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ORIGINAL ARTICLE

APPLICATION OF A PNEUMONIA PREVENTION BUNDLE IN A PEDIATRIC ICU
APLICAÇÃO DE *BUNDLE* DE PREVENÇÃO DE PNEUMONIA EM UTI PEDIÁTRICA
APLICACIÓN DEL *BUNDLE* DE PREVENCIÓN DE NEUMONÍAS EN UCI PEDIÁTRICA

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ABSTRACT

Objective: to evaluate the impact of a prevention bundle for Mechanical Ventilation Associated Pneumonia in a Pediatric Intensive Care Unit. ***Method:*** This is a quantitative and quasi-experimental study conducted in a pediatric Intensive Care Unit. All Patients in Mechanical Ventilation were analyzed during a period of two years (in the pre- and post-intervention phases), in relation to the occurrence of Mechanical Ventilation Associated Pneumonia. The following items were verified from the adopted bundle: high head; prevention of gastric ulcer; oral hygiene and daily assessment of sedation. ***Results:*** it is shown that there was a decrease in the incidence of pneumonia (P=0.002) and in the mean time of use of the ventilator after the application of the protocol (P=0.045). A significant difference was detected regarding bacteria, with predominance of Gram-negative in the group of patients without the use of the protocol, compared to the group with the bundle (P=0.001). ***Conclusion:*** It was concluded that the risk factors for VAP are considered modifiable and can be prevented through the creation of specific care protocols. It is argued that the implementation of bundle in pediatrics can reduce nosocomial infections, highlighting the pneumonia reported in this study.

Descriptors: Broncopneumonia; Prevention & Control; Nursing Education; Artificial Respiration; Pediatrics Assistants; Hospital Infection.

RESUMO

Objetivo: avaliar o impacto de um *bundle* de prevenção da Pneumonia Associada à Ventilação Mecânica em uma Unidade de Terapia Intensiva pediátrica. ***Método:*** trata-se de um estudo quantitativo e quase-experimental realizado em uma Unidade de Terapia Intensiva pediátrica. Analisaram-se todos os Pacientes em Ventilação Mecânica durante um período de dois anos (nas fases pré e pós-intervenção), em relação à ocorrência de Pneumonia Associada à Ventilação Mecânica. Verificaram-se, a partir do *bundle* adotado, os seguintes itens: cabeceira elevada; prevenção de úlcera gástrica; higiene oral e avaliação diária da sedação. ***Resultados:*** demonstra-se que houve uma diminuição da incidência de pneumonias (P=0,002) e no tempo médio de uso do ventilador após a aplicação do protocolo (P=0,045). Detectou-se uma diferença significativa no que

diz respeito às bactérias, com predomínio das Gram-negativas no grupo dos pacientes sem o uso do protocolo, em comparação ao grupo com o *bundle* (P=0,001). ***Conclusão:*** concluiu-se que os fatores de risco para a PAV são considerados modificáveis e que podem ser prevenidos por meio da criação de protocolos específicos de cuidados. Defende-se que a implementação do *bundle* na Pediatria pode reduzir as infecções nosocomiais, destacando-se a pneumonia relatada neste estudo.

Descritores: Broncopneumonia; Prevenção & Controle; Educação em Enfermagem; Respiração Artificial; Assistentes de Pediatria; Infecção Hospitalar.

RESUMEN

Objetivo: evaluar el impacto de un *bundle* para la prevención de la neumonía asociada a la ventilación mecánica en una unidad de cuidados intensivos pediátricos. ***Método:*** se trata de un estudio cuantitativo y cuasiexperimental realizado en una Unidad de Cuidados Intensivos pediátricos. Todos los pacientes con ventilación mecánica fueron analizados durante un período de dos años (en las fases previa y posterior a la intervención), en relación con la aparición de neumonía asociada a la ventilación mecánica. Desde el *bundle* adoptado, se verificaron los siguientes elementos: cabecero elevado; prevención de úlcera gástrica; la higiene bucal y la evaluación de la sedación diaria. ***Resultados:*** se demostró que hubo una disminución en la incidencia de neumonía (P = 0,002) y en el tiempo medio de uso del ventilador posterior a la aplicación del protocolo (P = 0,045). Se detectó una diferencia significativa con respecto a las bacterias, con predominio de gramnegativos en el grupo de pacientes sin uso del protocolo, frente al grupo con el *bundle* (p = 0,001). ***Conclusión:*** se concluyó que los factores de riesgo de NAV se consideran modificables y que se pueden prevenir mediante la creación de protocolos de atención específicos. Se argumenta que la implementación del *bundle* en Pediatría puede reducir las infecciones nosocomiales, destacando la neumonía reportada en este estudio.

Descriptores: Bronconeumonía; prevención & Control; Educación en Enfermería; Respiración Artificial; Asistentes de Pediatría; Infección Hospitalaria

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INTRODUCTION

Mechanical ventilation-associated pneumonia (VAP) is defined as that which occurs up to 48 hours after the patient's admission to the ICU and represents the second main Health Care Related Infection (HCRI). It is a serious infection that, in children, presents a high rate of morbidity and mortality, since its defense mechanisms are compromised by the disease itself, by the therapy used or by the numerous invasive procedures to which they are submitted. Respiratory Tract Infections (RTI) are divided into Upper Respiratory Tract Infections (URTI) and Lower Respiratory Tract Infections (LRTI), being the most prevalent RTIs. It should be noted that the URTI are responsible for the most severe conditions such as tuberculosis, bronchiolitis and pneumonia.[2]

It is understood that VAP is the one that most affects the mechanically ventilated patient, affecting from 9% to 27%, being mechanical ventilation the main risk factor for the development of hospital pneumonia, increasing this risk by 6% to 21%. It was verified, in a study conducted at the Teaching Hospital of Paraná, that the most prevalent HCRI were Surgical Site and VAP, reaching the percentage of 19.38%.[20] It is noted that hospital infection rates in Pediatric Intensive Care Units (PICU) vary around 12%, with 20% corresponding to VAP. The increase in the morbidity and mortality of this condition in children is associated with the increase in mechanical ventilation time, hospital stay and irrational use of antimicrobials.[3]

The suspicion of VAP in pediatrics is due to symptoms such as a drop in saturation, fever, cough, leukocytosis, increased pulmonary secretion and a change in its color, isolation of the pathogen in alveolar culture, changes in the respiratory pattern (apnea, tachypnea, beating of the wing of the nose, subcostal, furcular or intercostal circulation) and pulmonary auscultation (wheezing, wheezing and snoring). The suspicion is detected, according to radiological criteria, through chest radiography with infiltrate and persistent consolidation.[4]

It is known that Mechanical Ventilation (MV) is the artificial method of ventilating the patient until he presents clinical and/or laboratory improvement. It is proven that MV repairs hypoxemia and respiratory acidosis, decreases respiratory work and prevents circulatory failure secondary to increased CO_2 production.[5] It is observed, when patients are submitted to MV, that their defense mechanisms are altered, becoming vulnerable to risk diseases, significantly compromising their recovery and contributing directly to the increase in the number of cases of VAP.[6]

Age is related to the development of the immune system, and it is noted that younger and premature children are more likely to acquire infections. It is understood that factors such as dorsal decubitus position, sedation with opiates, neuromuscular blockage, enteric nutrition, previous antibiotic therapy, immunodepression, orotracheal tube without cuff, accidental

extubations, frequency of nasotracheal intubations and the development of teeth increase the risk of acquiring VAP.[3]

It is important to note, since respiratory tract infections in ICUs represent high morbidity and mortality rates, affecting the health of individuals and significantly increasing the length of hospital stay and the costs of care for health institutions, that the adoption of strategies for prevention and creation of protocols is necessary. The Institute for Healthcare Improvement (IHI) has created a package of measures (bundle) of VAP in order to combat the incidence of this type of infection in ICUs, thus reducing morbidity and mortality rates. It is pointed out that care packages or bundles are groups of interventions that, when implemented together, result in substantial improvements in health care.[8] The components of this bundle are based on scientific evidence and are elaborated with the objective of standardizing care in assistance. The measures proposed are listed below.

Elevated headboard

It is known that patients in intensive care present a potential risk for bronchoaspiration of secretions, especially if exposed to manipulation of the airways and/or digestive tract, including the use of endotracheal tubes and gastrointestinal probes. The objective is to prevent contaminated secretions from migrating to the lungs of mechanically ventilated patients. [9]

Gastric ulcer prevention

It is understood that the prophylaxis of stress ulcers has great relevance due to its potential as a factor of increased risk for nosocomial pneumonia. It is verified that the agents that raise the gastric pH can promote the growth of bacteria in the stomach, mainly Gram-negative bacilli originating from the duodenum. For the prevention of ulcers, intravenous antacids are used.[10]

Oral hygiene with 0.12% chlorhexidine

The orotracheal tube is estimated to favor the formation of dental biofilm, which can be a large reservoir of pathogens and, if suctioned, can cause VAP. [9]

Daily interruption or readiness for sedation removal

It is noted that the daily interruption of sedation favors early weaning and, consequently, decreases the risk of VAP contraction. [9]

OBJECTIVE

To evaluate the impact of a prevention bundle for Mechanical Ventilation Associated Pneumonia in a Pediatric Intensive Care Unit.

METHOD

This is a quantitative, descriptive, quasi-experimental study, carried out in a Pediatric Intensive Care Center of a university hospital in the metropolitan region of Porto Alegre (RS), which has ten beds intended for children from 28 days to 12 years. All beds were analyzed with patients under invasive mechanical ventilation, either by Orotracheal Tube (OTT) or tracheostomy cannula, from October 2014 to October 2016. Pre- and post-intervention VAP rates in children admitted to the unit diagnosed with VAP for at least 48 hours were evaluated.

The following items were verified by the bundle adopted in this study: high head; prevention of gastric ulcer; oral hygiene and daily evaluation of sedation. Initially, the infection data of patients from October 2014 to October 2015 were considered. Then, it was pointed out that the professionals responsible for health care were called and guided in relation to the standardization and prevention of VAP procedures. Specific training was applied in which the items of the bundle were explained, their components and their applicability. It should be noted that the care proposed in the protocol was already performed in patient care and evaluated by the Infection Control Service of the institution; however, it was not standardized and used routinely for all patients on mechanical ventilation.

It is observed that the training and the implementation of the protocol had the objective of standardizing the care so that all the patients of the study could benefit, preventing, later, the colonization and infection of the respiratory tract. With the definition of the protocol, it is pointed out that the professionals started to work together, applying and standardizing the proposed measures and the HICS followed the adherence of these professionals through a daily check. With these data, the composite items in the bundle were analyzed.

After the study began, meetings were scheduled with those responsible for the assistance to adjust and adapt all variables and collection procedures. Information was obtained to confirm the inclusion of the patient through the medical records. The data was collected from a checklist, which is the routine of the hospital unit, and the patient's collaboration was not necessary. The evaluation of the adherence to the bundle was performed through a checklist developed by the author of the study and made available to the Infection Control Service team.

The checklist for the headboard position item was filled in between 30º and 45º, and in all ICU beds a red adhesive was placed indicating the appropriate angulation. The items oral hygiene, gastric ulcer prevention and sedation evaluation were checked in the patient's chart, always at the prescription of the day before the collection.

Data on the incidence of VAP was collected retrospectively in the computerized system of the central archive sector of the hospital studied, in the same periods of the pre- and post-intervention phases, to evaluate the impact of adherence to the bundle under such index. Health Care Related

Infections of patients admitted to Intensive Care Centers were verified through epidemiological data of each patient. It is explained that all of them present a chart in which are described the signs, symptoms, comorbidities and the radiological, laboratory and cultural exams of each patient for the current month. After the period, all these data were analyzed through the Anvisa manuals, discussing them with the team about the possible HCRI.

This study included patients admitted to the ICU during the research period, with or without diagnosis of pneumonia, under MV for at least 48 hours and who remained for more than 48 hours after data collection. Those with restrictions regarding elevation of the head or the performance of physiotherapy were excluded.

It should be noted that the use of protocols followed the conditions established in Resolution 466/12 of the National Health Council (NHC). Patient data were obtained through the computerized hospital records, with the approval of the Institution's Ethics Committee and the Ethics Committee of LaSalle University Center, under the opinions numbers 1,320,803 and 1,320,803, respectively.

It should be noted that it was not necessary to apply the Free and Informed Consent Term (FICT), because all the items proposed in the study protocol were already applied in the care, however, in a disorganized manner and without a standard for all patients and professionals. Information was collected from Infection Control Service quality indicators, without any identification by name or number of professionals. With the application of this indicator, specific training was performed, addressing all items together, for the improvement of VAP prevention. Both parties signed the consent form for the use of data.

VAP Prevention Measures Adherence Assessment Indicator

It is an instrument containing all the items proposed in the protocol as described in the experimental design item. It is pointed out that this instrument contains all the measures that must be taken together in order to prevent the VAP. It is noted that the HICS professional attended the unit daily and, through this instrument, performed the checklist, monitoring the application of the proposed measures. After the end of the month, the adherence of the measures by the professionals was evaluated, observing the items that presented higher and lower adherence. The indicator was measured in percentage and, later, training was carried out with the professionals for the maintenance and stimulus of this measurement.

Hand Hygiene Adherence Assessment Indicator

It is an instrument containing the five moments in which to sanitize hands distributed by professional category and methods. It is recorded that the HICS professional attended the unit daily and, through this instrument, performed the checklist, generating, at the end of the month, the quality indicator. The indicator was measured in percentage and, later, training sessions were held

with the professionals to maintain and stimulate this measurement. The purpose of the study is to collect data on the effectiveness of the measurement and discuss the relationship of interaction between professional and patient.

Conventional descriptive statistics were used to summarize the characteristics of the sample

The categorical variables were expressed in percentages and evaluated by the chi-square test or Fisher's exact test. For the continuous variables, the normality of the data was verified by the Shapiro-Wilk and Komogorov-Smirnov tests. In the case of normal distribution, the comparison between the sample without application of the bundle and the application of this protocol was used, the t-t test for independent samples and, to verify the correlations between parametric continuous variables, Pearson's correlation was applied. When the data distribution was given as non-normal, the Mann-Whitney test or Spearman correlation was chosen. It was established, for all analyses, the level of statistical significance for the alpha error of $P<0.05$, bicaudal. The analyses were processed in the Statistical Package for Social Sciences (SPSS) software, version 20.0 (SPSS, Chicago, IL).

RESULTS

The sample consisted of 307 individuals who were admitted to the pediatric ICU from October 2014 to October 2016 and who used the mechanical ventilator. Table 1 shows the variables discriminated by the application or not of the protocol.

It is pointed out, after the application of the protocol, that this time has dropped to 8.5 days, and the results are presented in:

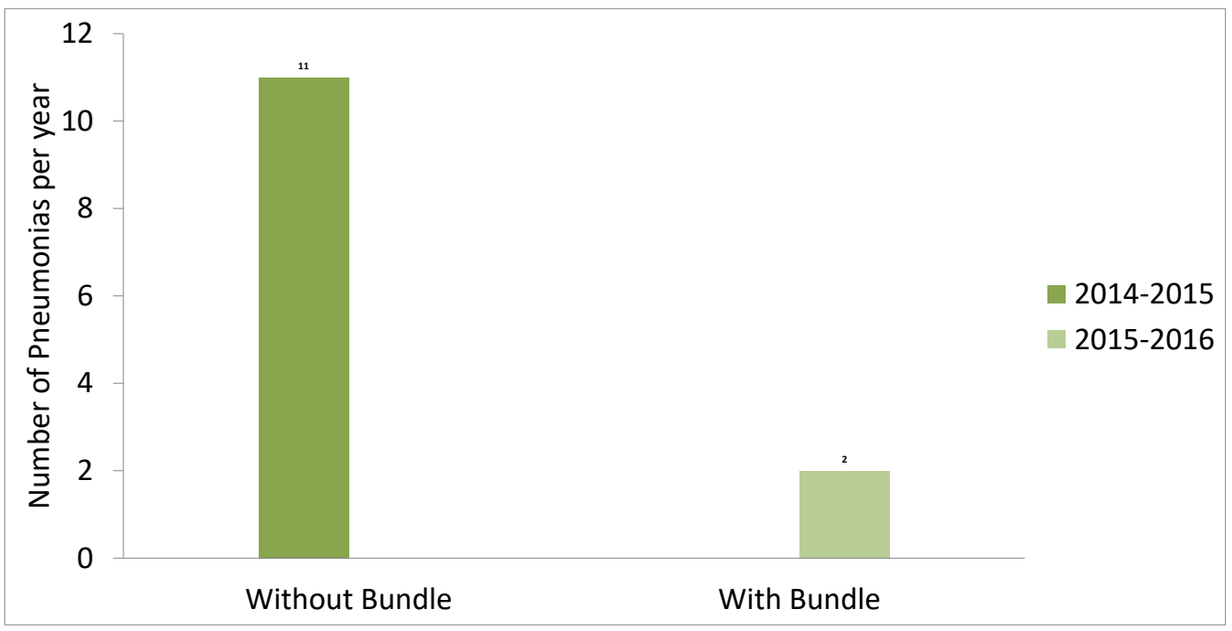
Table 1 – Sociodemographic and health variables discriminated by the application or not of the bundle. Canoas (RS), Brazil, 2016.

Variables	Without bundle (n=133)	With bundle (n=174)	Total (n=307)	Value of P
×**Sex**				0.609&
Female % (n)	17.9% (55)	21.2% (65)	39.1% (120)	
Male % (n)	25.4% (78)	35.5% (109)	60.9% (187)	
† **Age in months**				
Median (interquartile)	12.00 (2.00-30.00)	12.00 (3.00-51.00)		0.372
† **Mechanical Ventilation Time in days**				
Median (interquartile)	13.00 (6.00-31.00)	8.50 (5.00-30.00)		0.045
×**Cause of hospitalization (pathology)**				0.483&
Respiratory dysfunctions % (n)	24.1% (74)	29.0% (89)	53.1% (163)	

Genetic syndromes % (n)	8.5% (26)	11.1% (34)	19.5% (60)	
Neurological dysfunctionss % (n)	8.5% (26)	10.7% (33)	19.2% (59)	
Gastrointestinal dysfunctions % (n)	0.0% (0)	1.3% (4)	1.3% (4)	
Others	2.3% (7)	4.6% (14)	6.8% (21)	
ˣ**Bacteria**				>0.001&
Gram-negatives % (n)	5.9% (18)	1.6% (5)	7.5% (23)	
Gram-positives % (n)	2.0% (6)	0.3% (1)	2.3% (7)	

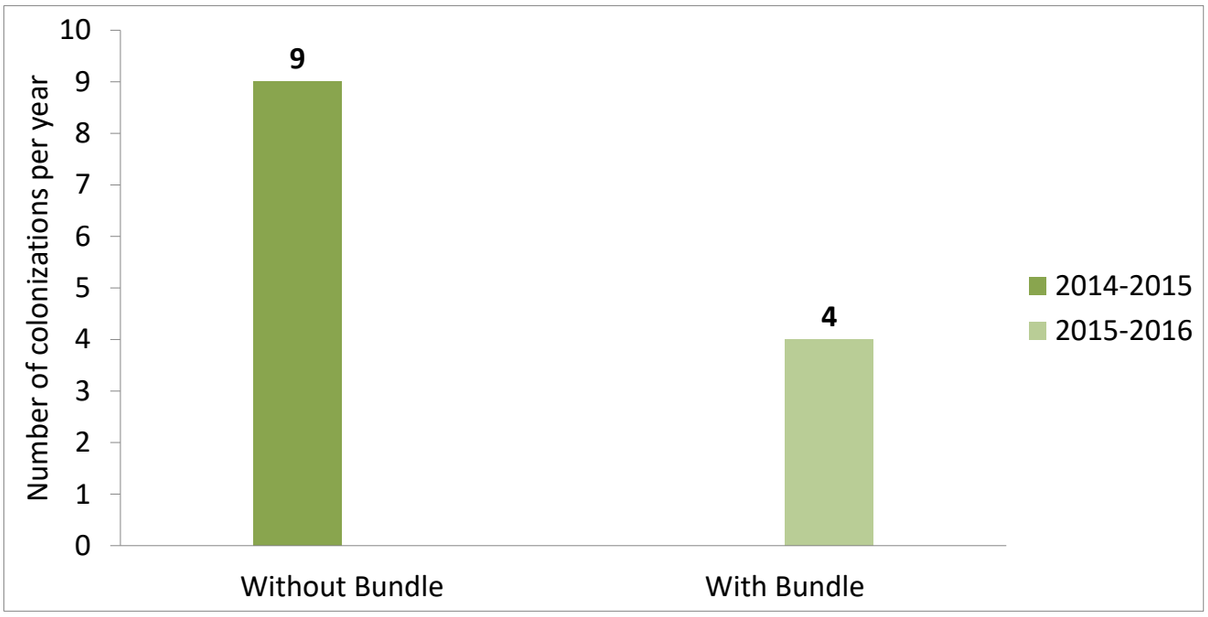
ˣ The categorical variables are expressed in percentages and absolute numbers. †As continuous variables are expressed in median and interquartile range. & Chi-square. *Mann Whitney U test

It is emphasized, regarding the use of antibiotics, that there was no significant difference (P=0,356), since most patients did not use antibiotics (52.1%, 160), against 47.9% (147) who used antimicrobials in the study. The significant difference (P=0.002) of the number of pneumonias between groups of patients, before and after bundle, is observed in figure 1. It is noteworthy that 11 patients developed VAP before the application of the protocol and, after the application, only two cases were registered, with a decrease of 81%. It is pointed out that there was no significant difference (P=0.054) in colonization, identifying nine colonizations before the bundle and four after.



* Different from the group without the bundle (Mann-Whitney test, P=0.002)

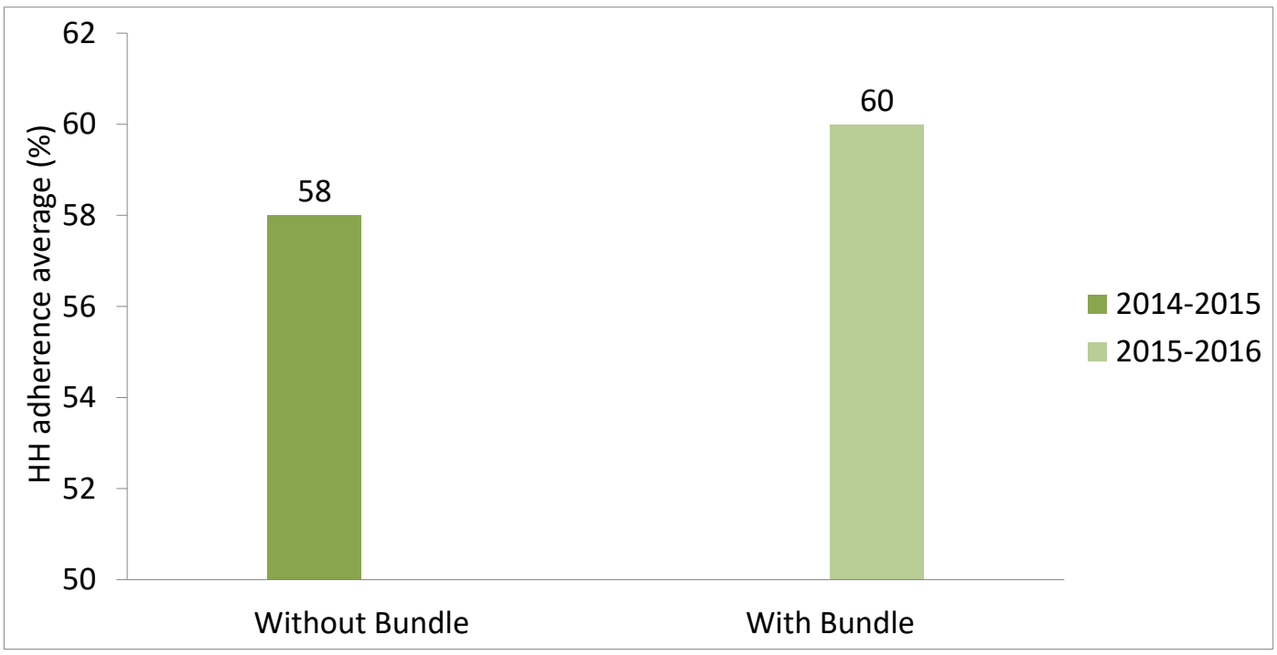
Figure 1. Number of pneumonias per year between groups without bundle and with bundle. Canoas (RS), Brazil, 2016.



* Different from Group without bundle (Mann-Whitney Test, P=0.054)

Figure 2. Number of colonizations per year between groups without the bundle and with the bundle. Canoas (RS), Brazil, 2016.

It is recorded that there was no significant difference in adherence to hand hygiene by professionals before and after the application of the bundle (P=207), as shown in figure 3. It is estimated that the average adherence to hand hygiene was 58%, before the intervention, and 60%, after the application of the protocol.



* No significant difference (Mann-Whitney Test, P=0.207)

Figure 3: Average adherence of hand hygiene (HH) (%) per year between groups without the bundle and with the bundle. Canoas (RS), Brazil, 2016.

DISCUSSION

The data obtained in the study shows that the application of the bundle had a satisfactory result in reducing VAPs by 81%, proving that educational measures have a fundamental role in preventing infections. It was demonstrated, in a study by Ana Lúcia CL, a statistical significance between the two periods (pre- and post-intervention), with P=0.013 and P=0.001, respectively.[4] An intervention was performed in a neonatal ICU, where they found a 68% reduction in VAP after implementation, decreasing from 38 pneumonias before to 22 after.[19]

Found itself in a systematic review study:[11]

In five of the six studies analyzed, positive results were obtained in terms of VAP prevention when bundles were adopted. Besides the decrease in VAP rates per 1000 days of ventilation, there were benefits in other dimensions, that is, there was also a decrease in the number of ICU days, mechanical ventilation time, use of antibiotherapy, as well as mortality and associated costs.

This study showed that male children had more hospitalizations and, consequently, the highest rate of VAPs, corroborating a survey conducted, where the male sex prevailed, with a rate of 54.2% of the study's hospitalizations.[21]

It is understood, in relation to age, that infants are very prominent. The literature shows that the number of alveoli grows with age, confirming that the smaller the child, the smaller the number of alveoli it presents, making gas exchange more difficult and increasing the chance of acquiring lung infections.[14]

In this study, among the diagnoses that led the patients to the pediatric ICU, it was found that respiratory dysfunctions appear as the main cause, affecting the lungs, causing an infiltration of interstitial tissue by inflammatory cells, leading to a consolidation of the lung alveoli and promoting a change in lung compliance and a reduction in oxygen concentration in the blood. It is considered essential, therefore, the use of the mechanical ventilator, because it aims to correct the abnormalities of gas exchange, reduce the respiratory work and allow the musculature to rest. It is evaluated that, while it positively influences the respiratory dysfunction, it also increases the risk of the patient developing the VAP by its prolonged use.[14] The study by Diana TOJ, relating the diagnoses of entry into the ICU and MV, showed that 22 patients came from respiratory diseases, 12 from polytrauma and four from neurological malformations or diseases.[15]

It should be noted that genetic syndromes appeared as the second major cause of hospitalizations of patients who were under MV. It is argued that they can be a marker for comorbidities that can make a child more susceptible to VAP, for the longer time of exposure to invasive procedures or a long period of stay in the ICU, thus becoming more vulnerable to colonization and infection. It is emphasized that many genetic syndromes, due to their

pathophysiology, lead the patient to prolonged hospitalization, making it impossible to rotate the bed for other children who may benefit from treatment.[16]

It is pointed out, comparing the age, sex and causes of hospitalization of patients before and after the bundle, that there was no difference between the periods, as in a similar study by Ana Lúcia CL, where the participants of the two phases showed no significant difference in relation to sex, age and rate of use of MV.[4]

It was pointed out in this study that the longer the time of use of mechanical ventilation, the greater the chance of VAP, confirming that, before the application of the protocol, the MV time was longer and so was the VAP index. It is understood that most patients in this study, affected by VAP, were isolated from Gram-negative bacteria, evidencing that this class of germs arise mainly in patients with use of MV, which allows a breach of the barrier between the environment and the tracheal mucosa of patients, providing progressive colonization through it. The same finding was detected in Ana Lúcia CL's study where there was a predominance of Gram-negative bacteria before and after the implementation of the protocol.[4]

It is considered that the pathogens causing VAP can be viral, fungal or bacterial. It is verified that the most found bacteria are Gram-negative, which are more present in the lower airways and, consequently, in mechanically ventilated patients. It is known that the sources of contamination can be of endogenous origin (oral, gastric and pharyngeal flora) and exogenous origin (humidifier, ventilator circuits, aspiration catheter and bronchoscopic).[3] It is signaled that colonization by these types of bacteria in the oropharynx and trachea increases the length of hospitalization and the severity of the disease.[18] It should be taken into account that the pathogens causing VAP may differ according to the duration of the MV, with early VAP usually being related to pathogens more sensitive to antibiotics, unlike late VAP, which presents more cases of multi-resistant bacteria.[22]

It was demonstrated in this study that patients used more antibiotics before the application of the bundle, confirming that, before the execution of the protocol, patients had more infections. The prolonged administration of antibiotics is related to the high risk of developing VAP. It is estimated by the Centers for Disease Control (CDC) that each year about 100 million antibiotics are prescribed, 50% of which are unnecessary for a given patient at any given time. It is warned that the selection of the antimicrobial must be based on the tolerance of the patient, besides the nature of the disease and the bacteria.[17]

It is recorded, in relation to the hand hygiene rate, that the professionals working in the study unit had low adherence before and after the application of the care package. It is noted that the rates of colonization were higher before the bundle and reached close to zero after application,

indicating the great probability that colonizations and infections do not occur due to isolated factors, but because of their multiplicity.

It is understood that hand hygiene always has great prominence in the prevention of VAP, being an essential factor in the care package. It is evaluated that the results of this study corroborate the findings about the low adherence to the practice of hand hygiene, confirming the need for permanent educational actions as strategies to encourage this practice.[12] In a study, the importance of hand hygiene in the ICU is stressed, as it is a place where procedures are performed on critically ill patients.[12] It is considered that the conduct of sanitizing the hands in the five moments is of extreme importance for the prevention of HCRI.[13] It is believed that these results lead to the reflection that, although essential for the prevention of infections, hand hygiene is still discredited by most health professionals, reinforcing the need for permanent educational actions on the technique.

This research has shown that health education is of paramount importance in reducing pneumonia, which motivates the creation of care protocols for other types of nosocomial infections. It is pointed out that the nurse has a fundamental role in reducing the risk of VAP, implementing strategies that reduce the risk for the client and this knowledge should be provided systematically and continuously to health professionals, enabling the maintenance of care in the service.

CONCLUSION

It is concluded that the results of this study showed that risk factors for VAP are considered modifiable factors and can be prevented through the creation of specific care protocols. It is argued that the implementation of bundle (elevation of the head, peptic ulcer prophylaxis, evaluation for ventilatory weaning, oral hygiene and hand hygiene) can reduce nosocomial infections, highlighting pneumonia. It is believed that there was a good adherence of professionals to the protocol due to the accessible bundle methodology, which did not imply an increase in the workload or additional costs for the institution, and can be applied in any Intensive Care Unit.

In conclusion, the importance of educational programs to raise health professionals' awareness of the importance of reducing VAPs and thus improving the health quality of patients using mechanical ventilators, bringing safety to care and reducing costs is highlighted. It is suggested that, with the elaboration of this protocol, the importance of all actions being carried out together and by a multidisciplinary team be stressed. However, it is observed that the low number of articles found on the subject in the databases investigated indicates the need to develop other studies, addressing the best level of evidence to treat EPI in children, since they are the most vulnerable patients to Health Care Related Infections.

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