

QUALIFICATION OF NURSING STAFF FOR BEST PRACTICE IN THE USE OF BRONCHODILATORS IN MECHANICALLY-VENTILATED PATIENTS

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ABSTRACT: Inhalation therapy with bronchodilators is one of the main therapeutic strategies to treat respiratory diseases as long as it is correctly executed to produce proper absorption and effective medication action. A quantitative and quasi-experimental study was conducted with a pretest and posttest design to assess the knowledge of nursing technicians concerning the administration of inhaled bronchodilators in ventilator-supported patients hospitalized in an Intensive Care Unit and also to qualify them to correctly administer these medications. A training program was administered to 34 nursing technicians based on the pretest results and afterwards, a posttest was applied to assess the technique to administer bronchodilators. Pretest was applied and none of the interviewees properly described the stages required to provide inhaled medication to mechanically ventilated patients. The stages were properly described in the posttest by 44.11% of the participants. The analysis of the results concerning both the pretest and posttests indicate the participants acquired learning based on best practices.

DESCRIPTORS: Intensive care units. Education, nursing. Respiration, artificial. Bronchodilator. Respiratory tract diseases.

CAPACITAÇÃO DOS TÉCNICOS DE ENFERMAGEM PARA AS MELHORES PRÁTICAS NO USO DE BRONCODILADORES EM PACIENTES MECANICAMENTE VENTILADOS

RESUMO: A inaloterapia de broncodiladores é uma das principais terapêuticas no tratamento de doenças respiratórias, desde que a administração seja correta para produzir uma absorção e uma ação medicamentosa efetiva. Assim, realizou-se uma pesquisa quantitativa, quase-experimental, com o delineamento pré e pós-teste, cujos objetivos foram avaliar o conhecimento dos técnicos de enfermagem na administração de broncodiladores inalatórios, em pacientes mecanicamente ventilados, na Unidade de Terapia Intensiva, e capacitá-los para a correta aplicação desses fármacos. Com base no pré-teste, foi realizada a capacitação de 34 técnicos de enfermagem e, após, um pós-teste para a avaliação da técnica de administração dos broncodiladores. Aplicou-se um questionário. Os resultados sinalizam que nenhum dos entrevistados descreveu, adequadamente, as etapas da nebulização no paciente mecanicamente ventilado no pré-teste. Já no pós-teste, 44,11% responderam adequadamente. Através da análise dos resultados, avaliando os pré e pós-testes, nota-se um aprendizado balizado nas melhores práticas.

DESCRIPTORIOS: Unidade de terapia intensiva. Educação em enfermagem. Ventilação mecânica. Broncodiladores. Doenças respiratórias.

CAPACITACIÓN DE TÉCNICOS DE ENFERMERÍA PARA MEJORAR LAS PRÁCTICAS EN EL USO DE BRONCODILADORES EN PACIENTES MECÁNICAMENTE VENTILADOS

RESUMEN: La inhaloterapia con broncodiladores, es una de las principales terapias en el tratamiento de enfermedades respiratorias, desde que la administración sea correcta para producir absorción y acción medicamentosa efectivas. Así, se realizó una pesquisa cuantitativa, casi experimental, con el delineamiento pre y pos-teste, para evaluar el conocimiento de los técnicos de enfermería sobre la administración de broncodiladores inhalatorios en pacientes mecánicamente ventilados en la Unidad de Terapia Intensiva y

capacitarlos para su correcta aplicación. Basado en el pre-teste, se realizó la capacitación de 34 técnicos de enfermería y, a continuación, un pos-teste para evaluar la técnica de administración de los broncodilatadores. Se aplicó un cuestionario. Los resultados señalan que ninguno de los entrevistados describió adecuadamente las etapas de la nebulización en el paciente mecánicamente ventilado en el pre-teste. Ya en el pos-teste, 44,11% respondieron adecuadamente. El análisis de los resultados, evaluándose el pre y pos-testes, indica un aprendizaje con soporte en las mejores prácticas.

DESCRIPTORES: Unidades de terapia intensiva. Educación em enfermería. Respiración artificial. Agentes broncodilatadores. Enfermedades respiratorias.

INTRODUCTION

Inhalation therapy is currently one of the main therapeutic strategies used to treat respiratory diseases. Increasingly more efficient devices coupled with medications having a low incident of side effects have been used.¹⁻⁶ Bronchodilators are mainly designed to activate mechanisms that induce relaxation of the airway's smooth muscles and reduce the action of autacoids and neurotransmitters that trigger bronchospasms. The preferred route to administer bronchodilators is through inhalation because the medication is taken directly to the lungs and airways and is effective in doses that cause fewer systemic adverse effects.⁷ Bronchial dilation depends on balancing factors that tend to relax the smooth muscle (calcium efflux). Bronchial tone control is accomplished by adrenergic systems (sympathetic nervous system) and cholinergic (parasympathetic system) and medication that activates (agonist) or inhibits (antagonist) autonomic nervous system receptors, which are potentially important in pharmacological therapy. Parasympathetic stimulation decreases the diameter of bronchi and bronchioles; sympathetic stimulation has the opposite effect. Inhaled bronchodilators are subdivided into two categories: adrenergic agonists (alpha and beta), such as phenoterol, salbutamol and salmeterol; and the antagonist cholinergic ipratropium bromide.⁷

Bronchodilators play an important role in reducing airway resistance, hyperinflation, and dyspnea in patients with Chronic Obstructive Pulmonary Disease (COPD), asthma, and Auto-Positive and End-Expiratory Pressure (auto-PEEP).² Additionally, they increase tolerance to exercise when in the presence of COPD,⁶ since reduced tolerance to exercise and the decreased ability to perform labor activities seem to be the disease's greatest losses.⁸⁻¹⁰ Ipratropium bromide and beta-agonist drugs are equally efficient during COPD crises,¹¹ reducing the volume of sputum without changing its viscosity.^{7,11}

Hence, inhaled bronchodilators are used to

treat pulmonary diseases, are practical, painless and efficient if we consider the high concentration of medication supplied.¹ Nebulizers and pressurized Metered-Dose Inhalers (pMDI) attached to a spacer device are the most effective ways to administer medication in mechanically ventilated patients, both intubated and tracheostomized patients.¹⁻²

Inhaled bronchodilators need to be correctly administered to produce effective absorption and action.¹⁻² Therefore, the technique to administer inhaled medication needs to be carefully executed to achieve the desired effect since incorrect technique compromises the medication's efficiency and, consequently, the patient's treatment.¹⁻⁴ Mechanical ventilation aims to deliver a certain volume of gas to the lungs, enabling the patient's adjustment of alveolar ventilation and arterial oxygenation to achieve values considered to be ideal.⁵ In the meantime, inhaled drugs can be administered in mechanically ventilated patients through jet nebulizers, ultrasonic nebulizers, or through pMDI.²

In practice, we observe that poor technique in the administration of medication occurs both due to a lack of knowledge on the part of professionals and a lack of training or guidance on the part of health facilities. The efficacy and side effects of inhaled medications depend on the application of this technique, thereby response to medication varies. From this perspective, the importance of this study is in the evaluation of the technique used to administer bronchodilators in mechanically ventilated patients.

The main question related to this topic and which motivated this study was: Do nursing technicians correctly administer inhaled bronchodilators in mechanically ventilated patients? In this context, the following objectives were proposed: to evaluate the knowledge of nursing technicians in administering inhaled bronchodilators in mechanically ventilated patients hospitalized in Intensive Care Units (ICU) and to qualify nursing technicians to correctly administer these medications.

MATERIAL AND METHODS

Data were collected by the researchers in the ICU specializing in respiratory diseases at the Pereira Filho Facility in the Santa Casa Hospital in Porto Alegre, RG, Brazil from September to October 2007. The questionnaire was applied to the ICU's nursing technicians, who are the professionals responsible for the administration of bronchodilators to patients. Intentional sampling was used and 34 nursing technicians were included in the study according to the following inclusion criteria: (1) having at least one month of experience; (2) being on duty for the day the pretest was applied.

The project was submitted to and approved by the Ethics Research Committee at the *Irmandade da Santa Casa de Misericórdia* in Porto Alegre, Brazil (Protocol n. 1668/07 and Process n. 382/07). The study complied with Resolution 196/96 that provides Guidelines and Standards for Research Involving Human Subjects.¹² The nursing technicians were informed of the study's objectives and ensured of the confidentiality of their information and their right to withdraw from the study at any time. All doubts were clarified after reading free and informed consent forms, two copies of which were signed, one for the researcher and another for the participant.

This quasi-experimental study has a pretest and posttest design and a quantitative approach. Data were collected at two points in time: (pretest) before intervention was applied and (posttest) after intervention was implemented. This study included three stages: pretest, training, and posttest. All stages were implemented for three different work shifts (morning, afternoon, and night) and the researchers formed two groups in each shift, totaling six groups. Each group participated in the pretest, training, and posttest during working hours in a room specifically assigned for this purpose within the ICU itself. The activity took from 60 to 90 minutes on average and included filling out the pretest, training, and filling out the posttest.

Training was based on the pretest results and included information, discussion of content, skills and attitudes. Posttest was applied after the training to evaluate the technique used to administer bronchodilators. A structured questionnaire with 10 open questions (appendix) was used in the pretest and posttest.

The results are presented in a table as percentages. The analysis of results presents a description of the pretest and posttest applied to 34 nursing technicians in the studied ICU. This is an analysis of central tendency where the means of the evaluated themes are compared. These are described below.

The technique to administer inhaled bronchodilators described by Duarte and his collaborators was evaluated:¹

- Technique to administer aerosol through pMDI attached to a spacer: (1) vacuum the tube; (2) adjust the volume of airflow > 500ml; (3) adjust inspiratory flow < 60L/min; (4) confirm the position of the device in the inspiratory limb; (5) shake the canister and insert it into the end of the spacer; (6) press down the device at the beginning of inspiration; and (7) repeat the dose 20 to 30 seconds after the first puff.

- Technique to administer aerosol through a nebulizer: (1) vacuum the tube; (2) adjust the volume of airflow > 500ml; (3) adjust inspiratory flow < 60L/min, (4) put solution into the nebulizer device; (5) dilute the medication in 4 to 6 ml of saline solution at 0.9%; (6) place the nebulizer in the inspiratory limb at a distance of 30 cm from the endotracheal tube; (7) adjust flow to 6L/min in the nebulizer; (8) pat gently on the nebulizer during operation; and (9) disconnect the nebulizer from the circuit.

RESULTS

We noticed the nursing technicians were anxious at the beginning of the training process even though the content addressed a technique that is part of their work routine. The pretest was applied and then training was undertaken with an initial Power Point presentation, which raised questions and encouraged discussion among the nursing technicians and with the researchers about the correct technique to be used and how it was performed up to that point. The posttest was applied after the training. The questionnaire used with open questions is presented in the Appendix with respective answers considered correct by the authors. The objective of including this questionnaire is to provide relevant information for good practice.

The results concerning the 10 questions are presented in Table 1.

Table 1 - Relation of percentage of correct answers in the pretest and posttest. Porto Alegre-RS, Brazil, 2007

Questions	Pretest (%)	Posttest (%)
Q1	-	44.11
Q2	5.88	38.23
Q3	2.94	88.23
Q4	8.82	100
Q5	2.94	17.64
Q6	-	17.64
Q7	88.23	94.12
Q8	85.29	100
Q9	70.58	100
Q10	17.64	73.53

Figure 1 presents the percentage of errors verified in the administration of bronchodilators through nebulization during the individual analysis of the nine stages of the process in the posttest.

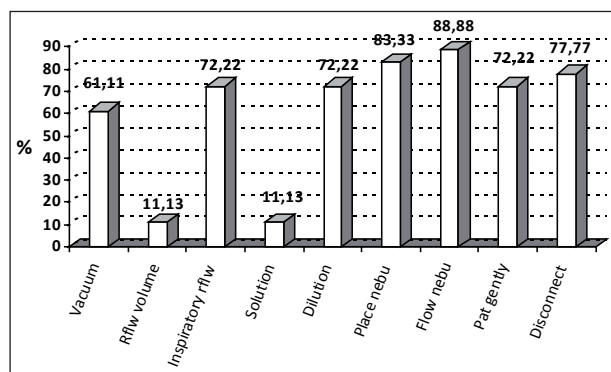


Figure 1 - Percentage of errors in the administration of bronchodilators through nebulization. Porto Alegre-RS, Brazil, 2007

Figure 2 shows the percentage of errors verified in the administration of bronchodilators through pMDI attached to a spacer device during individual analysis of the seven stages of the process in the posttest.

None of the nursing technicians were able to describe the stages of the nebulization technique using a nebulizer in ventilator-supported patients. In the posttest, after training, 44.11% of the nursing technicians were able to answer this question correctly. The remaining 55.89% answered this question wrongly because they did not describe all the steps in the process, as shown in Figure 1.

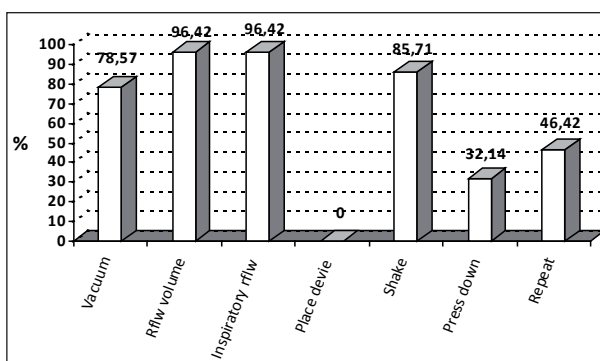


Figure 2 - Percentage of errors in the administration of bronchodilators through pMDI. Porto Alegre-RS, Brazil, 2007

Question number 2 of the pretest asks for the necessary airflow to perform nebulization using a nebulizer in intubated patients and only 5.88% of the respondents were able to answer this question correctly. In the posttest, 38.23% of the respondents were able to answer it correctly. We realized there was a comprehension issue in this specific question, since 21 individuals answered it wrongly in the posttest. After resolving comprehension issues, 19 respondents provided the ventilator flow and two provided the airflow volume instead of the nebulizer flow.

None of the nursing technicians described the administration of bronchodilator with a spacer device correctly in pretest (question 6) while 85.36% of the respondents did not correctly describe all seven stages of the procedure in the posttest (Figure 2).

A total of 70.58% of the respondents knew in the pretest that the most efficient device to administer aerosol is the spacer device rather than the nebulizer, while all nursing technicians were able to answer this question correctly in the posttest. They also justified in the posttest why the spacer is more efficient: “the spacer provides a more reliable dose” (29.41%); “there is no risk of bacterial contamination” (23.52%); “it is more efficient” (23.52%); 14.70% did not justify the answer; and “it does not interfere with ventilation” (8.82%).

Question number 10 asked whether the parameters of the mechanical ventilator influence the supply of aerosol and why. A total of 17.64% of respondents answered this question correctly in the pretest and this percentage increased to 73.53% in the posttest. Of the 26.47% of the re-

spondents who answered this question wrongly in the posttest, either they said: "the parameters of the mechanical ventilator influence the supply of aerosol" but were not able to explain why (44.44%), or "it does not influence it" but could not explain why (33.33%), or did not answer the question (22.22%).

DISCUSSION

This study's results show the nursing technicians acquired knowledge after the training program on the administration of bronchodilators in mechanically ventilated patients. The nursing staff was instructed in the administration of bronchodilators, increasing their knowledge and, consequently, becoming more qualified to provide more efficient treatment to patients. Increased knowledge, however, means understanding that nursing activities are successively learned and, therefore, are practiced, modified and eventually superseded. "What is currently seen as valid knowledge is immediately relegated to the background, or even abandoned, as new knowledge is validated".^{13:172}

It is worth noting that questions numbers 1 and 6 demanded a detailed description of the steps to be followed. The analysis of these questions, especially in the posttest, seems to indicate that some nursing technicians did not have the disposition or patience required to answer the questions since their answers were very brief, which negatively impacted the final result. This perception, however, encourages reflection upon the best strategies to integrate education and practice. From this perspective, the results of this investigation helped the researchers to understand that the professionals' routines are directly linked to the success or failure of transforming reality based on best practices. That is, concomitant with any qualification process, there is a need to instill a critical view and value the daily routine of the work team, considering it a partner in the search for concrete operational results.¹⁴

The distribution of inhaled medicine is hindered in intubated patients. Only 2.9% of the drug reaches the lungs when administered through nebulizers. The administration of aerosol through a pMDI should be used via an adapter linked to the circuit of the ventilator and synchronized with the inspiratory phase. To ensure appropriate dosage, it should be two or four times greater, due to losses

that occur in the circuit of the ventilator.¹¹ Appropriate deposition of aerosol in the lower airways depends on multiple factors, among which are: the physical and chemical properties of medications, the characteristics and appropriate placement of aerosol generators, ventilators' parameters and modes, the type of ventilator circuit, humidification and heating of inspired air, and the patient's anatomy and presence of secretion in the airways.¹ Patients whose ventilator's parameters are in the assist-control mode have a 23% increase in the supply of aerosol when compared to controlled modes with equivalent volume of airflow. Airway flow greater than 500ml is recommended for adults to ensure appropriate release of aerosol in the lower airways.¹ These aspects were appropriately considered important by the nursing technicians, as shown by the results of the ninth and tenth questions.

We also verified, given the results in the pretest concerning the seventh and ninth questions, that the nursing technicians already considered the administration of bronchodilator via pMDI and spacer more effective than through a nebulizer. One of the possible reasons is the greater facility with which the procedure is performed for ventilator-supported patients. Recent studies show that using a regular spacer attached to a pMDI improves the efficiency of the therapy with bronchodilators in mechanically ventilated patients when the procedure is synchronized with the beginning of inspiration, with careful attention to the administration technique. MDIs are easy to use, require less time, provide a more reliable dose, and offer no bacterial contamination risk; in-line spacers do not need to be disconnected, reducing the risk of pneumonia associated with the ventilator.¹

Studies show that inhalers differ in relation to the degree of pulmonary deposition but their efficiency also depends on the source and degree of airways obstruction.^{1,15-16} Pulmonary deposition reaches from 5% to 10% of the nominal dose released to the patient when using an MDI. In fact, studies show that the efficiency of supply of aerosol in the lower respiratory tract in ventilator-supported patients with the use of a nebulizer is from zero to 42% and with an MDI it is from 0.3% to 97.5%.¹⁻²

However, the spacer volume can affect the availability of medication for inhalation, which can also vary according to the drug used.

Hence, health workers should be aware that deposition data concerning spacers come from studies using a specific drug and may not apply to other drugs.⁸

The fifth question shows a low percentage of correct answers both in the pretest and posttest even though, paradoxically, the answer seemed to be easy in the posttest. That is, the pMDI is more effective in aerosol deposition when placed at a 30 cm distance from the endotracheal tube in comparison to placing it between the patient Y and the endotracheal tube. In this case, the circuit acts as a spacer for the aerosol to accumulate between inspirations.^{1,15-16} Once more, this result may have shown the need for the researchers to reconsider and discuss with the nursing technicians their comprehension concerning the importance of appropriate aerosol deposition for patients using bronchodilators.

The fourth question, which asks the nursing technicians what should be done with the nebulizer during nebulization, obtained no correct answers in the pretest, meaning that none of the respondents knew what to do with the nebulizer. After the training program, 100% of the answers were correct in the posttest. In this context, we note that nebulizers are associated with bacterial contamination. Taking such an aspect into account, they should be cleaned and disinfected as soon as nebulization is finished to minimize risk of contamination and hospital-acquired pneumonia. The additional flow of gas from the nebulizer can lead to a situation in which the patient is unable to maintain respiratory drive during ventilation of sustained pressure, causing hypoventilation.¹

CONCLUSION

This study presents some limitations such as: reduced sample size; it was conducted in a single facility, and the knowledge of the technicians in the subsequent months was not evaluated. Its strengths include the verification of a common educational problem in the field; the indication that we should pay attention to how we administer training processes and how we evaluate respective results; the study was conducted in a center of excellence in respiratory diseases; and the objective and careful description of an educational practice based on international guidelines.

The analysis of results from both the pretest and posttest, and the participation of the nursing

technicians in the qualification process, show that the participants acquired knowledge of the administration of bronchodilators in mechanically ventilated patients. The nursing staff was instructed concerning the administration of bronchodilators and the resulting increase in knowledge enabled them to provide patients improved care based on best practices.

Continuing education should be a common practice in hospitals, since techniques that become routine are often forgotten and even superseded. In summary, nurses are technically and ethically responsible for nursing care provided to patients, thus, should be interested in having a competent team of nursing technicians aware of the need to provide quality and effective care.

APPENDIX - STRUCTURED QUESTIONNAIRE WITH OPEN QUESTIONS

Appropriate use of bronchodilators in mechanically ventilated patients

Question 1) Describe all the steps you take to perform nebulization with a nebulizer in mechanically ventilated patients.

Expected answer) Vacuum the tube; adjust air-flow volume > 500ml; flow < 60L/min; put saline solution into the device; place the nebulizer in the inspiratory limb at a distance of 30 cm from the connection; observe flow of 6L/min in the nebulizer; tap gently on the nebulizer during procedure; disconnect the nebulizer from the circuit.¹

Question 2) What is the necessary airflow to perform nebulization with a nebulizer in intubated patients?¹

Expected answer) 6 to 8 l/min.

Question 3) What is the correct volume of solution to be placed in the nebulizer to enable nebulization in mechanically ventilated patients?

Expected answer) 4 to 6 ml.¹

Question 4) What you should do with the nebulizer during nebulization?

Expected answer) Tap gently on it.¹

Question 5) What is the best placement of the nebulizer in the ventilator's circuit for the procedure to be efficient?

Expected answer) vertically at a 30 cm distance from the Endotracheal tube.^{1,11}

Question 6) Describe how you administer bronchodilators using a spacer device in mechanically ventilated patients.

Expected answer) Vacuum the tube; observe and keep the airflow > 500ml; observe and keep flow < 60L/min; confirm the position of the device in the inspiratory limb; shake the medication and place it into the spacer; press it down at the beginning of inspiration; repeat dose 20 to 30 seconds later; observe the correct placement – ventilator – filter – spacer.¹

Question 7) In which breathing phase should inhaled medication (inhalers) be sprayed into the spacer?

Expected answer) Inspiratory.¹⁻⁶

Question 8) What should we do with the inhaled medication canister before spraying it into the spacer?

Expected answer) Shake.¹

Question 9) What is, in your opinion, the best device to deliver aerosol more efficiently? Why?

Expected answer) The spacer. Because it is more efficient, easier to use, require less time, provide a more reliable dose, and offer no bacterial contamination risk.¹⁻¹¹

Question 10) In your opinion, do the parameters of the mechanic ventilator influence the supply of aerosol? Why?

Expected answer) Yes. Because deposition of aerosol increases in 23% when the ventilator's parameters are in the assist-control mode when compared to controlled modes. An airflow volume > 500ml is required to ensure appropriate release of aerosol in the lower airways.¹¹

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