DOI: 10.1590/1809-2950/20006428032021

ORIGINAL RESEARCH

Assessing the impact of an educational intervention on ventilator-associated pneumonia

Avaliação do impacto de uma intervenção educacional em pneumonia associada à ventilação mecânica

Evaluación del impacto de una intervención educativa en Neumonía Asociada a Ventilación Mecánica

Ilse Maria Kunzler[1], Sandra Omizzollo[2], Solange de Fatima Mohd Suleiman Shama[3]

ABSTRACT | Ventilator-associated pneumonia is a condition of the lung parenchyma in artificially ventilated patients. Considered a public health problem, it is preventable through good evidence-based practices. This study aimed to highlight the efficacy of training in ventilator-associated pneumonia with the use of pre- and post-tests as tools to evaluate retention of the content addressed. This is a cross-sectional, exploratory and quantitative study conducted in a public hospital in the Sinos River Valley/RS in December 2019. The sample consisted of healthcare providers and supervised interns who attended training developed with audiovisual resources and rounds of talks, excluding those who failed to complete the questionnaires in the pre- and/or post-test stages composed of five questions about the endotracheal tube, headboard angle, aspiration of secretions and risk factors for and prevention of ventilator-associated pneumonia. Descriptive statistical procedures, paired Student's *t*-test and boxplot construction of the participants' scores were used for data analysis. The study was composed of 45 participants with a mean age of 34.5±8.9 years, mostly women (75.6%) and nursing technicians (60%). We observed that the global average of correct answers in the pre-test questions was 28 (62.2%) and 38 (84.4%) in the post-test, expressing a 35.7% increase in correct answers after training, but this increase was statistically insignificant (p=0.103). Despite the potential benefits of the applied educational intervention, the results obtained were insignificant, contrary to our hypothesis.

Keywords | Cross Infection; Pneumonia, Ventilator-Associated; In-service Training; Continuing Education.

RESUMO | A Pneumonia Associada à Ventilação Mecânica consiste na afecção do parênquima pulmonar em pacientes ventilados artificialmente. Considerada um problema de saúde pública, ela é prevenível através de boas práticas baseadas em evidências. Objetivamos evidenciar a eficácia de uma capacitação em Pneumonia Associada à Ventilação Mecânica com utilização de pré e pós-testes como ferramenta avaliativa da fixação do conteúdo abordado. Estudo transversal, exploratório e quantitativo, conduzido em um hospital público da Região do Vale dos Sinos (RS) em dezembro de 2019. A amostra foi constituída por profissionais de saúde e acadêmicos em estágio supervisionado que frequentaram capacitações desenvolvidas com recursos audiovisuais e rodas de conversa, excluindo-se aqueles que não preencheram os questionários nas fases pré e/ou pós-teste e compostos por cinco questões sobre o tubo endotraqueal, altura cabeceira, aspiração de secreções e fatores de risco e prevenção da Pneumonia Associada à Ventilação Mecânica. Foram utilizados procedimentos de estatística descritiva, o teste t de Student pareado e construção de *Box-plot* das notas dos participantes para análise dos dados. O estudo foi composto por 45 participantes com média de idade 34,5±8,9 anos, em sua maioria mulheres (75,6%) e técnicos de enfermagem (60%). Evidenciou-se que, a média global de acertos nas questões do pré-teste foi de 28 (62,2%) e no pós-teste 38 (84,4%), expressando aumento de 35,7% no aproveitamento dos participantes após a capacitação. No entanto, esse acréscimo não

[1]Universidade Feevale – Novo Hamburgo (RS), Brasil. E-mail: ilse@feevale.br. ORCID-0000-0001-9338-5007
[2]Universidade Feevale – Novo Hamburgo (RS), Brasil. E-mail: sandra_omizzollo@hotmail.com. ORCID-0000-0003-3572-954X
[3]Universidade Feevale – Novo Hamburgo (RS), Brasil. E-mail: solangeshama@feevale.br. ORCID-0000-0002-9183-9754

Corresponding address: Sandra Omizzollo - Rua dos Camboins, 110 – Vila Flores (RS), Brazil – ZIP Code: 95334-000 – E-mail: asardim@hotmail.com – Financing source: nothing to declare – Conflict of interest: nothing to declare – Presentation: March 21st, 2020 – Accepted for publication: July 28th, 2020 – Ethics Committee Approval: No. CAAE 12245819.2.0000.5348.

foi estatisticamente significativo (p=0,103). Apesar dos potenciais benefícios da intervenção educacional aplicada, os resultados obtidos não foram significantes, contrariando a hipótese do estudo.
Descritores | Infecção Hospitalar; Pneumonia Associada à Ventilação Mecânica; Capacitação em Serviço; Educação Continuada.

RESUMEN | La Neumonía Asociada a Ventilación Mecánica es la afección del parénquima pulmonar que se desarrolla en pacientes con ventilación artificial. Aunque es un problema de salud pública, se puede prevenirlo con buenas prácticas basadas en la evidencia. Nuestro objetivo es demostrar la efectividad de una capacitación en Neumonía Asociada a Ventilación Mecánica con el uso de pruebas antes y después como una herramienta evaluativa para retener los contenidos abordados. Este es un estudio transversal, exploratorio y cuantitativo, realizado en un hospital público de la región de Vale dos Sinos (Rio Grande do Sul, Brasil) en diciembre de 2019. La muestra estuvo conformada por profesionales de la salud y académicos en prácticas supervisadas que asistieron a capacitaciones desarrolladas con recursos audiovisuales y círculos de conversación, y fueron excluidos aquellos que no completaron los cuestionarios en las fases pre- y/o posprueba que contenían cinco preguntas sobre el tubo endotraqueal, la altura de la cabecera, la aspiración de secreciones y los factores de riesgo y prevención de Neumonía Asociada a Ventilación Mecánica. Se utilizó como procedimientos estadísticos descriptivos la Prueba t de Student emparejada y la construcción de *Box-plot* de las notas de los participantes para el análisis de los datos. El estudio contó con 45 participantes de edad media de 34,5±8,9 años, en su mayoría mujeres (75,6%) y técnicos de enfermería (60%). El promedio global de aciertos en las preguntas de la preprueba fue de 28 (62,2%); y en la posprueba, de 38 (84,4%), mostrando un incremento del 35,7% en el rendimiento de los participantes después de la capacitación. Pero este aumento no fue estadísticamente significativo (p=0,103). A pesar de los potenciales beneficios de la intervención educativa aplicada, los resultados obtenidos no fueron significativos contrariamente a la hipótesis del estudio.
Palabras clave | Infección Hospitalaria; Neumonía Asociada al Ventilador; Capacitación en Servicio; Educación Continua.

INTRODUCTION

Every year, millions of patients suffer disabling harm from unsafe healthcare, often originated in Healthcare-related infections (HRIs)[1,2]. HRIs consist of infections acquired after the patient's admission manifesting during hospitalization or after hospital discharge and detected in 5 to 17% of hospitalizations, impacting morbidity and mortality, length of hospitalization and expenses with diagnostic and therapeutic procedures[3,4].

Ventilator-associated pneumonia (VAP) corresponds to 15% of total HRIs and about 25% of all infections occurring in intensive care units (ICUs)[5,6].

It consists of an infectious process of the pulmonary parenchyma occurring between 48 and 72 hours after endotracheal intubation, tracheostomy and invasive mechanical ventilation (IMV) or up to 48 hours after its interruption[7,8]. VAP is considered a public health problem, since it affects 9 to 27% of patients undergoing IMV, with an overall mortality between 20 and 60%[5,9,10].

VAP is an infection of difficult diagnostic precision because interpreting its defining clinical criteria is open to subjectivity and heterogeneity. VAP bundles are good evidence-based practices developed and disseminated worldwide to prevent this infection. They determine a standard of service and healthcare that depends on the offered structure and healthcare providers' support, including: rinsing patient's mouths with 0.12% chlorhexidine gluconate; sanitizing healthcare providers' hands; preventing the bronchoaspiration of secretions by maintaining the patient in elevated decubitus (30-45°), unless contraindicated; inserting an orogastric tube instead of a nasogastric one given the risk of sinusitis; pausing enteral nutrition when lowering the decubitus; constantly evaluating patients' cuff pressure (20 to 30 cm H_2O); aseptically aspirating secretions only when necessary; avoiding the instillation of a 0.9% saline solution; aspirating subglottic secretions when possible; promoting the care of the ventilatory circuit; avoiding condensate accumulation and exchanging it only in case of failure

or dirt; evaluating patients' daily awakening routine concomitant to ventilatory weaning and extubation; and offering continuing education for health teams[9]. The Brazilian National Health Surveillance Agency (Anvisa) points to hand hygiene and the training of multidisciplinary teams assisting IMV patients as the main measures to prevent VAP[5,11].

Given COVID-19, caused by SARS-CoV-2, IMV became an indispensable therapeutic modality for individuals who developed the severe forms of the disease. This can, however, cause biophysical and biochemical lesions triggering lung diseases and even death, mainly because these critically ill patients need immunosuppressive drugs which, associated with intense immunological activity, leave the body susceptible to the development of coinfections or secondary superinfections. Moreover, COVID-19 patients admitted to ICUs are exposed to the risk of HRIs, and healthcare providers must handle ventilatory support systems with care to prevent VAP[12,13].

Prevention combined with a qualified health team is the priority strategy for dealing with VAP. It remains, however, a healthcare challenge, especially in ICUs. In-service continuing education ensures intervention systematization and the elaboration of institutional protocols favoring patient safety and, consequently, causes team awareness and effective management in implementing a preventive bundle[6,14].

Permanent Health Education (PHE) approaches work both as an issue and as daily learning mediating a commitment to collectives, that is, it refers to teaching mechanisms which integrate theory and practice[15,16]. The multiple risk factors for VAP challenge multidisciplinary teams, especially in ICUs. Considering how notorious healthcare providers are in preventing and controlling this infection, this study aims to show the efficacy of VAP training using pre- and post-tests as tools to evaluate retention of the knowledge addressed.

METHODOLOGY

This is a cross-sectional, exploratory, quantitative study conducted in a public hospital in the Sinos River Valley in the state of Rio Grande do Sul, Brazil, in December 2019. Our sample consisted of healthcare providers and supervised interns who worked in sectors with patients undergoing IMV. Participants who attended training and agreed to participate in this study were included by signing an informed consent form. Failure or non-completion of the questionnaire in its pre- and post-test stages were considered exclusion criteria.

To participate in this study, the sample was approached by the hospital coordination disseminating the training internally, whereas its population was approached actively in their workplace at different times within their working hours. Data intervention and collection were always applied by the same researcher, and sessions lasted about 50 minutes each (between training and application of the data collection instrument).

Data sources were obtained via a collection instrument developed by the authors, composed of multiple-choice questions applied in two stages: in the first one, a pre-test questionnaire was applied which included sociodemographic data (age, gender, profession, training background and professional experience at the institution), an inquiry into prior training provided by the institution and questions on the endotracheal tube, headboard height, correct order of secretion aspiration, and VAP risk factors and prevention to be answered by each participant's previous knowledge; while the second stage consisted of a post-test questionnaire applied immediately after training containing the pre-test questions (Table 1) and questions on the training received (whether the proposed subject was covered, questions were answered, behavior change was encouraged, language used was adequate and contributions were made to the knowledge in the area). Post-tests were applied immediately after training given the limitations imposed by work demand.

Table 1. Questions 1 to 5

	Questions	Answer
Question 1	IMV is associated with high rates of pneumonia because the endotracheal tube: I. inhibits important defense mechanisms of the upper respiratory tract II. contributes to the production and accumulation of oropharyngeal secretions III. inhibits effective cough mechanisms IV. may be a source of infection CORRECT is (are) only the alternative(s): 1. ☐ II, III 2. ☐ I, II, IV 3. ☐ II, III, IV 4. ☐ I, II, III, IV	4

(continues)

Table 1. Continuation

	Questions	Answer
Question 2	Unless contraindicated, headboard elevation should be adopted in order to prevent VAP. What angle is recommended? 1. ☐ Between 30 and 45° 2. ☐ Between 20 and 40° 3. ☐ Between 25 and 45°	1
Question 3	Aspiration of secretions should follow what order? 1. ☐ Tracheal Prosthesis – Mouth – Nose 2. ☐ Nose – Tracheal Prosthesis – Mouth 3. ☐ Tracheal Prosthesis – Nose – Mouth	3
Question 4	All measures below prevent VAP, EXCEPT: 1. ☐ Oral hygiene with antiseptics 2. ☐ Daily interruption of sedation 3. ☐ Constant aspiration of secretions 4. ☐ Constant cuff pressure between 20 and 30 cmH_2O	3
Question 5	Below, all are risk factors for VAP, EXCEPT: 1. ☐ Host Factors 2. ☐ Antibiotics use 3. ☐ Extended IMV time 4. ☐ Healthcare providers' poor hand hygiene	2

Training was carried out in the institution and developed via audiovisual presentations and rounds of talks; the latter raised issues, seeking trainees' participation in debates on the subject in order to build knowledge through dialogue.

Theoretical components were taught via poster presentations in an A2 sheet (Figure 1) and covered the definition, diagnosis, etiology, risk factors for and prevention of VAP - as recommended by the literature[3,5,8,16-24]. Practical demonstrations explained the cleaning of the closed aspiration system, the aspiration of subglottic secretions and the verification via cuff manometer of tube cuff pressure with cmH_2O measurements. Rounds of talks discussed the five situations in which hand hygiene must be performed and the necessary materials for it to encourage healthcare providers to support the practice. Tube cuffs were also discussed; what is their function and why they should be inflated to the recommended values.

For care units in which hospital beds had no mechanism for measuring angles, an individualized grade protractor was elaborated and attached to each bed to facilitate the participants' understanding and, consequently, maintain the headboard at the correct height (30 to 45°), unless contraindicated. It was made with an A4 sheet of paper, a green highlighter pen, a latex tie and a transparent contact paper casing which allowed its cleaning (Figure 2).

Statistical analysis of the data was performed in Microsoft Office Excel 2016®. Descriptive statistical procedures (frequency distribution) and the paired Student's *t*-test were used to compare pre- and post-test correct answers. Statistical significance was verified with a level of 0.05. For better visualization of the results found, a boxplot of participants' scores was constructed, according to pre- and post-tests.

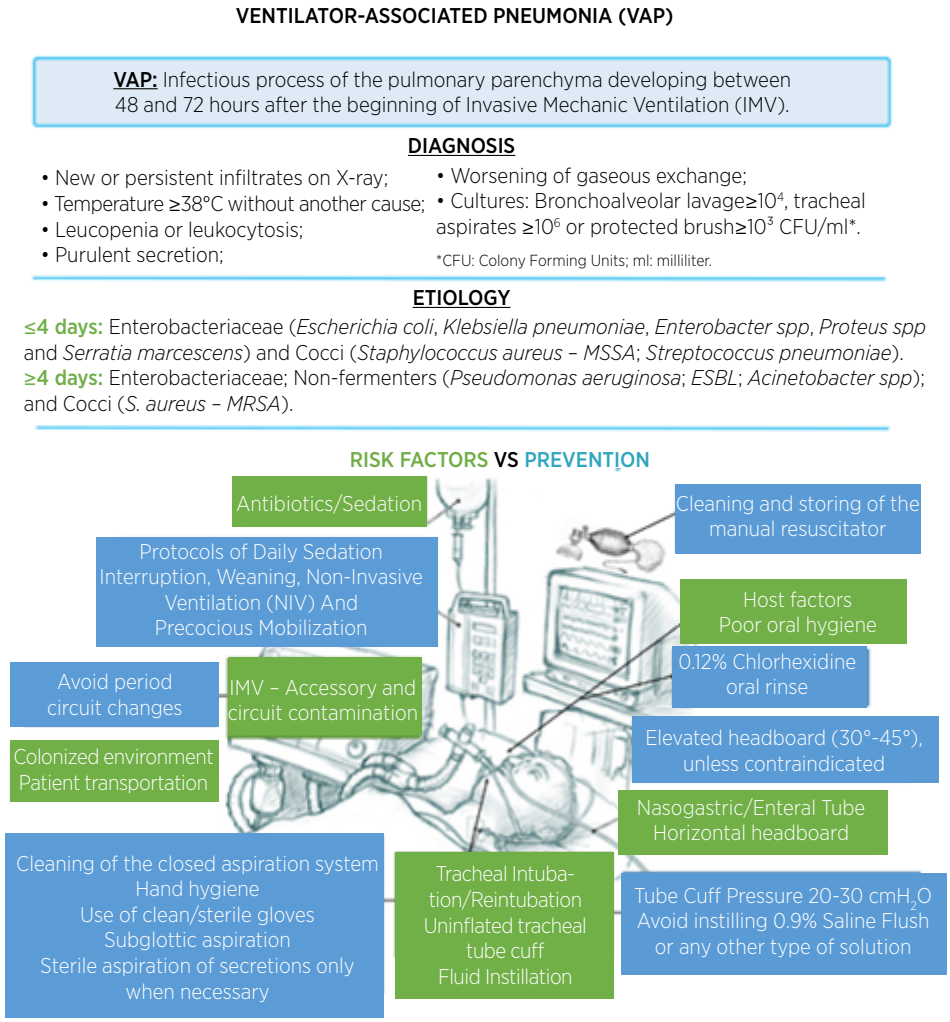

Figure 1. Poster used to train participants in the study

Figure 2. Grade protractor

RESULTS

In total, we trained 55 healthcare providers, of which 48 agreed to participate in the study. Three participants were excluded for failing to answer post-test questionnaires. Thus, the sample consisted of 45 questionnaires. 11 (24.4%) participants were male and 34 (75.6%), female, with a mean age of 34.5±8.9 years, distributed in the following medical specialties: 27 (60%) nursing technicians, five (11.1%) nurses, five (11.1%) nursing students, four (8.9%) physiotherapists, one (2.2%) physician, two (4.4%) nutritionists and one (2.2%) pharmacist. By excluding students, we observed an average period of training and professional experience of 112.1±93.8 and 60.1±70.8 months, respectively, among the 40 healthcare providers qualified in their respective professional councils.

The questions on the first stage of this study had only one correct answer. Our analysis of the questionnaires prior to training showed that 48.9% of participants answered the first question correctly – on the association between VAP occurrence and endotracheal tubes; 97.8%, the second one – on the ideal headboard angle; 91.1%, the third one – on the correct order of secretion aspiration; 22.2%, the fourth one – on the prevention factors for VAP; and only 51.1%, the fifth one – on the risk factors for VAP.

Table 2 shows that more than 90% of participants answered the questions correctly before and after the intervention in only two topics (2 and 3). Moreover, we observed that less than 50% of participants marked the correct alternatives for questions 1 and 4 in the pre-test, whereas the post-test saw an increase in the mean of correct answers, indicating satisfactory results and retention of knowledge after the intervention.

Table 2. Correct answers to pre- and post-training questions (n=45)

	Pre-test	Post-test	p-value*
	n (%)	n (%)	
Question 1 – Orotracheal tube and VAP association	22 (48.9)	37 (82.2)	0
Question 2 – Ideal headboard angle	44 (97.8)	45 (100)	0.323
Question 3 – Aspiration of secretions	41 (91.1)	42 (93.3)	0.323
Question 4 – VAP prevention	10 (22.2)	36 (80)	0
Question 5 – VAP risk factors	23 (51.1)	30 (66.7)	0.007
Global mean	28 (62.2)	38 (84.4)	0.103

*Paired Student's *t*-test

Overall, we observed a higher percentage of incorrect answers in the pre-test than in the post-test. When comparing the means of correct and incorrect answers before and after training using the paired Student's t-test, we found statistical significance in questions 1, 4 and 5, but none in questions 2 and 3. The fact that most participants answered correctly questions 2 and 3 in the pre-test may explain this non-significance, that is, training only corroborated previous knowledge.

The overall average of correct answers in pre-test questions was 28 (62.2%) and 38 (84.4%) in the post-test, showing a 35.7% increase in participants' success after training. This increase was, however, statistically insignificant (p>0.05). Table 2 shows the comparison of participants' correct answers before and after training.

We constructed Figure 3 by transforming the percentage data on the frequency of correct answers for each of the five questions into scores from zero to 10 – that is, the percentage of correct answers divided by 10. It illustrates the descriptively statistical values and the dispersion related to participants' pre- and post-training scores. Of the five questions applied in each evaluation, we observed that just over half of the participants indicated the correct alternative producing the median score of 5.11 in the pre-test, whereas in the post-test this value increased to 8.20.

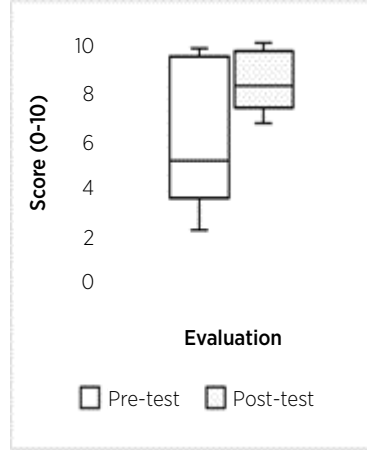

Figure 3. Boxplot of participants' scores, according to pre- and post-tests

When asked whether they had received previous VAP-related training, nine participants from our sample (20%) reported having received it, 27 (60%) received none and nine (20%) did not specify. When asked about the training received, 42 (93.3%) stated that it addressed the proposed subject, answered questions, encouraged behavior change, showed adequate language and contributed to knowledge in the area, while three (6.7%) did not specify.

DISCUSSION

In this study, female nursing technicians with no previous VAP-related training composed most of the sample. For Silva, Nascimento and Salles[8], in-service education and training has a positive impact on the communication, application and reduction of VAP incidence rates.

By analyzing the five questions in this study, we observed that participants showed greater difficulties in answering question 4 – followed by questions 1 and 5 – before training. After training, we noted an improved proportion of correct answers for all questions, and 1, 4 and 5 showed the most statistically significant increase. The training received showed positive results in the extension, questions answered, encouragement to behavioral change, knowledge teaching and propagation.

In answering the questionnaires, we observed the preponderance of correct answers in questions 2 and 3 both in pre- and post-tests. These questions related to the correct headboard angle to prevent VAP and the correct order of secretion aspiration, respectively.

According to the literature, the recommended angle for headboard elevation, unless contraindicated, is between 30 to 45°[5,8,17,18,19]. The literature recommends, for patients under mechanical ventilation, avoiding the supine position in favor of a semi-reclined one to prevent the aspiration of oropharyngeal or gastric contents, leading to the pathogenesis of VAP[17,18].

It also recommends a correct order in aspirating secretions to avoid cross-contamination and decrease VAP incidence rates. The order follows the principle: from the least to the most contaminated medium, that is, the procedure involves first aspirating the tracheal prosthesis followed by the nose and the mouth[20].

We observed an increase in the mean number of correct answers in relation to knowledge prior to training in questions 1, 4 and 5. Question 1 referred to the tracheal tube. Its presence was the most important risk factor, due to it inhibiting defense mechanisms in the upper respiratory tract, contributing to the production and accumulation of oropharyngeal secretions, inhibiting effective cough mechanisms, and since it is an invasive device, it is considered a source for spreading infections. Therefore, participants need to know these characteristics[5,21].

Question 4 listed the measures to be adopted by multidisciplinary teams to prevent the proliferation of unwanted microorganisms in patients, which included oral hygiene with antiseptics, daily interruption of sedation and maintenance of the pressure of the tube cuff between 20 and 30 cmH_2O. The correct answer was the aspiration of secretions, which should be performed only when necessary, since it exposes patients to risks and damages, such as hypoxemia, dysrhythmias, and contamination and reduction of lung volume and capacity[22].

Question 5 addressed the risk factors for VAP, including host factors, prolonged IMV time and healthcare providers' poor hand hygiene[5,21]. Its correct answer was the rational use of antibiotics. The hospital environment, along with the vulnerability of hospitalized patients, are sources for outbreaks of multidrug-resistant microorganisms and the subsequent predisposition to infections. The inadequate or indiscriminate use of antibiotics is linked to VAP incidence rates and 35 to 48% of patients who received inadequate empirical antibiotic therapy for the etiological agent may suffer from it[23].

Patients using artificial prostheses show increased oral colonization of resistant pathogens. Thus, healthcare providers need to rinse these patients' mouths with a 0.12% chlorhexidine compound at least twice a day. When used correctly, the oral mucosa and teeth absorb the compound and release it within 12 hours, acting against aerobic and anaerobic bacteria and reducing dental plaque formation[24].

Healthcare providers' hands, equipment, solutions, patient's vomiting, susceptibility and the environment may favor the spread of hospital infections and/or colonizations[3]. Simple measures can prevent about 30% of HRIs, and healthcare providers' proper hand hygiene is the most effective of them[16].

Results show a higher score in the questionnaire for healthcare providers/interns' practices. In this study, questions that required theoretical knowledge showed poorer scores. Healthcare providers' attitude interfere directly with VAP prevention, sometimes relying on the belief of its benefits, reinforcing the importance of training and qualification, whether via lectures, video presentations, posters and practice sessions in preventive measures while caring for IMV patients in addition to monitoring infection levels, and identifying and correcting issues. Healthcare providers' low motivation also relates directly to low protocol compliance, either due to working conditions, hours or scale overload[6,14].

The results obtained in this study showed the positive effect of the educational intervention on the overall mean of correct answers for the VAP questionnaire, but this increase was statistically insignificant. Melo et al.[24], observing the same follow-up proposal in this study, evaluated the knowledge of healthcare providers based on the VAP-prevention bundle combined with PHE in critically ill patients admitted to ICUs, and showed that, despite participants' awareness of and enthusiasm for the discussions, their knowledge was poor.

Gonçalves et al.[20] conducted a non-randomized controlled clinical trial to determine the efficacy of a medium-term educational strategy (workshops with cartoon posters) in how a nursing team performed procedures to prevent VAP. The authors found that the training was effective in teaching the team how to correctly assemble the mechanical ventilator with the aseptic technique, sanitize patient's tongues and maintain the correct tube-nose-mouth order during the bronchial hygiene procedure.

The training of the multidisciplinary team assisting IMV patients is fundamental and has a direct impact on VAP rates. It should, therefore, involve multimodal teaching methodologies[5]. With a proposal similar to this study, Parisi et al.[25] aimed to evaluate VAP incidence

rates in an ICU after the implementation of bundles and team education using as their teaching methodology the distribution of leaflets, lectures, implementation of an oral hygiene protocol and exhibition of posters describing the correct procedure for hand hygiene. The authors showed that after adopting the preventive measures, IMV and ICU time and VAP rates decreased.

This study has as its limitations its small sample, questions not validated in the literature, the generalization of the results in the population studied, the lack of continuity in the process of knowledge evaluation and the repercussion of learning in the care routine. The theme of this study, due to the complex situation with the pandemic in the world and in Brazil, raises the need for many studies that can bring new knowledge and alternatives that contribute to new health practices. Studies that seek the view of healthcare providers contribute especially to those at the forefront of the pandemic, reflect data that can show and discuss the current experience of health services, and thus the understanding that the issue is socially relevant. We recommend that qualitative studies be conducted to better understand this multicentric phenomenon, adapting the research instrument to the investigated populations and realities to verify the impact of education strategies on the practice of healthcare providers.

CONCLUSION

We trained 45 healthcare providers and supervised interns – most of them female nursing technicians – using audiovisual resources and rounds of talks. We observed an increase in the overall average of correct answers in the pre-test and post-test VAP questions, but despite the potential benefits of the applied educational intervention, the proposed statistical analysis showed no significant results, contrary to our hypothesis. We can conclude that the employed strategy had no beneficial results, indicating the need for studies describing in-service training methodologies for obtaining new knowledge and updating previous ones, so that by seeking the view of healthcare providers, especially those at the forefront of the pandemic, these studies may contribute to new health practices.

REFERENCES

1. Figueiredo ML, Oliveira e Silva CS, Brito MFSF, D'Innocenz M. Análise da ocorrência de incidentes notificados em hospital-geral. Rev Bras Enferm. 2018;71(1):121-30. doi: 10.1590/0034-7167-2016-0574.
2. World Health Organization (WHO). Conceptual framework for the international classification for patient safety: final technical report [Internet]. Geneva: WHO; 2009 [cited 2021 Sep 28]. Available from: https://bit.ly/3oabp34
3. Padilha JMFO, Sá APC, Silvino ZR. Luvas e adesão de profissionais de enfermagem às precauções de contato: uma revisão integrativa. Rev Enferm UFPE On Line. 2017;11(2):667-74. doi: 10.5205/1981-8963-v11i2a11986p667-674-2017.
4. Lacerda MKS, Souza SCO, Soares DM, Silveira BRM, Lopes JR. Precauções padrão e precauções baseadas na transmissão de doenças: revisão de literatura. Rev Epidemiol Control Infect. 2014;4(4):254-59. doi: 10.17058/reci.v4i4.4952.
5. Brasil. Agência Nacional de Vigilância Sanitária. Medidas de Prevenção de Infecção Relacionada à Assistência à Saúde [Internet]. Brasília, DF: Anvisa; 2017 [cited 2021 Sep 28]. Available from: https://bit.ly/2WhGsOK
6. Sousa GC, Santos KES, Silva LB, Mendes JR, Viana MRP, Cardoso SB. Medidas preventivas de pneumonia associada à ventilação mecânica. Res Soc Dev. 2021;10(5):e51010515207. doi: 10.33448/rsd-v10i5.152071.
7. Brasil. Agência Nacional de Vigilância Sanitária. Critérios Diagnósticos de Infecções Relacionadas a Assistência à Saúde [Internet]. Brasília, DF: Anvisa; 2017 [cited 2021 Sep 28]. Available from: https://bit.ly/3maXxTH
8. Silva SG, Nascimento ERP, Salles RK. Bundle de prevenção da pneumonia associada à ventilação mecânica: uma construção coletiva. Texto Contexto – Enferm. 2012;21(4):837-44. doi: 10.1590/S0104-07072012000400014.
9. Pulzi Júnior AS, Ferraz RRN, Lapchick MS. Pneumonia associada à ventilação mecânica como indicador de qualidade e segurança em saúde. Rev Med Minas Gerais. 2016;26:e-1776. doi: 10.5935/2238-3182.20150116.
10. Núñez SA, Roveda G, Zárate MS, Emmerich M, Verón MT. Ventilator-associated pneumonia in patients on prolonged mechanical ventilation: description, risk factors for mortality, and performance of the SOFA score. J Bras Pneumol. 2021;47(3):e20200569. doi: 10.36416/1806-3756/e20200569.
11. Rodrigues AN, Fragoso LVC, Beserra FM, Ramos IC. Impactos e fatores determinantes no bundle de pneumonia associada à ventilação mecânica. Rev Bras Enferm. 2016;69(6):1108-14. doi: 10.1590/0034-7167-2016-0253.
12. Fernandes TP, Abreu CM, Rocha JO, Bianchetti LO, Sales LA, Alves MQ, et al. Infecções secundárias em pacientes internados por COVID-19:consequências e particularidades associadas. Rev. Eletrônica Acervo Cient. 2021;34:1-7. doi: 10.25248/REAC.e8687.2021.
13. Cruz DA, Sousa IL, Santana PVD, Oliveira LKA, Sousa FWS, Araújo AMX, et al. Impactos da ventilação mecânica invasiva em pacientes de COVID-19: revisão integrativa. Res Soc Dev. 2021;10(11):e380101119656. doi: 10.33448/rsd-v10i11.196561.
14. Silva TG, Souza GN, Souza SS, Bitencourt JVV, Madureira VF, Luzardo AR. Incidência de pneumonia associada à ventilação mecânica em uma Unidade de Terapia Intensiva. Rev Fund Care Online. 2017;9(4):1121-5. doi: 10.9789/2175-5361.
15. Brasil. Ministério da Saúde. Secretaria de Gestão do Trabalho e da Educação na Saúde. Departamento de Gestão da Educação

na Saúde. Política Nacional de Educação Permanente em Saúde: o que se tem produzido para o seu fortalecimento? [Internet]. Brasília, DF: Ministério da Saúde; 2018 [cited 2021 Sep 28]. Available from: https://bit.ly/39LCGk0

16. Souza ECP; Silva FL. Conhecimento e adesão da prática de higienização das mãos dos profissionais da saúde: revisão bibliográfica. Rev Saude em Foco [Internet]. 2016 [cited 2021 Sep 28];3(1):84-93. Available from: https://bit.ly/3m98wga
17. Hellyer TP, Ewan V, Wilson P, Simpson AJ. The Intensive Care Society recommended bundle of interventions for the prevention of ventilator-associated pneumonia. J Intensive Care Soc. 2016;17(3):238-43. doi: 10.1177/1751143716644461.
18. Zeng WP, Su H, Chen CW, Cheng SM, Chang LF, Tzeng WC, et al. Care bundle for ventilator-associated pneumonia in a medical intensive care unit in Northern Taiwan. J Med Sci. 2015;35(2):68-73. doi: 10.4103/1011-4564.156013.
19. Chicayban LM, Terra ELVS, Ribela JS, Barbosa PF. Bundles de prevenção de pneumonia associada à ventilação mecânica: a importância da multidisciplinaridade. Rev Persp Online: Biol & Saúde. 2017;7(25):25-35. doi: 10.25242/886872520171200.
20. Gonçalves FAF, Brasil VV, Minamisava R, Caixeta CR, Oliveira LMAC, Cordeiro JABL. Eficácia de estratégias educativas para ações preventivas da pneumonia associada à ventilação mecânica. Esc. Anna Nery. 2012;16(4):802-8. doi: 10.1590/S1414-81452012000400023.
21. Kalanuria AA, Zai W, Mirski M. Ventilator-associated pneumonia in the ICU. Crit Care. 2014;18(2):208. doi: 10.1186/cc13775.
22. Jerre G, Silva TJ, Beraldo MA, Gastaldi A, Kondo C, Leme F, et al. Fisioterapia no paciente sob ventilação mecânica. J. bras. pneumol. 2007;33(Suppl2):142-150. doi: 10.1590/S1806-37132007000800010.
23. Nepomuceno RM, Miranda CB, Nogueira C, Silva LCF, Silva LD. Fatores de risco modificáveis para pneumonia associada à ventilação mecânica em terapia intensiva. Rev Epidemiol Control Infect. 2014;4(1):23-7. doi: 10.17058/reci.v4i1.3933.
24. Melo MM, Santiago LMM, Nogueira DL, Vasconcelos MFP. Pneumonia associada à ventilação mecânica: conhecimento dos profissionais de saúde acerca da prevenção e medidas educativas. Rev Fund Care Online. 2019.11(2):377-82. doi: 10.9789/2175-5361.2019.v11i2.377-382.
25. Parisi M, Gerovasili V, Dimopoulos S, Kampisiouli E, Goga C, Perivolioti E, et al. Use of ventilator bundle and staff education to decrease ventilator-associated pneumonia in intensive care patients. Crit Care Nurse. 2016;36(5):e1-e7. doi: 10.4037/ccn20165.