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Clinical Assessment of Nursing Care Regarding Prevention of Ventilator-associated Pneumonia in Neonates

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) is the second common nosocomial infection in NICUs leading to some complications. Nurses are one of the main resources in health care that directly influence neonatal health care. Responsibility of most of preventive strategies related to VAP complications lies with nurses; therefore, nursing care should be assessed until the nurses show standard level of performance in hospitals. The aim of this cross-sectional study, conducted within 2015-2016, was to assess nursing care regarding VAP prevention in neonatal intensive care units (NICUs) in selected hospitals affiliated to Shahid Beheshti University of Medical Sciences.

Methods: In this descriptive cross-sectional study, 100 observations of nursing care regarding VAP were selected by convenience method in NICUs of Mahdiyeh, Mofid, and Imam Hossein hospitals affiliated to Shahid Beheshti University of Medical Sciences within 2015-2016. The data collection tools included demographic information questionnaire and a developed checklist related to VAP prevention. The observations were assessed and documented with two sampling methods, including time and event sampling. The data were analyzed in SPSS software (version 16).

Results: According to the results of the current study, the rate of compliance of nursing care with the standards for prevention of VAP in neonates under mechanical ventilation in NICU with developed standards was estimated at 62.81 percent.

Conclusion: Authorities should pay more attention to nursing cares especially incompetent cares explained in this study to increase the health of hospitalized neonates, decrease complications, length of stay, and costs. Moreover, future research is needed to investigate the reasons of this incompetency.

Keywords: Mechanical ventilation, Neonate, Nursing Care, Prevention, Ventilator-associated pneumonia

Introduction

Mechanical ventilation is commonly used in neonatal intensive care units (NICUs), suggested by three possible organisms, namely *Pseudomonas pseudoalcaligenes*, *Pseudomonas stutzeri* and *Burkholderia cepacia* (1, 2). Although it saves the life of many newborns, if inappropriately used it could cause some complications, (3). One of the most common complications is ventilator-associated pneumonia (VAP)(4). Pneumonia is the inflammation of lung, due to biological agents which are community-acquired or nosocomial(5). The Center for Disease Control and Prevention

(CDC) has defined VAP as a nosocomial infection in patients requiring mechanical ventilation for at least 48 hours(6). The VAP is the second most common nosocomial infection in NICUs leading to prolonged hospitalization, increase in medical costs, antibiotic use, prolonged mechanical ventilation, and morbidity rates(7). It is responsible for 6.8%-32.3% of nosocomial infections in NICUs(8) and its incidence in Asian countries is 3.5-46 cases per 1,000 intubated newborns per day. The incidence of VAP in developing countries is higher than that of developed countries(9-11). This

value in Iran has been reported as 17.3%(12) to 42%(13). VAP is a common and severe complication among NICU patients, and its treatment costs 30,000 US dollars for each affected newborn (14). The CDC recommends some criteria for diagnoses of VAP in patients younger than one year. This includes worsening gas exchange with at least three signs: unstable temperature with unknown cause, increased respiratory secretions, purulent sputum, abnormal white blood cell count, signs of respiratory distress, and abnormal heart rate (12, 15). Newborns are prone to nosocomial infections due to immune deficiency and skin and mucosal membrane vulnerable to infections (16). It occurs more in newborns on mechanical ventilation by tracheal intubation, compared to those on mechanical ventilation by continuous positive airway pressure (CPAP)(7). The risk factors for VAP can be classified into three groups, including host, device-related, and personnel-related factors. Host factors include prematurity, low birth weight, male sex, underlying disease, such as respiratory disease, genetic syndrome, immunodeficiency, and immunosuppressive medications, such as H2 blockers, broad-spectrum antibiotics, parenteral nutrition, transfusion of any blood product, bloodstream infection, reintubation that causes systemic infection, causes of secretion aspiration such as supine position, loss of consciousness after sedation, trauma, decreased gag reflux, and cough. Device-related factors include invasive procedures, such as central venous catheterization, the presence of endotracheal tube (ETT) and gastric tube, ventilator circuit, and increased duration of ventilation. Personnel-related factors include improper hand washing during interventions, such as suctioning and manipulation of the ventilator circuit, resulting in the cross-contamination of neonates (4, 6, 17, 18). The VAP can be prevented and its incidence is expected to decrease to a third of the initial incidence rate if health care workers take some measures in their practice, such as assessment of readiness to extubate, prevention of unplanned extubation and reintubation, using noninvasive forms of ventilation when feasible, proper hand hygiene, wearing gloves before coming into contact with secretions, using separate suction catheters for tracheal and mouth suctioning, avoiding disruption of the ventilation circuit, oral hygiene and wiping the oral cavity with normal saline, avoiding normal saline instillation with ETT suctioning, suctioning the ETT only when secretions are visible or there is a change in breath sounds or respiratory status, prevention of

aspiration by elevation of the head of the bed 30-45 degrees, avoiding abdominal distention and severe sedation, and excessive drugs to prevent drug resistance(8, 19-22). Responsibility of preventive strategies and newborns care on mechanical ventilation lie with nurse. Nurses are one of the main resources in health care that directly influence patient health care. Since nurses are always with patients and look after them, they have a positive effect on newborns' ventilation care and prevention of side effects. Therefore it is expected that they play an important role in the prevention of VAP (3, 23). NICU nurses play an important role in VAP prevention in newborns undergoing mechanical ventilation by applying acquired knowledge(24). They should be aware of possible complications so that they can take preventive measures. Nurses are at the central point of efforts to promote the quality of care in hospitals. They are key contributors to the care of patients and help other personnel to promote quality of care (13). Recently, many studies have reported on the epidemiology of VAP and its preventive methods; however, there is little information regarding nurses' performance level in VAP prevention(4), and authors are not able to find any research on this issue. Therefore, the assessment of nurses' compliance with standards for the prevention of VAP can improve their performance and provide clinical guidelines. This study aimed to assess the compliance rate of nursing care with standards in VAP prevention in newborns under mechanical ventilation.

Methods
Study design and participants
This descriptive cross-sectional study was conducted in 100 observation of nursing care of neonates undergoing ventilator by collecting data through a checklist at NICUs of Mahdiyeh, Mofid, and Imam Hossein Hospitals (51, 37, and 12 nursing cares, respectively) admitted to Shahid Beheshti University of Medical Sciences within 2015-2016. The checklist included 24 statements on the standard of careapropos VAP nursing cares in neonates undergoing ventilator by observation.

Two raters observed and filled checklists on 10 observations of VAP nursing care at the same time since there was no previous study on newborns. The accuracy of observations among the raters was approved by an intra-class correlation coefficient (ICC) of 0.96 (in the pilot study), and these 10 observations were excluded from the study. The 100 observations of nursing care were

selected by convenience method.

Data collection and measurements

In this study, nurses who had intubated patients with different work experience and education were selected in different shifts (morning, evening, and night), and their nursing care was observed. The data collection tools includeda demographic information questionnaire and a checklist regarding standard procedures of care for preventing VAP in newborns. This checklist was developed by reviewing literature and standards from neonatal intensive care textbooks and using articles from reliable scientific websites and based on the viewpoints of team experts in 24 items and 5 categories, and was scored according to a special formula with the highest score of 48 considered to be 100%.

The checklist consisted of criteria with two parts as follows:

1. "Yes", including:

A. Correct (When a score is given (2) to this part of a task that is carefully and properly done.)

B. Incorrect (When a score is given (1) to this part of task means that is not fully and properly done.)

2. "No" (When a score is given (0) to this part of a task that is not done.)

The checklist was assessed by face validity and content validity index (CVI) of 0.95 by 12 experts, including medicine and nursing faculty members, head nurses, and the nurses working in NICU. After summarization, their viewpoints were applied in formulating the checklist. In order to investigate the reliability of the tool, the authors also assessed the level of agreement among raters. Therefore, the checklist was given to a second rater, who was a specialist in NICU, and the raters completed the questionnaires concurrently for 10 nursing care-related observations to prevent VAP in newborns. Thereafter, the ICC of 0.98 was

calculated from the scores of two raters. To prevent the Hawthorne effect, the researcher did not fill the checklist in front of the nurses; immediately after the observations, she filled the checklist and increased her presence on the ward as an intern. After obtaining approval from university and college authorities, the researcher introduced herself to the selected hospitals. In morning, evening and night shifts, when nurses performed nursing care on the intubated neonates, the researcher recorded the observed cares into the checklist.

Data analysis

The collected data were entered into SPSS software (version 16.0) as the codes 0, 1 and 2 for "performed correctly", "performed wrongly" and "not performed," respectively. Statements in the checklist were scored and descriptive statistics (frequencies and percentages) were used to analyze the collected data.

Ethical consideration

This research is derived from a thesis for a Master of Nursing in Neonatal Intensive Care and has been approved by Shahid Beheshti University of Medical Sciences Num: SBMU2.REC.1394.80. In order to comply with the ethical considerations, the name of the hospitals will not be mentioned in the results the hospitals section.

Results

The results of the present study revealed that the highest rates of compliance with the standard were related to temperature monitoring, head and body positioning, and evaluating synchronous breathing with a ventilator. The lowest rates of compliance were related to assessing abdominal distention, adjustment of suction pressure, using separate suction catheters in ETT and mouth, nose suctioning, and auscultating the chest (Table 1).

Table 1. The Compliance rate of nursing cares with standards related to ventilator associated pneumonia prevention

Nursing Care Related to Prevention of VAP	Item	Percentage of practice
Prevention of unplanned extubation	Evaluate the security of endotracheal tubes Auscultation of breath sounds and evaluating synchronous chest wall movements Evaluating signs of distress Evaluating synchronous breathing with ventilator	67/25
Suction	Chest physiotherapy before suction Neutral positioning of head and body during suction Correct size and length of suction catheter according to weight or gestational age Suction Pressure between 60-100 mmHg Suction of ETT with Sterile Technique and Mouth and Nose with Clean Technique Suction ETT only when visible secretions, change in breath sounds or respiratory status Avoiding saline instillation with ETT suctioning Separate Suction Catheter in ETT and mouth-nose Suction	60/18

Table 1 Continued.

Prevention of aspiration	Note of Color and volume of secretions retrieved while clearing the oropharynx and endotracheal tube Note of Color and volume of secretions of Gastric Assessment of abdominal distention and it's Change 30 degree angle of head Make anti-reflux position with the help of a second person	55/5
Mouth Care	Wipe oral cavity with normal saline Clean lips mucus with wet cotton or gauze Lubricate lips	63/16
Infection Control	Hand washing wearing gloves when contact with secretions Temperature monitoring ever 3-4 hours avoiding ventilation circuit disruption	60/35

Table 2. The score of nursing care related to ventilator associated pneumonia prevention

Nursing care related to prevent VAP	N (%)
performed correctly	1202(50.1%)
performed wrongly	611(25.45%)
not performed	587(24.45%)
Total	2400(100%)
Score (%)	62.81

Generally, the compliance rate of VAP prevention nursing care was 62.84% (Table 2).

Discussion

In this study the nursing care related to VAP prevention was 62.84%, whiles a study on nurses' VAP prevention practices in Iran showed that 33.6% of the nurses had a relatively desirable performance and 66.4% of them had undesirable quality and the performance scores in suctioning, aspiration prevention, and oral care were 53.67%, 40.78%, and 18.87%, respectively. Moreover, the compliance rate in suctioning, aspiration prevention, and oral care were 60.18%, 55.5%, and 63.16%, respectively. It seems that the difference in total performance was due to the different study environments since their study was conducted on adult wards. According to the author, more attention should be paid to planning appropriate training programs for nurses, especially on wiping the oral cavity with normal saline, using separate suction catheters in the ETT and mouth, nose suctioning, and adjusting suction pressure(25). In another study on the knowledge and performance of nurses in NICU to prevent VAP in Tanzania, nurses had sufficient knowledge to prevent VAP; however, this knowledge had no effect on their performance, which was weak. The quality of their hand washing, cleanness of suction equipment, and oral health was insufficient. In the current study study, the oral health care and hand washing with standards were not low but were incompetent; accordingly, according to the author, nurses need to be encouraged to put knowledge into practice, and the environment and facility should enable nurses to adapt acceptable guidelines(4). In a study on recognizing strategies of VAP prevention practices by a nursing team in Brazil, the researchers reported that most of the nurses did not follow the VAP prevention recommendations about head positioning, oral health, and assessment of the ventilator circuit. In the present study, head positioning and oral health followed the standards, but not completely. As the authors said, this may indicate that their amount of learning was not significant(26). Additionally, a study conducted in Egypt to investigate nurses' knowledge and agreement on VAP prevention performance showed that the nurses did not have sufficient knowledge on VAP prevention and did not follow the latest recommendations by the CDC, including increasing head angle, suctioning of subglottic secretions, hand washing, oral health, and using gloves. Their findings were in contradiction to the results of the present study; however, as the authors suggested there is a need for training programs for nurses (27). Tajalli et al. indicated that educating the nursing staff about nursing care guidelines in neonates can augment the standard of care in neonatal units and NICUs (28).

This should lead to the reduction of complications associated with VAP and earlier weaning from mechanical ventilation, reduction in mechanical ventilation usage and length of stay, faster improvement of the health of newborn inpatients, and a reduction in hospital costs (19, 29, 30).

The results of another study on the investigation of the effect of training on VAP prevention principles on the knowledge and performance of nurses in Texas, showed that before training 11% of nurses washed their hands before touching the patient, 44% of them were positioning the patient's head at an angle of at least 30 degrees, and 51% were recorded more

than 30 degrees, 16% of nurses performed oral health three times in a shift and 3% of them checked the residue of gastric contents three times in a shift. After training, these numbers raised to 45%, 74%, 69%, 35%, and 18% respectively showing a remarkable level of improvement (31). In this study with respect to incompetent color and volume of gastric secretions, it could be concluded that training can improve nursing care level similar to previous study and should be paid more attention. Considering the limitation in this study, the presence of the researcher in the NICU may affect the nurses' performance; however, by passing the internship in these wards and increasing the number of presence times in the ward, the researcher made it look ordinary and decreased the impact of her presence as much as possible to rate nurses' real performance. Moreover, the reasons of incompetent care and their resolution were not intended.

Limitations

Presence of the researcher in the scene of the study may affect the nurses' performance during care process. Therefore, the researcher has been continuously involved in the wards in different shifts to normalize and reduce the effect of her presence as much as possible.

Suggestion

The improvement in the present study may be attributed to a combination of factors related to the gap between standard care and present care related to VAP in neonates. Since there is not a standard comprehensive checklist for nursing care regarding VAP in infants, the results of this study could be the basis for the standardization of these nursing cares and subsequent decisions on human resources programs, such as personnel selection and evaluation criteria in the neonatal ICU. Comprehensive familiarization of nurses and nursing students with the VAP prevention in newborn is one of the other applications of this research.

Conclusion

In conclusion, nursing care regarding adherence to neonatal ventilation guidelines was relatively competent; however, it is not enough. Because of the importance of VAP as a serious and life-threatening infection, authorities should pay more attention to nursing cares especially incompetent cares explained in this study in order to increase the health of hospitalized neonates, decrease

complications, length of stay, and costs. In addition, the causes of incompetency should be investigated in future researches.

Conflicts of interests

The authors declare that they have not conflict of interest.

References

1. Wijesooriya LI, Jayaratna HS, Wanasinghe DS. Exploring the cause of an outbreak of neonatal sepsis following ventilator-associated pneumonia in a base hospital, Sri Lanka 2018. 19th Conference on Postgraduate Research, International Postgraduate. University of Kelaniya, Sri Lanka; 2018.
2. Malhotra P, Kumar N, Thapar K, Bagga AK. Comparative study of incidence, risk factors, etiological agents and outcome of early and late ventilator associated pneumonia in paediatric intensive care unit at a tertiary care centre. Int J Contemp Pediatr. 2018; 5(3):708-13.
3. Gupta S, Sinha S. Care of the ventilated infant. Pediatr Child Health. 2009; 19(12):544-9.
4. Said A. Knowledge and practice of intensive care nurses on prevention of ventilator associated pneumonia at muhimbili national Hospital. Dar es Salaam, Tanzania. [Doctoral Dissertation]. Tanzania: Muhimbili University of Health and Allied Science; 2012.
5. Yazdani M, Sabetian G, Ra'ofi SH, Roudgari A, Feizi M. A comparative study of teaching clinical guideline for prevention of ventilator-associated pneumonia in two ways: face-to-face and workshop training on the knowledge and practice of nurses in the Intensive Care Unit. J Adv Med Educ Professionalism. 2015; 3(2):68.
6. Cernada M, Brugada M, Golombek S, Vento M. Ventilator-associated pneumonia in neonatal patients: an update. Neonatology. 2014; 105(2):98-107.
7. Fallahi M, Dasht AS, Naeempour N, Bassir M, Ghadamli P. Ventilator-associated pneumonia in hospitalized newborns in a neonatal intensive care unit. Arch Pediatr Infect Dis. 2014; 2(3):e16514.
8. Garland JS. Strategies to prevent ventilator-associated pneumonia in neonates. Clin Perinatol. 2010; 37(3):629-43.
9. Zhou Q, Lee SK, Jiang SY, Chen C, Kamaluddeen M,

Hu XJ, et al. Efficacy of an infection control program in reducing ventilator-associated pneumonia in a Chinese neonatal intensive care unit. Am J Infect Control. 2013; 41(11):1059-64.

10. Goerens A, Lehnick D, Büttcher M, Daetwyler K, Fontana M, Genet P, et al. Neonatal ventilator associated pneumonia: a quality improvement initiative focusing on antimicrobial stewardship. Front Pediatr. 2018; 6:262.

11. Sodhi MK, Kumar GA, Singh K, Kumar A, Malhotra S, Neki N. Incidence, clinical and microbiological pattern of ventilator associated pneumonia (VAP) in neonatal intensive care unit in Amritsar, India. Int J Curr Res Med Sci. 2018; 4(2):21-30.

12. Afjeh SA, Sabzehei MK, Karimi A, Shiva F, Shamshiri AR. Surveillance of ventilator-associated pneumonia in a neonatal intensive care unit: characteristics, risk factors, and outcome. Arch Iran Med. 2012; 15(9):567-71.

13. Moradi M, Nili F, Nayeri F, Amini E, Esmaeilnia T. Study of characteristics, risk factors and outcome for Ventilator Associated Pneumonia in Neonatal Intensive Care Unit patient. Tehran Univ Med J. 2013; 71(6):373-81.

14. Ceballos K, Waterman K, Hulett T, Makic MB. Nurse-driven quality improvement interventions to reduce hospital-acquired infection in the NICU. Adv Neonatal Care. 2013; 13(3):154-63.

15. Iosifidis E, Pitsava G, Roilides E. Ventilator-associated pneumonia in neonates and children: a systematic analysis of diagnostic methods and prevention. Future Microbiol. 2018; 13(12):1431-46.

16. Foglia E, Meier MD, Elward A. Ventilator-associated pneumonia in neonatal and pediatric intensive care unit patients. Clin Microbiol Rev. 2007; 20(3):409-25.

17. Brito DV, Brito CS, Resende DS, Moreira do Ó J, Abdallah VO, Gontijo Filho PP. Nosocomial infections in a Brazilian neonatal intensive care unit: a 4-year surveillance study. Rev Soc Bras Med Trop. 2010; 43(6):633-7.

18. Chawla R. Epidemiology, etiology, and diagnosis of hospital-acquired pneumonia and ventilator-associated pneumonia in Asian countries. Am J Infect Control. 2008; 36(4 Suppl):S93-100.

19. Goldsmith JP, Karotkin E, Suresh G, Keszler M. Assisted ventilation of the neonate e-book: evidence-based approach to newborn respiratory care. New York: Elsevier Health Sciences; 2016.

20. Aelami MH, Lotfi M, Zingg W. Ventilator-associated pneumonia in neonates, infants and children.

Antimicrob Resist Infect Control. 2014; 3(1):30.

21. Lucas A. The effect of a nurse-respiratory therapist weaning protocol on the duration of mechanical ventilation and the incidence of ventilator-associated pneumonia. Huntington, United States: The Graduate School of Marshall University; 2008.

22. McBeth CL, Montes RS, Powne A, North SE, Natale JE. Interprofessional approach to the sustained reduction in ventilator-associated pneumonia in a pediatric intensive care unit. Crit Care Nurse. 2018; 38(6):36-45.

23. Zolfaghari M, Aeen FB, Noghabi AA, Mehran A. Effects of active and passive implementation of ventilator associated pneumonia guideline on nurses' performance in critical care units: a controlled clinical trial. Nurs Pract Today. 2015; 1(3):126-34.

24. Thelan LA. Critical care nursing: diagnosis and management. Missouri: Mosby Inc: CV Mosby; 1994.

25. Aeen FB, Zolfaghari M, Asadi Noghabi AA, Mehran A. Nurses' performance in prevention of ventilator associated pneumonia. Hayat. 2013; 19(3):17-27.

26. Gonçalves FA, Brasil VV, Ribeiro LC, Tipple AF. Nursing actions for the prevention of ventilator-associated pneumonia. Acta Paulista Enfermagem. 2012; 25:101-7.

27. Ali NS. Critical Care Nurses' knowledge and compliance with ventilator associated pneumonia bundle at Cairo university hospitals. Crit Care. 2013; 4(15):66-78.

28. Tajalli S, Nourian M, Rassouli M, Baghestani AR. Clinical assessment of nursing care regarding hemovigilance in neonatal wards and neonatal intensive care units in selected hospitals affiliated to Shahid Beheshti University of Medical Sciences (2013-2014). Iran Red Crescent Med J. 2015; 17(7):e19987.

29. Jiang K, Wang C, Sun C, Zhong H, Yan S, Zhou S. Ventilator-associated pneumonia in premature newborns admitted to the intensive care unit. Int J Clin Exp Med. 2018; 11(5):4695-701.

30. Geslain G, Guellec I, Guedj R, Guilbert J, Jean S, Valentin C, et al. Incidence and risk factors of ventilator-associated pneumonia in neonatal intensive care unit: a first French study. Minerva Anestesiol. 2018; 84(7):829-35.

31. 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.