REVIEW

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The Nurse's Role in Preventing Ventilator-Associated Pneumonia

Ventilatörle İlişkili Pnömoniyi Önlemede Hemşirenin Rolü

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ABSTRACT

Ventilator-associated pneumonia(VAP) is an important condition constituting the half of the hospital-originated pneumonia cases. The ventilator-associated pneumonia can result from microorganisms in the patient's own flora, visitors, hospital staff, other patients and environmental factors. Elimination ofventilator-associated pneumonia, which causes high mortality rates, prolonged hospitalizations, excessive use of antibiotics and consequently increased health expenditures in adult patients with endotracheal intubation worldwide, is possible with multidisciplinary team work. In this adversaria, it is thought that the methods applied to eliminate the risk of ventilator-associated pneumonia and nursing practices will contribute to direct the care practices of the staff in charge and affect the patient care results positively.

Keywords: Ventilator-Associated Pneumonia, Risk Prevention, Nurse

ÖZ

Ventilatörle ilişkili pnömoni (VİP), hastane kaynaklı pnömoni vakalarının yarısını oluşturan önemli bir durumdur. Ventilatörle ilişkili pnömoni, hastanın kendi florasındaki mikroorganizmalardan, ziyaretçilerden, hastane çalışanlarından, diğer hastalardan ve çevresel etkenlerden kaynaklanabilir. Dünya genelinde endotrakeal entübe yetişkin hastalarda yüksek mortalite oranları, uzamış hastane yatışları, fazla antibiyotik kullanımı ve buna bağlı olarak artmış sağlık harcamalarına neden olan ventilatörle ilişkili pnömoninin, risk faktörlerinin ortadan kaldırılması mutidisipliner ekip çalışması ile mümkündür. Bu derlemede, ventilatörle ilişkili pnömoni riskini ortadan kaldırmak için uygulanan yöntemler ve hemşirelik uygulamaları ele alınarak, hemşirelerin bakım uygulamalarını yönlendirmelerine katkı sağlaması amaçlanmaktadır. Böylelikle hasta bakım sonuçlarının da olumlu yönde etkileneceği düşünülmektedir.

Anahtar Sözcükler: Ventilatörle İlişkili Pnömoni, Risk Önleme, Hemşire

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INTRODUCTION

Ventilator-associated pneumonia (VAP) is defined as pneumonia that occurs at least 48 hours following mechanical ventilation applied endotracheal intubation (1). VAP is characterized by symptoms of systemic infection (fever, altered white blood cell count), changes in sputum characteristics and detection of a causative microorganism following endotracheal intubation (2). VAP is the second most common hospital infection in the intensive care unit (ICU) and the most common hospital infection in patients undergoing mechanical ventilation (3). The risk of VAP is greatest in the first five days (3%) of mechanical ventilation and the time between intubation and VAP development is 3.3 days (2,3). In the statement made by the International Nosocomial Infection Control Consortium in 2013, the overall VAP rate is 13.6 attacks / 1000 ventilator days (4). Studies conducted by Chen et al. and Haghighi et al. found that the VAP incidence varied between 9% and 69% during the 1000-day mechanical ventilation period (5,6). It is stated that, in the world, the prevalence of VAP in ICU is approximately 9-28%, mortality ratio is at a high rate being between 24% and 70%, the data in Turkey are reported to be similar in this range (7-11). Individual rate varies depending on patient group, risk factors, and hospital environment (12). In our country, according to the National Hospital Infections Surveillance Network 2017 data, when the VAP rates of adult ICUs within the scope of university hospitals throughout Turkey are analyzed (during 1000 ventilator days), it was determined to be 10.7 in the anesthesiology and reanimation ICU and 15.2 in the brain surgery ICU, 19.2 in thoracic diseases ICU, 11.3 in internal diseases ICU, 10.9 in neurology ICU, 7.4 in thoracic surgery ICU, respectively. Approximately 50% of all antibiotics applied in ICUs are used for VAP treatment (8). VAP is divided into two groups depending on the day of emergence after tracheal intubation. Early-onset VAP is defined as pneumonia occurring within four days and this is usually caused by antibiotic sensitive pathogens. Late-onset VAP is caused by highly resistant bacteria and occurs after four days of intubation (2,3,8).This grouping is important in terms of differentiation of active pathogen agents according to the emergence day of VAP and antibiotic selection in the treatment to be applied (3). Microorganisms responsible for early-onset VAP are staphylococcus aureus, streptococcus pneumoniae and haemophilus influenzae; in late-onset pneumonia,hospital pathogens such as pseudomonas aeruginosa, methicillin-resistant staphylococcus aureus (MRSA), klebsiella species, and acinetobacter bauannii are responsible (12). Pneumonia is caused by microorganisms in the patient's own flora, visitors, hospital staff, other patients, environmental factors (13). VAP causes high mortality rates, prolonged hospital admissions, excessive use of antibiotics and consequently increased health expenditures in endotracheal intubated adult patients in ICUs worldwide (13).

RISK FACTORS

Many risk factors have been identified in VAP development. These risk factors are analyzed in three groups as patient-related risk factors, healthcare professionals-associated factors and treatment and care interventions (7,14). Patient-related factors are the patient's risk factors that exist before the intensive care unit and cannot be changed (15). Risk factors for treatment, care and healthcare professionals are changeable risk factors (14). Risk factors related to the patient that cannot be changed are male gender, advanced age (> 60), pre-existing lung disease, cardiopulmonary disease, immunosuppression therapy, thoracoabdominal surgery, excessive gastric aspiration, central nervous system surgery, trauma or burns, intracranial pressure monitoring,the severity of the disease (APACHE II score>16), coma (Glaskow coma score <9), presence of neuromuscular disease and multiple organ failure (15-18). The most important of changeable risk factors is invasive mechanical ventilation for more than 48 hours (19,20). This risk is followed by nasal intubation, mechanical ventilation with endotracheal intubation longer than two days, tracheostomy, insufficient subglottic aspiration, reintubation, cuff pressure below 20 cmH2O, unplanned extubation, insufficient hand hygiene, ineffective mouth cleaning, unnecessary frequent replacement of materials used, enteral nutrition, use of paralytic agents or application of continuous intravenous sedation, stress ulcer prophylaxis, transfer out of intensive care, patient's supineposition, prior use of antibiotics (15,18,21). Improving changeable risk factors will reduce the VAP incidence.

PREVENTION OF VAP DEVELOPMENT AND NURSE'S ROLE

Healthcare Improvement Institute care package practices are evidence-based interventions that significantly improve the patient's VAP outcome when applied together.Health Improvement Institute contains five materials in the VAP prevention package: Bedside height, oral care with chlorhexidine, stress ulcer prophylaxis, deep venous thrombosis prophylaxis and daily sedation assessment and spontaneous breathing trials. In addition to these items, it was updated in 2010 to include subglottic aspiration and endotracheal tube cuff pressure monitoring (22,23). Although the quality of evidence supporting the effectiveness and importance of each intervention has been questioned, each of these elements has been shown to reduce the incidence of VAP (24). In a study that implemented a systematic VAP prevention package using the Health Improvement Institute methodology, a significant reduction in VAP rates, antibiotic use, and MRSA acquisition was observed (22). Although

the Health ImprovementInstitute emphasizes the need for high (95%) overall compliance rates with VAP bundles, this particular study reported total package compliance rates as 70%. Effective approaches in the prevention of VAP are avoiding unnecessary use of stress ulcer prophylaxis, selective digestive system decontamination, oral care with chlorhexidine, hand hygiene, oral intubation, use of endotracheal tube that provides continuous subglottic aspiration, non-invasive mechanical ventilation, endotracheal tube cuff pressure, mechanical ventilator breathing circuit, frequency of use and replacement of humidifier, aspiration method, nutrition, disconnecting from ventilator, prevention of unplanned extubation and reintubation, and patient position (1,3,15,16,25).

1. Stress Ulcer Prophylaxis

Stress ulcer prophylaxis is applied to all patients in intensive care. The most preferred stress ulcer prophylactic drugs preferred in ICUs are H2 receptor antagonists, proton pump inhibitors and sucralfate (26). While drugs used in stress ulcer prophylaxis suppress gastric acid secretion and prevent gastrointestinal system (GIS) bleeding, they cause an increase in gastric pH and accordingly increase VAP risk with increased bacterial colonization. Therefore, it is recommended to avoid unnecessary use of stress ulcer prophylaxis (3,15,16,25). In the randomized controlled study conducted by Bashar et al. in patients with traumas, the effects of proton pump inhibitor drugs and H_2 receptor antagonist drugs on VAP were compared, and it was reported that ICU patients with whom proton pump inhibitors were used had three times the risk of developing VAP compared to the group using the H_2 receptor antagonist (27). The Manualfor the Prevention of Healthcare-Related Pneumonia recommends deciding which agent to use based on the patient's clinical condition (1).

2. Selective Digestive System Decontamination

The main purpose in selective digestive system decontamination is to destroy gram negative bacteria and fungi in the digestive system without damaging the anaerobic flora in the intestines (3,25). This application is based on the principle of preventing colonization of antimicrobial drugs such as colistin, tobramycin, amphotericine-B with digestive system and mouth pathogen microorganisms (28). In an intensive care study, it was reported that the application of selective digestive system decontamination reduced mortality by about 3.5%, and selective oropharyngeal decompression by approximately 2.9% (28). Since antibiotic resistance is a serious problem in intensive care units, there is no clarity in routinely using selective digestive system decontamination. For this reason, routine use of selective digestive system decontamination is not recommended in international manuals (3,15,16,25,28).

3. Oral Care With Chlorhexidine

Oral care reduces the risk of VAP by up to 60%, as it reduces the number of bacteria in the mouth, translocation and colonization in the lung. Patients receiving ventilation support with ETT cannot perform their daily oral hygiene, which carries a risk of biofilm colonization by pathogenic microorganisms (29). In a meta-analysis study, oral antiseptic use in 2144 patients has been reported to significantly reduce the incidence of VAP (30). Protocols on the use of oral antiseptics have been established to reduce and prevent oropharyngeal colonization of bacterial pathogens (29). There is a high level of evidence for the use of chlorhexidine gluconate against resistant bacteria that cause late-onset VAP (30-32). Health institutions should establish an oral care protocol and training plan in order to provide comprehensive oral care to the patient,oral care is recommended to be done with an antiseptic solution at 2- 4 hour intervals as to cover the teeth, cheeks and tongue (15,33). It is recommended to use 0.12% oral chlorhexidine to clean the oral cavity / pharynx with mouth sticks containing 1.5% hydrogen peroxide in mouth cleaning (25,33,34).

4. Hand Hygiene

Placing a sign in the patient room entrance in terms of visual warning to remind healthcare proffesionals to wash their hands and wear gloves is an easy and cost-effective measure that helps minimize bacterial contamination between patients in preventing cross contamination (15). It is the first line of defense to prevent bacterial colonization of the oropharynx and gastrointestinal tract (GIS) (16). Hands should be washed for 10 seconds before and after contact with patients, gloves should be worn when there is a risk of contact with oral or endotracheal secretions. Alcoholic hand antiseptic can be used if there is no visible contamination on the hands after contact with the equipment contaminated by mucous and respiratory secretions (1,15,16).

5. Oral Intubation

In the CDC / NHSN (2019) manual, it is recommended to apply an orotracheal tube instead of using a nasotracheal tube in intubation.Nasotracheal intubation application increases the risk of VAP compared to orotracheal intubation due to aspiration of infected secretions from the nasal sinuses. Therefore, if there are no contraindications, oral intubation should be preferred (1,15,16,35).

6. Endotracheal Tube Use Providing Continuoussubglottic Aspiration

Disruption of cough reflex causes accumulation of approximately 100-150 ml of secretion in the posterior part of the oropharynx in 24 hours (29). Accumulated secretions pass to the lower airways as a leak causing VAP. The use of tubes providing continuous subglottic aspiration reduces

the VAP rate by 45-50% (1,15). For this reason, it is beneficial to use special intubation and tracheostomy tubes that provide aspiration of secretions accumulating on the microaspiration and intratracheal tube balloon.

7. Non-Invasive Mechanical Ventilation

The most important risk factor in the development of VAP is the presence of endotracheal tube. It has been reported that the risk of VAP increases 6-21 times when ETT is used (35). Non-invasive mechanical ventilation (NIMV) should be considered whenever possible to avoid endotracheal intubation and to reduce the risk of VAP in patients with acute respiratory failure (1). In the meta-analysis study conducted in patients with chronic obstructive pulmonary disease (COPD), the effect of invasive positive pressure MV and non-invasive positive pressure MV was examined, and it was observed that non-invasive positive pressure MV significantly decreased the VAP incidence, mortality rate and ICU and hospital stay (36). Although NIMV is considered as an applicable alternative to invasive MV in some clinical conditions, it should be known that it is not applicable in all patients. Therefore, NIMV cannot replace MV and endotracheal intubation in all cases (35). Clinical conditions where NIMV can be used: COPD, patients with cardiogenic pulmonary edema, acute hypoxemic respiratory failure and immunocompromised respiratory failure (2).

8. Endotracheal Tube Cuff Pressure

Endotracheal tube cuff pressure of 20-30 cmH_2O is among the applications to prevent VAP (3). Cuff pressure lower than 20 cmH_2O causes gas leakage from the lower respiratory tract and subglottic secretions enter into the lower respiratory tract, which causes bacterial pathogens also to enter the lower respiratory tract, while cuff pressure higher than 30 cmH_2O causes mucosal ischemia due to barotrauma (15,16). Therefore, endotracheal tube balloon pressure should be monitored.

9. Mechanical Ventilator Breathing Circuit, Frequency Of Humidifier Use And Replacement

One of the risk factors associated with increasing hospital stay is frequent replacementin the ventilator circuit. It is recommended that only one respiratory circuit is used in patients undergoing MV and replaced only when there is mechanical damage or contamination (blood, vomiting or purulent secretion) (3,37). The fluid accumulated in the breathing circuits should be drained periodically, and only sterile water should be used in humidifier containers (3). As the water in the humidifier containers decreases, no additions are made; the water is replaced. It is not recommended to routinely replace humidifier filters unless there is visible contamination or malfunction. Instead of heated humidifiers, it is recommended to use heat-moisture exchanger traps (HME) if there are no contraindications (3,38,39).

10. Aspiration Method

Tracheobronchial aspiration is the procedure of removing the secretions of the respiratory system with a vacuum device operating with negative pressure in patients undergoing ETT. It is divided into two as open system and closed system aspiration method. In open system aspiration application, the patient is separated from the ventilator for a short period of time and the secretions are cleaned by following the principles of surgical asepsis with a disposable aspiration probe. In closed system aspiration application, there is a closed system aspiration probe connected to the ventilator circuit and used more than once. While the patient is connected to the ventilator, the secretions accumulated in the respiratory tract are removed, there is no need to wear sterile gloves (40). In a randomized controlled study, open system aspiration (n=75) method and closed system aspiration (n=66) method were compared, and no difference was observed between the two methods in terms of VAP incidence (41).The final manual for VAP prevention states that there is no difference between open aspiration and closed aspiration in terms of developing pneumonia (1).

11. Nutrition

Enteral nutrition is preferred to prevent parenteral nutrition complications of intensive care patients such as infection, cost, fluid-electrolyte imbalances. Nasogastric nutrition increases the risk of bacterial colonization and aspiration as it causes an increase in stomach volume and stomach pH (1). Nasogastric nutrition application is one of the important factors that play a role in the development of VAP due to the fact that it increases VAP development approximately three times (42). Keeping the head of the patient 30-45^{0}up during the nasogastric nutrition and monitoring the gastric residual volume reduces this risk to a minimum (42,43). Residue monitoring should not be neglected in enterally fed patients, and if 150-200 ml of fluid comes from the patient's stomach during residual control, nutrition should be interrupted for one or two hours (16,38,44).

12. Disconnecting From The Ventilator (Weaning)

Weaning from MV is a condition that requires close monitoring of the patient. Monitoring the patient's symptoms is necessary to detect a possible failure of the weaning process (breathing, tachycardia, sweating, oxygen desaturation, hypertension and increased anxiety) (44). The prolonged MV duration increases the risk of VAP. Therefore, it is important to keep MV time short (15). Today, the most commonly used separation method is the spontaneous breathing trial that allows observation for signs of respiratory failure. During a spontaneous breathing trial, the patient breathes automatically from the ETT attached to a T-piece (37). Since the duration of MV is difficult to estimate, current manuals recommend the use of protocols to assess whether there are

conditions for initiating the weaning from the ventilator (3, 16). Invasive MV weaning protocols involve discontinuation of sedation drugs because this procedure has been found to contribute to reduced MV time and reduced ICU stay time, and thus to reduce VAP risk (35,37).

13. Prevention Of Unplanned Extubation And Reintubation

Unplanned extubations generally result in reintubations within 48 hours. Reintubation increases the risk of developing VAP due to the high rate of aspiration. Adequate ICU personnel should be provided to minimize unplanned extubations that require reintubation, the intubation tube should be identified and continuously checked, and planned extubations should be carefully considered (3,44).

14. Half-Sitting Position

The purpose of raising the bedhead is to reduce the aspiration of the stomach contents. This initiative reduces VAP risk (45). Half-sitting position (30-45°) plays an important role in VAP development (44). In patients undergoing mechanical ventilation in the intensive care unit, the supine position (0°) causes aspiration of the contaminated stomach contents and increases the VAP incidence (46). If there is no medical contraindication such as increased intra-abdominal pressure, it is recommended to have a head height of 30-45° (25,47,48). In a randomized controlled study, a group of patients with a head position raised up to ≥30 ° and a group of patients with 0° to 10° head position were compared, and a significant reduction in VAP rates was detected in the patient group with a head position raised up to ≥30° (45). In a study conducted by Schallom et al., the head height of more than 30° has been shown to prolong the weaning process from the ventilator and increase the pressure injury especially in the sacral area other than VAP (49). In the study conducted by Ghezeljeh et al., the patients in the 45° head height group had 12.5% less VAP than those in the 30° head height group, and this difference was determined not to be statistically significant (50). While it is clear that supine position should be prevented in patients with MV associated with ETT, there is no clarity about head height. Clinical practice guidelines recommend keeping the head over 30° to prevent aspiration (44).

CONCLUSION

In order to prevent VAP, initiatives should be started from the moment the patient is intubated and continued until extubated.Although there are many risk factors in the development of VAP, it is a strong evidence that the frequency of VAP decreases with effective nursing practice. Keeping the bed head 30-45°up, providing oral care, preventing unplanned extubation, monitoring gastric residue, sterile endotracheal intubation, controlling endotracheal tube cuff pressure, mechanical ventilator breathing circuit, not replacing humidifier filters unless there is contamination, ensuring hand hygiene, aspiration of subglottic secretions are the initiatives that the nurse can implement independently to eliminate the risk of VAP. The intensive care nurse who provides care to patients receiving mechanical ventilator support with an endotracheal tube has critical responsibilities in preventing this important complication associated with healthcare. Nurses' fulfillment of their responsibilities for patients in the mechanical ventilator will contribute to improved quality of care, shorten the time of weaning from the ventilator and prevent VAP development.

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The authors declare that they have no conflict of interest.

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