

Strategies for preventing ventilator-associated pneumonia: an integrative review

Estratégias para prevenção de pneumonia associada à ventilação mecânica: revisão integrativa
Estrategias para la prevención de la neumonía asociada a la ventilación mecánica: revisión integrativa

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ABSTRACT

Objective: to identify studies about strategies for prevention of ventilator-associated pneumonia deployed in health services and classify their level of evidence. **Method:** integrative review of the literature, in 7 databases, which included the following descriptors: Prevention and Control AND Pneumonia Ventilator-Associated AND Intensive Care Units AND Bundle AND Patient Care. **Results:** twenty-three scientific productions were included. Of the preventive measures identified, 9 (39.1%) correspond from three to five strategies. The most frequent were: 22 (95.6%) lying with head elevated, 19 (82.6%) oral hygiene with chlorhexidine and 14 (60.8%) reduction of sedation whenever possible. **Final Consideration:** the application of measures based on scientific evidence is proven to be effective when carried out in conjunction, impacting the reduction of the incidence of ventilator-associated pneumonia.

Descriptors: Disease Prevention; Ventilator-Associated Pneumonia; Patient Care Bundles; Intensive Care Unit; Nursing.

RESUMO

Objetivo: identificar estudos acerca de estratégias de prevenção de pneumonia associada à ventilação mecânica implantadas em serviços de saúde e classificar o nível de evidência destes. **Método:** revisão integrativa da literatura, em sete bases de dados, incluindo os seguintes descritores: "Prevention and Control AND Pneumonia Ventilator-Associated AND Intensive Care Units AND Bundle AND Patient Care". **Resultados:** foram incluídas 23 produções científicas. Dentre os conjuntos de medidas de prevenção identificados, nove (39,1%) contemplam de três a cinco estratégias. As mais frequentes foram: decúbito elevado – 22 (95,6%); higiene oral com clorexidina – 19 (82,6%); e redução da sedação sempre que possível – 14 (60,8%). **Considerações Finais:** a aplicação de medidas baseadas em evidências científicas são comprovadamente eficazes quando aplicadas em conjunto, impactando na redução da densidade de incidência de pneumonia associada à ventilação mecânica.

Descritores: Prevenção de Doenças; Pneumonia Associada à Ventilação Mecânica; Pacotes de Assistência ao Paciente; Unidades de Terapia Intensiva; Enfermagem.

RESUMEN

Objetivo: identificar estudios sobre estrategias de prevención de neumonía asociadas a la ventilación mecánica implantadas en servicios de salud y clasificar el nivel de evidencia de los mismos. **Método:** revisión integrativa de la literatura, en 7 bases de datos, que incluyó los siguientes descriptores: Prevention and Control AND Pneumonia Ventilator-Associated AND Intensive Care Units AND Bundle AND Patient Care. **Resultados:** Se incluyeron 23 producciones científicas. Entre los conjuntos de medidas de prevención identificados, 9 (39,1%) contemplan entre tres a cinco estrategias. Fueron las más frecuentes: el decúbito elevado, 22 (95,6%); la higiene oral con clorhexidina, 19 (82,6%); y la reducción de la sedación siempre que sea posible, 14 (60,8%). **Consideraciones Finales:** La aplicación de medidas basadas en evidencias científicas es comprobadamente eficaz cuando se aplica en conjunto, impactando en la reducción de la densidad de incidencia de neumonía asociada a la ventilación mecánica.

Descriptor: Prevención de Enfermedades; Neumonía Asociada al Ventilador; Paquetes de Atención al Paciente; Unidades de Cuidados Intensivos; Enfermería.

INTRODUCTION

Healthcare-associated infections (HAI) are serious adverse events that affect hospitalized patients, mostly in the intensive care unit (ICU). Among them, ventilator-associated pneumonia (VAP) stands out, being defined by the Brazilian National Health Surveillance Agency (ANVISA) as pneumonia associated with clinical, radiological and laboratory criteria evidenced 48 hours after the start of mechanical ventilation (MV)⁽²⁾.

In the United States of America (USA), about 300,000 patients are submitted to MV every year and, despite the efforts to reduce the incidence of VAP, its density still remains around 4.4 cases/1,000 MV-day⁽¹⁾.

According to the System of Surveillance of Hospital Infections of the State of São Paulo, the density of VAP incidence in the state's ICUs in 2017 was 7.69/1000 MV-day for ICUs with more than 500 patients/day in public hospitals and 9.63/1000 MV-day in university hospitals⁽⁴⁾. General mortality attributed to VAP varies considerably, reaching rates from 20% to 60%⁽⁵⁾.

A successful strategy in the control of HAI refers to the adoption of intervention or best-practice bundles. The methodology of the bundle strategy requires the implementation of interventions in conjunction, as this practice has been proved to be more effective than the application of isolated measures⁽⁶⁾.

In this context, following the example of international organizations, ANVISA has been recommending the adoption of bundles for prevention of VAP, considering its impact on healthcare and the reduction in infection rates, with the assumption that the choice of interventions considers their cost, ease of deployment and adherence^(5,7).

The interventions regarded as best practices and the extensive literature published in recent years on the subject, with various levels of evidence, led to the conduction of this integrative literature review, with the objective to organize the studies according to level of evidence to make them more accessible to professionals, motivating the implementation of strategies that promote the adherence to best practices in the prevention of VAP. Awareness about the magnitude of HAI and their influence on health outcomes as well as access to the evidence available have the potential to motivate behavior changes among professionals, with impacts on the process and outcome indicators.

OBJECTIVE

To identify studies about strategies for prevention of ventilator-associated pneumonia deployed in health services and classify their level of evidence.

METHOD

Integrative literature review carried out in the period from April to September 2017. The research question was chosen based on the PICO strategy (patient, intervention, comparison and outcomes), where: P: ventilator-associated pneumonia; I: VAP prevention strategies; C: comparison of the VAP prevention strategies; O: reduction in the incidence of VAP.

Six steps recommended for this type of review were applied: 1) Identification of the theme and selection of the hypothesis or research question; 2) Establishment of criteria for inclusion and exclusion of studies/sampling or search in the literature; 3) Definition of the information to be extracted from the selected studies/categorization of studies; 4) Evaluation of the studies included in the integrative review; 5) Interpretation of results and 6) Presentation of the review/summary of knowledge⁽⁸⁾.

The databases consulted were: *Scientific Electronic Library Online* (SCIELO), *U.S. National Library of Medicine* (PUBMED), *Medical Literature Analysis and Retrieval System Online* (MEDLINE), *The Cochrane Library* (Cochrane). The following databases were accessed through the Virtual Health Library (VHL): Latin American and Caribbean Center on Health Sciences Information (LILACS), Brazilian Nursing Database (BDENF) and Spanish Bibliographic Index of Health Sciences (IBECs).

To perform the search of scientific productions, the following descriptors were used in English in the seven databases: *Prevention and Control AND Pneumonia Ventilator-Associated AND Intensive Care Units AND Bundle AND Patient Care*.

The inclusion criteria were: researches conducted with human beings, productions in English, Portuguese and Spanish, full texts available for access without delimitation of date of publication. The work's relevance in relation to the research question was determined through the reading of the studies' titles and abstracts, and those that had their adequacy to the topic of interest ascertained were evaluated through a content analysis and classified according to level of evidence⁽⁹⁾. Duplicate publications and those that were not aligned with the inclusion criteria were excluded, as well as studies with animals and children. Figure 1 shows the flowchart of the selection and identification of studies. In total, 23 scientific productions were included in the review. The results were organized and will be presented in the form of a table containing a synthesis of the information extracted from the articles.

The steps of selection are presented in figure form, being organized as follows: 1st selection: search by descriptors; 2nd selection: selection of inclusion criteria; 3rd selection: reading of titles and abstracts and 4th selection: reading of the article in full.

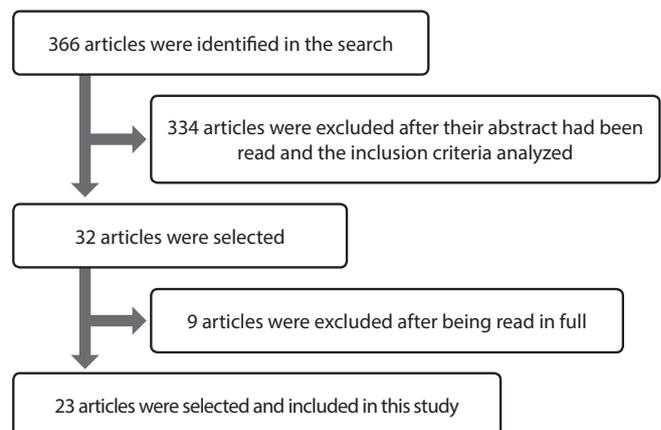


Figure 1 – Flowchart of the selection and identification of studies according to the PRISMA recommendations⁽¹⁰⁾

RESULTS

Using the methodology employed for the literature review, 23 articles published between 2007 and 2016 were selected, 15 (65.2%) with foreign origins and 08 (34.7%) having been produced in Brazil. Table 1 presents the summary of the articles selected for the study by ascending chronological order of publication:

Overall evaluation of the studies

In relation to objectives, all 23 studies (100%) assessed the impact of different interventions on the occurrence of VAP. The level of evidence of the included studies was as follows: 74% concentrated in score III, characterized by observational designs and 26% in score II, experimental studies without randomization.

Table 1 – Summary of the Selected Articles

Authors, place and date of publication	Objective	Type of study/Level of evidence	Preventive measures and interventions	Outcome/Conclusions
Landrum ML, <i>et al.</i> USA 2007 ⁽¹¹⁾ .	To analyze the impact of a VAP prevention program in the ICU of an Iraqi Hospital.	Observational study/ III	Hand hygiene. Oral hygiene with chlorhexidine. Reduction in the duration and range of action of surgical prophylaxis. Cohort of patients in contact precaution and professionals. Periodically barring beds for cleaning and disinfection. Daily inspections of procedures related to VAP prevention.	Reduction in VAP rate from 60.6/1000 MV-day to 9.7/1000 MV-day.
Blamoun J, <i>et al.</i> USA 2008 ⁽¹²⁾ .	To assess the reduction in VAP incidence, after implementation of a prevention protocol in the ICU of a university hospital.	Observational study/ III	Elevated headboard. Daily awakening. Prophylaxis for deep vein thrombosis. Prophylaxis for stress ulcer.	Reduction in VAP rate from 14.1/1000 MV-day to near-zero VAP rate for 30 months.
Marra AR, <i>et al.</i> Brazil, 2009 ⁽¹³⁾ .	To evaluate the effect of the implementation of a VAP prevention bundle on the reduction of its occurrence.	Quasi-experimental study/ II	Elevation of the headboard. Reduction of sedation and evaluation for extubation. Prophylaxis for peptic ulcer. Prophylaxis for deep vein thrombosis. Replacement of circuits and humidifiers when necessary. Proper drainage and disposal of the circuits' condensate. Use of heat and moisture filter Oral hygiene with 0.12% chlorhexidine. Continuous aspiration of subglottic secretions.	The density of VAP incidence ranged from 1.3/1000 MV-day to zero when adherence to the measures was greater than 95%. Mortality ranged from 83.3% to 100% for patients with VAP and the rate of use of MV decreased from 28% to 27%
Zaydfudim V, <i>et al.</i> USA 2009 ⁽¹⁴⁾ .	To implement electronic monitoring and assess the impact on adherence to preventive measures and VAP rate in a surgical ICU.	Observational study/ III	Implementation of the electronic panel. Spontaneous breathing test. Titration of sedation and analgesia. Elevation of the bed's headboard. Oral hygiene and hypopharyngeal aspiration. Prophylaxis for stress ulcer. Prophylaxis for deep vein thrombosis.	The average adherence to the VAP prevention bundle went from 39% to 89% and VAP incidence decreased from 15.2 to 9.3/1000 MV-day.
Bouadma L, <i>et al.</i> France 2010 ⁽¹⁵⁾ .	To describe the long-term impact of a multifaceted program to reduce VAP incidence.	Experimental study/ II	Hand hygiene. Proper use of gloves. Elevation of the headboard between 30-45° Keeping cuff pressure > 20 cm H ₂ O Using an orotracheal tube rather than a nasotracheal one Preventing gastric distension Oral hygiene with 0.12% chlorhexidine 4 times a day; Not using a continuous suction tube routinely.	Reduction in VAP rate from 22.6 to 13.1 cases/1000 MV-day, representing a 43% reduction.
Tawfiq AAJ, <i>et al.</i> Asia 2010 ⁽¹⁶⁾ .	To deploy the intervention bundle, with the goal of reducing VAP incidence in an adult ICU.	Observational study/ III	Elevation of the bed's headboard. Daily interruption of sedation. Assessment of readiness for extubation. Prophylaxis for peptic ulcer. Prophylaxis for deep vein thrombosis.	Reduction in VAP rate from 9.3/1000 MV-day to 2.2/1000 MV-day.
Mona B, <i>et al.</i> USA 2010 ⁽¹⁷⁾ .	To evaluate the effectiveness of specific interventions for VAP prevention in five ICUs, improving adherence to preventive measures and decreasing VAP incidence and number of MV days.	Observational study/ III	Hand hygiene. Elevated headboard. Oral hygiene. Educational interventions	There was no significant reduction in the following indicators: VAP rate, MV time and adherence to preventive measures

To be continued

Chart 1

Authors, place and date of publication	Objective	Type of study/Level of evidence	Preventive measures and interventions	Outcome/Conclusions
Stone P, <i>et al.</i> New York 2011 ⁽¹⁸⁾ .	To determine the effectiveness of isolated interventions in VAP incidence; To determine the effectiveness of at least two interventions for reduction of the VAP rates.	Observational study/ III	Elevation of the headboard. Daily awakening from sedation. Prevention of stress ulcer. Prevention of deep vein thrombosis	The average VAP rate was 2.7 cases/1000 MV-day. Among the units, 39% reported adequate adherence to the intervention bundle.
Tao L, <i>et al.</i> China 2012 ⁽¹⁹⁾ .	To analyze the impact of a multimodal approach for reduction of VAP in 3 ICUs of a Chinese hospital.	Observational study/ III	Education, surveillance of outcomes and process, feedback on the VAP rates and practices for evaluation of infection control. Elevated headboard; Oral hygiene with chlorhexidine. Hand hygiene.	The VAP rate in the 1st phase of the study was 24.1 cases/1000 MV-day, and decreased to 5.7, which represents a 79% cumulative reduction which was maintained for the 3 following years. Significant reduction of the average mortality rate.
Caserta RA, <i>et al.</i> Brazil 2012 ⁽²⁰⁾ .	To evaluate the VAP rates after application of multiple interventions.	Quasi-experimental study/ II	Active surveillance of VAP. Surveillance of adherence to hand hygiene. Elevated headboard Weaning protocols. Oral hygiene with antiseptic solution. Use of non-invasive ventilation whenever possible. Preferred use of orotracheal tube. Keeping cuff pressure at 20 cm H ₂ O. Removal of condensate from the circuits. Replacement of the fan's circuit and humidifier only when visibly dirty or malfunctioning. Prevention of gastric overdistention. Use of gastric protectors. Use of sterile water for rinsing respiratory equipment.	VAP rates ranged from 1.3 to 2.0/1000 MV-day, reaching zero VAP incidence whenever adherence to the bundle was greater than 90%.
Gonçalves FAF, <i>et al.</i> Brazil 2012 ⁽²¹⁾ .	To determine the effectiveness of educational strategies to improve the performance of the nursing staff in carrying out selected procedures for VAP prevention.	Experimental study/ II	Cleaning, disinfection, assembly and testing of fan. Proper handling of ventilation circuits. Replacement and handling of humidifiers. Verification of cuff pressure. Positioning on the bed. Bronchial hygiene. Oral hygiene. Proper handling of enteral probe. Hand hygiene.	The intervention was effective for some measures evaluated. The team members did not carry out all selected interventions for VAP prevention.
Ajenjo MC, <i>et al.</i> Chile 2013 ⁽²²⁾ .	Evaluate general and specific interventions implemented to reduce the incidence of VAP in cardiac surgery postoperative ICUs.	Observational study/ III	Use of hand sanitizer for hand hygiene. Contact precaution for patients colonized and/or infected by multidrug-resistant bacteria. Periodic supervision of the measures implemented by the HICC nurses. Training of nurses in the sector to carry out the cleaning, disinfection and sterilization of the MV equipment, replacing the service that was provided by an external company. Early extubation. Proper handling of secretions, transportation and maintenance of ventilation devices Elevated headboard. Periodic meetings with the healthcare team about surveillance of process and outcomes for creation of a VAP prevention plan.	Significant reduction in VAP rates from 56.7 cases/1000 MV-day to 4.7 cases/1000 MV-day.

To be continued

Chart 1

Authors, place and date of publication	Objective	Type of study/Level of evidence	Preventive measures and interventions	Outcome/Conclusions
Garcell HG, <i>et al.</i> Cuba 2013 ⁽²³⁾ .	To evaluate the effect of preventive measures on the VAP rates in microorganisms isolated from a Cuban ICU.	Observational study/ III	Education, surveillance of process and outcome, active VAP surveillance, feedback on VAP rates. Adherence to hand hygiene Sedation weaning protocols. Oral hygiene with antiseptic solution. Use of non-invasive ventilation. Use of an orotracheal tube rather than a nasotracheal one. Keeping cuff pressure at 20 cm H ₂ O. Proper removal of condensate from the circuit and replacement only if necessary. Prevention of gastric distension with medicines. Use of sterile water in the reprocessing of respiratory materials.	The VAP rates were reduced from 53.4 cases/1000 MV-day to 5.4 cases/1000 MV-day, which corresponds to a 90% reduction over time. The isolated bacteria included <i>Acinetobacter</i> spp. and <i>Pseudomonas aeruginosa</i> in phase 1 and <i>Klebsiella</i> spp in phase 2.
Souza AF, <i>et al.</i> Brazil 2013 ⁽²⁴⁾ .	To include oral hygiene and dental care in the standardized bundle and evaluate the outcomes associated with VAP prevention.	Observational study/ III	Elevated headboard. Evaluation for sedation and extubation. Prophylaxis for stress ulcer. Prophylaxis for deep vein thrombosis. Oral hygiene and dental care.	Reduction of VAP from 33.3% to 3.5%.
Rello J, <i>et al.</i> Spain 2013 ⁽²⁵⁾ .	To evaluate the impact of the care bundle on VAP incidence, MV time, rate of stay in five Spanish ICUs and adherence to isolated preventive measures.	Observational study/ III	Replacement of the fan's circuit only if dirty. Daily sedation control. Hand hygiene with an antiseptic solution before handling the airways. Oral hygiene with 0.12% chlorhexidine every 8 hours. Cuff pressure control.	Reduction in VAP incidence from 12.9/1000 MV-day to 9.28/1 MV-day. Decrease of MV days from 8.0 to 4.0 days. Decrease of length of stay in the ICU from 10 to 6 days. The isolated measures with the highest rate of compliance were: replacement of the ventilatory circuit when necessary (34%), sedation control (27%), oral hygiene (21%) and hand hygiene (19%). Cuff pressure control was carried out in only 18%. For cases where there was no adherence to the complete bundle, VAP incidence was 19.5/1000 MV-day.
Mehta Y, <i>et al.</i> India 2013 ⁽²⁶⁾ .	To evaluate the effectiveness of a multimodal approach for VAP prevention in 21 ICUs of 10 Indian cities and the profile of isolated microorganisms.	Observational study/ III	Intervention bundle for infection control, education and surveillance of process and outcome. Feedback on VAP rates and performance of infection control practices. Adherence to hand hygiene guidelines and direct observation of hand hygiene. Headboard elevated to 30-45°. Daily assessment of sedation for extubation and oral hygiene with antiseptic solution. Use of non-invasive ventilation and minimization of MV time. Preferred use of orotracheal tube. Maintenance of cuff pressure at 20 cm H ₂ O. Proper removal of condensate from the ventilation circuits. Replacement of the fan's circuit only when visibly dirty or malfunctioning. Prevention of gastric overdistention. Use of gastric protectors. Use of sterile water for rinsing in the reprocessing of articles.	The VAP rate went from 17.43/MV-1000 day to 10.8/MV-1000 day, totaling a 38% reduction. <i>Pseudomonas aeruginosa</i> , <i>Acinetobacter</i> spp. and <i>Klebsiella</i> spp. accounted for 80% of isolated bacteria.

To be continued

Chart 1

Authors, place and date of publication	Objective	Type of study/Level of evidence	Preventive measures and interventions	Outcome/Conclusions
Ongstad SB, <i>et al.</i> USA 2013 ⁽²⁷⁾ .	To assess the implementation of a protocol to reduce VAP incidence in trauma patients and days of stay in the ICU	Observational study/ III	Elevated headboard. Daily spontaneous breathing test. Daily awakening and evaluation of readiness for extubation. Prophylaxis for deep vein thrombosis and peptic ulcer. Hand hygiene before and after contact with the patient. Oral hygiene with antiseptic solution. Individual breathing equipment, new or sterilized.	Decrease in VAP incidence, even with increased rates of MV use. Reduction in days of stay in the ICU from 8.28 to 6.21 days.
Sachetti A, <i>et al.</i> Brazil 2014 ⁽²⁸⁾ .	To assess adherence to the MV bundle in an ICU, and the impact on the VAP rates, after an educational intervention.	Experimental study/ II	Educational intervention. Elevated headboard Positioning of the humidifier above the trachea. Control of presence of liquid in the circuit and humidifier. Oral hygiene three times a day, with chlorhexidine. Daily maintenance of cuff pressure between 20 and 30cm H ₂ O. Respiratory physical therapy three times a day.	Increased adherence to individual measures and to the bundle. There was no impact on VAP incidence.
Granda MJP, <i>et al.</i> Spain 2014 ⁽²⁹⁾ .	To evaluate the impact of deployment of four VAP prevention measures in a cardiac surgery ICU, on VAP rates, MV days, costs and use of antimicrobials	Observational study/ III	Specific training program. Aspiration of subglottic secretions. Positioning of the patient. Oral hygiene with chlorhexidine.	41% reduction in VAP incidence. Reduction in the VAP-related mortality rate from 13.0% to 10.2%. Reduction in expenditure on antimicrobials from €70.612/1000 days of stay to €52.775/1000 days of stay in the ICU.
Eom JS, <i>et al.</i> Korea 2014 ⁽³⁰⁾ .	To assess the impact of some preventive measures that were already part of the routine of ICUs in 6 Korean hospitals.	Experimental Study/ II	Educational training on the bundle. Elevation of the bed's headboard. Prophylaxis for peptic ulcer. Prophylaxis for deep vein thrombosis. Oral hygiene with 0.12% chlorhexidine. Continuous aspiration of subglottic secretions, when available.	Reduction in VAP incidence from 4.08 cases/1000 MV-day to 1.16 cases/1000 MV-day. Incidence density decreased 0.28 times.
Lim KP, <i>et al.</i> Taiwan 2015 ⁽³¹⁾ .	To evaluate the effectiveness of a set of measures for reduction of the VAP rates, global compliance with measures, use of fan and stay in the ICU.	Observational study/ III	Bed's headboard elevated to 45°. Daily awakening or sedation weaning. Prophylaxis for stress ulcer. Prophylaxis for deep vein thrombosis. Oral hygiene with chlorhexidine. Hand hygiene before and after the procedures. Cuff pressure between 20-25cm H ₂ O. Oral hygiene before the change in decubitus. Sterilization of respiratory materials. Use of sterile water on respiratory devices. Well-defined indication for intubation.	VAP density decreased from 3.3 to 1.4 1000 MV-day Rates of global compliance with VAP prevention items for doctors, nurses and physical therapists were 97.9%, 80.3% and 73.7%, respectively. There was no difference in the length of stay in the ICU; however, the fan's use decreased from 1148.5 days to 956.1 days.
Rodrigues AN, <i>et al.</i> Brazil 2016 ⁽³²⁾ .	To assess the impact of the bundle, the determining factors that influence compliance with the VAP prevention measures in an ICU, the profile of microorganisms and mortality rate.	Observational study/ III	Daily interruption of sedation. Headboard elevated from 30° to 45°. Enteral nutrition care. Use of neuromuscular blockers. Maintaining cuff pressure between 25-35°. Oral hygiene with 0.12% aqueous chlorhexidine.	Increase in VAP incidence after implementation of the bundle from 11.53 to 16.42/1000MV-day. Prevalence of gram-negative bacteria <i>Acinetobacter</i> spp. and <i>Pseudomonas</i> spp. in the first phase and <i>Klebsiella</i> spp after implementation of the bundle. Mortality rate was 50%.

To be continued

Chart 1 (concluded)

Authors, place and date of publication	Objective	Type of study/Level of evidence	Preventive measures and interventions	Outcome/Conclusions
Ferreira CR, et al. Brazil 2016 ⁽³³⁾ .	To assess the impact of a VAP prevention bundle called fasthug on costs and VAP-related mortality rates in an ICU.	Observational study/ III	Enteral nutrition care. Promotion of analgesia. Reduction of sedation. Elevated headboard. Prophylaxis for deep vein thrombosis. Prophylaxis for stress ulcer. Capillary glucose control. Oral hygiene with 0.12% chlorhexidine. Cuff pressure between 20-25cm H ₂ O. Subglottic aspiration every 6 hours and whenever necessary.	Considerable reduction in VAP incidence and 64% reduction in VAP-related mortality. Significant reduction in hospital ICU costs and improvement in the quality of care.

Note: VAP: Ventilator Associated Pneumonia; ICU: Intensive Care Unit; MV: Mechanical Ventilation. CCIH: Hospital Infection Control Committee.

Only 4 (7.3%) studies included the assessment of conformity with the bundles' measures, two (8.69%) evaluated the measures' influence on MV days, one (4.34%) study evaluated the length of stay in the ICU, and one (4.34%) evaluated the expenditure on antimicrobials and mortality.

Of the 23 scientific productions selected, 9 (39.1%) included intervention bundles as proposed by the Institute for Healthcare Improvement (IHI), which advocates the joint implementation of three to five interventions with high level of evidence. The other productions feature intervention check lists.

When analyzing the interventions proposed in the studies, we can identify lying with head elevated between 30° and 45° in 22 (95.6%), oral hygiene with chlorhexidine in 19 (82.6%), and sedation weaning whenever possible or daily awakening from sedation in 14 (60.8%) of them.

Hand hygiene, prophylaxis for gastric ulcer and prophylaxis for deep vein thrombosis were mentioned in 11 (47.8%) of the articles. In lower frequency than the others, maintenance of cuff pressure was reported in 10 (43.4%), general care with ventilation circuits, including their replacement only if visibly dirty, in 8 (34.7%), and subglottic aspiration in 5 (21.7%) of the studies as VAP prevention measures. For the researches that assessed the rate of compliance with the bundle's elements, it was found that the lower the adherence to them, the less impact they had on the reduction of VAP rates. Adherence rates higher than 90% were significantly associated with the reduction in VAP rates. Maintaining adherence to the measures in the long term contributed to reaching VAP rates close to zero.

The two studies that evaluated the bundle's effect on MV time found discrepant results. One of them showed an increase in MV days despite the reduction in VAP rates, while the other showed reduction in MV days. Additionally, the studies that assessed the expenditure on antimicrobials and mortality rates showed favorable results.

Among all the studies that compared the VAP rates before and after the implementation of the set of measures, 20 (86.9%) showed positive results, 1 (4.34%) did not identify significant improvements, 1 (4.34%) reported similar rates in the two stages and 1 (4.34%) revealed an increase in the VAP rates after implementation of the bundle, related to lack of equipment and inputs needed for the provision of care, in addition to the turnover of

professionals that happened in this period, as the newcomers had no adequate training.

Of the 23 (100%) researches included in the review, 20 (86.9%) of them reported the importance of health professionals knowing the VAP rates of their services, receiving guidance and feedback on the conformity of the VAP prevention measures and practicing the continuous surveillance of these measures for the maintenance of the low density of VAP incidence. Through the association of these strategies with the implementation of best practices, it is possible to reduce VAP incidence by up to 90%, when the proposed measures are followed properly.

DISCUSSION

Although significant progress has occurred with regard to the implementation of the best practices for the prevention of HAI, efforts must be made to reduce their frequency. The World Health Organization recommends that national and regional authorities develop actions for reduction of HAI, through the engagement between public health agencies, healthcare professionals and local institutions for the implementation, sustainability and expansion of a program of surveillance and prevention of HAI⁽³⁴⁾.

In the prevention and control of VAP, listing priorities is crucial. Monitoring the adherence to best practices, education, and establishment of process, structure and outcome indicators is essential for further reducing its incidence. In ICUs, it is relevant to carry out VAP surveillance with standardized definitions and criteria, as well as calculate the VAP rates, report these rates to the health team and, above all, associate them with the relevant preventive measures. These actions can become an important ally in the evaluation of the quality of care⁽⁵⁾.

To this end, surveillance should be carried out by a trained team with defined epidemiology concepts and criteria, through the development of educational strategies, which should preferably be multimodal and evidence-based. Most of the researches identified in the review featured evidence level II and III, which correspond to evidence derived from non-randomized clinical trials and well-delineated cohort and case-control studies. The adoption of recommendations from studies with this level of evidence has the potential for reduction of the density of VAP incidence, hospital costs, MV days and mortality rates⁽³⁵⁻³⁷⁾.

However, it should be noted that the indication of some interventions present in these studies does not derive from randomized clinical trials, classified as evidence level I, which could provide missing information about VAP prevention.

Still, it is essential to maintain a routine of multidisciplinary visits with participation of the professionals directly involved in the care to patients using MV, promoting the identification of non-compliance with healthcare processes, assisting the management of preventive measures and facilitating the relationship between professionals⁽⁵⁾.

Hand hygiene, a recommended measure with proven impacts on HAS prevention, including VAP, was present in 47.8% of the bundles identified; however, adherence to this action remains below the expected among professionals.

According to the Brazilian National Program for Prevention and Control of Healthcare-Associated Infections, which sets targets for the reduction of HAS, the VAP prevention protocol must contain at least guidelines to keep the headboard of the patients' beds elevated between 30° and 45°; evaluate daily sedation and reduce it where possible; and carry out oral hygiene with antiseptics. Most of the studies included in the review adopted actions that are strongly recommended by Anvisa; however, non-compliance with all of the proposed measures was identified in 60.8% of them⁽³⁴⁾.

Other recommendations of international agencies, like CDC, have also been reported in the studies, such as maintenance of the suction system, enteral diet, use of passive humidifiers, appropriate processing of ventilatory assistance products, use of sterile water for procedures, proper handling of inhalers and nebulizers, among others^(1,38).

Researches for evaluation of specific measures, such as proper handling of ventilation circuits and secretions, early extubation protocol and the patient's positioning at 45°, have shown significant reduction in VAP incidence^(35-36,39).

Other strategies described in the VAP control studies included prophylaxis for deep vein thrombosis and gastric ulcer, indication for cautious use of neuromuscular blockers, adoption of non-invasive MV and prevention of accidental extubation and reintubation⁽⁵⁾.

Constant staff turnover, lack of training, lack of knowledge about the density of VAP incidence, lack of supplies and poor structure are determining factors for the failure of preventive measures. In this context, the need for permanent education of the team is emphasized, with the purpose of promoting the adherence to the protocol and preventing VAP, reducing its rates⁽⁴⁰⁾.

Within the perspective of transformation of practice, permanent education of the staff is an indispensable component for

the achievement of the desired changes and for improving the quality of the service provided. The challenge of promoting VAP prevention is directly related to the modification of the behavior of healthcare professionals. This behavior change involves aspects related to the environment, context, knowledge, beliefs and social influences. Evaluating the individual's behavior highlights particularities that, when addressed, can contribute to a change that is more evident and sustained.

Study limitations

The limitation of this study refers to the fact that it has not been possible to integrate research findings that compare interventions for VAP prevention, due to shortage of clinical trials and variability of the methodology used in the studies.

Contributions to the field of nursing, health or public policy

Healthcare-related infections, like VAP, are important adverse events which compromise patient safety. Despite all efforts for the prevention of these infections, their prevalence remains high, mainly due to the low adherence to the scientifically proven measures intended for this purpose.

Most of the specific interventions for VAP prevention directly involve the nurse's performance, be it in their implementation, surveillance or management. This makes the nursing staff essential to the implementation of preventive and educational strategies. The compilation of current researches on the subject, made possible by literature reviews, facilitates and makes the information more accessible to professionals who participate in health-related practices and decision-making processes. Once they have acquired this knowledge, they become more likely to change behaviors and gain motivation for the adoption of HAS prevention measures, consequently reducing the morbidity and mortality caused by this event.

FINAL CONSIDERATIONS

VAP can result in serious repercussions for patients affected by this condition, and features a large impact on morbidity and mortality rates, MV time, length of stay in the ICU and increase in welfare costs. Given this, the selection and application of evidence-based measures which are appropriate for each health service, based on the individual needs of patients, is fundamental, seeing as these measures, arguably, when applied collectively, decrease the density of VAP incidence, this being one of the most frequent healthcare-related infections in intensive care units.

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