the quality of care provided to critically ill patients undergoing IMV[8]. Thus, it is considered pertinent to investigate which strategies are used for weaning IMV in critically ill patients, in order to substantiate their applicability in clinical practice.

Thus, the objective of this integrative literature review is: to identify the strategies used by health professionals, which promote the success of ventilatory weaning of critically ill patients under IMV, admitted to the ICU.

METHODS

The research question was outlined according to the methodology PI[C]O (Population, Intervention, [Comparison], Outcome):

- Regarding critically ill patients under IMV, admitted to ICU **(P)**, which strategies are used by health professionals **(I)**, promoters of ventilatory weaning success **(O)**?

Given the objective and issue outlined, the following inclusion criteria were defined: **Participants** – Critically ill adult (age ≥ 18 years) admitted to ICU; **Intervention** – strategies used by health professionals in ventilatory weaning; **Outcome** – ventilatory weaning success.

In parallel to the above criteria, it was decided to limit the search to the 2014-2018 time interval in order to obtain the most recent evidence. It was decided to include studies with quantitative, qualitative or mixed methodology, freely accessible and in full text, published in English, Portuguese or Spanish; no geographical limits have been imposed. In order to give quality to the review, it was determined that articles that, when applying critical appraisal tools would be excluded[9], not at least 70% of the criteria evaluated.

The descriptors for the research were extracted from the Medical Subject Headings vocabulary (MeSH®) and the survey was conducted on content providers available through B-On®: CINAHL, MEDLINE, Scopus®, SciELO, Social Sciences Citation Index, ScienceDirect, Directory of Open Access Journals, Complementary Index, Academic Search Complete, Science Citation Index, Supplemental Index, Nursing Reference Center, OpenDissertations and RCAAP.

Boolean descriptors and operators were combined into the following search formula: (ventilator weaning OR respiratory weaning) AND (trial protocols OR methods OR algorithms) AND (artificial respiration OR mechanical ventilation) AND (critically ill OR intensive care OR critical care).

RESULTS

716 articles were identified; removing duplicates resulted in 518 studies. Two independent reviewers proceeded to the screening of articles, by analyzing the titles and abstracts, and 504 articles were excluded due to the previously defined inclusion and exclusion criteria, and the remaining 14 were read in full. After full reading, six studies were excluded, since their content did not fit the objective and question defined.

Thus, eight studies were evaluated, by two independent reviewers, regarding the level of evidence and methodological quality by applying the instruments provided by The Joanna Briggs Institute (JBI)[9,10]. After applying critical appraisal tools[9], seven articles were included for extraction of results, and one article was excluded because it had methodological quality below 70%. The selection process of the studies is described through a flow diagram represented in the Figure 1↗.

Once the articles to be included were identified, information about authors, year, country, sample, objectives, interventions, results/conclusions, and limitations of the studies was extracted, using an instrument appropriate to the question and previously established objectives. The identification of the studies is presented in Table 1↗ and the individualized synthesis of the data extracted from the included studies is presented in Table 2↗.

Table 3↗ presents a summary of the main results, after analysis of the extracted data.

DISCUSSION

The analysis of the studies shows that ventilatory weaning of critically ill patients submitted to IMV comprises several strategies that can be organized in consecutive stages, and the progression to the next stage depends on the verification of the previous one, namely: interruption of sedation and daily patient assessment against predictive criteria for weaning success; achievement of SBT and evaluation of the success/failure criteria of the SBT; extubation[12,14-17].

Discontinuation of sedation and daily evaluation, in view of the predictive criteria for successful weaning, are reported in most studies. This strategy consists of clinical evaluation and objective criteria related to neurological status, hemodynamic and ventilatory stability, and allows the identification of patients who are able to initiate ventilatory weaning, reducing the likelihood that weaning opportunities will be neglected and unnecessary IMV extension[12,14-17].

The performance of SBT emerges as a unanimous strategy in the studies analyzed, in order to assess whether the patient is able to breathe spontaneously, prevent early extubation and prevent reintubation, i.e., failure to ventilate weaning[12-17]. Regarding the method of performing SBT, the strategies presented in the studies were diverse: SBT in PS[12,15]; T-tube[16]; CPAP and T or PS tube[14]; SBT in CPAP, PS or T-tube[18].

The success of SBT was superior when performed in PS compared to SBT with T-tube[13] and a lower reintubation rate was found at 48 hours post extubation in patients undergoing SBT in PS compared to patients using the T-tube method[17]. However, patients undergoing PS required more attempts at SBT prior to extubation than those in which T-tube was used[17]. No significant differences were found between the two methods regarding weaning success, mortality, reintubation rate, ICU and hospital length of stay, incidence of VAP and hemodynamic changes[13,17]. Thus, although performing SBT in PS has shown some advantages, the data do not allow accurate conclusions to be drawn about the superiority of one method over the other[13,17].

Regarding the duration of the SBT, three of the studies report that it was performed for a period of 120 minutes[14,15,17]; one study reports that they performed SBT lasting 30 to 120 minutes[16], and another specifies that the SBT lasted 30, 60 or 120 minutes[18]. Therefore, SBT occurred between 30 to 120 minutes, however, in the analyzed studies, the duration of SBT is not crossed with other variables, and it is not possible to identify the most favorable SBT duration for ventilatory weaning of critically ill patients.

After initiation of SBT, it is necessary to evaluate its success/failure criteria, i.e. to verify the patient's response to SBT, through clinical reassessment and hemodynamic and ventilatory parameters, and this evaluation determines if the person meets conditions for extubation, or if ventilatory support should be maintained[12,14,16-18].

In most studies, they extubated immediately after successful SBT[12,14-17]. In one study, the results were compared between immediate extubation after successful SBT and a different method of reconnecting the patient to IMV for one hour after SBT and then extubating[18]; concluded that the reintubation rate was lower in the group undergoing this method than in the group that was extubated immediately after SBT, suggesting that this is an effective strategy for successful ventilatory weaning[18].

In one study, NIV after extubation was instituted as a strategy to prevent prolongation of IMV in patients with congestive heart failure, COPD, post-extubation stridor, muscle weakness, ineffective cough, or who failed more than one attempt of SBT[16].

Overall, the studies analyzed demonstrate beneficial effects of the application of ventilatory weaning strategies, and the reduction of IMV time is the most reported result[12,14,15]. They also describe the decrease in the time before the first SBT and the length of ICU stay[14]; as well as the increase in weaning success, manifested by the reduction in the reintubation rate[16,18]. Therefore, we verified that the results corroborate the advantages of applying previously mentioned ventilatory weaning strategies[4,6].

The studies analyzed report some limitations, namely the use of retrospective data[12,15], incomplete adherence of health professionals to the implementation of strategies[12,16], not including some important outcomes[13,14,18], heterogeneity among participants[14,17] and finally, the fact that blind data collection was not possible[14,17,18]. The finding of the mentioned limitations suggests that the practical application of the identified strategies should be cautious and complemented with other sources of information.

CONCLUSION

Strategies identified by health professionals, promoting the success of ventilatory weaning of critically ill patients under IMV, admitted to the ICU, which allowed the patient to obtain favorable results, namely, early identification of the ability to initiate ventilatory weaning and increased weaning success, with a consequent decrease in IMV time.

Ventilatory weaning is a complex process, the pursuit of which depends on several strategies, which require persevering assessment of the critically ill patient and should therefore be applied by trained professionals with high expertise and clinical judgment.

More research is needed on the subject in less heterogeneous populations, and a more detailed analysis of the strategies used and their outcomes in patients can be safely replicated in clinical practice.

Authors' contributions

MM: Study design, bibliographical research, evaluation of the methodological quality and classification of evidence levels of the articles, data extraction, data synthesis, discussion and writing of the article.

MS: Study design, bibliographical research, evaluation of the methodological quality and classification of evidence levels of the articles, discussion and review.

All authors read and agreed with the version published in the manuscript.

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REFERENCES

1. Portugal. Ordem dos Enfermeiros. Regulamento n.º 124, 18 de fevereiro de 2011. Regulamento das Competências Específicas do Enfermeiro Especialista em Enfermagem em Pessoa em Situação Crítica. Diário da República, 2.ª série, parte E, n.º 35. 8656-8657. [accessed 2018 Dec]. Available from: https://dre.pt/home/-/dre/3477013/details/maximized.

2. Ministério da Saúde. Rede Nacional de Especialidade Hospitalar e de Referenciação – MEDICINA INTENSIVA. Portugal. 2017. [accessed 2018 Dec]. Available from: https://www.sns.gov.pt/wp-content/uploads/2017/08/RNEHR-Medicina-Intensiva-Aprovada-10-agosto-2017.pdf.

3. Hess DR, Kacmarek RM. Essentials of Mechanical Ventilation. 3. ed. Philadelphia: McGraw Hill; 2014.

4. Blackwood B, Burns KE, Cardwell CR, O'Halloran P. Protocolized versus non-protocolized weaning for reducing the duration of mechanical ventilation in critically ill adult patients. Cochrane Database Syst Rev. 2014;2014:CD006904. doi:10.1002/14651858.CD006904.pub3.

5. Boles JM, Bion J, Connors A, Herridge M, Marsh B, Melot C, et al. Weaning from mechanical ventilation. Eur Respir J. 2007;29:1033-56. doi:10.1183/09031936.00010206.

6. Girard TD, Alhazzani W, Kress JP, Ouellette DR, Schmidt GA, Truwit JD, et al. An official American Thoracic Society/American College of Chest Physicians Clinical Practice Guideline: liberation from mechanical ventilation in critically ill adults. Rehabilitation protocols, ventilator liberation protocols, and cuff leak tests. Am J Respir Crit Care Med. 2017;195:120-33. doi: 10.1164/rccm.201610-2075ST.

7. Direção-Geral da Saúde. Norma n.º 021/2015 - "Feixe de Intervenções" de Prevenção de Pneumonia Associada à Intubação. Lisboa: DGS; 2017. [accessed 2018 Dec]. Available from: https://www.dgs.pt/directrizes-da-dgs/normas-e-circulares-normativas/norma-n-021201 5-de-16122015-pdf.aspx.

8. Rose L. Strategies for weaning from mechanical ventilation: a state of the art review. Intensive Crit Care Nurs. 2015;31:189-95. doi:10.1016/j.iccn.2015.07.003.

9. The Joanna Briggs Institute. Critical Appraisal Tools. 2017. [accessed 2018 Dec]. Available from: https://joannabriggs.org/criticalappraisaltools.

10. The Joanna Briggs Institute. New JBI Levels of Evidence. 2013. [accessed 2018 Dec]. Available from: https://joannabriggs.org/sites/default/files/2019-05/JBI-Levels-of-eviden ce_2014_0.pdf.

11. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med. 2009;151:264-9. doi: https://doi.org/10.1371/journal.pmed.1000097.

12. Jones K, Newhouse R, Johnson K, Seidl K. Achieving quality health outcomes through the implementation of a spontaneous awakening and spontaneous breathing trial protocol. AACN Adv Crit Care. 2014;25:33-42. doi:10.4037/NCI.0000000000000011.

13. Ladeira MT, Vital FM, Andriolo RB, Andriolo BN, Atallah ÁN, Peccin MS. Pressure support versus T-tube for weaning from mechanical ventilation in adults. Cochrane Database Syst Rev. 2014;2014:CD006056. doi:10.1002/14651858.CD006056.pub2.

14. Zhu B, Li Z, Jiang L, Du B, Jiang Q, Wang M, et al. Effect of a quality improvement program on weaning from mechanical ventilation: a cluster randomized trial. Intensive Care Med. 2015;41:1781-90. doi: https://doi.org/10.1007/s00134-015-3958-z.

15. Kallet RH, Zhuo H, Yip V, Gomez A, Lipnick MS. spontaneous breathing trials and conservative sedation practices reduce mechanical ventilation duration in subjects with ARDS. Respir Care. 2018;63:1-10. doi:10.4187/respcare.05270.

16. Borges LG, Savi A, Teixeira C, de Oliveira RP, De Camillis ML, Wickert R, et al. Mechanical ventilation weaning protocol improves medical adherence and results. J Crit Care. 2017;41:296-302. doi:10.1016/j.jcrc.2017.07.014.

17. Chittawatanarat K, Orrapin S, Jitkaroon K, Mueakwan S, Sroison U. An Open Label Randomized Controlled Trial to Compare Low Level Pressure Support and T-piece as Strategies for Discontinuation of Mechanical Ventilation in a General Surgical Intensive Care Unit. Med Arch. 2018;72:51. doi:10.5455/medarh.2018.72.51-57.

18. Fernandez MM, González-Castro A, Magret M, Bouza MT, Ibañez M, García C, et al. Reconnection to mechanical ventilation for 1 h after a successful spontaneous breathing trial reduces reintubation in critically ill patients: a multicenter randomized controlled trial. Intensive Care Med. 2017;43:1660-7. doi:10.1007/s00134-017-4911-0.

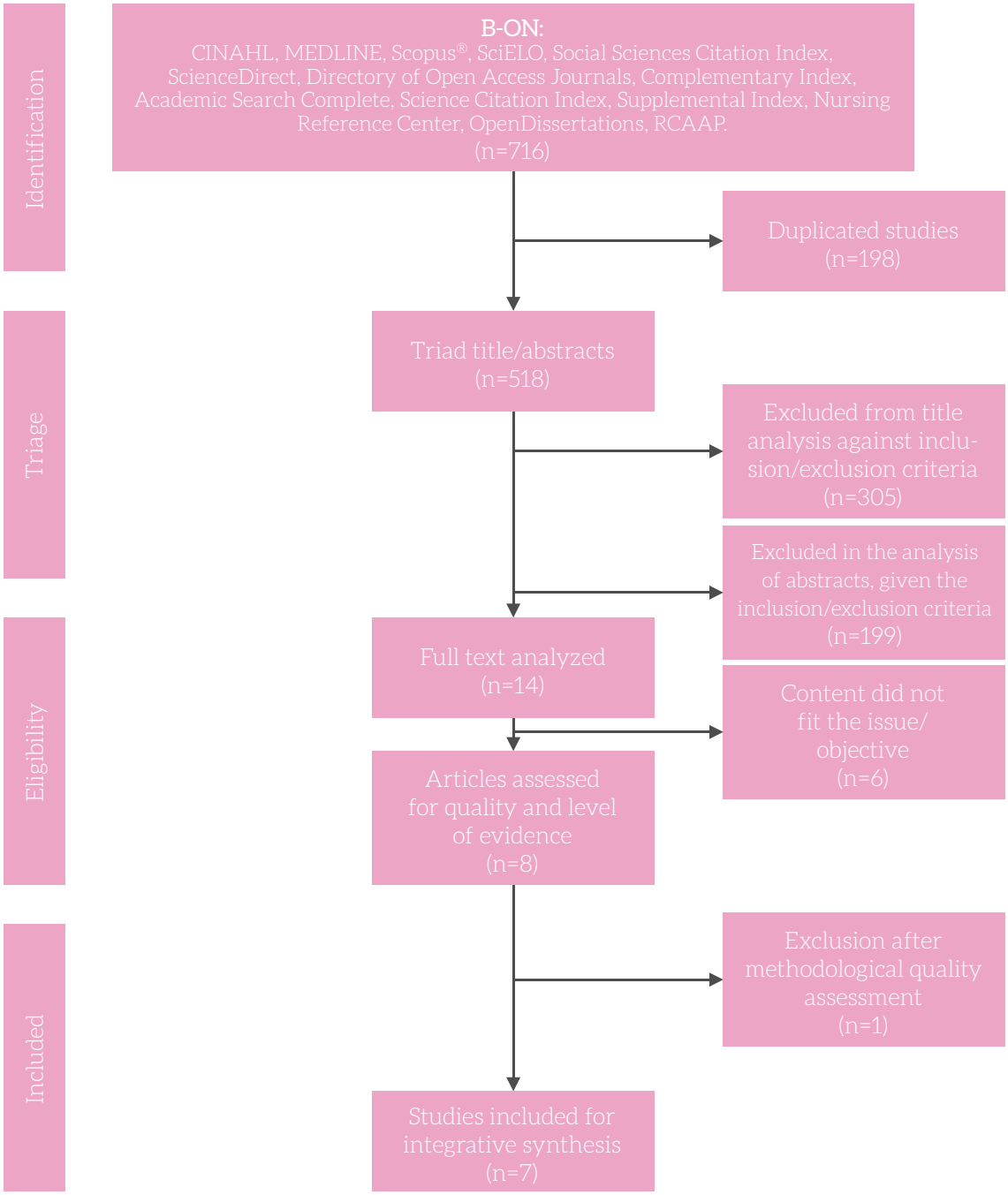

Figure 1 – Flow chart adapted from PRISMA Statement.[7]

Table 1 – Identification of included studies and classification of evidence levels and methodological quality.

Study	Authors (Year), Country	Level of Evidence/Study Design[10]	Methodological quality[9]
E1	Jones *et al* (2014), EUA[12]	2.d – Quasi-experimental / retrospective control groupo	77.8%
E2	Ladeira *et al* (2014), Brasil[13]	1.a – Experimental / Systematic review of randomized controlled clinical trials (RCTs)	100%
E3	Zhu *et al* (2015), China[14]	1.c – Experimental / RCT	76.9%
E4	Kallet *et al* (2018), EUA[15]	3.c – Observational / Cohort Study with Control Group	72.7%
E5	Borges *et al* (2017), Brasil[16]	3.c – Observational / Cohort Study with Control Group	81.8%
E6	Chittawatanarat *et al* (2018), Tailândia[17]	1.c – Experimental / RCT	76.9%
E7	Fernandez *et al* (2017), Espanha[18]	1.c – Experimental Design / RCT	84.6%

Table 3 – Summary of main results[12-18].

Strategies		Main results reported
1. Interruption of sedation and daily assessment of predictors of successful ventilatory weaning	• Neurological, hemodynamic and ventilatory assessment.	Decrease in IMV time; Decrease in the time before the first SBT; Increase in ventilatory weaning success; Reduction in ICU length of stay.
2. SBT execution	• PS; • T-tube; • CPAP and T-tube or PS; • CPAP or PS or T-tube; • Lasting 30 to 120 minutes.	
3. Assessment of criteria success/failure of SBT	• Neurological, hemodynamic and ventilatory reassessment during SBT.	
4. Extubation	• Immediately after successful SBT; • One hour rest on IMV after SBT and before extubation.	

Table 2 – Results extracted from the analyzed articles.

Study	Objective(s)	Sample	Interventions	Results/Conclusions	Limitations
E1	To evaluate the results of the application of a daily sedation interruption protocol and SBT.	112 patients.	Protocol built by the multidisciplinary team; training for disclosure of the protocol; application of the protocol; retrospective analysis of IMV time, ICU stay, incidence of auto-extubation and reintubation; comparison between pre and post protocol groups. Strategies: Daily assessment of inclusion criteria for sedation interruption; interruption of sedation; daily assessment of inclusion criteria for SBT; SBT performed at pressure support (PS); evaluation of the success / failure criteria of the SBT; extubation.	Reduction in mean ventilation time after protocol implementation. Between pre and post-protocol groups, there were no differences in ICU length of stay, incidence of self-extubation or reintubation.	Retrospective data collection through the registries, the degree of compliance with the protocol has not been evaluated. Incomplete adherence of health professionals to the protocol.
E2	To evaluate the efficacy and safety of two strategies for performing SBT: T-tube and PS.	1208 patients.	Systematic review of RCTs, which compared the use of T-tube with PS to perform SBT when weaning from IMV. Strategies: SBT execution, with T-tube or PS.	Meta-analysis of nine studies involving 622 patients undergoing SBT in PS and 586 with T-tube. The success of the SBT was superior when performed in PS. No significant differences were found in weaning success, ICU mortality, reintubation, length of stay and incidence of VAP.	Moderate or poor quality studies. RCTs suggested to assess whether PS method is safer and more effective in achieving relevant clinical outcomes.

Table 2 – Results extracted from the analyzed articles.

Study	Objective(s)	Sample	Interventions	Results/Conclusions	Limitations
E3	Evaluate the effectiveness of a quality improvement program through protocol-driven IMV weaning.	844 patients.	Implementation of a program to improve protocol-driven weaning adherence; comparison of the results obtained between the protocol group and the control group. Strategies: Daily screening of patients under IMV; evaluation of predictive criteria of ability to perform SBT. If the patient had criteria to perform SBT, he or she continued the continuous airway positive pressure (CPAP) test, otherwise he had IMV and was reevaluated the following day. If successful CPAP testing, T-tube or PS SBT was performed for 120 minutes. Performed evaluation of the success criteria of the SBT; if successful SBT the patient was extubated; if it failed the SBT criteria, the cause of failure was investigated and retried the next day.	In the group with protocoled weaning: the duration of IMV decreased from seven to three days; the time leading up to the first SBT decreased from 3.63 to 1.96 days; ICU stay decreased from 23 to 19 days. Protocol-driven ventilatory weaning promotes beneficial clinical outcomes with improved quality of care.	Differences found between groups. Data collection was not blind to professionals who applied the protocol. Initially, the study was not oriented to clinical results, so we suggest studies with this objective in mind.
E4	Investigate whether the implementation of protocols, which include SBT and daily sedation interruption, reduces IMV duration and ICU stay in ARDS patients.	1053 patients.	Strategies: Daily interruption of sedation; daily assessment of ventilatory weaning criteria; SBT (120 minutes duration in PS); extubation.	In the post-protocol group, the duration of IMV (from 14 to nine days) and ICU stay (from 18 to three days) were reduced). Evidence-based practice changes have positive effects on patient outcomes.	Study conducted in a single hospital; retrospective data collection, used for quality assessment. Records made manually, influencing the quantity and quality of data collected.

Table 2 – Results extracted from the analyzed articles.

Study	Objective(s)	Sample	Interventions	Results/Conclusions	Limitations
E5	Investigate the effectiveness of a multi-pronged strategy to implement an IMV weaning protocol; to evaluate weaning success rate and protocol adherence.	2469 patients.	Protocol elaboration; implementation of a multifaceted strategy: continuous training for the multidisciplinary team and regular feedback on the results obtained. Strategies: Avoid positive water balance within 24 hours prior to ventilatory weaning; daily interruption of sedation; daily assessment of predictive criteria for weaning; SBT tube SBT, lasting 30 to 120 minutes; assessment of success / failure of SBT. Patients who did not tolerate SBT returned to IMV and the test was repeated the next day; patients successfully on SBT were extubated. Noninvasive ventilation (NIV) extubation if: more than one unsuccessful weaning attempt, congestive heart failure, COPD, stridor after extubation, muscle weakness, and ineffective cough.	Weaning success increased from 73.1% to 85.4%. Greater success in weaning patients undergoing the protocol compared to those who underwent weaning based on clinical practice (85.6% vs 67.7%).	Application of the protocol requires changes in the routines of professionals, which makes it difficult to adhere to it.
E6	To compare the efficacy of PS mode with T-tube method as strategies for mechanical ventilation interruption and extubation in a surgical ICU.	520 patients.	Strategies: Daily assessment of inclusion criteria for SBT; SBT for 120 minutes in PS or T-tube; evaluation of SBT success criteria. If the SBT was successful, the patient was extubated; otherwise, it was ventilated in a controlled mode and daily reevaluated until it met criteria for extubation ; After extubation, O2 was instituted by face mask, and NIV was not allowed.	No differences were observe in hemodynamic status during SBT, post-extubation pneumonia, in-hospital mortality, length of stay in ICU and hospital. The group undergoing PS required more SBT attempts before extubation. Lower reintubation rate in the SBT group in PS than in the T-tube group (PS-10%; T-tube 14.6%).	Imbalance of some group characteristics (diagnosis and duration of ventilation before SBT). The intervention was not blind.

Table 2 – Results extracted from the analyzed articles.

Study	Objective(s)	Sample	Interventions	Results/Conclusions	Limitations
E7	Assessing whether an IMV reconnection for one hour after successful SBT can reduce the need for endotracheal reintubation.	470 patients.	Daily identification of patients submitted to IMV for more than 12 hours, who had conditions for extubation; randomization in two groups. Strategies: SBT performed with T, PS or CPAP tube for 30, 60 or 120 minutes. Control group: immediate extubation after successful SBT. Intervention group: reconnected to ventilator for one hour after successful SBT before extubation.	Mean ventilation time was similar between the two groups. The reintubation rate at 48 hours after extubation was higher in the control group (14%) compared to the intervention group (5%). Allowing patients to rest one hour after successful SBT reduces reintubation and post-extubation respiratory failure in critically ill patients.	Weaning protocols applied differed from hospital to hospital. NIV reintubation and institution remained at the discretion of the attending physicians. The study was not blind. Additional studies are needed to analyze the optimal duration of rest after SBT and the type of patients who can benefit from this strategy.