



Respiratory Tract Infections in Trauma Patients in General Profile Intensive Care Units

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Received: March 25, 2024

Published: March 29, 2024

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Abstract

Introduction: Respiratory tract infections, such as purulent endobronchitis and healthcare-associated pneumonia, including ventilator-associated pneumonia (VAP), remain a relevant issue in the ICU. Infections with multidrug-resistant pathogens, particularly ESBL and carbapenemase producers, complicate the selection of appropriate antibiotic therapy, and inhalation of antibacterial agents remains a method of questionable efficacy. The updated classification of ventilator-associated conditions, including VAP, and assessment with the CPIS scale are intended to simplify diagnosis and guide healthcare professionals to actively identify these conditions. Despite some progress, respiratory tract infections remain a serious, life-threatening complication with a high mortality rate.

Materials and Methods: An analysis of medical records of inpatients treated in the Department of Anesthesiology and Intensive Care of Khmelnytskyi Regional Hospital Municipal Non-Profit Enterprise of Khmelnytskyi Regional Council, Ukraine, who required mechanical ventilation for more than 48 hours during the period 2021-2023 was conducted.

Conclusion: A high percentage of multidrug-resistant Gram-negative flora, mainly ESCAPE group microorganisms such as *A. baumannii*, *Kl. pneumoniae* and *Ps. aeruginosa*, continue to be isolated from sputum. The susceptibility of these pathogens to carbapenems, aminoglycosides, Cefoperazone/Sulbactam has decreased. The diagnosis of ventilator-associated pneumonia in general intensive care units remains extremely low. The use of a standardized approach to the diagnosis and antibacterial therapy of respiratory tract infections is beneficial.

Keywords: Ventilator-Associated Pneumonia; Bronchoalveolar Lavage (BAL); Escape

Introduction

More than 70% of intensive care unit (ICU) patients receive antibiotic therapy. Risk factors for multidrug-resistant bacterial colonization include prolonged hospital stay, admission or transfer to the intensive care unit, mechanical ventilation, invasive procedures, emergency surgery, and indiscriminate use of antibiotics [8,18].

Materials and Methods

An analysis of medical records of inpatients treated in the Intensive Care Unit (ICU) of Khmelnytskyi Regional Hospital Municipal Non-Profit Enterprise of Khmelnytskyi Regional Council, with the diagnoses isolated traumatic brain injury (174 patients) and polytrauma, combined trauma (150 patients) who required mechanical ventilation for more than 48 hours in 2021-2023.

Results

The number of patients with isolated neurotrauma was as follows: in 2021 - 58 patients (death rate 51.47%), in 2022 - 55 patients (death rate 45.45%), in 2023 - 61 patients (death rate 54.09%). In the polytrauma group, the figures were: in 2021 - 34 patients (death rate 32.35%), in 2022 - 55 patients (death rate 25.45%), in 2023 - 61 patients (death rate 13.1%). A total of 28 patients (24.67%) in the polytrauma group and 56 patients (32.18%) in the neurotrauma group were on mechanical ventilation for more than 48 hours. Tracheostomy was performed in 16 (10.67%) polytrauma patients and 39 (22.41%) neurotrauma patients at the end of the first week of hospitalization. Bacteriologic examination of sputum and bronchoalveolar lavage was performed on days 1, 3, and 7 and subsequently as needed in the presence of clinical signs of purulent endobronchitis or pneumonia (including ventilator-associated pneumonia). Aspiration techniques (catheter aspiration of sputum) were used in 80% of cases, while lower respiratory tract sampling during bronchoscopy and bronchoalveolar lavage were used in 20% of cases. The most common terms in the patient's history were pulmonary contusion, congestion pneumonia, respiratory distress syndrome, and septic pneumonia. The diagnosis of ventilator-associated pneumonia was made in only 10.9% of patients. A high incidence of ESCAPE group microorganisms was found in sputum isolate cultures: *Klebsiella pneumoniae* was isolated in 13% of patients, including 76.9% from total sputum samples; *Pseudomonas aeruginosa* in 14% of patients, including 92.86% from sputum samples; *Acinetobacter baumannii* in 16% of patients, including 50% from sputum samples. The most common indications for antibiotic therapy were persistent hyperthermia, leukocytosis, presence of purulent sputum, and procalcitonin levels above 0.5 pg/mL. For initial antibacterial therapy, third-generation cephalosporins (Ceftriaxone, Cefoperazone/Sulbactam) and fourth-generation cephalosporins (Cefepime) are most commonly used, beta-lactam/beta-lactamase inhibitor combinations (Amoxicillin/Clavulanate), combinations of the above with fluoroquinolones (Levofloxacin) and aminoglycosides (Amikacin, Tobramycin). The dynamics of the use of these antibiotics as initial antibiotic therapy for respiratory tract infections in this patient category is shown in figure 1.

At the same time, there was a negative trend in the results of the analysis of the antibiotic susceptibility of isolated strains of microorganisms to antibacterial drugs. It should be noted that the

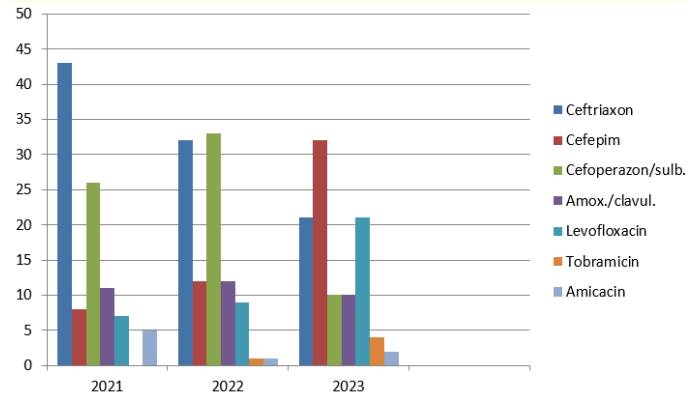


Figure 1: Dynamics of antibiotic use as initial antibiotic therapy for respiratory tract infections. The percentage (%) of prescribed antibiotics in the specified group of patients is shown on the y-axis.

susceptibility of these pathogens decreased over three years in KI. pneumoniae to carbapenems by 41.2%, aminoglycosides by 39%, third and fourth-generation cephalosporins by 19.3% respectively (Figure 2).

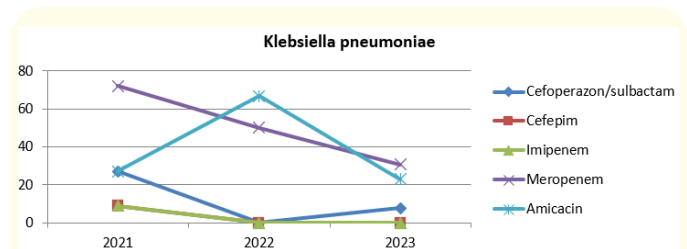


Figure 2: Dynamics of antibiotic susceptibility of *Klebsiella pneumoniae* strains isolated from tracheobronchial aspirates of trauma patients.

The susceptibility of *Ps. aeruginosa* strains to carbapenems (Meropenem) decreased by 22%, to Cefoperazone/Sulbactam by 23.6%, to Amikacin by 27%. The susceptibility of this pathogen to Ceftazidime remained unchanged (18 - 18.9%), as shown in figure 3.

A decrease in antibiotic susceptibility was observed in *A. baumannii* strains isolated from sputum: Cefoperazone/Sulbactam by 50%, carbapenems (especially Meropenem) by 58.5%, aminoglycosides (Amikacin) by 51%. No strains of this pathogen susceptible to Ampicillin/Sulbactam were found (Figure 3).

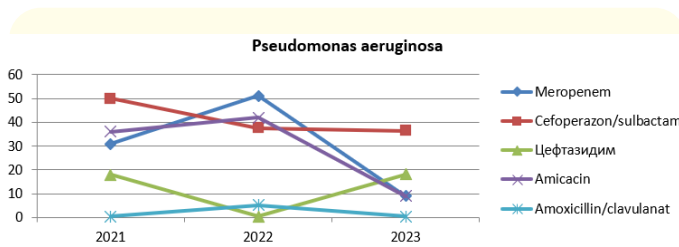


Figure 3: Antibiotic susceptibility dynamics of *Ps. aeruginosa* strains isolated from tracheobronchial aspirates of trauma patients.

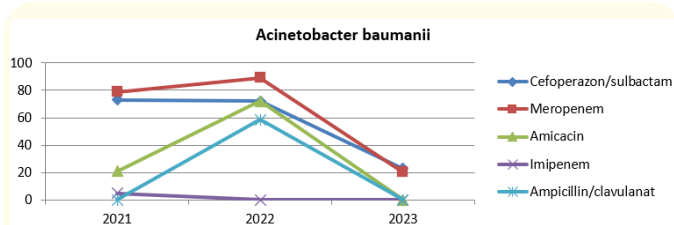


Figure 4: Dynamics of antibiotic susceptibility of *A. baumannii* strains isolated from tracheobronchial aspirates of patients with trauma.

It should be noted that the frequency of detection of multidrug-resistant strains of these microorganisms was as follows: for *A. baumannii* 18.48%, *Kl. pneumoniae* 15.04%, *Ps. aeruginosa* 3.36%.

When analyzing cases of ventilator-associated pneumonia (VAP) in polytrauma and neurotrauma patients in the general profile ICU, the following trends were observed. Traditionally, chest radiography was used to diagnose VAP in 100% of patients, with indications including persistent hyperthermia, purulent sputum, and the need for high or progressively increasing oxygen concentrations. Bronchoalveolar lavage (BAL) data were used for diagnosis in individual cases, with the main indication for the use of this technique being the need to obtain material for culture studies and the presence of atelectasis. Procalcitonin level dynamics was determined in 67.4% of patients, and normalization of its level was an indication to discontinue antibiotic therapy in only half of the cases. It should be noted that lung ultrasound and evaluation by recommended scales were used in individual cases. Sputum bacteriology was combined with CBC, urinalysis, and CSF testing as appropriate. *Kl. pneumoniae* was isolated in blood - 7.7% of patient samples, urine and stool -

7.7% each; *Ps. aeruginosa* was isolated in urine - 7.14% of samples; *A. baumannii* was isolated in blood samples in 18.75% of cases and in CSF in 31.25% of samples.

Discussion

The management of various infectious complications is one of the most important issues in intensive care. Known risk factors for nosocomial infections include severity of illness with an initial score on the ARASNE II scale greater than 14 scores, severe combined trauma, patient age, duration of mechanical ventilation for more than 48 hours, presence of abdominal compartment syndrome, inadequate early initiation of antibiotic therapy, etc. [1,14]. It should also be noted that a significant risk factor for the development of ventilator-associated pneumonia is understaffing of intensive care units. The prevalence of nosocomial infections in ICUs is approximately 26%, of which nearly 42% are respiratory infections [3,16]. The most important pathogens associated with nosocomial infections and with a high potential for antibiotic multi-resistance are grouped under the acronym ESKAPE: *Enterococcus faecium* (VRE) - vancomycin-resistant enterococci, *Staphylococcus aureus* (MRSA) - methicillin-resistant golden staphylococcus, *Klebsiella* and *Escherichia coli* (ESBL-producing - extended-spectrum beta-lactamases), *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Enterobacteriaceae* [23,24]. These pathogens have different mechanisms of antibiotic resistance, making them the predominant flora in ICUs in Europe and around the world [1,19]. According to Laurent Papazian, *et al.* (2020), the incidence of ventilator-associated pneumonia (VAP) ranges from 5% to 40%, with an attributable mortality rate of 10% [12,13]. Traditional methods for diagnosing respiratory infections include clinical data, the presence of new or progressive and persistent infiltrative changes on radiographs, and positive microbiologic cultures from lower respiratory tract samples, which were performed in less than 1/3 of cases in our setting [6,22]. Monitoring the dynamics of procalcitonin levels is currently recommended to establish indications for initiation or discontinuation of antibiotic therapy [4,15,21], which in our case was performed in only half of the patients. Furthermore, existing recommendations and guidelines do not recommend the CPIS scale for diagnosis of VAP and adjustment of antibiotic therapy because of its low specificity [7,17]. For the treatment of patients with this pathology, it is recommended to prescribe antibiotics, taking into account the risk of infection with multidrug-resistant strains, which includes: high (over 25%) local prevalence of MDR microor-

ganism strains, antibiotic therapy in the previous 90 days, hospital stay longer than 5 days, septic shock, ARDS, and the need for renal replacement therapy [9,11]. The recommended initial drugs are third-generation cephalosporins without antipseudomonal activity (the frequency of which reached approximately 45% in our inpatient department), combinations of broad-spectrum beta-lactam antibiotics with aminoglycosides or fluoroquinolones (according to our data, between 5 and 22% of prescriptions), or carbapenems. Prior antibiotic therapy, colonization, and the prevalence of multidrug-resistant pathogens are considered in the use of these medications [2]. Pharmacodynamic and pharmacokinetic studies of antibacterial drugs are ongoing. Proposed methods of prolonged infusion of beta-lactam antibiotics, especially carbapenems, have controversial results [5,10], and the use of inhaled aminoglycosides has not yet been proven effective [20].

Conclusion

1. When examining sputum aspirates from the tracheobronchial tree, a high percentage of multi-resistant Gram-negative flora caused by the ESCAPE microorganism remains high (*A. baumannii* 18.48%, *Kl. pneumoniae* 15.04%, *Ps. aeruginosa* 3.36%).
2. The susceptibility of gram-negative flora to carbapenems, aminoglycosides and Cefoperazone/Sulbactam has decreased significantly.
3. Diagnosis of respiratory tract infections, especially ventilator-associated pneumonia, remains inadequate in general anesthesia and intensive care units.
4. It is beneficial to use a standardized approach to the diagnosis and antibacterial therapy of respiratory tract infections in this patient group, along with validated scales and biomarkers.

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