

Amanda Sachetti^{1,2}, Viviane Rech¹, Alexandre Simões Dias^{2,3,4}, Caroline Fontana¹, Gilberto da Luz Barbosa^{5,6}, Dionara Schlichting⁶

Adherence to the items in a bundle for the prevention of ventilator-associated pneumonia

Adesão às medidas de um bundle para prevenção de pneumonia associada à ventilação mecânica

1. Faculdade de Fisioterapia, Universidade de Passo Fundo - Passo Fundo (RS), Brazil.
2. Postgraduate Program in Pneumology Sciences, Universidade Federal do Rio Grande do Sul - Porto Alegre (RS), Brazil.
3. Postgraduate Program in Human Movement Sciences, Escola de Educação Física, Universidade Federal do Rio Grande do Sul - Porto Alegre (RS), Brazil.
4. Physiotherapy Service, Hospital de Clínicas de Porto Alegre - Porto Alegre (RS), Brazil.
5. Faculdade de Medicina, Universidade de Passo Fundo - Passo Fundo (RS), Brazil.
6. Hospital Infection Control Unit, Hospital São Vicente de Paulo - Passo Fundo (RS), Brazil.

ABSTRACT

Objective: To assess adherence to a ventilator care bundle in an intensive care unit and to determine the impact of adherence on the rates of ventilator-associated pneumonia.

Methods: A total of 198 beds were assessed for 60 days using a checklist that consisted of the following items: bed head elevation to 30 to 45°; position of the humidifier filter; lack of fluid in the ventilator circuit; oral hygiene; cuff pressure; and physical therapy. Next, an educational lecture was delivered, and 235 beds were assessed for the following 60 days. Data were also collected on the incidence of ventilator-acquired pneumonia.

Results: Adherence to the following ventilator care bundle items increased:

bed head elevation from 18.7% to 34.5%; lack of fluid in the ventilator circuit from 55.6% to 72.8%; oral hygiene from 48.5% to 77.8%; and cuff pressure from 29.8% to 51.5%. The incidence of ventilator-associated pneumonia was statistically similar before and after intervention ($p=0.389$).

Conclusion: The educational intervention performed in this study increased the adherence to the ventilator care bundle, but the incidence of ventilator-associated pneumonia did not decrease in the small sample that was assessed.

Keywords: Health education; Ventilator-associated pneumonia/prevention & control; Intensive care units; Intervention studies

Conflicts of interest: None.

Submitted on May 10, 2014
Accepted on August 3, 2014

Corresponding author:

Amanda Sachetti
Faculdade de Fisioterapia da Universidade de Passo Fundo
Rua Harry Becker, 567 - Santa Maria
Zip code: 99070-190 - Passo Fundo (RS), Brazil
E-mail: amandasachetti@gmail.com

Responsible editor: Thiago Lisboa

DOI: 10.5935/0103-507X.20140054

INTRODUCTION

Infections are the most common hospital-acquired diseases and are currently considered to be a public health problem as a function of their high mortality rates. Although Fagon et al.⁽¹⁾ already highlighted that approximately a decade ago, the population still faces the same situation despite the advances in the techniques used. According to Porzecanski and Bowton⁽²⁾ and Martino,⁽³⁾ the incidence of ventilator-associated pneumonia (VAP) is seven to 21 times higher in intubated patients compared to that of non-intubated patients. Still, according to Porzecanski and Bowton,⁽²⁾ the length of stay in the intensive care unit (ICU) might increase by 6.1 days in cases with VAP, and the cost of hospital care might increase by up to USD 40,000 per patient. As a function of the relevance of that subject, hospital managers shown concern and have investigated approaches to prevent the occurrence of VAP in ICU. Within that context, the Institute for Healthcare Improvement (IHI) elaborated a bundle of items for the prevention of VAP based on scientific evidence.

As a function of the abovementioned arguments, the main aims of this study were to assess the adherence of professionals directly involved in the care of ICU patients to a bundle for VAP prevention as well as to analyze the impact of the bundle items on the VAP rates.

METHODS

This cross-sectional descriptive and quantitative study was conducted at the ICU of *Hospital São Vicente de Paulo, Passo Fundo*, which has 22 beds for patients from northern *Rio Grande do Sul* state, Brazil. That ICU admits approximately 2,000 patients per year. The study was approved by the Ethics Committee of the *Universidade de Passo Fundo*, ruling nº 453/2011, with a waiver of informed consent.

All of the beds occupied by patients subjected to invasive mechanical ventilation (MV) through orotracheal (OTT) or tracheostomy tubes were assessed for inclusion in the study from January to May 2012. Patients admitted to the central ICU of the selected regional hospital, with or without pneumonia, under invasive MV for at least 24 hours, and who remained at the ICU for at least 24 hours after data collection were included in the study. Individuals with restrictions as to the inclination of the bed head or the performance of physical therapy were excluded.

The bundle applied in this study was the same as those used at the *Hospital de Clínicas de Porto Alegre* in *Rio Grande do Sul* state in 2006.⁽⁴⁾ The bundle included the following items: bed head inclination 30° to 45°;⁽⁵⁾ humidifier filter connected to the OTT, which ought to be above the tracheal area; verification of lack of fluid in the ventilator circuit and humidifier filter;⁽⁶⁾ oral hygiene with chlorhexidine at least once per shift, i.e., three times per day;⁽⁷⁾ daily verification of the OTT cuff pressure, which ought to be maintained at 20 to 30 cmH₂O;⁽⁸⁾ and performance of physical therapy sessions three times per day.⁽⁹⁾

A pilot study lasting 15 days was previously conducted in August 2011 to assess the feasibility of this study as well as to perform the adjustments needed and identify eventual flaws in the procedures for data collection. The pilot study consisted of the verification of a checklist three times per day, i.e., once per shift, every day for 15 days by previously trained investigators. The checklist included the six items that comprised the bundle selected for application in this ICU, as described above. Those items were assessed in all of the beds occupied by patients under MV. After the end of the pilot study, the members of the team that performed

this study conducted several meetings to adjust and verify all of the variables and procedures for data collection.

Information regarding the inclusion criteria was collected from the patients' clinical records. The data were collected from a checklist, which should be routinely used at the hospital unit, with no need for patient collaboration. The adherence to the bundle was assessed using a checklist elaborated by these authors based on the IHI⁽¹⁰⁾ criteria and the bundle applied at the *Hospital de Clínicas de Porto Alegre* in 2006.⁽⁴⁾ That checklist was verified by always following the same steps relative to all of the beds included in the study in two different periods: before (60 days) and after (60 days) an educational intervention. Data collection was performed every third day in alternating shifts to avoid eventual measurement bias due to the habituation of the area workers. A four-day interval was established between the two periods of assessment to perform the abovementioned educational intervention and to organize the procedure.

The following items in the list were checked: lack of fluid in the ventilator circuit; position of the OTT-connected filter; and bed head at 30 to 45° - a red sticker was placed at each ICU bed to indicate the appropriate bed head inclination.⁽¹¹⁾ Information on the oral hygiene and physical therapy items was collected from the patients' clinical records, corresponding to the prescription made for the previous day. The cuff pressure was systematically checked using a Portex[®] cuff pressure indicator; the pressure level on inspiration was recorded.

After the initial period (60 days) of data collection, an educational intervention was performed that consisted of lectures to provide technical orientations to groups of five to 10 professionals from the area. The intervention lasted two days and included all the professionals in the area. All the items in the bundle as well as the need to adhere to its items were explained in the lectures.

The data relative to the incidence of VAP were retrospectively collected from the informatics system of the hospital central archive, corresponding to the pre- and post-intervention periods, to assess the impact of adherence to the bundle on that indicator. The patients with VAP were defined as including all of the cases for which the area intensivist physician had registered that diagnosis.

Statistical analysis

For the statistical analysis, the categorical variables were expressed as absolute and relative frequencies. Means were calculated using descriptive statistics. Comparison of

the adherence to the bundle items before and after the educational intervention was performed using Pearson's chi-square test, with the significance level set as ≤ 0.05 . The statistical analysis was performed using the software Statistical Package for Social Science for Windows (SPSS), version 20.0, Coimbra, Portugal.

RESULTS

The pre-intervention sample consisted of 198 beds/patients, and the post-intervention sample consisted of 235 beds/patients. Table 1 describes the frequency of the professionals' adherence to each bundle item. The adherence to the following four items was significantly greater during the post-intervention period compared to that of the pre-intervention period: bed head inclined 30 to 45°; lack of fluid in the ventilator circuits; cuff pressure; and oral hygiene. Among those items, the one most frequently performed during the post-intervention period was oral hygiene (29.3%) followed by cuff pressure, which increased by 21.7%, and lack of fluid in the ventilator circuit (17.2%). The item with the lowest rate of adherence among the items that exhibited significance was bed head elevation, the frequency of which increased by 15.8%.

Table 1 - Adherence to the bundle items

| Bundle items | Before intervention | After intervention | p value |
|---------------------------------|---------------------|--------------------|---------|
| Bed head position | 37 (18.7) | 81 (34.5) | <0.001 |
| Filter position | 161 (81.3) | 196 (83.4) | 0.658 |
| Fluid in the ventilator circuit | 110 (55.6) | 171 (72.8) | <0.001 |
| Cuff pressure | 59 (29.8) | 121 (51.5) | <0.001 |
| Physical therapy | 134 (67.7) | 155 (66.0) | 0.705 |
| Oral hygiene | 96 (48.5) | 183 (77.8) | <0.001 |

Results expressed as number (%). The p-value was calculated by means of Pearson's chi-square test.

The overall rate of adherence to the bundle items by the professionals during the post-intervention period was 66.7%. In no case was adherence to the bundle complete during either period of assessment. The rate of adherence was greater in the morning shift (55.4%) than that in the night shift (54%).

A total of 94 patients were diagnosed with VAP, 42 in the pre-intervention period and 52 in the post-intervention period, corresponding to 1,494 and 1,640 patient/days, respectively. Therefore, the incidence of VAP was similar in both periods of assessment, namely, 28.5 and 27.1/1,000 patients/day, respectively, $p=0.389$.

DISCUSSION

The frequency of adherence to the bundle by the professionals exhibited statistical significance in four out of the six items, namely, bed head inclined 30 to 45°; lack of fluid in the ventilator circuit; cuff pressure; and oral hygiene. The overall rate of adherence was 66.7%, and in no case was the adherence to the bundle complete during either period of assessment. The rate of adherence to the bundle was greatest in the morning shift, and the incidence of VAP was similar in both periods of assessment.

According to the IHI, the hospitals that adopted the bundle found that lower VAP rates are associated with adherence to all the items in the bundle, in which case the incidence of VAP might exhibit up to 40% reduction.⁽¹⁰⁾ In this study, a significant difference was found relative to the adherence to only four out of the six bundle items, and bed head elevation was the item with the lowest percentage of adherence (34.5%). This finding attracted the attention of the authors, as the beds had been adapted with markers indicating the 30-to-45° inclination since the beginning of the study. That result might be accounted for by frequent changes of decubitus and of the patients' position every day for the performance of procedures, which make keeping the bed in the appropriate inclination difficult. A possible strategy to improve the rate of adherence to that item might be to place warning signs on the beds as well as periodic provision of orientation to professionals.

The rate of adherence to the item lack of fluid in the ventilator circuit was 72.8%. This high rate of adherence in the post-intervention period might be accounted for by the simplicity of the technique as well as by the elucidation of some doubts raised by the professionals as to the time and conditions under which the circuit should be changed.

The rate of adherence to the item cuff pressure was 51.5%. The fact that this percentage was slightly over 50% might be accounted for by the various factors liable to modify the cuff pressure, such as manipulation during physical therapy sessions, bathing, and changes of decubitus, among others. The study by Stanzani et al.,⁽¹²⁾ who applied a questionnaire, found that after an educational intervention and the establishment of an assessment routine, the cuff pressure was adequate in 63.3% of the measurements. Based on the results reported by Stanzani et al.,⁽¹²⁾ it is believed that a possible strategy to improve the rate of adherence to this item would be to maintain the routine for cuff pressure measurement by the same professional at least once per shift or to perform

such measurement immediately after any procedure liable to modify the cuff internal pressure.

The rate of adherence to the item oral hygiene was 77.8% in the study. In the course of the educational intervention, the relevance of recording the performance of this procedure in the patients' clinical records was repeatedly stressed because we encountered difficulties in assessing whether that procedure had been performed or not, due to the lack of data in the clinical records. Nevertheless, it is believed that the considerable increase in the adherence rate was due to greater rigor at the time of the records. The performance of oral hygiene is effectively relevant as a function of the action of chlorhexidine on Gram-positive and Gram-negative bacteria⁽¹³⁾ and is associated with a reduced occurrence of VAP.⁽¹⁴⁾

The bundle items that did not exhibit significant adherence were the performance of physical therapy and the position of the humidifier filter. These two reasons might account for the results found relative to the item physical therapy: difficulty obtaining the participation of physical therapists at the time of intervention as a result of the demand of patients relative to the limited number of professionals and the lack of data regarding the performance of physical therapy in the patients' clinical records. With regard to the position of the humidifier filter, the high rate of adherence in the pre-intervention period might account for the lack of a significant difference in the rate of adherence after intervention.

In contrast to this study, Bird et al.⁽¹⁵⁾ found a reduction of the incidence of VAP following the adoption of preventive protocols. In contrast, in this study, the rate of VAP did not exhibit a reduction, which might most likely be explained by the short follow-up of the indexes,

the short duration of the educational intervention, and the partial adherence to the bundle items.

The rate of adherence to the bundle following educational intervention was 66.7%. That improvement in the rate of adherence notwithstanding, i.e., the intervention did not suffice to achieve excellent levels of adherence, is most likely due to its too short duration. Thus, other modalities of continued intervention are needed to improve the medium- and long-term results. In an observational study, Salahuddin et al.⁽¹⁶⁾ found that the VAP rates decreased to 51% following the establishment of a weekly bedside educational program, while the adherence to preventive practices was 95%. The study by Ferrer et al.⁽¹⁷⁾ observed rates of adherence to a program of educational intervention in the short and medium term and found that the rates of adherence increased immediately after intervention, only to decrease before one year had elapsed. Therefore, that type of strategy influences behavior only over a short period of time, and its effects decrease over time when intervention is not repeated on a regular basis.

The limitations of this study derive from the short duration of the educational intervention, the impossibility of encompassing all of the professionals from the area at the time of intervention, and the lack of data in the patients' clinical records, which hindered the confirmation of some of the data found.

CONCLUSION

The educational intervention performed in this study increased the adherence to the ventilator care bundle; however, the incidence of ventilator-associated pneumonia did not decrease in the small sample that was assessed.

RESUMO

Objetivo: Avaliar a adesão ao *bundle* de ventilação mecânica em uma unidade de terapia intensiva, bem como o impacto dessa adesão nas taxas de pneumonia associada à ventilação mecânica.

Métodos: Foram avaliados 198 leitos em 60 dias por meio de uma lista de checagem, contendo os itens: elevação da cabeceira de 30 a 45°, posição do filtro umidificador, ausência de líquidos no circuito do ventilador, higiene oral, pressão do balonete e fisioterapia. Posteriormente, foi realizada uma palestra educativa e foram avaliados outros 235 leitos nos 60 dias posteriores à intervenção. Ainda foram coletados dados de incidência de pneumonia associada à ventilação mecânica.

Resultados: O estudo demonstrou aumento da adesão dos seguintes itens do *bundle* de ventilação: elevação da cabeceira de 18,7% para 34,5%, ausência de líquidos no circuito do ventilador de 55,6% para 72,8%, higiene oral de 48,5% para 77,8%, e pressão do balonete de 29,8% para 51,5%. A incidência de pneumonia associada à ventilação mecânica foi estatisticamente semelhante em ambos os períodos ($p=0,389$).

Conclusão: Esta intervenção educacional resultou em aumento da adesão ao *bundle* de ventilação, porém não foi possível detectar redução na incidência de pneumonia associada à ventilação mecânica na pequena amostra estudada.

Descritores: Educação em saúde; Pneumonia associada à ventilação mecânica/prevenção & controle; Unidades de terapia intensiva; Estudos de intervenção

REFERENCES

1. Fagon JY, Chastre J, Hance AJ, Montravers P, Novara A, Gilbert C. Nosocomial pneumonia in ventilated patients: a cohort study evaluating attributable mortality and hospital stay. *Am J Med.* 1993;94(3):281-8.
2. Porzecanski I, Bowton DL. Diagnosis and treatment of ventilator-associated pneumonia. *Chest.* 2006;130(2):597-604. Review.
3. Martino M. Infecções do trato respiratório inferior. In: Levi CE. Manual de microbiologia clínica aplicada ao controle de infecção hospitalar. São Paulo: APECIH; 2004.
4. Vieira DF. Implantação de protocolo de prevenção da pneumonia associada à ventilação mecânica: impacto do cuidado não farmacológico [tese]. Porto Alegre: Faculdade de Medicina da Universidade Federal do Rio Grande do Sul; 2009.
5. Drakulovic MB, Torres A, Bauer TT, Nicolas JM, Nogué S, Ferrer M. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. *Lancet.* 1999; 354(9193):1851-8.
6. Díaz LA, Llauradó M, Rello J, Restrepo ML. [Non-pharmacological prevention of ventilator-associated pneumonia]. *Arch Bronconeumol.* 2010;46(4):188-95. Review. Spanish.
7. Cason CL, Tyner T, Saunders S, Broome L; Centers for Disease Control and Prevention. Nurses' implementation of guidelines for ventilator-associated pneumonia from the Centers for Disease Control and Prevention. *Am J Crit Care.* 2007;16(1):28-36; discussion 37; quiz 38.
8. Eaton KA, Biller DS, DiBartola SP, Radin MJ, Wellman ML. Autosomal dominant polycystic kidney disease in Persian and Persian-cross cats. *Vet Pathol.* 1997; 34(2):117-26.
9. Jerre G, Beraldo MA, Silva TJ, Gastaldi A, Kondo C, Leme F, et al. Fisioterapia no paciente sob ventilação mecânica. *Rev Bras Ter Intensiva.* 2007;19(3):399-407.
10. Berwick DM. The 5 million lives campaign. Institute for Healthcare Improvement: Cambridge (Massachusetts) [Internet]. 2008. [cited 2014 Aug 13]. Available from: <http://www.ihl.org/Engage/Initiatives/Completed/5MillionLivesCampaign/Pages/default.aspx>
11. Williams Z, Chan R, Kelly E. A simple device to increase rates of compliance in maintaining 30-degree head-of-bed elevation in ventilated patients. *Crit Care Med.* 2008;36(4):1155-7.
12. Stanzini VL, Ribeiro R, Silva ES, Pinto WM. Conhecimento teórico-prático da equipe assistente sobre manejo e pressão do balonete endotraqueal. *ConScientiae Saúde.* 2009;8(1):25-34.
13. Fourrier F, Cau-Pottier E, Boutigny H, Roussel-Delvallez M, Jourdain M, Chopin C. Effects of dental plaque antiseptic decontamination on bacterial colonization and nosocomial infections in critically ill patients. *Intensive Care Med.* 2000;26(9):1239-47.
14. Carvajal C, Pobo A, Díaz E, Lisboa T, Llauradó M, Rello J. Higiene oral con clorhexidina para la prevención de neumonia en pacientes intubados: revisión sistemática de ensayos clínicos aleatorizados. *Med Clin.* 2010;135(11):491-7.
15. Bird D, Zambuto A, O'Donnell C, Silva J, Korn C, Burke R, et al. Adherence to ventilator-associated pneumonia bundle and incidence of ventilator-associated pneumonia in the surgical intensive care unit. *Arch Surg.* 2010;145(5):465-70.
16. Salahuddin N, Zafar A, Sukhyani L, Rahin S, Noor NF, Hussain K, et al. Reducing ventilator-associated pneumonia rates through a staff education programme. *J Hosp Infect.* 2004;57(3):223-7.
17. Ferrer R, Artigas A, Levy MM, Blanco J, González Díaz G, Garnacho-Montero J, Ibáñez J, Palencia E, Quintana M, de la Torre-Prados MV; Edusepsis Study Group. Improvement in process of care and outcome after a multicenter severe sepsis educational program in Spain. *JAMA.* 2008;299(19):2294-303.