Original Investigation / *Özgün Araştırma*

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Ventilator-Associated Pneumonia in Pediatric Intensive Care: 7-Year Evaluation

Çocuk Yoğun Bakımda Ventilatör İlişkili Pnömoni: 7 Yıllık Değerlendirme

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Abstract

Objective: Ventilator-associated pneumonia (VAP) is hospital-acquired pneumonia that develops 48 hours after endotracheal intubation in patients receiving invasive mechanical ventilation support. VAP is among the leading causes of morbidity and mortality in the intensive care unit. This study aimed to evaluate the demographic, clinical, diagnosis and prognosis of patients diagnosed with VAP in the pediatric intensive care unit.

Material and Methods: Of the 7.094 patients treated in the Pediatric Intensive Care Unit of Çukurova University Faculty of Medicine in the last seven years, 55 patients diagnosed with VAP were included in the study. Patient data were examined retrospectively from patient files.

Results: It was determined that 7.094 patients followed in the pediatric intensive care unit between 2016 and 2023 were hospitalized, the number of sick days was= 27.620, and the number of days spent on the ventilator was= 18.154. Fifty-five patients with a median age of 43 months (minimum= 3 months, maximum= 211 months) diagnosed with VAP were included in the study. VAP rate was= 3/1000 ventilator days. Thirty-one (56.4%) of the patients were girls and 24 (43.6%) were boys. The average length of stay of the patients was 36 days (minimum= 8 days, maximum= 219 days). Fifty-two of the patients (94.5%) had an underlying disease. In our study, it was determined that three patients died due to VAP, and VAP mortality rate was 5.5%. There were numerous microorganisms growing in the tracheal aspirate culture of 23 (41.8%) of the patients. Tracheal aspirate cultures showed 74.5% growth of *Acinetobacter baumannii*, 29.1% *Pseudomonas aeruginosa* and 23.6% *Klebsiella pneumonia*.

Öz

Giriş: Ventilatör ilişkili pnömoni (VİP), invaziv mekanik ventilasyon desteği alan hastalarda endotrakeal entübasyondan 48 saat sonra gelişen hastane kökenli pnömonidir. Ventilatör ilişkili pnömoni yoğun bakımda morbidite ve mortalitenin önde gelen nedenleri arasındadır. Bu çalışmada çocuk yoğun bakım ünitesinde VİP tanısıyla izlenen hastaların demografik, klinik, tanı ve prognozunun değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Çalışmaya Çukurova Üniversitesi Tıp Fakültesi Çocuk Yoğun Bakım Ünitesinde son yedi yılda tedavi edilen 7.094 hasta arasından VİP tanısı konulan 55 hasta dahil edilmiştir. Hastaların verileri hasta dosyalarından geriye dönük olarak incelenmiştir.

Bulgular: 2016-2023 yılları arasında çocuk yoğun bakım ünitesinde izlenmiş 7.094 hastanın yatırıldığı, hasta gün sayısının= 27.620, ventilatör gün sayısının= 18.154 olduğu saptandı. Çalışmaya VİP tanısı konulan ortanca yaşı 43 ay olan (minimum= 3 ay, maksimum= 211 ay) 55 hasta dahil edildi. Ventilatör ilişkili pnömoni hızı= 3/1000 ventilatör günü idi. Hastaların 31 (%56.4)'i kız, 24 (%43.6)'ü erkekti. Hastaların yatış süresi ortanca 36 gün idi (minimum= 8 gün, maksimum= 219 gün). Hastaların 52 (%94.5)'sinde altta yatan hastalık vardı. Çalışmamızda üç hastanın VİP nedeniyle yaşamını yitirdiği ve VİP mortalite oranının %5.5 olduğu belirlendi. Hastaların 23 (%41.8)'ünün trakeal aspirat kültürlerinde çoklu mikroorganizma üremesi vardı. Trakeal aspirat kültürlerinde %74.5 *Acinetobacter baumannii*, %29.1 *Pseudomonas aeruginosa*, %23.6 *Klebsiella pneumonia* üremesi vardı.

Sonuç: Ventilatör ilişkili pnömonide mortalitenin %50'ye kadar çıktığı bildirilmiştir. Ventilatör ilişkili pnömoni altta yatan hastalığı olan çocuklarda daha sık görülmekte ve mortalitesi de daha yüksek olmaktadır.

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Conclusion: Mortality in VAP has been reported to be up to 50%. VAP is more common in children with underlying diseases, and its mortality is higher. In addition to the high risk of mortality in ventricular-related pneumonia, other problems including prolonged hospitalization, increased treatment costs, increased use of antibiotics, prolonged use of antibiotics, and development of antibiotic resistance. Therefore, it is extremely important to comply with protective preventive methods in VAP.

Keywords: Child, intensive care, ventilator associated pneumonia

Ventilatör ilişkili pnömonide yüksek mortalite riski yanında; hastane yatışında uzama, artan tedavi maliyetleri, antibiyotik kullanımının artması, antibiyotik kullanımının uzaması ve antibiyotik direnç gelişimi diğer sorunlardır. Bu nedenle VİP'te koruyucu önleyici yöntemlere uyulması son derece önemlidir.

Anahtar Kelimeler: Çocuk, yoğun bakım, ventilatör ilişkili pnömoni

Introduction

Ventilator-associated pneumonia (VAP) is one of the most common nosocomial infections in pediatric intensive care units as well as in adult intensive care units (1-3). VAP is a term used to describe nosocomial pneumonia that develops in the lung parenchymal tissue in a patient who has been on invasive mechanical ventilation (endotracheal intubation or tracheostomy) for more than 48 hours in the intensive care unit (1-3). VAP is the second most common nosocomial infection among patients in pediatric and neonatal intensive care units (1-4). It is more common in adults, data on children are limited, therefore most of the information is obtained from adult studies (1-3). Patients who are endotracheally intubated due to acute airway management and patients who have tracheostomy due to chronic respiratory failure are at risk for VAP. In pediatric patients hospitalized in the intensive care unit, it is difficult to make a diagnosis of VAP, especially in young children, because of the frequent occurrence of underlying disease (Figure 1).

The causative pathogens of VAP may vary according to the country, city, hospital/unit flora, antibiotics used and infection control measures taken in the institution (3-5). According to the current literature, the incidence of VAP in children is very variable, with a variability of 0.7-21/1000 ventilator days in developing countries compared to developed countries (6).

VAP increases the duration of ventilator stay, hospitalization, morbidity and mortality. As a result, treatment costs are increasing (7). In this study, it was aimed to retrospectively evaluate the demographic, clinical, diagnostic and prognostic data of patients followed up in the pediatric intensive care unit with a diagnosis of VAP.

Materials and Methods

Among 7.094 patients treated in the pediatric intensive care unit of Çukurova University Faculty of Medicine between 2016 and 2023, 55 patients diagnosed with VAP were included in the study. Patients who underwent invasive mechanical ventilation for more than 48 hours in the pediatric intensive care unit and were diagnosed with VAP were included in the study. Demographic data, number of hospitalization days, underlying disease and microorganisms grown in tracheal aspirate cultures were recorded.

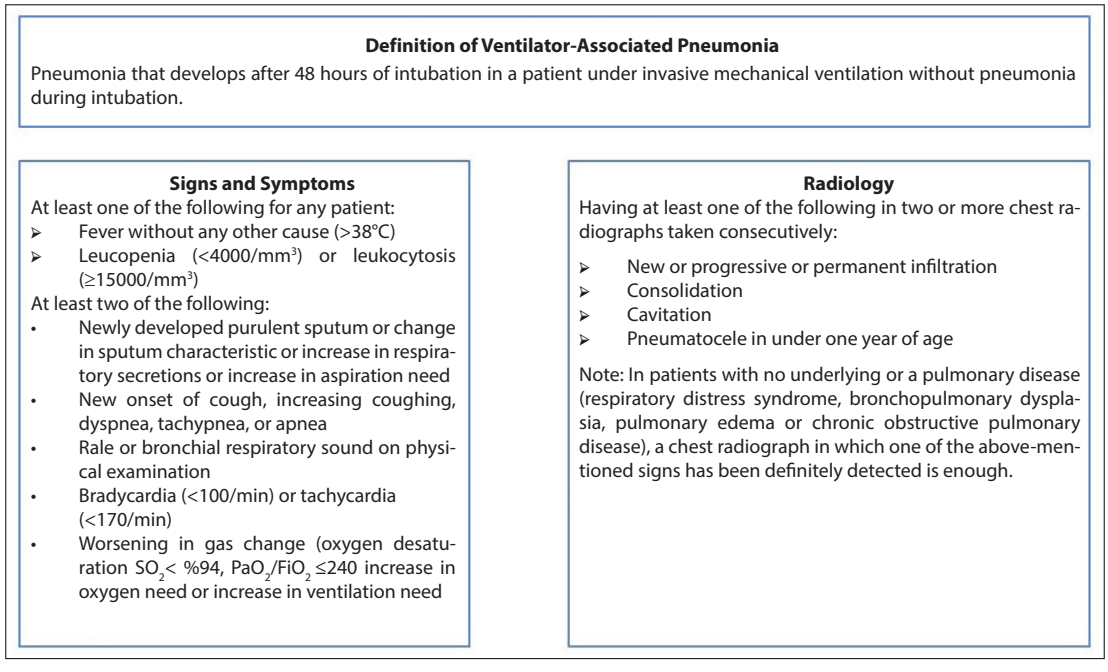

Figure 1. Diagnostic criteria for ventilator-associated pneumonia (8).

VAP diagnosis was based on clinical findings (fever, tachypnea, increased secretion, rales, ronchi, bronchospasm), the need for increased ventilator support, deterioration in laboratory values (leukocytosis, increased acute phase reactants), increased hypoxemia and findings on chest radiographs (Figure 1). In the study, ventilator utilization rate was calculated as ventilator days/inpatient days and VAP rate (number of VAPs/ventilator days) x 1000. The US Centers for Disease Control and Prevention (CDC) criteria were used in the calculation of the ventilator use rate and the rate of VAP (8).

Culture of tracheal aspirate samples and identification of pathogens grown in culture were performed at the Central Laboratory-Microbiology Unit of Çukurova University Medical Faculty Hospital. Gram stained preparations were prepared from tracheal aspirate samples and cultured on 5% Sheep Blood Agar, MacConkey agar and chocolate agar media by single colony inoculation method. The medium plates incubated at 37°C for 48-72 hours were evaluated daily. Identification of the isolates in the medium plates where growth was observed at genus/species level was performed by conventional methods and VITEK®2 (bioMérieux, Marcy l'Etoile, France) automated system.

Ethics committee approval was obtained from T.C. Çukurova University Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (Date: 03/11/2023, meeting no: 138).

Statistical Analysis

Statistical analysis of the study was performed with the Statistical Package for Social Sciences version 20 (IBM Corp., Armonk, NY, USA). Whether the numerical measurements in the study group met the assumption of normal distribution was tested with the Shapiro Wilk test, descriptive statistics of the parametric numerical data were calculated as mean ± standard deviation, median (minimum-maximum) of the non-parametric data, and categorical data were given as percentage (%). Chi-square test was used to compare categorical measurements between groups. The significance limit was accepted as $p< 0.05$ in the study.

Results

During the study period, 7.094 patients were hospitalized in the pediatric intensive care unit, the number of patient days was= 27.620 days and the number of ventilator days was= 18.154 days. VAP rate was= 3/1000 ventilator days. Ventilator utilization rate was= 0.66 (0.59 in 2016, 0.61 in 2017, 0.66 in 2018, 0.65 in 2019, 0.72 in 2020, 0.72 in 2021, 0.68 in 2022). There was no significant change in the rate of ventilator use between the years. Of the 55 patients diagnosed with VAP included in the study, 31 (56.4%) were female and 24 (43.6%) were male, with a median age of 43 months (minimum= 3, maximum= 211 months). Fifty-two (94.5%) of the patients had underlying disease. Of the patients with underlying disease, 20 (38.5%) had neurologic disease, 10 (19.2%) endocrine and metabolic diseases, 9 (17.3%) cardiac disease, 4 (7.7%) immunodeficiency and 9 (17.3%) other diseases. While 36 (65.5%) of the patients were endotracheally intubated, 19 (34.5%) had tracheostomy. In our study, 94.5% of the patients had an underlying chronic disease, 6 (10.9%) patients received gastroprotective therapy, 41 (74.5%) patients had a nasogastric tube inserted, and 31 (56.4%) patients received enteral nutrition. No data on steroid use were found in the patient files. Demographic characteristics of the patients included in the study are shown in Table 1.

Multiple microorganisms were grown in tracheal aspirate cultures of 23 patients (41.8%). Tracheal aspirate cultures grew *Acinetobacter baumannii* 74.5%, *Pseudomonas aeruginosa* 29.1%, *Klebsiella pneumonia* 23.6%, *Stenotrophomonas maltophilia* 5.5%, *Serratia marcescens* 5.5%, *Achromobacter xylosoxidans/denitrificans* 3.6%, *Klebsiella oxytoca* 1.8%, *Sphingomonas paucimobilis* 1.8% (Figure 2).

Table 1. Demographic and clinical characteristics of the patients

	Patients (n= 59)
Sex, n (%)	
Female	31 (56.4%)
Male	24 (43.6)
Age (month)	
Median (minimum-maximum)	43 (3-211)
Mean ± standard deviation	59.78 ± 58.84
Length of stay (day)	
Median (minimum-maximum)	36 (8-219)
Mean ± standard deviation	57.23 ± 51.08
Underlying disease	
Present	52 (94.5%)
None	3 (5.5%)
Intubation type, n (%)*	
Endotracheal	36 (65.5%)
Tracheostomy	19 (34.5%)
Transfusion, n (%)**	
Present	23 (41.8%)
None	32 (58.2%)
Drug use reducing gastric acidity***	
Present	6 (10.9%)
None	49 (89.1%)
Nasogastric tube****	
Present	41 (74.5%)
None	14 (25.5%)
Enteral feeding, n (%)*****	
Present	31 (56.4%)
None	24 (43.6%)
Mortality, n (%)	3 (5.5%)
There was no statistically significant association between mortality and risk factors. *p= 0.360, ** p= 0.544, *** p= 0.460, **** p= 0.328, ***** p= 0.775.	

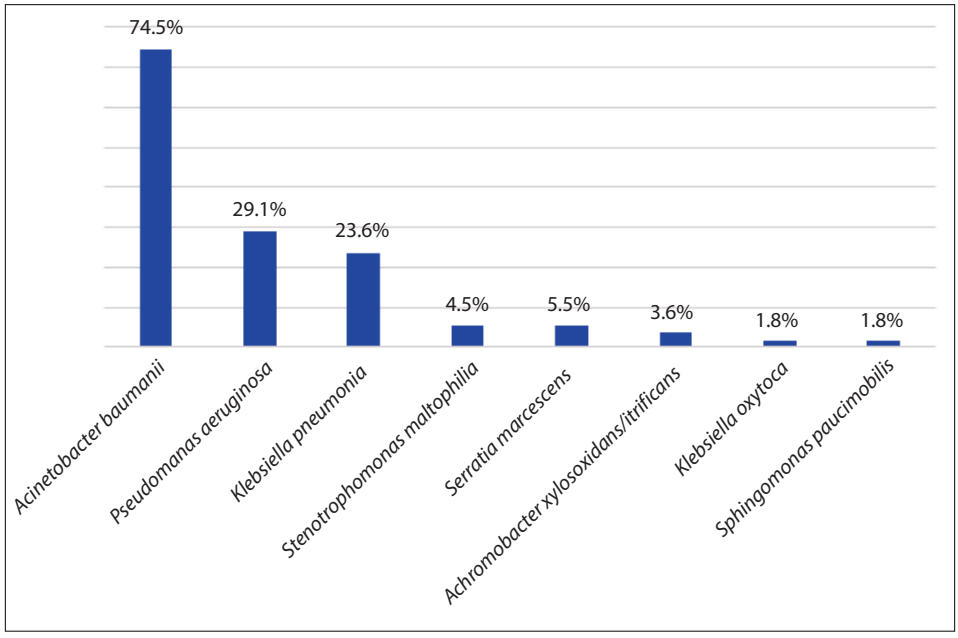

Figure 2. Microorganisms grown in tracheal aspirate cultures.

Median duration of hospitalization was 36 days (minimum= 8, maximum= 219 days). All patients were receiving broad spectrum antibiotics. The choice of antibiotic used in empirical treatment was planned according to the intensive care unit flora and the patient's past culture results. When the treatments initiated to the patients were analyzed, 31 (56.3%) of the patients were started on dual antibiotic treatment and 20 (36.3%) were started on single antibiotic treatment. In dual treatment, vancomycin and meropenem was the most commonly used combination with 38.2%. According to the culture antibiogram results of the patients, colistin was added to the treatment of 34 patients due to resistance to other antibiotics. Antibiotic data of four patients were not available. In our study, three patients died due to VAP. VAP mortality rate was 5.5% in our study (Table 1). No statistically significant correlation was found between mortality and VAP risk factors (type of intubation p= 0.360, transfusion p= 0.544, use of drugs that reduce gastric acidity p= 0.460, nasogastric tube p= 0.328, enteral nutrition p= 0.775).

Discussion

VAP, a medical complication associated with mechanical ventilation, is the second most common healthcare-associated infection after catheter-associated bloodstream infections in patients hospitalized in intensive care units. VAP increases treatment costs, morbidity and mortality by prolonging the duration of mechanical ventilator stay. As with most infectious diseases, VAP is more common in developing countries than in developed countries. In a prospective study conducted by Galal et al. in 427 patients receiving mechanical ventilation treatment, the incidence of VAP was found to be 21.3/1000 ventilator days (9). In a study conducted in India, they found the incidence of culture-confirmed VAP to be 24.4/1000 ventilator days (38.4/1000 ventilator days according to CDC criteria) (10). The incidence of VAP may vary according to the region, conditions and time interval of the intensive care unit even in the same country (7). In a study conducted by Van Wyk et al. in intensive care unit patients in 2013 and 2017, the incidence of VAP was found to be 4/1000 ventilator days in 2013 and 5.4/1000 ventilator days in 2017 (6). In developed countries, these rates are lower in tertiary intensive care units. In another study conducted in pediatric intensive care units in the United States of America, the incidence of VAP was found to be 0.7/1000 ventilator days and a regression of 1.2% was found in the last five years (11). In our study, the incidence of VAP was found to be 3/1000 ventilator days. In our study, when the incidence of VAP was calculated according to years, it varied between 3-5/1000 ventilator days in the period until 2022, while this rate was calculated as 1.5/1000 ventilator days in the last year. We think that this decrease has been achieved as a result of the increase in awareness about the prevention of VAP in recent years, the implementation of VAP preventive Bundle applications and increased education.

There are studies with different results regarding the relationship between VAP and gender. In the study by Vijay et al. the male sex ratio was found to be 71.4%, in another study the male sex ratio was found to be 57%, in the study by Galal et al. the female sex ratio was found to be 55% and in the study by Tekgündüz et al. the female sex ratio was found to be 55% (4,9,10,12). In our study, the female sex ratio was found to be 56.4%.

VAP prolongs the duration of hospitalization, and likewise, as the hospitalization period prolongs, the rates of VAP increase.

In our study, the median length of hospitalization was 36 days (minimum= 8, maximum= 219 days). There are different results in the literature regarding the length of hospitalization of patients with VAP and similar to our study, there were prolonged results. The median length of hospitalization was 16 days (8-22) in Galal et al. study, 25 days (17-37) in van Wyk et al. study, 81 days (40-182) in Gionfriddo et al. study, and 5-185 ventilator days in Tekgündüz et al. study (4,6,9,13).

VAP is observed more frequently especially in children with underlying diseases, and its mortality is higher. In our study, 94.5% of the patients had underlying diseases and almost 40% had neurologic diseases. In a similar study, all patients had underlying disease, mostly neurologic disease (4). In another study, underlying diseases were found in 66% of the patients and were mostly cardiac and neurologic diseases (14).

VAP is a nosocomial infection with a high mortality rate. Mortality rates are very variable due to the difficulties in the diagnosis of VAP, the fact that fewer studies have been conducted in pediatric patients compared to adult patients, and problems arising from records. Mortality rates varied according to the conditions of the intensive care unit in which the patients were hospitalized. The mortality rate which was 33% in the study by Gionfriddo et al. increased to 42.4% in the study by Vijay et al., 47.7% in the study by Meliyanti et al. and 68.2% in the study by Galal et al. (9,10,13,14). In our study, the mortality rate was found to be 5.5%. When national hospital surveillance network data were examined in our country, it was observed that the ventilator utilization rate in university hospitals was 0.54 and the VAP rate was 3.5/1000 ventilator days (15). In the pediatric intensive care unit of our hospital, general infection preventive measures and VAP preventive measures were implemented, and our results were similar to the national data, with a ventilator utilization rate of 0.66 and VAP rate of 3/1000 ventilator days.

In the literature, the most frequently isolated organisms in patients with VAP are *P. aeruginosa*, *Staphylococcus aureus*, *Haemophilus influenzae*, *A. baumannii and K. pneumoniae* (6,16). Different results can be observed in the studies conducted. The results may be affected by the flora of the centers where the study was conducted. While *P. aeruginosa* (47%) was found most frequently in Galal et al. study, *A. baumannii* (48%) was found in Vijay et al. study and *K. pneumoniae* (31%) was found in van Wyk et al. study. In our study, 41.8% of tracheal aspirate cultures grew multiple microorganisms. The most common agents were *A. baumannii* and *P. aeruginosa*. The increase in multidrug-resistant gram-negative strains negatively affects the outcomes of treatment of VAP. In addition to standard strategies to prevent VAP, antibiotics used in intensive care units should be carefully considered and unnecessary or unnecessary broad-spectrum antibiotics should not be used. Each unit should determine its own causative pathogen and resistance profiles and apply empirical treatments accordingly. It has been shown that multidrug-resistant gram-negative microorganisms such as *A. baumannii* decreased with these additional practices (17).

Conclusion

VAP diagnosis is not always easy because patients are in intensive care, have additional health problems and technical difficulties. The classic signs of lower respiratory tract infection (fever, cough, purulent sputum and new or progressive pulmonary infiltration on chest radiography) may not always be present and may belong to another disease such as atelectasis or acute respiratory distress syndrome. There is a need to increase awareness of the diagnosis of VAP and to emphasize general infection prevention measures and VAP prevention measures to reduce its incidence. The most important practice in the prevention of Healthcare-Associated Infections, and hence VAP, is staff training and hand hygiene. Preferring non-invasive mechanical ventilation in appropriate patients, avoiding sedation as much as possible, daily interruption of sedation and spontaneous breathing trials, daily evaluation of patients in terms of preparation for extubation, early mobilization, changing ventilator circuits in case of contamination and keeping the head of the bed at 30-45°C are the basic measures that can be taken in each unit. It is important for each unit to regularly monitor its own surveillance and antibiotic resistance in terms of measures to be taken.

Ethics Committe Approval: This study was approved by the Ethics Committee for non-Interventional Clinical Research of Çukurova University Faculty of Medicine, (Approval No: 138, Date: 03.11.2023).

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References

1. *Semenkovich TR, Frederiksen C, Hudson JL, Subramanian M, Kollef MH, Patterson GA, et al Postoperative pneumonia prevention in pulmonary resections: A feasibility pilot study. Ann Thorac Surg 2019;107(1):262-70. https://doi.org/10.1016/j.athoracsur.2018.08.008*
2. *Silva ARAD, Silva TCD, Bom GJT, Vasconcelos RMB, Junior RS. Ventilator-associated pneumonia agents in Brazilian Neonatal Intensive Care Units: A systematic review. Braz J Infect Dis 2018;22(4):338-44. https://doi.org/10.1016/j.bjid.2018.06.002*

3. *Antcliffe DB, Wolfer AM, O'Dea KP, Takata M, Holmes E, Gordon AC. Profiling inflammatory markers in patients with pneumonia on intensive care. Sci Rep 2018;8(1):14736. https://doi.org/10.1038/s41598-018-32938-6*
4. *Tekgündüz KŞ, Bulgan M, Türkay M. The retrospective analysis of the value of endotrac heal aspirate cultures for the diagnosis of ventilator-associated pneumonia in pediatric ıntensive care unit. J Pediatr Emerg Intens Care Med 2015;1:13-18. https://doi.org/10.5505/cayb.2015.44127*
5. *Erdoğan M, Özcengiz D. Ventilatör ilişkili pnömoni. J Hum Rhythm 2016;2(3):109-16.*
6. *van Wyk L, Applegate JT, Salie S. Ventilator-associated pneumonia in PICU: How are we doing?. South Afr J Crit Care 2022;38(2):10.7196/SAJCC.2022.v38i2.536. https://doi.org/10.7196/SAJCC.2022.v38i2.536*
7. *Watson K, Heales LJ, Fernando J, Reoch J, Tan E, Smith K, et al. Incidence and characteristics of ventilator-associated pneumonia in a regional non-tertiary Australian intensive care unit: Protocol for a retrospective clinical audit study. BMJ Open 2018;8(9):e021733. https://doi.org/10.1136/bmjopen-2018-021733*
8. *US Centers for Disease Control and Prevention. National Healthcare Safety Network. Pneumonia [Ventilator-associated (VAP) and non-ventilator-associated pneumonia (PNEU)] event. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/6pscvapcurrent.pdf. (Accessed date: 01.10.2023).*
9. *Galal YS, Youssef MR, Ibrahiem SK. Ventilator-associated pneumonia: Incidence, risk factors and outcome in paediatric intensive care units at Cairo University Hospital. J Clin of Diagn Res 2016;10(6):SC06-SC11. https://doi.org/10.7860/JCDR/2016/18570.7920*
10. *Vijay G, Mandal A, Sankar J, Kapil A, Lodha R, Kabra SK. Ventilator associated pneumonia in pediatric intensive care unit: Incidence, risk factors and etiological agents. Indian J Pediatr 2018;85(10):861-6. https://doi.org/10.1007/s12098-018-2662-8*
11. *Patrick SW, Kawai AT, Kleinman K, Jin R, Vaz L, Gay C, et al. Health care-associated infections among critically ill children in the US, 2007-2012. Pediatrics 2014;134(4):705-12. https://doi.org/10.1542/peds.2014-0613*
12. *Srinivasan R, Asselin J, Gildengorin G, Wiener-Kronish J, Flori HR. A prospective study of ventilator-associated pneumonia in children. Pediatrics 2009;123(4):1108-15. https://doi.org/10.1542/peds.2008-1211*
13. *Gionfriddo A, Nonoyama ML, Laussen PC, Cox PN, Clarke M, Floh AA. Retrospective application of new pediatric ventilator-associated pneumonia criteria identifies a high-risk population. Pediatr Crit Care Med 2018;19(6):507-12. https://doi.org/10.1097/PCC.0000000000001522*
14. *Meliyanti A, Rusmawatiningtyas D, Makrufardi F, Arguni E. Factors associated with mortality in pediatric pneumonia patients supported with mechanical ventilation in developing country. Heliyon 2021;7(5):e07063. https://doi.org/10.1016/j.heliyon.2021.e07063*
15. *Halk Sağlığı Genel Müdürlüğü. Ulusal Sağlık Hizmeti İlişkili Enfeksiyonlar Sürveyans Ağı (USHİESA) Özet Raporu 2022 Rehberi. Available from: https://hsgm.saglik.gov.tr/depo/birimler/bulasici-hastaliklar-ve-erken-uyari-db/Dokumanlar/Raporlar/USHIESA_OZET_RAPORU_2022.pdf (Accessed date: 01.10.2023).*
16. *Antalová N, Klučka J, Říhová M, Poláčková S, Pokorná A, Štourač P. Ventilator-associated pneumonia prevention in pediatric patients: Narrative review. Children (Basel) 2022;9(10):1540. https://doi.org/10.3390/children9101540*
17. *Ogutlu A, Guclu E, Karabay O, Utku AC, Tuna N, Yahyaoglu M. Effects of carbapenem consumption on the prevalence of acinetobacter infection in intensive care unit patients. Ann Clin Microbiol Antimicrob 2014;13:7. https://doi.org/10.1186/1476-0711-13-7*