Revista Brasileira de Enfermagem
REBEn

RESEARCH

Determining impacts and factors in ventilator-associated pneumonia bundle

Impactos e fatores determinantes no bundle de pneumonia associada à ventilação mecânica

Impactos y factores determinantes en cumplimiento del bundle de neumonía asociada a la ventilación mecánica

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How to cite this article:
Rodrigues AN, Fragoso LVC, Beserra FM, Ramos IC. Determining impacts and factors in ventilator-associated pneumonia bundle. Rev Bras Enferm [Internet]. 2016;69(6):1045-51. DOI: http://dx.doi.org/10.1590/0034-7167-2016-0253

Submission: 07-19-2016 **Approval:** 08-14-2016

ABSTRACT

Objective: Assessing the determining impacts and factors in ventilator-associated pneumonia (VAP) bundle. **Method:** descriptive retrospective longitudinal study, with quantitative approach, held at a public teaching hospital. Collection held between May 2014 and April 2015. Patients of the ICU with VAP participated in the research. For organizing data, the Microsoft Excel 2010 program was used. A critical analysis between the data collected and infection rates was performed. The survey was approved under no. 566,136. **Results:** an increase in the incidence of VAP after implementing the bundle was observed; the prevalent pathogens were gram-negative bacteria. Deaths were equal to or greater than 50%. Changes of professionals and lack of supplies were determining factors. **Conclusion:** in this context, the need for permanent qualification of the team is emphasized, with the purpose of promoting the adherence to the protocol and preventing VAP.

Descriptors: Pneumonia; Intensive Care Units; Patient Safety; Prevention; Ventilator-Associated Pneumonia.

RESUMO

Objetivo: avaliar os impactos e fatores determinantes no cumprimento do *bundle* para redução da pneumonia associada à ventilação mecânica. **Método**: estudo longitudinal retrospectivo, descritivo, com abordagem quantitativa, realizado no Hospital público de ensino. Coleta realizada entre maio de 2014 e abril de 2015. Participaram da pesquisa, os pacientes da UTI, notificados com PAV. Para a organização dos dados foi utilizado o programa Microsoft Excel 2010. Estabeleceu-se uma análise crítica entre os dados levantados e as taxas de infecção. A pesquisa obteve parecer favorável, sob o n° 566.136. **Resultados**: observou-se aumento na incidência de PAV após implementação do *bundle*; os patógenos prevalentes foram bactérias gram-negativas. Os óbitos foram iguais ou maiores a 50%. As mudanças de profissionais e a falta de insumos foram fatores determinantes. **Conclusão:** nesse contexto, ressalta-se a necessidade de qualificação permanente da equipe, com o propósito de favorecer a adesão ao protocolo e prevenir a PAV.

Descritores: Pneumonia; Unidades de Terapia Intensiva; Segurança do Paciente; Prevenção; Pneumonia Associada à Ventilação Mecânica.

RESUMEN

Objetivo: evaluar los impactos y factores determinantes en el cumplimiento del *bundle* para reducir la neumonía asociada a la ventilación mecánica (NAV). **Método**: se trata de un estudio descriptivo retrospectivo longitudinal con un enfoque cuantitativo, realizado en el hospital público universitario. La recolección de datos se ha llevado a cabo entre mayo de 2014 y abril de 2015. Los participantes fueron los pacientes de la UCI reportados con NAV. Para la organización de los datos se utilizó el programa Microsoft Excel 2010. Se estableció un análisis crítico de los datos recogidos y las tasas de infección. La investigación fue aprobada bajo el número de registro 566.136. **Resultados**: hubo un aumento en la incidencia de NAV después de la implementación del *bundle*; los patógenos prevalentes fueron las bacterias gramnegativas. Las muertes eran igual o superior al 50%. Cambios profesionales y la falta de insumos fueron factores determinantes. **Conclusión**: en este contexto, se destaca la necesidad de una formación continua del personal, con el fin de promover la adhesión al protocolo y prevenir la NAV.

Descriptores: Neumonía; Unidades de Cuidados Intensivos; Seguridad del Paciente; Prevención; Neumonía Asociada a la Ventilación Mecánica.

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INTRODUCTION

Hospital infections are currently known as Health care-associated infections (HAI), which may be defined as any infection that affects the individual, whether in hospitals, ambulatory care in partial hospitalization, or home care associated with some sort of care procedure, both therapeutic and diagnostic[1].

They constitute a significant risk to the health of users; their prevention and control are of paramount importance and involve hospital care qualification measures through actions that result in the improvement of the quality of health care and reduction in efforts, complications, and resources.

Ventilator-associated pneumonia (VAP) is the most important and common infection that affects critical patients who are mechanically ventilated in Intensive Care Units (ICU), due to the vulnerable state of these patients[2]. It is related to health care, and usually happens through aspiration, the secretions from the upper airways being its main source, followed by exogenous inoculation of contaminated material or gastrointestinal tract reflux[3].

VAP is the infection that occurs 48 hours after intubation, which was not incubated during the period of the patient's admission, and 72 hours after extubation[4]. According to the Society of Infectious Diseases of São Paulo[5], they may be classified according to the period after hospitalization in which they occur, that could be precocious, until the fourth day after intubation, and late, after the fourth day of intubation.

ANVISA[3] describes VAP risk factors as: old age (over 70 years old); coma; level of consciousness; tracheal reintubation and intubation; immune conditions; use of immunosuppressant drugs; shock; severity of the disease; having had Chronic Obstructive Pulmonary Disease (COPD); prolonged mechanical ventilation time greater than seven days; aspiration of the contaminated condensate of the ventilator's circuits; malnutrition; exogenous contamination; antibiotic therapy, such as prophylaxis; microbial colonization; extended surgeries; aspiration of contaminated secretions; gastric colonization and its aspiration; and gastric pH (> 4).

Mortality estimation attributed to this infection varies in different studies, but roughly 33% of patients with VAP die as a direct result of it, which results in prolongation of hospitalization in about 12 days and in an increase in costs of around $ 40,000 per episode[4].

Therefore, as a result of the search for protocols aimed at mitigating this type of infection, the bundle was implemented, which is a set of measures aiming at preventing VAP. The objective of this model is not being a comprehensive reference to the therapeutic arsenal available, but a small and simple set of evidence-based practices that, when performed collectively, improve outcomes for patients.

The ventilator bundle is defined as a set of measures for the prevention of VAP based on scientific evidence. It is a checklist that must be filled in a multidisciplinary manner according to the unit team. It is composed of seven measures that once performed together, tend to reduce the incidences of VAP.

In this institution, this set of measures to prevent VAP was chosen as priority for being the one related to the disease which most affects mechanically ventilated patients in intensive care units; preventive measures are carried out and filled in the document daily, during the three shifts. The bundle implemented was the one recommended by intensive care professionals along with the Hospital Infection Control Committee.

1. Identification of RASS (Richmond Agitation-Sedation Scale). The assessment of the level of sedation is made because when deep, it hinders weaning and may lead to increased risk of VAP[6].
2. Sedation, to identify whether it was maintained or discontinued. The daily interruption of sedation is associated with greater survival of patients undergoing mechanical ventilation[7-8].
3. Elevation of the headboard, with "yes/no" reply to be kept between 30º–45º. Keeping the headboard of the bed elevated between 30º–45º is one of the main recommendations to avoid pulmonary aspiration, especially in patients who are receiving enteral nutrition[9-10].
4. Enteral nutrition, with "yes/no" reply. This measure indicates enteral feeding as a predisposing factor for VAP, because of the risk of aspiration of gastric contents[7].
5. Neuromuscular blockade, with "maintained/interrupted/without indication" reply. Neuromuscular blocking agents (NMBAs) may induce neuromuscular dysfunction, characterized by generalized muscle weakness, hindering weaning[10].
6. Cuff pressure with "yes/no" reply to pressure between 25º–35º. Maintaining the proper pressure of the cuff should ensure the sealing of the trachea to prevent microaspiration of subglottic secretions to the lower respiratory tract[11-12].
7. Oral hygiene with aqueous chlorhexidine at 0.12% with "yes/no/lack of" reply, justifying the conducting of the procedure. The orotracheal tube favors the appearance of dental biofilm, which can be an important reservoir for pathogens that, if aspirated, may cause VAP[9].

Also, the bundle contains additional information, such as: date of intubation, date of extubation with identification of manner, if programmed or accidental, date of reintubation and tracheostomy. This study was performed because of the short time available for the local team to analyze the impacts, the factors that may influence the compliance with the measures, and the need of the professionals to report to the unit.

Therefore, it has as objective assessing the impact of the bundle and the factors that influence the compliance with the preventive measures for ventilator-associated pneumonia in an Intensive Care Unit, as a result of the patients having a high risk of, in this critical environment, being affected by these adverse events.

METHOD

Ethical aspects

The research project was submitted to Plataforma Brasil, being forwarded to the Ethics Committee of the Walter Cantídio University Hospital and accepted according to protocol

no. 566,136. The recommendations of the Guidelines and Standards of Research involving Human Beings, presented in Resolution 466/2012 of the National Health Council (2012), were followed.

Study design, location, and period

It is a descriptive retrospective longitudinal study, with quantitative approach, held at a Public Teaching Hospital located in Fortaleza, CE. Descriptive studies seek to determine the distribution of diseases or health-related conditions considering time, place, and/or individual characteristics[13].

A quantitative approach is influenced by natural sciences, which define the existence of an external reality that can be examined in an objective manner, and results in universal truths. Thus, the results of the research are reproducible and generalizable[14].

The study was conducted between May 2014 and April 2015.

Sample; inclusion and exclusion criteria

Twenty-six patients hospitalized in the Intensive Care Unit, who were undergoing mechanical ventilation from May 2014 to April 2015 and were notified about VAP by the Hospital Infection Control Committee in the mentioned period, were used as research subjects. The exclusion criteria included patients who were diagnosed with pneumonia on admission or who developed it in the first 48 hours of hospitalization in the ICU, data contained in the notification record.

Study protocols

For data collection, two instruments filled by the nurse of the Hospital Infection Control Committee were used. The first concerned identification and clinical data of the eligible patients, which is described as "Active surveillance record". The second was the "HAI notification record", performed by the Hospital Infection Control Committee.

The VAP bundle was implemented in the unit in November 2014; then, a comparative analysis on VAP incidence from May to October 2014 (prior to the implementation of the bundle) and from November 2014 to April 2015 (after implementation of the bundle) was performed, with focus on the following data contained in the records.

The active surveillance record contains clinical data, such as patients' name, gender, age, diagnosis, precedence, bed in which they are, admission date, as well as invasive procedures/devices that were conducted and/or installed such as CVC (central venous catheter), MAP (mean arterial pressure), mechanical ventilation, NGI (nasogastric intubation), IUC (indwelling urinary catheter), PN (parenteral nutrition), venous dissection, hemodialysis, hospital infection, and drains. The record also has a space for the identification of the type of antimicrobial agent used. It identifies the microbiological examination and the day it was held, as well as the result, with the description of the isolated agent.

After surveillance, the HAI notification record is filled according to the criteria for VAP identification, containing the following information: the patients' clinical data — such as name, chart, DOB (date of birth), age, gender, infirmary, bed, clinic; hospital data — such as hospital of origin, date of admission and discharge, diagnosis, date of admission and discharge from the current hospital, reason for discharge, date of infection, type of material collected, place of infection, diagnosis, and a space for additional comments such as the incidence of fever, aspect of the material, and characteristics of the exudate.

Analysis of the results

For data organization and analysis, the Microsoft Excel 2010 program was used. The results were subjected to a descriptive statistical analysis and presented with absolute and relative frequencies. Tables and graphics were used for the presentation of the findings, which were discussed in the form of text, confronted with relevant literature, being analyzed in September 2015.

RESULTS

For sample organization, it was divided into two periods, the first referring to the six months prior to the implementation of the VAP bundle; and the second to the six months after implementation. In total, concerning the exact amount in the first six months of study, 10 notifications of pneumonia were recorded; in the second period, 16 patients were notified with VAP.

The sample was evaluated in various aspects. First, the incidence of VAP before and after implementation of the bundle was recorded according to incidence density, calculated by dividing the number of episodes of ventilator-associated pneumonia (VAP) in patients hospitalized in intensive care units (ICU) by the number of patients undergoing mechanical ventilation (MV), multiplied by 1,000.

In the first period, prior to implementation, an average of density was calculated on the incidence of 11.53 patients notified with ventilator-associated pneumonia; in the second period, there was an increase, totaling 16.42 notified patients, after implementation of the bundle with the preventive measures, as depicted in the chart below.

Density of Pneumonia from May 2014 to April 2015

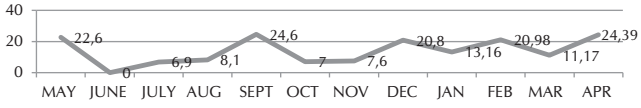

Figure 1 – Distribution of density of incidence of patients notified with ventilator-associated pneumonia, Walter Cantídio University Hospital, Fortaleza, Ceará, Brazil, 2014-2015

Regarding the age of patients with ventilator-associated pneumonia, there was a prevalence of patients "older than 60 years old" (Table 1). In the first period, the prevalence was of 70% of the sample; and in the second, it reached the value of 37% of the sample.

Table 1 – Distribution of the number of notified patients according to demographic variables, Walter Cantídio University Hospital, Fortaleza, Ceará, Brazil, 2014-2015

Variables (n = 10)	n	%	Variables (n = 16)	n	%
Age (May – October, 2014)			Age (November – April, 2015)		
< 20	0	00.0	< 20	1	6.25
20–40	2	20.0	20–40	4	25.0
41–60	1	10.0	41–60	5	31.25
> 60	7	70.0	> 60	6	37.5
Gender (May – October, 2014)			Gender (November – April, 2015)		
Female	4	40.0	Female	10	62.5
Male	6	60.0	Male	6	37.5

In relation to the development of VAP and gender of higher prevalence, the present study showed that, in the six months prior to implementation of the bundle, there was a prevalence of pneumonia in females, totaling 60%. This data is confirmed by the literature, and is demonstrated in another study, in which females had a prevalence of 72%[15]. However, within the six months after the implementation of the bundle, there was a prevalence of 62.5% of pneumonia in males. This risk factor associated with males is described by the Brazilian guidelines as a factor not yet confirmed, therefore emphasizing the absence of dominance about gender in scientific bases.

Among the patients notified who developed ventilator-associated pneumonia in the ICU and during the year of study, as shown in Figure 2, it was observed that these came mostly from external hospitals, more precisely from Emergency Care Units (UPA), not considering patients who had no record of origin.

For the cultures and diagnosis, tracheal aspirate samples were collected in all patients. There was a prevalence of gram-negative bacteria, with predominance of *Acinetobacter baumanii* in the six months prior to the bundle and of *Pseudomonas aeruginosa*; also, *Klebsiella pneumoniae* was the second most prevalent microorganism in the six months after the implementation of the preventive measures, as described in Tables 2 and 3, corroborating other studies that evaluate the causative profile of VAP[16].

Table 2 – Distribution of etiologic agent according to the results of the cultures and deaths, Walter Cantídio University Hospital, Fortaleza, Ceará, Brazil, May – October 2014

Variables (n = 10)	n	%
Microorganism (May – October 2014)		
Pseudomonas aeruginosa	1	10
Acinetobacter baumanii	5	50
Klebsiella pneumoniae	2	20
Clinical criteria	2	20
Gram-positive	0	00
Gram-negative	8	80
Average of days (May – October 2014)		
Orotracheal tube	13	-
Evolution		
Intensive Care Unit Discharge	5	50
Death	5	50

Table 3 – Distribution of etiologic agent according to the results of the cultures and deaths. Walter Cantídio University Hospital, Fortaleza, Ceará, Brazil, November–April 2015

Variables (n = 16)	n	%
Microorganism (November – April 2015)		
Pseudomonas aeruginosa	5	31.25
Acinetobacter baumanii	2	12.5
Klebsiella pneumoniae	3	18.75
Proteus mirabilis	1	6.25
Stenotrophomonas maltophilia	2	12.5
Citrobacter koseni	1	6.25
Staphylococcus aureus	1	6.25
Candida tropicalis	1	6.25
Gram-positive	1	6.25
Gram-negative	14	87.5
Average of days (November – April 2015)		
Orotracheal tube	7,7	-
Evolution		
Intensive Care Unit Discharge	5	31.25
Death	11	68.75

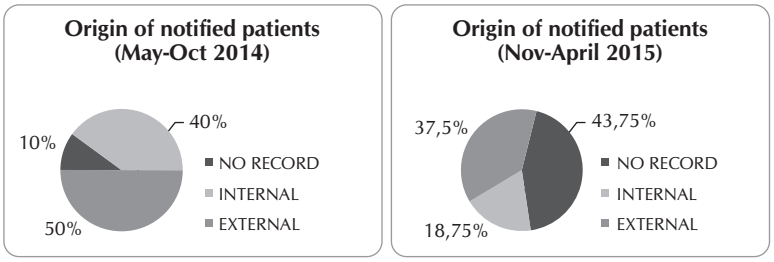

Figure 2 – Distribution of records of origin. Walter Cantídio University Hospital, Fortaleza, Ceará, Brazil, 2014-2015

It is noteworthy that, in both periods of the present study, the VAP development was late (> five days) with etiological agents of high infectivity.

DISCUSSION

The increase in incidence after implementation of the preventive measures did not corroborate literature, because there was an increase in infections. In other studies a reduction of 51% in the incidence of VAP was

observed after adoption of protocols with preventive measures for VAP[1]. In this study, in which there was a reduction in incidence, the adoption of preventive measures occurred concomitantly with an educational program, which did not happen in the present study, because there was admission of professionals (doctors, nurses, nursing technicians, and physiotherapists) in the referred hospital, which required, in addition to training, an adaption period. Since they were responsible for the compliance with the measures contained in the bundle, associated with the deficit in the training of these professionals, with emphasis on the importance of compliance with all preventive measures, non-conformities may have been generated in the prevention of VAP.

Another relevant factor that happened six months after implementation of the bundle (November 2014 to April 2015) concerned the lack of some supplies, such as 0.12% chlorhexidine for oral hygiene, which may have affected the increase in incidence. An inadequate oral hygiene along with the use of drugs will alter the salivation ability, as well as its pH, promoting an increase in the amount of bacteria in the oral biofilm, which — along with procedures such as aspiration, feeding, or any other form of manipulation of the patient — can facilitate contamination of the lower respiratory tract and the development of pneumonia[17].

Being older than 60 years old was also referred to in another study as an independent variable associated with death[18]. Researches concluded a median age that corroborates what was presented in this study, they justify as responsible factor the demographic characteristic of the region in which the hospital is located[15].

Concerning the most prevalent gender, the study did not show significant prevalence, because there was a discrepancy in values when the two periods of study were compared.

Considering that the origin of the patients is, mostly, intensive care units (UPA), we may observe that these patients underwent interventions and care in units that are not prepared for proper intensive care, care units with intermediate complexity structure, without materials and equipment for performing care on patients in critical condition. Furthermore, the classification criteria of VAP, according to ANVISA, were followed in a precise way.

We also noticed that a portion of these patients spent an important period of time in such units, which can be related to the clinical condition developed after admission, due to unprepared conducts, considering that these patients were admitted in the Intensive Care Unit while undergoing mechanical ventilation. It can also be considered that this time period at the UPA may be related to the lack of beds in the Intensive Care Unit, due to overcrowding.

The UPAs are part of the National Policy of Urgency and Emergency, and were created with the purpose of providing care for users of the Brazilian Unified Health System (SUS) in critical condition, decentralizing the care of patients with acute conditions of medium complexity, supporting Primary Care Units, and reducing the overload of hospitals of higher complexity that are now able to meet this demand, in addition to managing emergency flows[19].

Regarding the material for performing the cultures, there was a prevalence of tracheal aspirate, as in most hospitals in the region. This method is justified for being a cheap and effective way for VAP diagnosis, demonstrating good diagnostic accuracy through quantitative culture in other studies[20].

In another study, it was observed that when *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* were identified as etiological agents, they were located beyond the tracheal aspirate, in the humidifier tube and/or dental and tongue biofilm, highlighting the importance of oral hygiene and replacement of devices in the prevention of ventilator-associated pneumonia[17].

Considering that these pathogens comprise the microbiota of the hands, there may be a deficit of hands hygiene by the professionals that compose the intensive care team; in addition, it is important to emphasize the existence of a significant amount of students heading to the unit during school periods because it is part of a teaching hospital of the Federal University of Ceará. Thus, the local structure is considered deficient for the demand and performance of safe care[16].

It is worth mentioning that, in another study conducted in the same teaching hospital, it was observed that the microorganisms have the same etiologic profile for VAP, *Pseudomonas aeruginosa* (26%) and *Acinobacter Balmani* (19%) being identified as the main causes[21].

Study limitations

As study limitations there were problems with the adherence to protocols, because of the period of changes in staff, with admissions and transfers, that the hospital was going through. In addition, during the study period, there was lack of some essential supplies in the set of measures, such as the absence of chlorhexidine, used for oral hygiene and, above all, a structural deficit for the amount of patients and staff of the unit, which awaits renovations.

Contributions to the field of Nursing

Nurses are the health care professionals who spend the longest periods of time with patients in critical condition; in addition, the VAP bundle is composed of preventive measures that are mostly carried out by nurses. Therefore, the present study is quite relevant to the field. A study such as this promotes an alert for what may be affecting the fulfilment of the bundle, as for example in the structure of the unit, in the provision of supplies, and in the compliance with the measures, since the set of measures produces positive effects for reducing VAP when they are simultaneously performed.

Moreover, it is proof that education must be permanent, with an emphasis on intensive units, especially when there are changes or implementation of new protocols, in order to raise the awareness of the team and ensure the systematization of interventions.

CONCLUSION

It was observed that, after implementation, there was an increase in the incidence of VAP, observed by the increase in notifications of infection. Some factors are highlighted as

being possibly decisive, though the impacts do not corroborate the literature. This increase may be related to patients' age, origin, indiscriminate use of antibiotics, deficit of oral hygiene, and to the deficit of hand hygiene by the professionals or any other individual who has contact with them.

It is worth noting that the implementation of the bundle occurred in a period of admission of young professionals, which may have resulted in low adherence to preventive measures, which, in turn, could imply training deficit.

The profile of the etiological agents remained constant, with the same types of gram-negative bacteria. However, because the sample is small, it is not possible to build a reliable quantitative profile.

In this context, the need for continued training to sensitize professionals to adopt preventive measures and the registering of procedures in forms prepared by the intensive care service is emphasized. It is also important to promote the reporting of these VAP indicators periodically to the Hospital Infection Control Committee, in such a way that improvement plans for preventing these adverse events may be elaborated. It is important to emphasize that pneumonia is strongly related to the increase in mortality and aggravation in the prognosis of these patients as well as to high costs for the institution.

It is concluded that the adoption of a protocol is a complex matter, because many variables act directly over it, as it can be noted. Inadequate implementation due to training deficit, lack of necessary supplies, and continuous supervision to ensure the continuity of the process lead to application-related failures. Beyond implementing, it is important to emphasize planning, awareness of professionals, and the ensuring of supplies for the implementation of the measures advocated by the bundle.

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