ISSN: 2966-4837

Brazilian Journal of Respiratory, Cardiovascular and Critical Care Physiotherapy
Jornal Brasileiro de Fisioterapia Respiratória, Cardiovascular e em Terapia Intensiva

Inhalation therapy during mechanical ventilation: development and validation of a drug administration protocol

Inaloterapia durante ventilação mecânica: desenvolvimento e validação de um protocolo de administração de medicamento

Kathleen Asturian[1]*; Diogo Pilger[1]

Abstract

Background: The administration of inhaled medications during mechanical ventilation is a common practice in intensive care units. The inhalation technique, however, requires knowledge and skill on the part of the care team and the use of protocols can help professionals involved in care. **Aim:** To describe the validation process of a protocol for inhaled medication administration during mechanical ventilation. **Methods:** Methodological study of content and appearance validation through expert evaluation (stage 1) and target audience (stage 2). In stage 1, four intensive care specialists participated. In stage 2, 35 health professionals with previous experience in intensive care or emergency and urgency evaluated the protocol. Specific validation instruments were used and validity indices were calculated for each item and for the total score of each instrument. Items with a validity index ≥ 0.78 and a total instrument validity index ≥ 0.90 were considered excellent. **Results:** In stage 1, the total validity index for content was 0.9861 and for appearance was 1. The experts suggested modifications to the content, which were incorporated, resulting in the second version. In stage 2, the protocol obtained a content validity index of 0.9809 and an appearance validity index of 0.9761. In this stage, additional suggestions were made and the content was adjusted, resulting in the final version of the protocol. **Conclusion:** The protocol for administration of inhaled medication during mechanical ventilation was validated, obtaining indexes above 0.90, which indicates excellent validity.

Keywords: Clinical Practice Guideline; Validation Study; Critical Care; Aerosol Therapy; Artificial Ventilation.

Resumo

Introdução: A administração de medicamentos inalatórios durante ventilação mecânica é uma prática comum em unidades de terapia intensiva. A técnica inalatória, no entanto, requer conhecimento e habilidade por parte da equipe assistencial e a utilização de protocolos pode ajudar os profissionais envolvidos no cuidado. **Objetivo:** Descrever o processo de validação de um protocolo de administração de medicamento inalatório durante ventilação mecânica. **Métodos:** Estudo metodológico de validação de conteúdo e aparência por meio de avaliação de especialistas (etapa 1) e público-alvo (etapa 2). Na etapa 1, participaram quatro especialistas em terapia intensiva. Na etapa 2, 35 profissionais de saúde com experiência prévia em terapia intensiva ou emergência e urgência avaliaram o protocolo. Instrumentos de validação específicos foram utilizados e os índices de validade foram calculados para cada item e para o escore total de cada instrumento. Itens com índice de validade ≥ 0,78 e índice de validade total do instrumento ≥ 0,90 foram considerados excelentes. **Resultados:** Na etapa 1, o índice de validade total para conteúdo foi de 0,9861 e para aparência foi de 1. Os especialistas sugeriram modificações no conteúdo, que foram incorporadas, resultando na segunda versão. Na etapa 2, o protocolo obteve índice de validade de conteúdo de 0,9809 e de aparência de 0,9761. Nesta etapa, foram feitas sugestões adicionais e o conteúdo ajustado, resultando na versão final do protocolo. **Conclusão:** O protocolo de administração de medicamento inalatório durante ventilação mecânica foi validado obtendo índices acima de 0,90, o que indica validade excelente.

Descritores: Diretriz de Prática Clínica; Estudo de Validação; Cuidados Críticos; Terapia por Aerossol; Ventilação Artificial.

[1]Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brasil

How to cite: Asturian K, Pilger D. Inhalation therapy during mechanical ventilation: development and validation of a drug administration protocol. Brazilian Journal of Respiratory, Cardiovascular and Critical Care Physiotherapy. 2026;17:e00432025. https://doi.org/10.47066/2966-4837.e00432025en

Submitted on: March 12, 2025
Accepted on: January 22, 2026

Study carried out at: Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brasil.

Ethical approval: CAAE 66187622.5.0000.5347 da Universidade Federal do Rio Grande do Sul, nº 5.894.875.

***Corresponding author:** Kathleen Asturian.

E-mail: asturiank@gmail.com

BACKGROUND

Mechanical ventilation (MV) is a ventilatory support that partially or totally replaces spontaneous ventilation, contributing to improved gas exchange and a reduction in respiratory effort. It is a life-support treatment and the most commonly used technique in Intensive Care Units (ICU)[1,2].

The administration of aerosolized medications during mechanical ventilation is a common practice in ICU[3-5]. However, aerosol therapy for critically ill patients is considered complex. Factors related to the patient, the ventilator, the aerosol generation device, and the inhalation technique directly impact the delivery of the drug to the lower airways[6-9].

Protocols are systematically structured recommendations aimed at guiding healthcare professionals' decisions regarding appropriate care for specific clinical conditions[10]. Care protocols, also referred to as clinical care protocols, outline the actions to be followed and can reduce variation in care[11]. Given the importance of proper inhalation therapy in this context, a protocol with recommendations on the inhalation technique during MV was developed.

The protocol was systematically developed based on a scoping review[12], and the evidence was synthesized into recommendations for clinical practice. Validation, a process that assesses whether the content meets the proposed objectives, is a widely used method to evaluate the credibility and legitimacy of health protocols[13,14].

The objective of this study was to describe the content and appearance validation process of a medication administration protocol based on the evaluation of experts and the target audience.

METHODS

This is a methodological study on the content and appearance validation of the protocol titled *"Recommendations for Inhalation Technique with Metered-Dose Inhaler in Invasive Mechanical Ventilation"*[15]. The entire development process occurred in three phases: 1) scoping review and guideline development, 2) content and appearance validation, and 3) methodological quality validation. This manuscript specifically addresses the results obtained in phase 2, which are reported according to the guidelines proposed by the *GRRAS report – Guidelines for Reporting Reliability and Agreement Studies*[16].

The study period was between November and December 2023, and it was divided into two phases: expert validation and target audience validation. The study was approved by the Research Ethics Committee (*Comitê de Ética em Pesquisa – Universidade Federal do Rio Grande do Sul* - CEP – UFRGS), CAAE 66187622.5.0000.5347. The entire process was conducted virtually, and the evaluators who agreed to participate in the research provided their consent to the Informed Consent Form (ICF) through an electronic document.

Expert validation

The first version of the protocol was evaluated by experts (phase 1). This step aimed to improve the content of the document and adjust it based on the proposed suggestions. Four evaluators from a public university hospital in southern Brazil were invited: one physician, one nurse, one physiotherapist, and one clinical pharmacist. The inclusion criteria were: professional practice in an Adult Intensive Care Unit and a minimum specialization qualification.

Target audience validation

For phase 2, the inclusion criteria for participation in the target audience were: healthcare professionals (physicians, nurses, physiotherapists, clinical pharmacists, and nursing technicians) working in ICU or Emergency and Urgent Care, from public or private hospitals, with any level of specialization and years of experience, from all regions of the country. Professionals who did not respond within the pre-determined time frame were excluded.

Measurement instruments

Two previously validated measurement instruments were used. To evaluate the written content, the Educational Content Validation Instrument in Health (ECVIH) was used, which contains eighteen items[17]. For appearance validation, the Instrument for Validation of Appearance of Health Educational Technologies (Portuguese acronym: IVATES) was used, consisting of twelve items regarding the relevance and quality of the illustrations presented[18]. The two instruments were combined, resulting in a research questionnaire containing 30 items, divided into four domains: objectives, structure/presentation, relevance, and appearance.

The response options were based on the Likert Scale, with 1 = strongly disagree, 2 = disagree, 3 = partially disagree, 4 = agree, and 5 = strongly agree. At the end of each domain, there was a space for comments, and respondents were asked to justify any ratings of 'disagree' (scores 1, 2, and 3).

The evaluators responded to the questionnaire only once, anonymously and independently. Phase 1 took place in November 2023, and Phase 2 occurred in December 2023. The experts who participated in Phase 1 did not participate in Phase 2. Each participant received, via email, the protocol, the research technical report, the research questionnaire, and the ICF. The response deadline was 10 days.

Sample

The sampling technique used was snowball sampling, a non-probabilistic sampling method that utilizes referral chains. It is carried out through key informants, referred to as seeds, who assist the principal researchers in locating

individuals with the necessary profile for the study[19,20]. The seeds were selected for convenience, and this sampling method was used in both phases of the study.

In Phase 1, two experts (a physician and a pharmacist) were invited and designated as seeds. These professionals were responsible for locating other specialists with the necessary profile for the study. In Phase 2, seven seeds, each from a different hospital institution, were selected and recommended other professionals to compose the evaluator panel.

A literature search was conducted to determine the number of evaluators needed for Phase 2; however, the optimal number of judges is controversial[21-23]. It is estimated that either a very small or very large number of participants may compromise the results in terms of effective consensus and the relevance of the information obtained[24]. Therefore, it was decided that for each area of expertise, there should be an equal number of evaluators, totalling between 30 and 40 participants.

Considering that seven seed participants were selected to recommend healthcare professionals, a total of 35 evaluators was deemed sufficient to compose the validation panel, with seven evaluators from each area of expertise. Fifty professionals were invited to complete the questionnaire. Given the requirement of 35 evaluators for the validation process, the research questionnaire was configured such that, once the maximum number of responses per profession was reached, no further responses would be accepted.

Statistical analysis

The proportion of agreement between evaluators was the method used to analyze the responses. The Content Validity Index (CVI), a method widely used in health-related studies[24,25], was calculated for each item (CVIi) and for the total of each instrument (CVIt).

The score for each item was calculated by summing the responses scored as '4' (agree) and '5' (strongly agree), and dividing by the total number of responses. The total score of the instrument was calculated by summing the CVIs and dividing by the total number of items. These were referred to as the Content Validity Index (CVIi and CVIt) and the Appearance Validity Index (AVIi and AVIt), both calculated as described above.

Scores with CVIi / AVIi ≥ 0.78 and CVIt / AVIt ≥ 0.90 were considered satisfactory, according to the following scale: ≥ 0.78 excellent; between 0.60 and 0.77 good; and < 0.59 poor[24,25]. The mode and the maximum and minimum scores were described for each item.

The data were collected using Excel® software and subsequently exported to the Statistical Package for the Social Sciences (SPSS), version 21, where the statistical analysis was performed.

RESULTS

The validation of the first stage was conducted by four evaluators: one physician, one nurse, one clinical pharmacist, and one physiotherapist. Regarding their qualifications, one was a specialist, two were master's degree holders, and one held a doctoral degree. Two evaluators had more than 10 years of experience in intensive care, one had between 6.1 and 8 years of experience, and the other had between 2.1 and 4 years of experience.

The total CVI for content (CVIt) was 0.9861. Of the 18 items that make up the instrument, 17 were rated as 'agree' or 'strongly agree', resulting in CVIi = 1. One evaluator rated 'strongly disagree' for item 8 (CVIi = 0.75), but no justification was provided for the rating. The total AVI for appearance (AVIt) and for each item (AVIi) was 1.

According to the content and appearance validity indices obtained for the total of each instrument, the protocol did not require adjustments, as it resulted in excellent validity (≥0.90). However, the evaluators made suggestions, including: the inclusion of information about the best device for medication administration; the influence of the device's presence in the circuit; the provision of a condensed version of the protocol; the addition of a caption; and the inclusion of a new illustration (Table 1 and Figure 1). All suggestions were accepted, and the protocol was adjusted, resulting in the second version of the document.

The target audience validation (Phase 2) was conducted by a panel of 35 healthcare professionals, with seven evaluators from each area of expertise. The characteristics are presented in Table 2.

The total CVI for content (CVIt) was 0.9809. Three evaluators (8.57%) partially disagreed with the item 4 'provides reflection on the topic.' For item 8, related to interactive language and active involvement in the educational process, two evaluators (5.71%) partially disagreed, and one evaluator (2.86%) rated 'disagree'. Regarding item 14 (current topic), two evaluators (5.71%) partially disagreed, and for items 9, 15, 16, and 17, there was only one partial disagreement for each item. The mode was 5, as shown in Table 3, and the rating "1 = strongly disagree" was not selected by any evaluator.

The total AVI for appearance (AVIt) was 0.9761. For items 28, 29 and 30, two evaluators (5.71%) partially disagreed with each item. For items 19, 22 and 23, only one evaluator (2.86%) rated "partially disagree". The item 24 (the illustrations depict the daily life of the target audience of the intervention) received a rating 'disagree', which was the lowest rating assigned in the entire instrument. As shown in Table 4, the mode was 5, and the rating "1 = strongly disagree" was not selected by any evaluator.

The content and appearance validity indices were calculated for each area of expertise, as shown in Table 5. The lowest CVIt and AVIt were assigned by the

Table 1. Comments and suggestions made in Phase 1 and the actions taken.

Comments made by the experts	Actions taken
Inhalation technique performed in the prone position	The prone position is a maneuver that involves placing the patient in the ventral decubitus position, which helps improve respiratory mechanics. There are no studies on inhalation techniques in prone patients. Therefore, an observation was included in the protocol: *"For patients in the prone position, consult with the physician to determine if the medication administration should be maintained."*
Guidance on the positioning of the MDI adapter in relation to the ETT	The suggestion was accepted, and a new illustration (Figure 1) was added to the protocol, along with the following guidance: *"If you are using the MDI adapter, ensure that the internal opening of the adapter is directed toward the ETT. The spray should be directed towards the ETT."*
Guidance on different administration devices, duration of device placement in the circuit, and replacement of the HMEF	The suggestion was accepted, and an observation was added regarding the best device to be used, as well as the duration of the device's placement in the circuit in relation to the increase in resistance. It was decided not to include any observation regarding filter replacement, as this may vary depending on the manufacturer or institution.
Provide a summarized version of the protocol	The length of the protocol is due to the complexity of the subject matter. The authors agree that the document's length may discourage its reading. Therefore, the following guidance was included: *"To facilitate clinical processes and make the protocol more concise and appealing, a shortened version of this document may be made available for bedside use, provided that healthcare professionals have already been trained and instructed on the full content of the protocol."*
Employ the term 'record'	The suggestion was accepted and the sentence was modified in accordance with the suggested term – "*Record medication administration in medical records".*
Include the head-of-bed elevation angle.	The suggestion was accepted and the angle (45º) was inserted in the illustration corresponding to the semi-reclined position.
Include information regarding shaking of the pMDI	The suggestion was accepted and the following observation was included – *"Shake the spray again for each jet fired. Repeat the technique until the dose is complete."*

ETT: Endotracheal tube; HMEF: Heat and Moisture Exchanger Filter; MDI: Metered Dose Inhaler; pMDI: Pressurized metered dose inhaler.
Source: prepared by the authors.

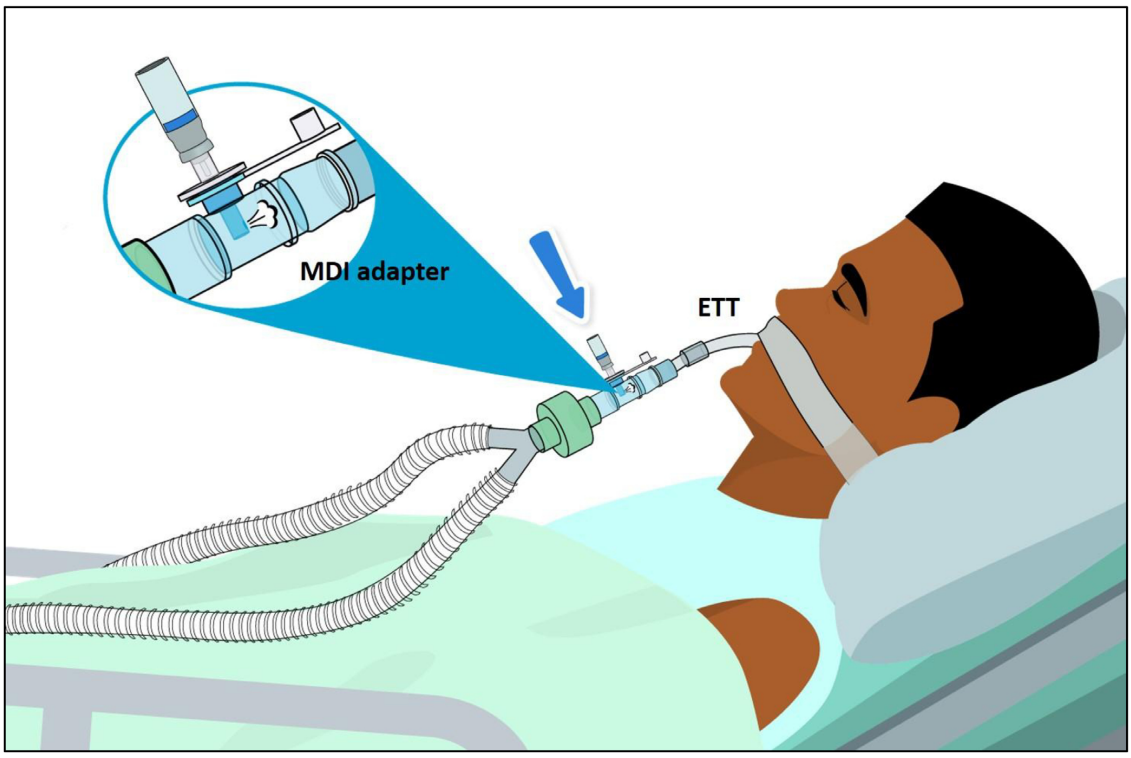

Figure 1. The illustration demonstrates the correct positioning of the MDI adapter in relation to the ventilation circuit. The MDI adapter should be positioned so that its internal opening faces the endotracheal tube (ETT), aligned with the direction of airflow. Incorrect positioning (towards the HMEF filter) prevents the delivery of aerosols to the lower respiratory tract. This figure was added after the Phase 1 Validation.
Source: prepared by the authors.

Table 2. Characteristics of the evaluators (Phase 2).

Academic qualification	n (%)
Technical	7 (20.00)
Specialization	4 (11.43)
Professional Residency	17 (48.57)
Master's Degrees	5 (14.29)
Doctorate	2 (5.71)
Time of experience (in years)	
0 to 4	18 (51.42)
4.1 to 8	6 (17.14)
8.1 to 10	6 (17.14)
More than 10	5 (14.26)
Institution	
Public Hospital	17 (48.57)
Private Hospital	6 (17.14)
Public and Private Hospital	12 (34.26)
Brazil's Region	
South	20 (57.14)
Southeast	10 (28.57)
Northeast	4 (17.43)
North	1 (2.86)
Midwest	0 (0)

n: Number of reviewers.
Source: prepared by the authors.

physiotherapists, while the highest were assigned by the nursing technicians.

The evaluators provided comments and suggestions regarding the second version of the protocol, including: the addition of new figures, the inclusion of a list of acronyms, and a discussion on the influence of Heat and Moisture Exchanger Filter (HMEF), the closed suction system, and the ideal scenario during medication administration (Table 6, Figure 2 and Figure 3). The content was adjusted, resulting in the final version of the protocol.

DISCUSSION

The protocol was constructed using textual elements (validated by the content assessment instrument) and visual resources (validated by the appearance assessment instrument). In phases 1 and 2, for both content and appearance, the protocol achieved satisfactory validity, considering the total validity index for each instrument was above 0.90 (excellent). In phase 1, only one item received a score of 0.75 (good), while all other items received excellent scores (≥0.78). In phase 2, all items scored above 0.78, indicating a high degree of agreement among evaluators and excellent validity.

Preliminary validation with a small sample of experts, which characterized phase 1, led to the development of a second version of the protocol with more refined information. In phase 1, although one expert assigned the lowest possible rating (1 = strongly disagree) to item 8 and did not justify this score, the protocol content was revised and some language adjustments were made to improve interactivity. In the second phase, two reviewers assigned a score of 3 (partially disagree) and one reviewer assigned a score of 2 (disagree), these being the lowest ratings for item 8. Comparing the two validation phases, it was observed that, in phase 2, item 8 obtained greater acceptance and agreement among the experts.

Two evaluators rated "partially disagree" for item 14. Only one of the evaluators provided a justification, stating that the protocol does not present a current topic, since inhalation in intubated patients is a routine practice in ICU. However, the evaluator commented that addressing this topic is essential for clinical practice. On the other hand, the same item received 28 maximum scores, and one evaluator commented that the topic was very current, given the recent Coronavirus Disease-19 (COVID-19) pandemic, during which there was a significant increase in the number of patients requiring mechanical ventilation and who needed medication via inhalation.

The illustrations used in the protocol aimed to facilitate understanding by the target audience, considering that health messages with a higher degree of difficulty in comprehension are more easily conveyed through the use of figures[16]. In phase 1, all appearance validation items received agreement ratings. In phase 2, one evaluator rated "disagree" for item 24; however, no justification was provided for this rating. For item 28, two experts partially disagreed and suggested the inclusion of additional figures to complement the information and facilitate understanding.

The content and appearance validation results, stratified by the target audience, showed satisfactory validity for all professionals, regardless of their area of expertise. As a result, it can be inferred that the content of the protocol was understood by the target audience.

Regarding the research participants, it is important to note that the snowball sampling method has a limitation related to the potential inconvenience of similar arguments and opinions among professionals, as individuals are recommended by people from their personal and/or professional networks[20]. To mitigate this limitation, in phase 2, the number of seeds was increased. Furthermore, to encompass all realities, the selected healthcare professionals were from different regions of Brazil and worked in both public and private hospital institutions.

Regarding the validation method, it is important to clarify that, although the protocol was validated by a panel of diverse

Table 3. Description of the Content Validity Index according to the ECVIH instrument[17].

Domain	Phase 1 (n=4) CVIi (min-max)	Phase 2 (n=35) CVIi (min-max/mode)
Aims		
1. Contemplates the proposed theme	1 (5)	1 (4 – 5 / 5)
2. Suits the teaching-learning process	1 (4 – 5)	1 (4 – 5 / 5)
3. Clarifies doubts on the addressed theme	1 (4 – 5)	1 (4 – 5 / 5)
4. Provides reflection on the theme	1 (5)	0.9142 (3 – 5 / 5)
5. Encourages behavior change	1 (5)	1 (4 – 5 / 5)
Structure/Presentation		
6. Language appropriate to the target audience	1 (5)	1 (4 – 5 / 5)
7. Language appropriate to the educational material	1 (5)	1 (4 – 5 / 5)
8. Interactive language, enabling active involvement in the educational process	0.75 (1 – 5)	0.9142 (2 – 5 / 5)
9. Correct information	1 (5)	0.9714 (3 – 5 / 5)
10. Objective information	1 (5)	1 (4 – 5 / 5)
11. Enlightening information	1 (4 – 5)	1 (4 – 5 / 5)
12. Necessary information	1 (4 – 5)	1 (4 – 5 / 5)
13. Logical sequence of ideas	1 (5)	1 (4 – 5 / 5)
14. Current theme	1 (5)	0.9428 (3 – 5 / 5)
15. Appropriate text size	1 (4 – 5)	0.9714 (3 – 5 / 5)
Relevance		
16. Encourages learning	1 (5)	0.9714 (3 – 5 / 5)
17. Contributes to knowledge in the area	1 (5)	0.9714 (3 – 5 / 5)
18. Arouses interest in the theme	1 (5)	1 (4 – 5 / 5)
CVIt	0.9861	0.9809

CVIi: Content Validity Index for each item; CVIt: Content Validity Index total; n: Number of reviewers; min: Lowest rating given to the item; max: Highest rating given to the item.

Source: prepared by the authors.

specialists, its primary authorship lies with professionals from the same field of training, which may reflect similar approaches to a multiprofessional topic. Furthermore, the validation focused specifically on the content and appearance of the document, and did not address its implementation or the extent to which professionals adhere to the recommendations. Finally, the protocol includes a scheduled plan for periodic updates, which is an essential element to ensure that the recommendations remain current and based on the best available scientific evidence.

The protocol was developed based on a scoping review[12] with the purpose of constructing the document based on the best and most current scientific evidence. The conversion of scientific content from the review results into an educational, multidisciplinary material applicable to clinical routines represents a strength of this study, considering that the information can be transmitted in a more didactic and accessible manner compared to technical academic writing.

The authors emphasize, however, that although the protocol achieved satisfactory performance regarding content and appearance validity, it is essential that the document be used as a teaching-learning tool in conjunction with other practices, such as prior training and capacity-building for the application of the presented content. As future perspectives, studies on the implementation of the protocol in ICU and studies on healthcare professionals' adherence to the proposed recommendations are considered.

CONCLUSION

The medication administration protocol was validated for its content and appearance with both experts and the target audience, achieving indices above 0.90, indicating excellent validity. It is estimated that, through the use of the validated document, it will be possible to contribute to clinical practice in intensive care units.

Table 4. Description of the Appearance Validity Index according to the IVATES (Portuguese acronym)[18].

Domain	Phase 1 (n=4) AVIi (min-max)	Phase 2 (n=35) AVIi (min-max/mode)
Appearance		
19. Illustrations are suitable for the target audience.	1 (4 – 5)	0.9714 (3 – 5 / 5)
20. Illustrations are clear and easy to understand.	1 (4 – 5)	1 (4 – 5 / 5)
21. Illustrations are relevant for the content understanding by the target audience.	1 (4 – 5)	1 (4 – 5 / 5)
22. The colors of illustrations are suitable for the type of material.	1 (5)	0.9714 (3 – 5 / 5)
23. The shapes of illustrations are suitable for the type of material.	1 (5)	0.9714 (3 – 5 / 5)
24. Illustrations depict the daily life of the target audience of the intervention.	1 (5)	0.9714 (2 – 5 / 5)
25. The layout of figures is in harmony with the text.	1 (5)	1 (4 – 5 / 5)
26. The pictures used elucidate the content of the educational material.	1 (4 – 5)	1 (4 – 5 / 5)
27. The pictures used elucidate the content of the educational material.	1 (5)	1 (4 – 5 / 5)
28. Illustrations are in appropriate quantity in the educational material.	1 (4 – 5)	0.9428 (3 – 5 / 5)
29. Illustrations are in appropriate size in the educational material.	1 (5)	0.9428 (3 – 5 / 5)
30. Illustrations help to change the behavior and attitudes of the target audience.	1 (5)	0.9428 (3 – 5 / 5)
AVIt	1	0.9761

AVIi: Appearance Validity Index for each item; AVIt: Appearance Validity Index total; n: Number of reviewers; min: Lowest rating given to the item; max: Highest rating given to the item.

Source: prepared by the authors.

Table 5. Description of the content and appearance validity index stratified by profession.

Target audience	Content validity CVIt (min-max)	Appearance validity AVIt (min-max)
Nurses (n=7)	0.9841 (3 – 5)	0.9880 (2 – 5)
Pharmacists (n=7)	0.9920 (3 – 5)	1 (4 – 5)
Physiotherapists (n=7)	0.9365 (3 – 5)	0.9285 (3 – 5)
Physicians (n=7)	0.9920 (2 – 5)	0.9642 (3 – 5)
Nursing technicians(n=7)	1 (4 – 5)	1 (4 – 5)

CVIt: Content Validity Index total; AVIt: Appearance Validity Index total; n: Number of reviewers; min: Lowest value assigned to the total instrument; max: Highest value assigned to the total instrument.

Source: prepared by the authors.

Table 6. Comments and suggestions made in Phase 2 and the actions taken.

Comments made by the target audience	Actions taken
Guidance on the positioning of the device in relation to the HMEF filter	The suggestion was accepted and guidelines on the HMEF and the positioning of the aerochamber in relation to the filter were added in a specific section entitled *"Connection in the circuit".*
Include a discussion on the limitations of the inhalation technique	The authors chose to include more comprehensive and detailed information on the methods of connecting the pMDI to the circuit. Therefore, the ideal connection and the implications of circuit manipulation were added in a specific section titled *"Connection to the Circuit."* Figure 2 was added.
Include information on the inhalation technique in patients with a closed suction circuit (TrachCare)	The suggestion was accepted, and guidelines on the closed suction system and the positioning of the spacer were added in a specific section titled "*Connection in Closed Suction Systems*." Figure 3 was added.
Incorporate a glossary into the protocol	The suggestion was accepted, and a list of acronyms was added at the beginning of the document.
Include an explanatory video to complement the protocol content	The authors agree that the inclusion of audiovisual material could contribute to the professionals' understanding. However, the validation tools used are specific to written educational materials and, therefore, cannot be applied to other educational resources.

HMEF: Heat and Moisture Exchanger Filter; pMDI: Pressurized metered dose inhaler.

Source: prepared by the authors.

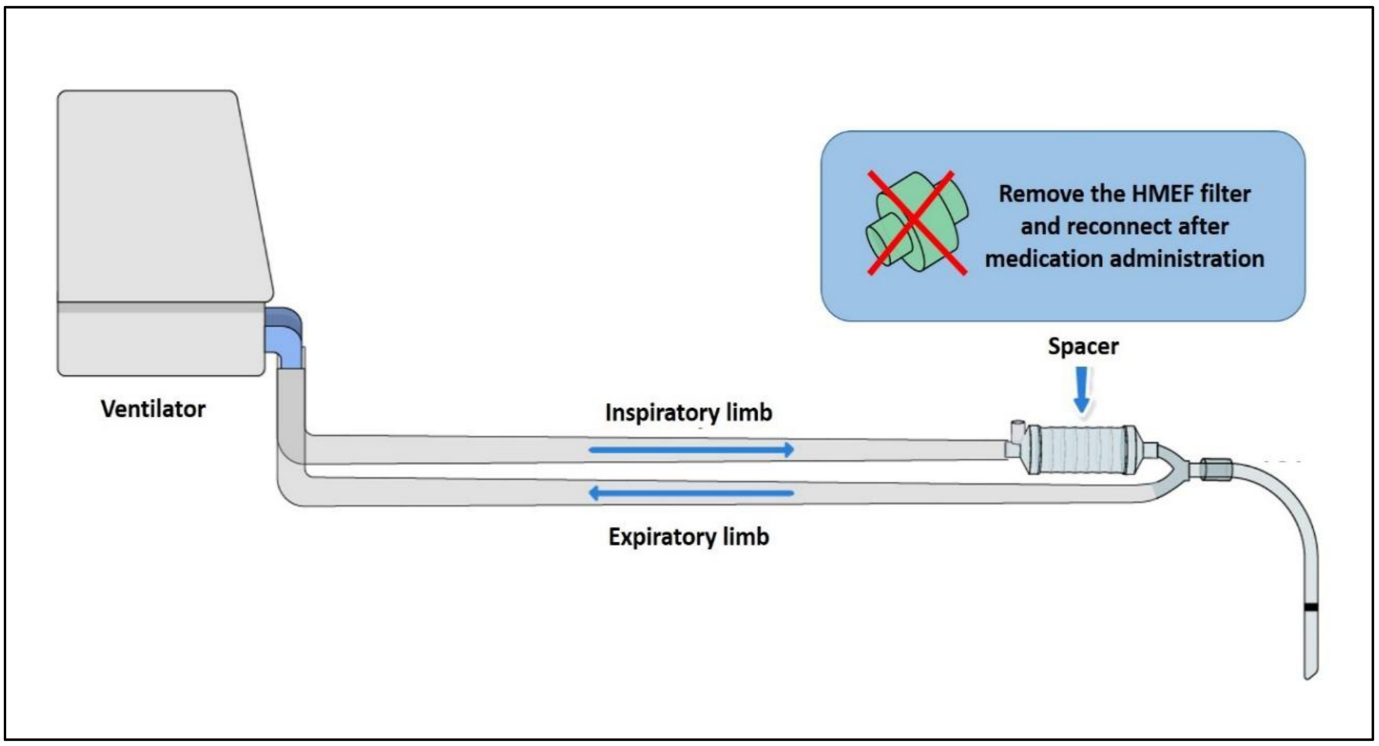

Figure 2. The illustration demonstrates the optimal way to insert the spacer into the circuit, considering greater efficiency in drug delivery and a reduction in dead space. In this scenario, the HMEF filter should be removed, and the spacer should be positioned in the inspiratory limb. This figure was added after Phase 2 Validation.
Source: prepared by the authors.

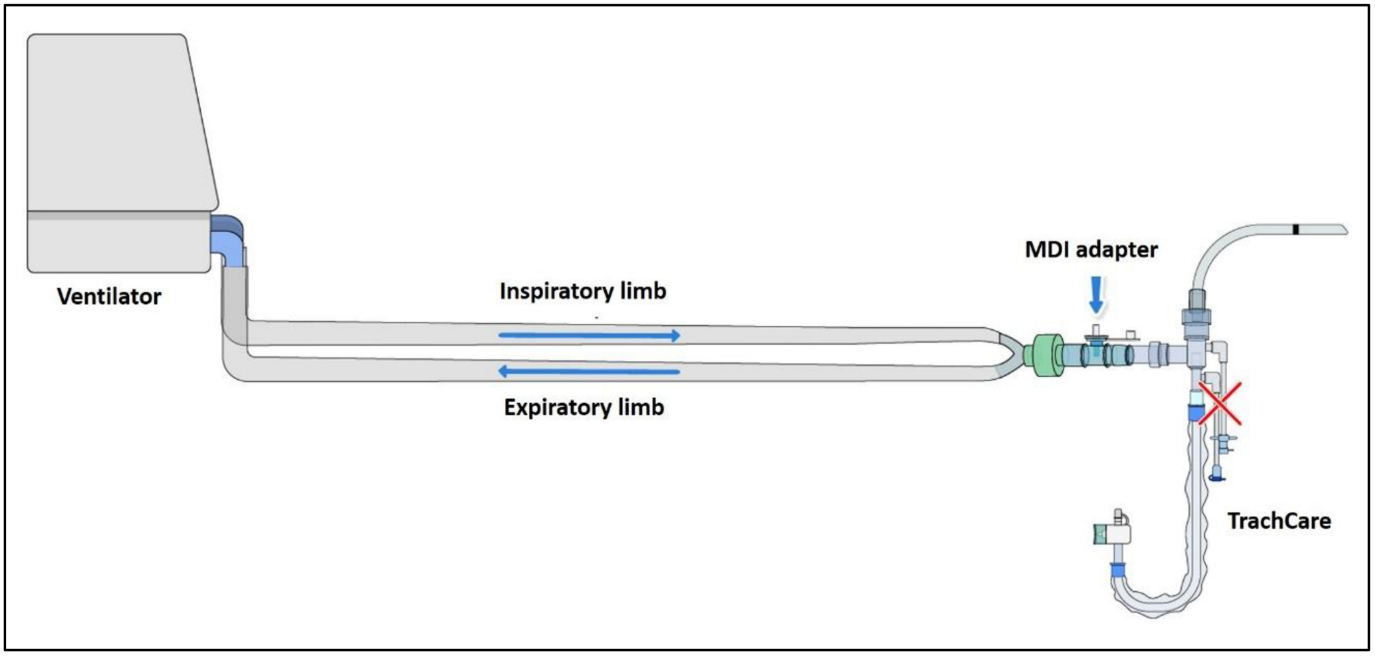

Figure 3. The illustration demonstrates the correct positioning of the MDI adapter in relation to closed suction systems (TrachCare). In this scenario, closed suction system valves should not be used for inhalation, as significant drug accumulation occurs within the valve. This figure was added after Phase 2 Validation.
Source: prepared by the authors.

FUNDING

Nothing to declare.

CONFLICT OF INTEREST

Nothing to declare.

ACKNOWLEDGEMENTS

We would like to thank all the experts and healthcare professionals involved in the validation of the protocol.

RESEARCH DATA AVAILABILITY

Research data is available in the body of the article.

ARTIFICIAL INTELLIGENCE USE STATEMENT

The authors declare that they did not use artificial intelligence tools at any stage of the manuscript production.

AUTHOR CONTRIBUTIONS

Asturian K: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Writing – Original Draft Preparation. Pilger D: Conceptualization, Methodology, Project Administration, Supervision, Writing – Review & Editing.

REFERENCES

1. Brochard L. Mechanical ventilation: invasive versus noninvasive. Eur Respir J Suppl. 2003;22(47 Suppl):31s-7s. https://doi.org/10.1183/09031936.03.00050403. PMid:14621115.
2. Tobin M, Manthous C. Mechanical ventilation. Am J Respir Crit Care Med. 2017;196(2):P3-4. https://doi.org/10.1164/rccm.1962P3. PMid:28707967.
3. Sun Q, Chang W, Liu X, Xie J, Qiu H, Yang Y, et al. Aerosol therapy during mechanical ventilation in intensive care units: a questionnaire-based survey of 2203 ICU medical staff in China. J Intensive Med. 2022;2(3):189-94. https://doi.org/10.1016/j.jointm.2022.04.003. PMid:36789017.
4. Ehrmann S, Roche-Campo F, Sferrazza Papa GF, Isabey D, Brochard L, Apiou-Sbirlea G. Aerosol therapy during mechanical ventilation: an international survey. Intensive Care Med. 2013;39(6):1048-56. https://doi.org/10.1007/s00134-013-2872-5. PMid:23525741.
5. Ehrmann S, Roche-Campo F, Bodet-Contentin L, Razazi K, Dugernier J, Trenado-Alvarez J, et al. Aerosol therapy in intensive and intermediate care units: prospective observation of 2808 critically ill patients. Intensive Care Med. 2016;42(2):192-201. https://doi.org/10.1007/s00134-015-4114-5. PMid:26602786.
6. Dhand R. Basic techniques for aerosol delivery during mechanical ventilation. Respir Care. 2004;49(6):611-22. https://doi.org/10.4187/respcare.04490611. PMid:15165296.
7. Dhand R. Aerosol delivery during mechanical ventilation: from basic techniques to new devices. J Aerosol Med Pulm Drug Deliv. 2008;21(1):45-60. https://doi.org/10.1089/jamp.2007.0663. PMid:18518831.
8. Ari A, Fink JB, Dhand R. Inhalation therapy in patients receiving mechanical ventilation: an update. J Aerosol Med Pulm Drug Deliv. 2012;25(6):319-32. https://doi.org/10.1089/jamp.2011.0936. PMid:22856594.
9. Dhand R. How should aerosols be delivered during invasive mechanical ventilation? Respir Care. 2017;62(10):1343-67. https://doi.org/10.4187/respcare.05803. PMid:28874611.
10. Rosenfeld RM, Shiffman RN, Robertson P. Clinical practice guideline development manual, third edition: a quality-driven approach for translating evidence into action. Otolaryngol Head Neck Surg. 2013;148(1, Suppl 1):S1-55. https://doi.org/10.1177/0194599812468849. PMid:23243141.
11. Hewitt-Taylor J. Clinical guidelines and care protocols. Intensive Crit Care Nurs. 2004;20(1):45-52. https://doi.org/10.1016/j.iccn.2003.08.002. PMid:14726253.
12. Asturian K, Balhego-Rocha M, Pilger D. Bronchodilator administration by pressurized inhaler during invasive mechanical ventilation in adults: a scoping review. Farm Hosp. 2025;49(1):53-8. https://doi.org/10.1016/j.farma.2024.03.012. PMid:38806364.
13. Catunda HLO, Bernardo EBR, Vasconcelos CTM, Moura ERF, Pinheiro AKB, Aquino PS. Methodological approach in nursing research for constructing and validating protocols. Texto Contexto Enferm. 2017;26(2):1-10. https://doi.org/10.1590/0104-07072017000650016.
14. Vieira TW, Sakamoto VTM, Moraes LC, Blatt CR, Caregnato RCA. Validation methods of nursing protocols: an integrative review. Rev Bras Enferm. 2020;73(Suppl 5):e20200050. https://doi.org/10.1590/0034-7167-2020-0050. PMid:33084808.
15. Asturian K. Recomendações para técnica inalatória com spray dosimetrado em ventilação mecânica invasiva: protocolo de administração de medicamento [dissertação]. Porto Alegre: Programa de Pós-graduação em Assistência Farmacêutica, Universidade Federal do Rio Grande do Sul; 2024 [citado em 2025 Mar 22]. Disponível em: http://hdl.handle.net/10183/274448
16. Kottner J, Audigé L, Brorson S, Donner A, Gajewski BJ, Hróbjartsson A, et al. Guidelines for reporting reliability and agreement studies (GRRAS) were proposed. J Clin Epidemiol. 2011;64(1):96-106. https://doi.org/10.1016/j.jclinepi.2010.03.002. PMid:21130355.
17. Leite SS, Áfio ACE, Carvalho LV, Silva JM, Almeida PC, Pagliuca LMF. Construction and validation of an educational content validation instrument in health. Rev Bras Enferm. 2018;71(Suppl 4):1635-41. https://doi.org/10.1590/0034-7167-2017-0648. PMid:30088634.
18. Souza ACC, Moreira TMM, Borges JWP. Development of an appearance validity instrument for educational technology in health. Rev Bras Enferm. 2020;73(Suppl 6):e20190559. https://doi.org/10.1590/0034-7167-2019-0559. PMid:33338125.
19. Martínez-Mesa J, González-Chica DA, Duquia RP, Bonamigo RR, Bastos JL. Sampling: how to select participants in my research study? An Bras Dermatol. 2016;91(3):326-30. https://doi.org/10.1590/abd1806-4841.20165254. PMid:27438200.
20. Vinuto J. A amostragem em bola de neve na pesquisa qualitativa: um debate aberto. Tematicas. 2014;22(44):203-20. https://doi.org/10.20396/tematicas.v22i44.10977.
21. Souza AC, Alexandre NMC, Guirardello EB. Psychometric properties in instruments evaluation of reliability and validity. Epidemiol Serv Saude. 2017;26(3):649-59. https://doi.org/10.5123/S1679-49742017000300022. PMid:28977189.
22. Marques JBV, Freitas D. Método DELPHI: caracterização e potencialidades na pesquisa em Educação. Pro-Posições. 2018;29(2):389-415. https://doi.org/10.1590/1980-6248-2015-0140.
23. Coutinho SS, Freitas MA, Pereira MJB, Veiga TB, Ferreira M, Mishima SM. O uso da técnica Delphi na pesquisa

em Atenção Primária à Saúde: revisão integrativa. Rev Baiana Saúde Pública. 2014;37(3):582-96. https://doi.org/10.22278/2318-2660.2013.v37.n3.a398.

24. Alexandre NMC, Coluci MZO. Content validity in the development and adaptation processes of measurement instruments. Cien Saude Colet. 2011;16(7):3061-8. https://doi.org/10.1590/S1413-81232011000800006. PMid:21808894.
25. Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Res Nurs Health. 2007;30(4):459-67. https://doi.org/10.1002/nur.20199. PMid:17654487.