Good practices in the prevention of ventilator-associated pneumonia

Boas práticas na prevenção de pneumonia associada à ventilação mecânica

Buenas prácticas en la prevención de la neumonía asociada a la ventilación mecánica

Raimunda Xavier Alecrim[1,2]
Mônica Taminato[1]
Angélica Gonçalves Silva Belasco[1]
Dulce Barbosa[1]
Denise Miyuki Kusahara[1]
Dayana Fram[1,3]

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Abstract
Objective: To evaluate the compliance of health professionals with a set of good practices for the prevention of Ventilator-Associated Pneumonia, compliance index to individual measures and association of clinical characteristics of patients and compliance with the set of good practices with pneumonia.
Methods: A prospective cohort study conducted at an Intensive Care Unit of a university hospital from May 2017 to October 2017. The sample consisted of patients hospitalized during the study period, who met the inclusion criteria. Data collection was performed through review of medical records.
Results: The item with the highest compliance was the daily assessment of sedation and reduction 81 (91.0%) whenever possible, followed by circuit changes every 7 days, 76 (82.6%). The maintenance of cuff pressure between 20- and 30-mm H2O was the item with the lowest compliance 22 (23.9%). Compliance with the complete set showed adherence in 20 (21.7%) of opportunities. This study showed that the greater compliance with good practice measures, the lower the risk of Ventilator-Associated Pneumonia, but it was not statistically significant data. Surgical and mechanical ventilation patients had a higher risk of developing VAP (p=0.05).
Conclusion: Ventilator-Associated Pneumonia can cause serious repercussions for patients. Thus, the application of measures with scientific basis is fundamental to prevent the occurrence of this event, which is one of the most frequent infections related to health care within Brazilian Intensive Care Units.

Resumo
Objetivo: Avaliar a adesão dos profissionais de saúde a um conjunto de boas práticas de prevenção de Pneumonia Associada à Ventilação Mecânica, índice de conformidade às medidas individuais e associação de características clínicas dos pacientes e adesão ao conjunto de boas práticas com a pneumonia.
Métodos: Estudo de coorte prospectivo realizado em uma Unidade de Terapia Intensiva de um hospital universitário no período de maio de 2017 a outubro de 2017. A amostra foi composta por pacientes internados no período do estudo, que preencheram os critérios de inclusão, a coleta de dados foi realizada por meio de consulta a prontuários. Resultados: O item com maior adesão foi a avaliação diária da sedação e redução sempre que possível, 81 (91,0%), seguido da troca do circuito a cada 7 dias, 76 (82,6). A manutenção da pressão do *cuff* entre 20 e 30 mm H2O foi o item com menor adesão 22 (23,9%). A adesão ao conjunto completo apresentou conformidade em 20 (21,7%) das oportunidades. O estudo mostrou que quanto maior a adesão às medidas de boas práticas, menor é o risco de Pneumonia Associada à Ventilação Mecânica, porém não foi um dado estatisticamente significante. Os pacientes cirúrgicos e em uso de ventilação mecânica apresentaram maior risco de desenvolver PAV (p= 0,05).
Conclusão: A Pneumonia Associada à Ventilação Mecânica pode trazer grave repercussão para o paciente, a aplicação de medidas com embasamento científico é fundamental, a fim de se prevenir a ocorrência deste agravo, que é uma das mais frequentes infecções relacionadas à assistência à saúde dentro das Unidades de Terapia Intensiva brasileiras.

Resumen
Objetivo: Evaluar la adhesión de los profesionales de salud a un conjunto de buenas prácticas de prevención de Neumonía Asociada a la Ventilación Mecánica, índice de conformidad con las medidas individuales y asociación de características clínicas de los pacientes y adhesión al conjunto de buenas prácticas con la neumonía.
Métodos: Estudio de cohorte prospectivo realizado en una Unidad de Terapia Intensiva de un hospital universitario durante el periodo de mayo de 2017 a octubre de 2017. La muestra ha sido formada por pacientes ingresados durante el periodo del estudio y que cumplieron los criterios de inclusión. La recolección de datos fue hecha a través de consulta a archivos.
Resultados: El ítem de mayor adhesión fue la evaluación diaria de la sedación y reducción siempre que posible, 81 (91,0%), seguido del cambio del circuito cada 7 días, 76 (82,6). El mantenimiento de la presión del *cuff* entre 20 y 30 mm H2O fue el ítem con menor adhesión 22 (23,9%). La adhesión al conjunto completo presentó conformidad en 20 (21,7%) de las oportunidades. El estudio mostró que cuanto mayor la adhesión a las medidas de buenas prácticas, menor el riesgo de Neumonía Asociada a la Ventilación Mecánica; sin embargo no es un dato estadísticamente significante. Los pacientes quirúrgicos y en uso de ventilación mecánica presentaron mayor riesgo de desarrollar PAV (p= 0,05).
Conclusión: Neumonía Asociada a la Ventilación Mecánica puede traer una grave repercusión al paciente. La aplicación de medidas con embasamiento científico es fundamental para evitar la ocurrencia de este agravio, que es una de las más frecuentes infecciones relacionadas con la asistencia a la salud dentro de las Unidades de Terapia Intensiva brasileñas.

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Corresponding author
Raimunda Xavier Alecrim
http://orcid.org/0000-0002-7775-5853
E-mail: raimundaalecrim@bol.com.br

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[1]Escola Paulista de Enfermagem, Universidade Federal de São Paulo, São Paulo, SP, Brazil.
[2]Hospital São Paulo, Universidade Federal de São Paulo, SP, Brazil.
[3]Serviço de Controle de Infecção Hospitalar, Hospital São Paulo, Escola Paulista de Medicina, Universidade Federal de São Paulo, SP, Brazil.
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Introduction

Ventilator-associated pneumonia (VAP) is an important healthcare-associated infections (HAI) that leads to increased mortality, days in the Intensive Care Unit (ICU) and increased hospital costs related to its occurrence.[1]

The Centers for Disease Control and Prevention (CDC) defines adverse events related to mechanical ventilation (MV) as for a worsening respiratory pattern after a period of stability or improvement of it, presence of lung infection or inflammation, and laboratory evidence of respiratory infection, detecting conditions and related complications to MV. Ventilator-associated pneumonia, specifically, is defined as pneumonia evidenced 48 hours after the onset of MV until its suspension, associated with clinical, radiological and laboratory criteria.[2,3]

In 2011, approximately 157,000 cases of healthcare-associated pneumonia (HCAP) were reported in ICUs in the United States of America, of which 39% were classified as VAP.[3] The incidence density of this infection remains around 4.4 cases/1,000 days of MV in American ICUs.[4]

According to the Surveillance System for Hospital Infections of the state of São Paulo in 2016, the incidence density of VAP in the ICUs in São Paulo was 10.64 cases/1,000 days of MV in public hospitals, and 6.56 cases/1,000 days of MV in private hospitals.[5]

Estimates of mortality due to VAP were difficult to assess due to factors such as sample sizes and difficulty in performing relevant subgroup analyzes, but it is estimated to be around 13%, ranging from 3% to 17%, according to published studies on the subject.[6,7]

Surveillance, prevention and control of VAP has been a challenge for health services. The implementation of strategies to prevent and control this infection must be proposed. They have been extremely effective in improving the quality of care, when carried out continuously and collectively by health professionals.[8]

The development of good practices, together with the training of the multiprofessional team is a determining factor for the reduction of the infection's incidence rates, ICU length of stay and its consequences, besides promoting a safe patient care.[9,10] Given this scenario, this study aimed to evaluate the compliance of health professionals with a set of good practices for the prevention of VAP, compliance index for each recommended measure and to associate clinical characteristics of patients and compliance with good practices with the development of pneumonia.

Methods

This is a prospective cohort study conducted from May to October 2017, after approval of the Research Ethics Committee (technical report number 2.003.925), in the adult ICU of a University Hospital, located in the city of São Paulo, Brazil. The ICU in question has 17 beds and is intended for patients with clinical and/or surgical conditions. Of the total beds, two are reserved for patients with respiratory precautions needs. In the ICU, there are pre-established care protocols, including those for the prevention of VAP.

Convenience sampling was used according to the pre-established period for data collection, without the calculation of the sample. Patients admitted to the ICU who met the following inclusion criteria were included: being 18 or over and use of MV for at least 24 hours. The exclusion criteria were: patients from another service or department and those who developed VAP within 48 hours after admission in the ICU.

Data collection was performed by the main researcher, by reviewing medical records and history of the interventions implemented. The following variables were studied: sex, age, ICU length of stay, prognostic index Sequential Organ Failure Assessment (SOFA) and Simplified Acute Physiology Score (SAPS 3), total days of sedation and days of MV, diagnosis of VAP according to the Brazilian Health Regulatory Agency (ANVISA),[2] isolated microorganism, level of sedation according to the Richmond Agitation-Sedation Scale (RASS), need for re-intubation, reason for hospitalization and causes of ICU admission.

In order to evaluate compliance with the set of good practices for the prevention of VAP, information regarding the measures implemented and standardized by the Hospital Infection Control Service of the institution were collected. They were: daily sedation assessment and reduction whenever possible, circuit changes every seven days, maintenance of cuff pressure between 20 and 30mm H2O, backrest elevation (from 30º to 45º), oral hygiene (OH) with chlorhexidine at 0.12% (three times a day). Despite recognizing the importance of performing hand hygiene to prevent infections, this measure was not evaluated because it requires a specific observation and collection methodology.

The interventions' records were monitored daily from the 24 hours of patient intubation until the time of extubation. The compliance of professionals with the set of good practices of VAP was considered accordingly only when performed in its entirety, during the patient's stay in the study. Patient's outcome was identified on the last day of participation in the study characterized by MV removal, discharge from the ICU and/or death.

A descriptive statistical analysis was performed, considering the variables of interest, through the average, median, minimum, maximum, standard deviation, absolute and relative frequencies. The inferential analysis used for the evaluation of compliance with VAP prevention measures was the univariate analysis, with the objective of investigating the relation of each variable regardless of the set of good practices, pre-selected when crossing the dependent variable, defined as the development of VAP, using the alpha significance level equal to 5%.

After this stage, multiple logistic regression was applied to determine the independent variables that continued to be associated with the development of VAP, considering those that obtained a level of statistical significance of up to 0.20 in the univariate analysis.

Data were entered in Excel 2010 spreadsheets for Windows to properly store information. Statistical analyzes were performed with the statistical software named Statistical Package for the Social Sciences (SPSS) version 19, Chicago, IL, USA.

Results

The study sample consisted of 92 patients who met the inclusion criteria; 56 (60.9%) were male and 36 (39.1%), female. In the study period, eight (7.36%) patients developed VAP. Of them, five (4.6%) cases were of clinical VAP and three (2.76%) of VAP with microbiological confirmation. The agents identified were: *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* and *Acinetobacter baumannii*.

In (Table 1) the descriptive analysis in relation to the age of participants and the univariate analysis of the length in the ICU are presented, as well as the prognostic index SOFA and SAPS3, days of sedation and days of MV. There was no statistically significant difference between these characteristics of the studied population and their relation with the development of VAP, except for ICU length of stay and days of MV, as demonstrated in (Table 1).

Table 1. Association between sociodemographic characteristics and clinical variables of patients and their relation with the development of Pneumonia (n=92)

Variables	Ventilator-Associated Pneumonia in Mechanical Ventilation		p-value[a]
	Yes Average (±SD)	No Average (±SD)	
Age (years old)	58.6(18.5)		
ICU length of stay (days)	36.9(38.8)	15.6(18.2)	0.022
SOFA	6.5(3.4)	6.9(3.7)	0.760
SAPS3	69.8(14.7)	63.2(16.5)	0.279
Days of Sedation	7.8(10.9)	4.6(3.4)	0.101
Days of MV	13.3(16.8)	4.6(3.4)	0.041

[a] Student's t-test; ICU: Intensive Care Unit; SOFA: Sequential Organ Failure Assessment SAPS: prognostic index Simplified Acute Physiology Score; MV - Mechanical Ventilation. *n SOFA: 88; n SAPS3: 90

The three main causes for ICU admission were neurological diseases, 38 (41.3%); pulmonary, 28 (30.4%); and surgical complications 20 (20.7%). Among other risk factors for VAP, the depth of sedation according to the RASS scale was evaluated in 90 cases (97.8%) and deep sedation was observed in 46 patients (50.0%) in the first day of admission in the ICU. The need for re-intubation was present in nine patients (9.9%) with MV. Table 2 shows the results regarding compliance with the isolated measures to prevent VAP and to the bundle.

Table 2. Compliance with preventive measures of VAP (n=92)

Measures assessed	Yes n(%)	No n(%)	Does not apply n(%)
Sedation assessment	81(88.0)	3(3.3)	08 (8.7)
Circuit Changes	76(82.6)	16(17.4)	-
Backrest elevation	47(51.1)	45(48.9)	-
Oral Hygiene	46(50.0)	46(50.0)	-
Cuff Pressure	22(23.9)	70(76.1)	-
Complete Bundle	20(21.7)	72(78.3)	-

VAP - Ventilator-Associated Pneumonia

Regarding the measures of prevention of VAP, the daily sedation assessment and circuit changes when indicated had higher compliance, as shown in table 2. Despite the importance of this prevention measure, cuff pressure was the item with the lowest adhesion. Table 3 shows the association between compliance with preventive measures of VAP and the development of pneumonia.

Table 3. Association between compliance with preventive measures of VAP and the development of pneumonia (n=92)

Measures assessed	VAP		p-value[a]
	No n(%)	Yes n(%)	
Sedation assessment			
Yes	81(91.0)	8(9.0)	0.999
No	3(100.0)	-(-)	
Circuit Changes			
Yes	69(90.8)	7(9.2)	0.704
No	15(93.8)	1(6.3)	
Backrest elevation			
Yes	45(95.7)	2(4.3)	0.142
No	39(86.7)	6(13.3)	
Oral Hygiene			
Yes	44(95.7)	2(4.3)	0.158
No	40(87.0)	6(13.0)	
Cuff Pressure			
Yes	21(95.5)	1(4.5)	0.440
No	63(90.0)	7(10.0)	
Complete Bundle			
Yes	19(95.0)	1(5.0)	0.515
No	65(90.3)	7(9.7)	

VAP - Ventilator-Associated Pneumonia *Fisher's Exact Test

Complete compliance with the VAP prevention bundle occurred in 21.7% of the opportunities and its relation with the development of VAP did present statistical significance (p=0.515). The association between clinical characteristics of the patients and the development of VAP is shown in table 4.

Variables with p-value of up to 0.20 in the univariate analysis were included in the multiple logistic regression. They were: days of mechanical ventilation (p=0.041), days of sedation (p=0.101),

Table 4. Association between clinical characteristics of patients and the development of pneumonia (n=92)

Clinical characteristics	VAP		p-value
	No n(%)	Yes n(%)	
Postoperative			
Yes	16(80,0)	4(20,0)	0.057[a]
No<0}	68(94,4)	4(5,6)	
Sedation (days)			
Median	4,0	4,0	0.101[b]
Min-Max	0-15,0	0-33,0	
Days of MV			
Median	6,0	10,5	0.041[b]
Min-Max	0-85,0	5,0-80,0	
SOFA			
Average ± SD	6,9±3,7	6,5±3,4	0.760[b]
SAPS3			
Average ± SD	63,2±16,5	69,8±14,7	0.279[b]
ICU length of stay (days)			
Median	9,5	21,5	0.022[b]
Min-Max	2,0-109,0	5,0-122,0	

[a]Fisher's Exact Test; [b]Student's t-test; MV - Mechanical Ventilation; SOFA – Sequential Organ Failure Assessment; SAPS3 - prognostic index Simplified Acute Physiology Score

ICU length of stay (0.022) and surgical patients (p=0.057). Statistical significance was identified in the association between the variable VAP and surgical patients (OR=6.68; CI95%=1.236-36.149), the latter being considered an independent risk factor for pneumonia.

Discussion

The evaluation of compliance with good practices based on scientific evidence, the establishment of outcome indicators, structural evaluation, education and process monitoring are fundamental for the prevention of HAI.[8]

Daily sedation interruption is a highly recommended measure to prevent pneumonia and frequently composes the sets of good practices identified in the literature. A multicenter, international study showed that the proportion of patients with deep sedation decreased from 55.2% to 44.0% after implementing a sedation protocol and analgesia managed by nurses. The ICU length of stay and mortality rates were similar in both groups. However, it was considered safe in relation to patient agitation stability.[11] A Brazilian study evaluating the implementation of a protocol to sedation interruption showed compliance of 59.2% by health professionals. For 40.7% of patients, there was no sedation assessed and they did not have any

records in their medical records justifying it.[12] In this study, the daily sedation assessment was characterized as the item with the best compliance rate (88.0%), showing better results than those identified by other researchers. This result is due to the multidisciplinary visit, performed daily in the studied ICU. This, among other items, discusses the possibility of discontinuing sedation according to the appropriate monitoring and surveillance scale, to avoid mistaken extubations and the need for re-intubations that increase the chances of VAP.[11,13]

Care of the ventilator circuit is classified as interventions with an evidence level I, and daily change of this device is not recommended.[10,14] Brazilian studies evaluating compliance with this measure identified high compliance rates ranging from 70% to 100%.[15,16] In this study, this measure was positively highlighted, since it was the second item with the best compliance by the professionals (82.6%). This result corroborates that of previous studies, proving to be a measure already consolidated in the ICU environment. These measures must be consistent to prevent the risk of contaminating patients.[17]

Regarding the backrest elevation from 30° to 45°, researchers demonstrated that compliance with this measure was associated with the reduction of the risk of VAP.[18] Although it is an easy measure to apply, compliance rates identified in the literature present wide variation. A study carried out in 2014 showed low compliance of professionals to this technique (34.5%), regardless of the resources used.[15] On the other hand, Almeida KMV, et al., observed a 97.9% compliance rate with this measure, proving to be a well-known action among the professionals researched.[12] The compliance for this item in this study was 51.1%, reflecting the need for strategic interventions to raise awareness on its importance to create good practices, as recommended by organizations such as the Institute for Health Care Improvement (IHI).[19]

Another frequently indicated intervention for the reduction of VAP in adult patients, especially those hospitalized for elective surgical procedures, is OH with chlorhexidine. Although OH characterizes essential care in patients submitted to MV, the results obtained in another study showed a low compliance with this measure (48.8%), which was attributed to the lack of knowledge of the professionals involved regarding the risk of not performing this procedure, inadequate technical training and lack of daily supervision by the professionals involved.[12] Like backrest elevation, the rates of compliance with this measure are varied, and depend on the system used for the measure implementation. International and national studies conducted previously, for example, demonstrated that compliance with OH was satisfactory in 84.7% and 92.0%, following specific protocol adoption.[17,20]

In this study, only in 50.0% of patients the OH was performed adequately. This fact may be related to the patients' severity, fear of extubation during manipulation and even lack of priority for care when it comes to infection prevention, in addition to a process of systematization of fragmented nursing care. Despite the quality of evidence level II in the reduction of VAP, it is still a measure recommended by the guidelines, since commonly the microorganisms of the oral cavity can migrate to the airways, leading to the occurrence of VAP.[10,14,19] Oral hygiene with chlorhexidine is not a risk-free intervention and the indiscriminate use of this antiseptic should be avoided through the divergence of results described in the literature for specific populations.[21]

Regarding cuff pressure, it is a measure considered level of evidence III, because results of clinical trials performed did not have an impact on length of stay in the ICU and mortality rates. Such an intervention presents satisfactory results in the duration of the MV and is therefore still a recommended measure to be part of the sets of good practices.[10]

A study carried out to evaluate compliance with a set of good practices of prevention of VAP had a high rate of nonconformity for the supervision and adequate maintenance of cuff pressure, with compliance of 51.5%.[15] Adequate maintenance of these pressure levels is a challenge in clinical practice, as it varies according to the patient's positioning, aspiration of secretions, body temperature and use of some anesthetic agents.

Checking cuff pressure rigorously before aspirating the airways and performing the OH must be done to obtain benefits.[17] In another national study, cuff pressure was checked periodically in 44.8% of the opportunities, and maintenance of adequate levels was present in only 16.5% of the situations, justifying the need for constant monitoring of this measure.[16] In this study, this initiative had the lowest compliance rate (23.9%), requiring strategies to improve compliance with this measure.

International studies on collective compliance with the best practices of prevention of VAP achieved satisfactory results in surgical and trauma ICU, with compliance rates ranging from 63% to 91%, reaffirming that positive results can only be achieved when there is education and vigilance, as well as multiprofessional engagement for safer care.[18]

Moreover, a study aimed at assessing compliance with the complete set of prevention of VAP, identified general compliance from 94% to 100%, reducing the incidence density of VAP from 18.5% to 9%, mortality from 38 % to 30%, ICU length of stay of two days and increased hospital costs from US$ 2000 to US$3000 per case of VAP.[22] The authors affirm that this result was only possible due to education and constant training, through strictly managed protocols, as a fundamental process to improve health services. The observational method used in this study was considered the most accurate monitoring method.

National researchers verified an index of compliance with the set of good practices of prevention of VAP nearly 66.7%, considered acceptable by the authors despite the recommendations of the IHI, which recommends that compliance with the good practice be greater than 95%.[15,19] In contrast to another Brazilian study for this purpose, only 35.3% of patients received all the recommended care in the set of good practices. This representes a low compliance with the simultaneous implementation of these interventions and commitment of the recommendations effectiveness, as set forth by the IHI.[12,19]

Researched shows an overall compliance rate with the set of good practices of prevention of VAP of 21.7%, which represents a very low compliance with the current reality, which can be explained by the frequent change in the professional staff and problems in publicizing bundle measures, training and supervision of recommended measures to prevent VAP. It all makes it difficult to achieve satisfactory compliance rates for all measures. This compliance index reflected in the non-association of the set of good practices with the expressive reduction of the incidence of VAP in the ICU in question.

When it comes to evaluating good practices in a collective way, the results found are variable, according to the profile of the health services, the consolidation of existing processes, the culture of patient safety and the methodology used. The set of best practices for the prevention of VAP needs to be consolidated among managers and the multiprofessional team. To obtain a change of the practice there is no partial credit for doing some of the steps. Results are only effective when there is complete compliance with the measures.

Conclusion

Individually, the items with the highest compliance were the sedation assessment and the circuit changes of MV when indicated. Cuff pressure checking was the item with the lowest adherence. The rate of compliance with the set of good practices for the prevention of VAP was 21.7%, much lower than that recommended in the literature. There was no statistically significant association between compliance with the set of good practices and the occurrence of VAP. Surgical procedures were related to higher occurrence of VAP.

Collaborations

Alecrim RX, Taminato M, Belasco A, Barbosa D, Kusahara DM and Fram D contributed with manuscript design, article writing, critical and relevant review of intellectual content and approval of the final version to be published.

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