Original Article

Nursing actions for the prevention of ventilator-associated pneumonia*

Ações de enfermagem na profilaxia da pneumonia associada à ventilação mecânica

Acciones de enfermería en la profilaxis de la pneumonía asociada a la ventilación mecánica

Fernanda Alves Ferreira Gonçalves[1], Virginia Visconde Brasil[2], Luana Cássia Miranda Ribeiro[3], Anaclara Ferreira Veiga Tipple[4]

ABSTRACT

Objective: To identify prevention actions of the nursing team related to ventilator-associated pneumonia (VAP). **Method:** A cross-sectional, observational study conducted in an Intensive Care Unit of a teaching hospital in Goiania/GO. **Results:**Hand hygiene occurred, mainly, after the procedures and most of care, such as elevating the head-of-bed, bronchial and oral hygiene, diet administration, also handlingmechanical ventilator circuits were not adequate and if experienced groups such as the one in the present study are not following the recommendations emerging from evidence, it may indicate that, for some reason, the learning is not being significant. **Conclusion:** Most recommendedmeasures to reduce VAP related to positioning the head-of-bed, bronchial and oral hygiene, administration of diet and handling mechanical ventilator circuit were not followed.

Keywords: Pneumonia, ventilator associated; Disease prevention; Intensive care units; Nursing care

RESUMO

Objetivos: identificar as ações da equipe de enfermagem relacionadas à profilaxia da pneumonia associada à ventilação mecânica (PAV). **Método:** estudo transversal, observacional realizado na Unidade de Terapia Intensiva de um hospital escola de Goiânia/GO. **Resultados:** A higiene das mãos ocorreu, sobretudo, após os procedimentos e a maioria dos cuidados como a elevação da cabeceira, higiene brônquica e bucal, administração da dieta e também dos cuidados com os circuitos do ventilador mecânico não foram adequados e, se grupos experientes como o do presente estudo, não estão seguindo as recomendações oriundas das evidências, pode ser indício de que, por alguma razão, o aprendizado não está sendo significativo. **Conclusão:** A maioria das medidas recomendadas para reduzir a PAV relacionadas ao posicionamento da cabeceira da cama, à higiene brônquica e bucal, à administração de dieta e ao manejo dos circuitos do ventilador mecânico não foi seguida.

Descritores: Pneumonia associada à ventilação mecânica; Prevenção de doenças; Unidades de Terapia Intensiva; Cuidados de Enfermagem

RESUMEN

Objetivos: identificar las acciones del equipo de enfermería relacionadas a la profilaxis de la pneumonía asociada a la ventilación mecánica (PAV). **Método:** estudio transversal, observacional realizado en la Unidad de Cuidados Intensivos de un hospital docente de Goiânia/GO. **Resultados:** La higiene de las manos ocurrió, sobre todo, después de los procedimientos y la mayoría de los cuidados como la elevación de la cabecera, higiene bronquial y bucal, administración de la dieta y también de los cuidados con los circuitos del ventilador mecánico no fueron adecuados y, si los grupos con experiencia como el del presente estudio, no están siguiendo las recomendaciones oriundas de las evidencias, puede ser indicio de que, por alguna razón, el aprendizaje no está siendo significativo. **Conclusión:** La mayoría de las medidas recomendadas para reducir la PAV relacionadas a la posición de la cabecera de la cama, a la higiene bronquial y bucal, a la administración de la dieta y al manejo de los circuitos del ventilador mecánico, no fueron tomados en cuenta.

Descriptores: Neumonia asociada al ventilador; Prevención de enfermedades; Unidades de cuidados intensivos; Atención de enfermería

---

** Study conducted in the ICU of a large public institution, located in Goiania (GO), Brazil.*

[1] Master's Degree Student in Nursing, Nursing Graduate Program, School of Nursing, Federal University of Goias – UFG – Goiania (GO), Brazil.

[2] PhD. Professor of the Nursing Graduate Program, School of Nursing, Federal University of Goias – UFG – Goiania (GO), Brazil.

[3] Master's in Nursing, Nursing Graduate Program, School of Nursing, Federal University of Goias – UFG – Goiania (GO), Brazil.

[4] PhD. Professor at School of Nursing, Federal University of Goias – UFG – Goiania (GO), Brazil.

Corresponding Author: **Fernanda Alves Ferreira Gonçalves**
Rua Claudio Costa, Quadra 50 A, apto 204 R
Condomínio Morada Nova. Cidade Jardim. Goiânia-GO
E-mail: mestradofernanda@gmail.com

Received article **06/03/2012** and accepted **27/08/2012**

INTRODUCTION

The use of mechanical ventilation (MV) in the Intensive Care Unit (ICU) is frequent and exposes patients to the risk of getting ventilator-associated pneumonia (VAP), primarily by decreasing the natural defenses of the upper respiratory tract[1,2].

Research conducted in the ICUs of Europe demonstrated that VAP was the most frequent cause of nosocomial infection (2.1% or 13.9 episodes/1000 days of MV)[3], especially in France, where the rate was 16,9 episodes/1000 days of MV[4]. In the United States of America, this was the second most common cause in 2006, reaching 27% of critical condition patients[5] and in Brazil, 18.8% of customers developed VAP (58.2 episodes/1000 days of MV)[6] .

VAP is one of the infections related to health care, because it involves the relationship between pathogen, host and epidemiological variables[2]. In the United States of America, there is a concern about the measures for control and prevention of VAP, evidenced by the publication of the report To err is human: building a safer health care system, which highlighted the deficiencies in the area of patient safety and revealed 98,000 deaths per year as a result of medical errors[7].

After this publication, the world looked on healthcare quality and patient safety. In 2004, the Institute for Healthcare Improvement (IHI) promoted the campaign "100,000 lives"[8] and, in 2006, "Protecting 5 million lives"[9], aiming to protect clients from errors related to health care.

This campaign recommended the use of preventive measures package called bundles, proposed by experts in intensive care in order to control infection by surveillance[10]. The use of these measures have contributed to the reduction of mortality rates, infection rates and length of hospitalization[11-13]. In this sense, Ventilator bundles were proposed to prevent VAP[10,14,15] and it includes actions of the team treating the patient under MV and refers to the position in bed[16], oral and hands hygiene, airway cleaning, handling of the prosthesis and ventilatory circuits[1,17,18].

Thus, the activities of the team, working in an environment where the MV is frequently used, should be continually evaluated, aiming to improve the quality of care provided. It is worth noting that this study may be an important reference for physiotherapists, although it was conducted with nursing professionals, since in the unit of study, the nursing staff performs most procedures related to MV, studying their adherence to proposed actions for prevention of VAP can contribute to a safe care.

This study sought to perform a situational diagnosis of reality of an intensive care unit in order to identify the actions that are being conducted by the nursing staff related to the prevention of ventilator-associated pneumonia.

METHODS

This is an observational cross-sectional study, conducted from October 2010 to January 2011 in the ICU of a large public teaching institution, located in Goiania/GO. We observed 35 members of the nursing staff (07 nurses and 28 nursing technicians) who worked in the ICU for more than six (06) months and were working at the time of data collection.

Data collection was conducted through structured and participating observation, using a questionnaire to identify sociodemographic characteristics (gender, age, highest qualification, time of professional experience) and a questionnaire containing a checklist[19] adapted based on the GuidelinesforPreventing Health Care-Associated Pneumonia[20] and the recommendations of the National Health Surveillance Agency[1].

The adapted checklist included the steps of the procedures that should be performed before, during setting of the MV, early in the ventilation process, andwhen installing the nebulizer in the ventilator circuit, positioning the head-of-bedand lateral rotating position; technique execution of bronchial hygiene; used product and the technique for oral hygiene; verification of cuff pressure; installation and testing of enteral feeding. Hand hygiene was included within each checklist procedure.

We observed the steps of the procedures performed by staff in three work shifts and each professional was observed at least three times in different days, registering only procedures in which complete observation was possible (steps performed before, during and after the procedure). Hand hygiene was observed without the intention to verify the correct performance of the technique[21].

The collected data were entered into the Statistical Package for Social Science (SPSS) version 11.5 for Windows with descriptive statistical analysis.

The study was approved by the Research Ethics Committee of the Clinical Hospital of the Federal University of Goias, Protocol. 146/2010. The subjects were informed about the objectives of the study and signed a consent form. Because it was collected through participant observation and aiming not interfere with the results of the study, subjects were not informed about the time that the data collection would be conducted.

RESULTS

In terms of sociodemographic characteristics, (Table 1) 35 members of the nursing staff of the ICU participated in the study (92%), they were predominantly

female, with mean age of 40.1 ± 7.0 years. Most of the group were nursing technicians, although they already perform that function, ten (35.7%) were also bachelors in nursing and four (40%) were nurses. It is noteworthy that all nurses had a graduate degree in ICU.

Table 1. Sociodemographic characteristics of the nursing staff (n = 35) of an Intensive Care Unit of a teaching hospital in the city of Goiania/GO, 2010-2011

Sociodemographic Characteristics	n(%)
Gender	
Male	09(25.7)
Female	26(74.3)
Age	
20 – 40 years	19(54.3)
> 41 years	16(45.7)
Professional Category	
Nursing technicians	28(80.0)
Nurse	07(20.0)
Highest Qualification	
High School	15(42.9)
Nursing diploma	06(17.1)
Diploma inanother area	05(14.3)
Graduationlato sensuprogram	07(20.0)
Graduation stricto sensuprogram	02(5.7)
Time of professionalexperience	
Until 10 years	14(40.0)
11 to 20 years	16(45.7)
> 20 years	05(14.3)
Time of ICU experience	
Until 10 years	28(80.0)
11 to 20 years	07(20.0)
Week workload	
Until 30 hours	06(17.1)
31 to 60 hours	23(65.8)
>60 hours	06(17.1)

Study subjects had a mean of 13.7 ± 5.9 years of professional experience, mean of 8.8 ± 4.5 years working in the ICU and had a workload of over 31 hours per week.

During the 120 days of data collection 1086 procedures performed by nursing staff were observed, related to the care provided to clients in MV. We analyzed 882 procedures that had all steps performed by professionals of the team.

Hand hygiene (HH) with soap and water or 70% alcohol before and after the treatment provided to clients in MV was observed during various procedures, occurring mainly after the procedures, except during installation of enteral feeding (Table 2).

Table 2. Hand hygiene before and after procedures for preventing ventilator-associated pneumonia (n = 882), conducted by the nursing staff of the Intensive Care Unit of a teaching hospital in the city of Goiania/GO, 2010-2011

Hands Hygiene	Pre procedures		Post procedures	
	Yes n(%)	No n(%)	Yes n(%)	No n(%)
Cleaning, disinfecting setting respiratory equipment (n=90)	46(51.6)	44(48.4)	65(73.0)	25(27.0)
Handling equipment during VAP (n=106)	16(15.1)	90(84.9)	57(53.8)	49(46.2)
Handling and change of flasks (n=72)	18(25.0)	54(75.0)	30(41.7)	42(58.3)
Cuffpressure verification1(n=149)	26(96.3)	01(3.7)	22(81.4)	05(18.6)
Patient bed positioning (n=205)	69(33.8)	136(66.2)	22(10.7)	183(89.3)
Bronchial hygiene (n=100)	24(24.0)	76(76.0)	70(70.0)	30(70.0)
Oral hygiene (n=75)	27(36.0)	48(64.0)	40(53.3)	35(46.7)
Enteral tube instalation (n=25)	20(83.3)	05(16.7)	20(83.3)	05(16.7)
Nutrition change and placement (n=60)	09(15.0)	51(85.0)	30(50.0)	30(50.0)

[1] It was verified cuff pressure in 27 out of 149 occasions.

Before the start of MV (n = 90), the ventilator cleaning was performed, followed by, in most cases (97.7%), disinfection with 70% alcohol. It was not observed, however, aseptic care during setting of circuits (72.8%). The mechanical ventilator test was conductedin 77.7% of times by nurses.

During the beginning of the MV, the use of Heat and Moisture Exchangers (HME) filter occurred in 48.9% of times. In other occasions, the heated humidifier was used, which was attached and filled with sterile water at all times. However, when it was necessary to replace the water, the remaining liquid was not always discarded.

Regarding the disposal of condensatedliquid from ventilator circuits, it was observed that the liquid was discarded in the trash in 50.9% of the opportunities, and 61.1% of them, without the use of Personal Protective Equipment (PPE).

In the case of nebulizers, 94% of occasions (n = 106) the equipment was neither discarded after use, nor adequately protected, being stored in plastic bags or hanging near the bed until the next use.

Out of the 149 observed occasions, in 27 cuff pressure was verified of the endotracheal tube and most of them (90%) was made by the nurse. The mean value ofcuff pressure in tracheostomized clients was 31.8 ± 8.4 mmHg, the lowest value was 23 mmHg and and the highest value 60mmHg. When the intubation wasorotra-

cheal, the mean pressure was 28.1 ± 6.4 mmHg, with extremes between 20 and 40 mmHg.

Bed mobilization (n=205) occurred in 172 of cases (83.9%) and for each 1.81 hours per period. The mean of head-of-bed elevation (n = 204) was 35.5°, maintained at 72.1% observations exceeding 30°, and 27.9% of observation, less than 30° during procedures (bath, diapering, changing bed sheets and repositioning in bed, installation of catheters and hemodynamic measurements checking).

The clientsoral hygiene on mechanical ventilation was observed in 75 occasions. The number of times that each step of the procedure was performed was recorded in the data of Table 3.

Table 3. Care provided by the nursing staff of the Intensive Care Unit of a teaching hospital in the city of Goiania/GO, 2010-2011 during Oral Hygiene (n = 75)

Care	n(%)
1. Interrupted enteral feeding before procedure	07(9.3)
2. Explained the procedure to the client	43(57.3)
3. Kept head-of-bed elevated during procedure	48(64.0)
4. Lateral rotation of client head	18(24.0)
5. Verified cuffpressures before procedure	11(14.7)
6. Aspirated airways during procedure	50(66.7)
7. Changed endotracheal tube	25(33.3)
8. Performed teeth brush / teeth cleaning moving the brush sideways, with vibration of the gingiva to the tooth crown.	45(60.0)
9. Hygienized tongue	33(44.0)
10. Used water/saline solution for product rinse	59(78.7)
11. Used antiseptic after procedure	27(36.0)
12. Hydrated lips	04(5.3)
13. Checked nursing prescription	40(53.3)
14. Registered procedure on medical record	05(6.7)

Most of the 75 times that oral hygiene was performed, teeth cleaning was done with brush and toothpaste, and in 24% a gauze using spatula was involved in (tongue depressor) and 9% gauze involving their own finger.

The bronchial hygiene was performed with an open system type and the number of times that steps were performed on the data are described in Table 4.

Table 4. Care provided by the nursing staff of an intensive care unit of a teaching hospital of Goiania/GO, 2010-2011 during Bronchial Hygiene (n = 100)

Care	(%)
1. Explained the procedure to the client	41.0
2. Interrupted the enteral feeding during procedure[1]	13.5
3. Performed preoxigenation (100%) or doubled FiO2 before procedure	8.0
4. Opened aspiration catheter bag and connected catheter to latex without contaminate	95.0
5. Followed aspiration sequence	87.0
6. Changed the catheter after tube aspiration	25.0
7. Used sterilized gauze to clean catheter secretions and dominat hand for cleaning[2]	92.7
8. Had contact with catheter only with sterilized gloves	60.0
9. Changed gloves/catheter in case of contamination of catheter or glove3	8.3
10. Performed hyperoxygenation after tracheal aspiration or during breaks	8.0
11. Used bag-valve4	32.0
12. Protect bag-valve4 and Y of mechanical ventilator in the aspiration moment	20.0
13. Protected latex after aspiration in clean and dry package	95.0
14. Reassessed client after finishing the procedure	22.0
15. Wrote down the procedure and characteristics of the aspirated secretion	35.0

[1] In 96 occasions the client was using enteral feeding.
[2] In 96 occasions sterile gauze was used to clean the probe.
[3] The contamination of the catheter/glove occurred in 60 times.
[4] ManualResuscitator or ambu.

The nursing technician was responsible for performing bronchial hygiene in most opportunities (81%), and tracheal aspiration occurred without prior assessment of nurses in 55% of cases (n = 100).

The mean aspiration time was 29.3 seconds. During the procedure saline was used in 87% of the time due to the thick secretion and the volume instilled varied between three and 60 ml. At the end of procedure, the catheter was discarded each time and the aspirator latex was washed in 98% of cases.

Regarding installation of enteral feeding (n=25), nasally was predominant (91.7%). The test location of enteral probe was auscultatory in 91.7% of cases and in 8.3% of procedures, the nurse assessed the abdominal X-Ray.

As for the care for the installation and maintenance of diet (n=60), gastric residual volume (GRV)assessment occurred in 48.3%, and auscultation of bowel sounds (ABS) in 3.3% of occasions.

Another precaution observed is related to the maintenance of head-of-bed during the entire period

of infusion of enteral feeding, which has not occurred in 88.4% (n=60) of times. All diets were infused at room temperature for an infusion pump, and sometimes interrupted due to the vomiting (33.3%), GRV between 50 and 100 ml (50%) and GRV between 200 and 300ml (16.7%) .

DISCUSSION

The number of nurses (20%) identified in the unit of study was lower than nursing technicians, as it is common in Brazil, not reaching the recommendationof Resolution No. 293/2004 of the Federal Board of Nursing on professionals dimensioning to intensive care, which establishes 52% to 56% [22,23], consisting of nurses.

Nursing technicians perform their duties following the level of complexity and severity of the clients admitted to ICU[23-24], but certain actions such as tracheal aspiration and installation of enteral feeding should preferably be performed by nurses and in the unit studied, they were performed by nurse technicians.

The study population was predominantly young, female and with experience in ICU. Although experience indicates advantage, it has also been implicated as a limiting factor due to the risk of care being performed automatically, predisposing to error[25].

Studies on the actions of prevention of VAP recommends examining the measures of better evidence[1,10,20], among which stands out the hand hygiene[10,20] and the head-of-bed elevation[26]. In this perspective, the results obtained in this study corroborate the results of other studies on the low adherence to hand hygiene(HH)practice, especially before the procedure[27], confirming the need for ongoing educational activities as strategies to encourage HH . In this regard, a recent study showed reduction of VAP rates after the introduction of a multimodal program to encourage HH[28].

Care related to the circuits, nebulizers and HME filter are not part of the ventilatorbundles [10,14,15], however, the lack of asepsis during assembly of circuits and improper handling of nebulizers and HME filters are concerning based on results of this study. Regarding the HME filter, although not confirmed superior efficacy compared to the heated humidifier to the prophylaxis of VAP, it is recognized that its use decreases condensation in the tubes of the ventilator should be preferred for cost and ease of use[10].

Traditionally, the circuit humidification of the ventilator is performed with heated water, as in the studied unit. It is worth noting that the use of this system is considered disadvantageous, particularly when it comes to excessive handling by the condensation of water vapor, the need to supply constant power and water, causing additional risk of contamination of airways[10]. It is also highlighted in the results of the study, that by using this method of humidification, sterile water was completed and not discarded as recommended, in addition, the condensate in the tubes was discarded in inadequate place and without adequate PPE. These actions, taken together, favor infections related to health care[1].

In this study, we observed that an important precaution was not properly done by the team concerning the calibration of intracuffpressure of endotracheal tube, drawing attention for its low frequency (18.1%). In Brazil, it is recommended that this pressure should be measured at least three times per day[29]. Moreover, when it was checked, the values did not meet the recommended by the international literature between 14.7 mmHg and 22 mmHg[30].

The results of this study in relation to the elevation of the head-of-bed above 30° can be considered satisfactory. Researchers recommend that the positioning of 45° to individuals on ventilators should become a common practice in the ICU setting,because this tecniquecan significantly reduce the incidence of VAP in relation to the patient in supine and horizontal position[12,26]. It should be recognized, however, that the goal of keeping the head-of-bed to 45° is difficult to achieve, since patients often change position. In the daily unit studied, patients on MV were frequently positioned between 10° and 30°, even though evidence recommends that patients with MV should not be held in positions lower than 30°[26].

Although the head-of-bed was elevated most of times, it is emphasized the fact that the infusion of enteral feeding was not suspended during care such as oral or bronchial hygiene and changing position, it can contribute to VAP[20]. Maintenance of head-of-bed above 30° is contraindicated for decubitus ulcers, hemodialysis, continuous renal replacement therapy, the intra-aortic balloon, emergency procedures, hypotension, hemodynamic monitoring and postoperative process, pelvic or spine instability or in patients in palliative care due to terminal illness[10,12].

Oral hygiene care or control of the residual volume of enteral feeding are not emphasized in the recommendations of the Centers for Disease Control and Prevention (CDC)[20], but some scholars have speculated that this carerelated to prevention of VAP is viable, safe and with low cost[12].

Oral hygiene in critically ill adults is an important issue and, in this study, although teeth brushing occurred most often, it was not always accompanied by tongue cleaning and mouthwash use. There is no evidence that teeth brushing has a significant effect in reducing the incidence of VAP, the use of chlor-

hexidine and teeth brushing control the organisms of dental plaque, with bactericidal activity and reduction of micro-organisms[18].

Another recommended care for prophylaxis of VAP is the subglottic aspiration because the accumulation of secretion in this space is associated with increased risk of developing this disease[10]. Due to the lack of supra-cuff aspiration tube in the unit of the study, the aspiration system of choice is the open suction system, which has no difference in the incidence of VAP when compared to closed suction system[20].

Although not directly related to VAP, it should be noted that during the aspiration procedure no recommended oxygenation happened, at least one minute[31] before and after the procedure as a way to prevent hypoxemia. The fact was aggravated by the time that lasted the technique (mean 29.3 seconds), which should not exceed 15 second[31]. Furthermore, the instilled volume during aspiration was higher than the recommended maximum of five ml of saline solution during the procedure and only in case of necessity of use[17]. There are recent reports suggesting that the instillation of saline solution before aspiration is associated with decreased incidence of VAP in ventilated adults, on the other hand, there is controversy about the routine use associated with the possibility of contamination during hyperinflation with valve bag (ambu)[31].

In relation to the insertion of enteral feeding,theoral site is recommended, by the possibility of reducing the nosocomial sinusitis and the probability of oropharyngeal colonization[12]. However, in this study the nasal insertion prevailed, perhaps because it is considered common.

In addition, even though the routine of the unit researched is to check the gastric residual volume (GRV) every 4 to 6 hours and suspend the diet for one hour if greater than 1.5 times the amount provided per hour[12,32], this verification occurred in less than half of the observations, with suspension of the diet in case of vomiting and GRV between 50 and 300 mL. This shows that the team did not follow what is recommended for routine or proposals from other studies that, in case of GRV> 150 mL, one must suspend the diet, providing access to the small intestine endoscopic or percutaneous and perform a simultaneous gastric decompression[33].

Based on the results it is worth noting that the bundles have been recommended to replace the separate measures of prevention[10] and, if experienced groups such as the present study, are not following the recommendations emerging from evidence and from established routines for the unity, it may indicate that, for some reason, the learning is not being significant.

As the acquisition of knowledge does not occur homogeneously we must consider this diversity in future proposals for staff continuing education. Also, it is noteworth that the use of protocols improves the safety and quality of care in the ICU, but requires daily audit and periodic training of staff in order to produce the desired impact and care package[10,14-15] may be considered quality indicators.

CONCLUSIONS

The results show that most of actions recommended to reduce VAP are related to positioning the head-of-bed, bronchial and oral hygiene, administration of diet and handling mechanical ventilator circuit werenot followed. It is recommended that the unit of study keep evaluating the results of the actions as a measure for the safe care and that further studies of this nature are performed, identifying behavior of other groups working with the prevention of VAP.

REFERENCES

1. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária – ANVISA. Infecções do trato respiratório orientações para prevenção de infecções relacionadas à assistência à saúde. Brasília (DF): Ministério da Saúde; 2009.
2. Rotstein C, Evans G, Born A, Grossman R, Light B, Magder S, et al. Clinical practice guidelines for hospital-acquired pneumonia and ventilator-associated pneumonia in adults. Can J Infect Dis Med Microbiol. 2008; 19(1):19-53.
3. Hortal J, Giannella M, Pérez MJ, Barrio JM, Desco M, Bouza E, et al. Incidence and risk factors for ventilator-associated pneumonia after major heart surgery. Intensive Care Med. 2009; 35(9):1518-25.
4. Zahar JR, Nguile-Makao M, Français A, Schwebel C, Garrouste-Orgeas M, Goldgran-Toledano D, et al. Predicting the risk of documented ventilator-associated pneumonia for benchmarking: construction and validation of a score. Crit Care Med. 2009; 37(9):2545-51.
5. Koenig SM, Truwit JD. Ventilator-associated pneumonia: diagnosis, treatment, and prevention. Clin Microbiol Rev. 2006; 19(4):637-57.
6. Carrilho CM, Grion CM, Carvalho LM, Grion AS, Matsuo T. [Ventilator-associated pneumonia in surgical Intensive Care Unit. Rev Bras Ter Intensiva. 2006; 18(1):38-44.
7. Kohn LT, Corrigan JM, Donaldson MS. To err is human: building a safer health system. Washington: National Academy Press; 2000.
8. Institute for Healthcare Improvement – IHI. Getting started kit: prevent ventilator-associated pneumonia. How-to guide.100,000 lives campaign [Internet]. 2006 [cited 2011 May 12]. Available from: http://www.premierinc.com/safety/topics/bundling/downloads/03-vap-how-to-guide.pdf
9. Institute for Healthcare Improvement – IHI. Protecting 5

million lives from harm. Some is not a number. Soon is not a time [Internet]. 2008 [cited 2011 May 12]. Available from: http://www.ihi.org/IHI/Programs/Campaign/.

10. Scotish Intensive Care Society Audit Group – SICSAG. VAP prevention bundle. Guidance for implementation. National Services Scotland [Internet]. 2008 [cited 2011 May 12]: Available from: http://www.sicsag.scot.nhs.uk/SubGroup/VAP_Prevention_Bundle_Guidance_For_Implementation1.pdf
11. O'Keefe-McCarthy S, Santiago C, Lau G. Ventilator-associated pneumonia bundled strategies: an evidence-based practice. Worldviews Evid Based Nurs. 2008; 5(4):193-204.
12. Tolentino-DelosReyes AF, Ruppert SD, Shiao SY. Evidence-based practice: use of the ventilator bundle to prevent ventilator-associated pneumonia. Am J Crit Care. 2007; 16(1):20-7.
13. Wip C, Napolitano L. Bundles to prevent ventilator-associated pneumonia: how valuable are they? Curr Opin Infect Dis. 2009; 22(2):159-66.
14. Al-Tawfiq JA, Abed MS. Decreasing ventilator-associated pneumonia in adult intensive care units using the Institute for Healthcare Improvement bundle. Am J Infect Control. 2010; 38(7):552-6.
15. Blamoun J, Alfakir M, Rella ME, Wojcik JM, Solis RA, Anees Khan MA, et al. Efficacy of an expanded ventilator bundle for the reduction of ventilator-associated pneumonia in the medical intensive care unit. Am J Infect Control. 2009; 37(2):172-5.
16. Grap MJ, Munro CL, Hummel RS 3rd, Elswick RK Jr, Mckinney JL, Sessler CN. Effect of backrest elevation on the development of ventilator-associated pneumonia. Am J Crit Care. 2009; 14(4):325-32.
17. Farias GM, Freire IL, Ramos CS. [Intratracheal suction: study in patients of na emergency and intensive care unit in a hospital of the metropolitan region of Natal City – RN]. Rev Eletrônica Enferm. 2006; 8(1):63-9. Portuguese.
18. Munro CL, Grap MJ, Jones DJ, McClish DK, Sessler CN. Chlorhexidine, toothbrushing, and preventing ventilator-associated pneumonia in critically Ill adults. Am J Crit Care. 2010;18(5):428-37.
19. Freire IL. A ventilação mecânica invasiva e a intervenção da equipe de saúde na prevenção das pneumonias nosocomiais [dissertation]. Natal: Universidade Federal Rio Grande do Norte; 2005.
20. Tablan OC, Anderson LJ, Besser R, Bridges C, Hajjeh R; CDC; Healthcare Infection Control Practices Advisory Committee. Guidelines for preventing health-care--associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. MMWR Recomm Rep. 2004; 53(RR-3):1-36.
21. World Health Organization. World Alliance for Patient Safety. WHO guidelines on hand hygiene in health care (advanced draft): a summary. Clean hands are safer hands. Switzerland: WHO; 2005.
22. Conselho Federal de Enfermagem. Resolução COFEN nº 293/2004. Fixa e estabelece parâmetros para o dimensionar o quantitativo mínimo dos diferentes níveis de formação dos profissionais de enfermagem para a cobertura assistencial nas instituições de saúde. Diário Oficial da República Federativa do Brasil, Brasília (DF); 2004.
23. Perroca MG, Jericó MC, Calil AS. [Composition of the nursing staff in Intensive Care Units]. Acta Paul Enferm. 2011; 24(2):199-205. Portuguese.
24. Conselho Federal de Enfermagem. Lei n. 7.498, de 25 de junho de 1986. Dispõe sobre a regulamentação do exercício da enfermagem e dá outras providências. Diário Oficial da República Federativa do Brasil, Brasília (DF); 1986; Jun 26; Seção 1.
25. Freitas GF, Oguisso T. Nursing professionals profile and ethical occurrences. Acta Paul Enferm. 2007; 20(4):489-94.
26. Alexiou VG, Ierodiakonou V, Dimopoulos G, Falagas ME. Impact of patient position on the incidence of ventilator-associated pneumonia: a meta-analysis of randomized controlled trials. J Crit Care. 2009; 24(4):515-22.
27. Neves ZC, Tipple AF, Silva e Souza AC, Pereira MS, Melo DS, Ferreira LR. Hand hygiene: the impact of incentive strategies on adherence among healthcare workers from a newborn intensive care unit. Rev Latinoam Enferm. 2006; 14(4):546-52.
28. Koff MD, Corwin HL, Beach ML, Surgenor SD, Loftus RW. Reduction in ventilator associated pneumonia in a mixed intensive care unit after initiation of a novel hand hygiene program. J Crit Care. 2011; 26(5):489-95.
29. III Consenso Brasileiro de Ventilação Mecânica. Fisioterapia no paciente sob ventilação mecânica. J Bras Pneumol. 2007; 33(Supl 2):S142-50.
30. Sengupta P, Sessler DI, Maglinger P, Wells S, Vogt A, Durrani J, et al. Endotracheal tube cuff pressure in three hospitals, and the volume required to produce an appropriate cuff pressure. BMC Anesthesiol. 2004; 4(8):1-6.
31. American Association Respiratory Care. AARC Clinical Practice Guidelines. Endotracheal suctioning of mechanically ventilated patients with artificial airways 2010. Respir Care. 2010; 55(6):758-64.
32. Murray T, Goodyear-Bruch C. Ventilator-associated pneumonia improvement program. AACN Adv Crit Care. 2007; 18(2):190-9.
33. Oliveira SMD, Burgos MGPDA, Santos EMC, Prado LVDS, Petribú MDMV, Bonfim FMTDS. Gastrointestinal complications and protein-calorie adequacy in intensive care unit enteral nutrition patients. Rev Bras Ter Intensiva. 2010; 22(3):270-3.