Archives of Anesthesiology and Critical Care (Spring 2025); 11(2): 259-261.

Available online at http://aacc.tums.ac.ir

Letter to Editor

Ventilator-Associated Pneumonia Prevention Strategies in Patients with Brain Damage

Ali Jabbari[1,2], Shabnam Tabasi[3*], Hasan Mirzai[1]

[1]Ischemic Disorder Research Center, Golestan University of Medical Sciences, Gorgan, Iran.

[2]Department of Anesthesiology and Critical Care Medicine, Golestan University of Medical Sciences, Gorgan, Iran.

[3]Department of Internal Medicine, Golestan University of Medical Sciences, Gorgan, Iran.

ARTICLE INFO

Article history:
Received 24 March 2024
Revised 09 August 2024
Accepted 24 August 2024

Patients who suffer from stroke (cerebral vascular accident), brain tissue injuries including traumatic brain injuries or hypoxia; in treatment process require respiratory support and mechanical ventilation due to the decrease in level of consciousness or correction of hypoxia and hypercarbia. An endotracheal tube is inserted and subjected to invasive positive pressure ventilation. Most of these patients need to design a breathing pattern. The breathing pattern should guarantee an appropriate level of blood oxygen with a minimum fraction of inspired oxygen (FiO_2) and a volume target of alveolar ventilation in order to achieve partial pressure of carbon dioxide ($PaCO_2$) within therapeutic goals. Sedative-hypnotic drugs are usually prescribed for these patients in order to relieve pain, tolerate the tracheal tube more easily and prevent tachycardia and tachypnea [1-2].

Several factors make patients with brain injuries hospitalized in the intensive care unit (ICU) susceptible to severe respiratory infections caused by mechanical ventilation. Ventilator-associated pneumonia (VAP) is a hospital-acquired infection of the lung parenchyma that occurs in intensive care unit patients who have been mechanically ventilated for more than 48 hours [3]. It is the most common nosocomial infection, which is the cause of many deaths among critically ill patients admitted to the ICU [3].

The pathogenesis of VAP depends on the bacterial strains that colonize the oropharyngeal tract and nasogastric tract and reach the lower respiratory tract mainly through microaspiration of secretions containing bacteria. Base on the pathogenicity of the bacterial strains and the level of host response, lung infection will eventually occur [1,3].

If ventilator-induced pneumonia is suspected, chest X-ray and periodic sampling of tracheal tube secretions are necessary to diagnose and follow up treatment mechanically ventilated patients admitted to the ICU with comorbidities. Treatment of VAP is difficult due to the heterogeneity of etiological agents, reduced host defense level, coexisting disease, and high resistance to common antibacterial agents. The results of studies have shown that the common cause of early VAP is usually Enterobacteriaceae and Staphylococcus aureus, while late VAP is more associated with Escherichia coli, Pseudomonas aeruginosa, and Klebsiella pneumoniae. The culture results from the patients' lung secretions showed that about 28% of the patients had multi-microbial infections and 30% of the isolated pathogens were resistant to different antibiotics (Multi Drug Resistance) [1-3].

Management of VAP is one of the important strategies in intensive care units. The first step in managing VAP is prevention. Intensivists use different strategies for this

The authors declare no conflicts of interest.

*Corresponding author.
E-mail address: tabasi.dr@gmail.com

purpose. The accepted advice in this regard is the correct head-up position [2].

Some measures that are commonly used to prevent VAP in intensive care units include draining subglottic secretions and shortening the duration of mechanical ventilation. Oral and dental hygiene with chlorhexidine (CHX) and selected oral antiseptics, body washing with CHX, disinfection of the digestive tract with antiseptic regimens and administration of probiotics, endotracheal tubes with silver coating and vaporized hydrogen peroxide. It has been considered among the methods [2-5].

Chlorhexidine (CHX) is the most commonly used oral hygiene product in the intensive care unit. It acts as a broad-spectrum antimicrobial agent. After short-term (one hour) exposure of Staphylococcus aureus and Gram-negative bacilli with low concentration chlorhexidine (0.20% and 0.12%), it was found that these species are significantly sensitive to CHX. Patient skin acts as a known reservoir for VAP-associated pathogens. Microorganisms migrate to the oral cavity and subsequently to the lower respiratory tract and cause VAP. Chlorhexidine solution can be used to disinfect the body of patients. The residual antibacterial activity of CHX on skin can reduce the bacterial load on patients' skin and be used in VAP control strategy. It has proven the effectiveness of CHX in decreasing the rate of infection [3-5].

Selective disinfection of the gastrointestinal tract is used as a preventive strategy in critically ill patients with the aim of eradicating the pathogenic microorganisms of the gastrointestinal tract responsible for VAP [3].

It is recommended to avoid the routine administration of proton pump inhibitors (PPI) in order to prevent peptic ulcers because these drugs replace the flora of the digestive tract by changing the pH of the stomach and increase the possibility of VAP [2-3].

Probiotics can be prescribed as a promising solution for the prevention of VAP. Lactobacillus is a known probiotic agent. It decreases intestinal pH, enhanced mucin secretion, and creates a mucosal barrier that prevents adhesion and invasion of pathogens and colonization of acid-fast bacteria, including Pseudomonas aeruginosa. The results of the meta-analysis showed that the administration of probiotic products significantly reduces the incidence of VAP [4].

The use of antibiotics as prophylactic strategy is controversial. Different antibiotics with different routes of administration have been studied. One study found that prophylactic administration of piperacillin-tazobactam may reduce early-onset VAP, but this benefit does not apply to late-onset VAP [1,3].

Silver-coated endotracheal tubes (ETTs) are intended to reduce the bacterial load in the airways of mechanically ventilated patients. The researchers found a statistically significant reduction in VAP in patients intubated with it for more than 24 hours [2-3].

Vaporized hydrogen peroxide (VHP) has been introduced to disinfect the ICU environment. VHP disinfection has been introduced as a useful measure to combat the colonization of potentially pathogenic respiratory pathogens in mechanically ventilated patients hospitalized in the ICU and can be used in VAP prevention strategies [3].

Some investigators recommend the administration of an initial dose of ceftriaxone (2 g) in all settings for the prevention of early VAP in patients suffering from brain injury with reduced level of consciousness and the need for invasive mechanical ventilation [2].

Early infusion of single-dose prophylactic ceftriaxone reduces the risk of early VAP in patients with recent brain injury requiring positive-pressure mechanical ventilation for more than 48 hours. In the administration of a prophylactic dose of ceftriaxone, significant results in reducing the probability of VAP by 50%, increasing the survival rate and reducing the length of hospitalization have been reported [2-3].

Tobramycin by nebulization and intravenous prescription of ampicillin-sulbactam were considered as one of the most effective regimens for VAP prevention [2,4-5]. It has been shown that the administration of prophylactic antibiotics in enteral or intravenous form reduces the rate of VAP, but is not associated with significant clinical benefits such as increased survival or reduced length of hospitalization, for adult patients undergoing Invasive mechanical ventilation in ICUs. [1,3].

Some researchers suggest long-term courses of enteral or parenteral antibiotics as "prophylactic" for long-term VAP prevention to reduce the risk of mortality, while there are side effects of VAP prophylactic antibiotic administration, such as an increased likelihood of antimicrobial resistance. Of course, the results of randomized clinical trials that report a new outcome and the results have not yet been replicated; long term antibiotic administration should be used with caution in clinical practice. Long-term administration of prophylactic antibiotics for the prevention of VAP has been investigated in studies and reported with inconclusive results [1-3]. uncertainty regarding the risk/benefit combination has limited the use of long-term antimicrobial prophylaxis against VAP, and professional societies have not recommended this practice. The benefits of short-term antibiotic prophylaxis continue to be of interest.

Available evidence is insufficient to support same unit VAP control protocol, and many centers use different strategies and therefore different guidelines. The most compelling evidence comes from interventions that directly target key factors in the pathogenesis of VAP, especially when they are used jointly in a strategy. It

seems that according to the available evidence, it is reasonable to recommend the formulation of a guideline in the mechanically ventilated patients due to brain damage to prevent VAP.

In conclusion, it seems that the use of a preventive strategy including head-up position in all patients, use of chlorhexidine to improve oral hygiene, periodic administration of selective disinfection, use of vaporized hydrogen peroxide, and early administration of a single dose of ceftriaxone have a significant effect in the management of VAP in patients admitted to the ICU with brain lesions. Administration of probiotics could be a promising non-antibiotic intervention to reduce the incidence of VAP by minimizing colonization by more virulent species and optimizing host immune defenses.

Acknowledgments

The authors thank the colleagues of the Ischemic Disorders Research Center of Golestan University of Medical Sciences for their support during the research period.

References

[1] Mirtalaei N, Farazi A, Monfared ME, Jokar A. Efficacy of Antibiotic Prophylaxis against ventilator-associated pneumonia. J Hosp Infect. 2019; 101(3); 272-275.

[2] Dahyot-Fizelier C, Lasocki S, Kerforne T, Perrigault PF, Geeraerts T, Asehnoune K, et al. Ceftriaxone to prevent early ventilator-associated pneumonia in patients with acute brain injury: a multicentre, randomised, double-blind, placebo-controlled, assessor-masked superiority trial. Lancet Respir Med. 2024; 12(5):375-85.

[3] Cotoia A, Spadaro S, Gambetti G, Koulenti D, Cinnella G. Pathogenesis-targeted preventive strategies for multidrug resistant ventilator-associated pneumonia: a narrative review. Microorganisms. 2020; 8(6):821.

[4] Zha S, Niu J, He Z, Fu W, Huang Q, Guan L, et al. Prophylactic antibiotics for preventing ventilator-associated pneumonia: a pairwise and Bayesian network meta-analysis. Eur J Med Res. 2023; 28(1):348.

[5] Su M, Jia Y, Li Y, Zhou D, Jia J. Probiotics for the prevention of ventilator-associated pneumonia: a meta-analysis of randomized controlled trials. Respir Care. 2020; 65(5):673-85.