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The Prevalence of Gram-Negative Microorganisms Isolated from Ventilator-Associated Pneumonia Patients in the Intensive Care Units of Southwest of Iran

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ABSTRACT

Background: Increasing microbial resistance is a severe threat to global public health. One of the most common diseases in the intensive care unit is ventilator-associated pneumonia.

Methods: The method of this research was non-interactive and descriptive. This study was carried out from January to March 2018, at the Golestan Hospital of Ahvaz. Patients with ventilator-associated pneumonia (VAP) were included in the study. The prevalence of resistant gram-negative microorganisms was studied through reported laboratory antibiogram results of cultures.

Results: From 373 hospitalized patients, 38 (10.2%) were diagnosed with VAP. From the 57 respiratory cultures performed, overall 90 microorganisms were isolated, from which Enterobacter with 36 cases (39.5%) and E.Coli with 28 cases (30.7%) were most frequently compared to other organisms. From the 90 organisms responsible for the infection, 43 cases (47.2%) were Multiple drug-resistant (MDR) microorganisms and 47 (51.6%) were Extensively drug-resistant (XDR) microorganisms. Enterobacter and E.Coli were the most prevalent MDR microorganisms with 17 cases (39.5%) and 13 (30.2%), respectively. Also, these two microorganisms were the most abundant XDR microorganisms with 19 cases (40.4%) and 15 (31.9%), respectively.

Conclusion: The results show the requirement of robust antibiotic monitoring and the optimization of antibiotic use in order to prevent the progression of antibiotic resistance in these units.

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Introduction

Pneumonia is one of the most common hospital-acquired infections. It has been reported by the US National Nosocomial Infection Surveillance (NNIS) that hospital-acquired pneumonia is the second most common nosocomial infection in intensive care units (ICU) (1).

Hospital-acquired pneumonia (HAP) is defined as pneumonia that develops more than 48 hours after hospitalization (2). Ventilator-associated pneumonia (VAP) is defined as parenchymal lung infection occurring more than 48 hours after the initiation of mechanical ventilation (1). The systemic signs of pneumonia include fever, leukocytosis, increased respiratory secretions, and Tachypnea (3). Pneumonia can be caused by several microorganisms simultaneously. However, gram-negative bacilli (Pseudomonas aeruginosa, Acinetobacter, and Enterobacter species) are responsible for 50-70% of hospital-acquired pneumonia. The prevalence of other common pathogens is as follows: Staphylococcus

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aureus 15-30%, anaerobic bacteria 10-30%, Haemophilus influenzae 10-20%, Pneumococci 10-20%, legionella 4%, viruses (Cytomegalovirus, Influenza, RSV) 10-20%, and less than 1% of cases caused by fungi such as Aspergillus (3, 4).

Multiple drug-resistant (MDR) pathogens refer to bacterial species that are resistant to at least 2 or more antibiotics used for their treatment. Extensively drug-resistant (XDR) pathogens apply to bacterial species which are resistant to at least one antibiotic in each group and two groups of antibiotics (4). It's essential to be aware of the regional resistance patterns upon decision making for the empirical treatment of hospital-acquired pneumonia and ventilator-dependent pneumonia (5). Effective antibiotic treatment includes choosing the right regimen, the onset of administration, and paying attention to laboratory results (6, 7). All patients with ventilator-associated pneumonia or hospital-acquired pneumonia should be evaluated for clinical and microbiology results after initial empirical treatment. For patients whose pathogens are identified as the cause of their infection, empirical treatment should be adjusted to specialized treatment based on the sensitivity of the microorganisms (8-10).

Microbial resistance is considered as one of the main problems in health care centers, which, unfortunately, is significantly increasing. Increasing microbial resistance leads to the unresponsiveness to antibiotics upon treatment of the infections, furthermore, increasing the length of hospitalization and the length of hospitalization in intensive care units.

The purpose of this study was to evaluate microbial resistance pattern and correct and reasonable indication for administration of antibiotics at the Golestan Hospital of Ahvaz.

Methods

This study is a descriptive cross-sectional epidemiologic research carried out from October 2017 until December 2017 to evaluate the proper use of antibiotics in patients who were admitted to Intensive care units of Golestan Educational Hospital in Ahvaz, Iran.

All patients diagnosed with HAP and VAP were included in the study according to the Centers for Disease Control and Prevention (CDC) guidelines. Patients who discharge, and death, and were excluded.

For data collection, individual forms were designed which include several sections: general patient information, medical records and diagnosis, invasive procedures for the patient, antibiotics prescribing information, and vital signs and information about the patient's condition.

In the patient information section, demographic data including age, sex, height, and body weight were collected. The file number and patient code, as well as the date of admission and discharge (or death) of the patient, were also gathered.

In the medical records section, chief complaint, diagnosis, the final diagnosis, and the underlying disease were recorded. The patient's vital signs including blood pressure, body temperature, pulse rate, and respiratory rate were also recorded on daily.

The data were analyzed using SPSS, Version 16 (SPSS Inc., Chicago, IL, USA). The results were also analyzed using descriptive statistics (frequency and percentage) and inferential statistics (Fisher's exact test and ANOVA). In this regard, $P< 0.05$ was considered statistically significant.

Results

In the present study, 373 patients were enrolled in the study, which were admitted in ICU of Golestan Hospital. Of which 38 were infected with hospital-acquired pneumonia and ventilator-associated pneumonia (10.2%). The average age of women with pneumonia was 51 years, and the mean age of men was 39.1 years. As shown, the percentage of demographic information is summarized in Table 1.

Table 1. Demographic data of the hospitalized patients in intensive care units at Golestan hospital.

Percentage of gender		
Gender	Number	Frequency (%)
Female	11	28.9%
Male	27	71.1%
Age distribution		
Ages (year)	Frequency (%)	Descriptive Statistics
<20	18.4%	Mean ± SD: 43.86±20.93 Range of ages: 11-79 year
30-21	15.9%	
40-31	13.1%	
50-41	13.1%	
60-51	18.4%	
70-61	7.9%	
80-71	13.1%	
Underlying disease		
Underlying disease	Number	Frequency (%)
With Underlying disease[a]	9	23.7%
Without Underlying disease	29	76.3%
Diagnosis		
HAP/VAP	Number	Frequency (%)
HAP	4	10.5%
VAP	34	89.5%

HAP: Hospital-acquired pneumonia, VAP:Ventilator-associated pneumonia

a Such as hypertension, cerebrovascular accident, Parkinson, diabetes mellitus

It is noteworthy, overall 18 cases (47.3%) of the subjects were admitted to the intensive care unit (trauma admission) because of severe injury.

From patients under the study, 35 patients (92.1%) were not subjected to a microbial culture before the administration of

antibiotics, however, 3(7.9%) were subjected to a microbial culture before the administration of antibiotics. Twenty-four patients (63.2%) had a bacterial culture 48-72 hours after beginning the use of antibiotics, and 14(36.8%) had no bacterial culture 48-72 hours after their start on antibiotics.

In the patients admitted in this study, there were 235 cultures. The lowest culture for patients was 1, and the highest culture was 23 cases. Of these, 57 cases were related to respiratory specimens. Only for three patients, the respiratory culture was taken before the start of antibiotics, and no re-cultivation was performed in 14 patients 24 to 72 hours after empirical therapy with antibiotic treatment, and empirical treatment was continued.

In cultures of throat and secretions taken from the patients, the highest frequency was related to Enterobacter microorganisms with 39.5% (36 cases), following was E. coli microorganisms with 30.7%(28 cases), Pseudomonas microorganisms with 13.1% (12 cases), Acinetobacter microorganisms with 11%(10 cases), Klebsiella microorganisms with 4.3% (4 cases), and the lowest frequency was related to Staphylococcus-coagulase negative microorganisms with 1.1% (1 case).

The highest rate of drug resistance was observed among the highest consumed drugs related to the Carbapenems. Enterobacter (97.2%), E.coli (92.8%), Pseudomonas (75%), Acinetobacter (100%) and Klebsiella (100%) microorganisms showed resistance to these antibiotics in cultures (Table 2). Of these microorganisms isolated from cultures, 47.7% (43 cases) were MDR microorganisms and 52.3% (47 cases) were XDR microorganisms which are shown Table 3.

Table 2. Drug resistances of microorganisms isolated from secretions and throat culture.

Antibiotic / Isolated microorganisms	Maropenem	Imipenem	Colomycin	Ceftazidime	Cefazolin	Ceftriaxone	Cefotaxime	Cefepime	Amikacin	Gentamicin	Ciprofloxacin	Bactrim	Piperacillin	Ampicillin
Enterobacter	97.2%	100%	52.7%	58.3%	63.8%	97.2%	97.2%	2.7%	100%	80.5%	100%	97.2%	2.7%	N[1]
E.coli	92.8%	96.4%	57.1%	50%	75%	96.4%	96.4%	N	96.4%	78.5%	96.4%	96.4%	N	N
Pseudomonas	75%	100%	50%	83.3%	33.3%	100%	83.3%	N	100%	75%	100%	83.3%	8.3%	N
Acinetobacter	100%	100%	50%	60%	50%	100%	100%	N	90%	90%	100%	100%	N	10%
Klebsiella	100%	100%	75%	75%	50%	100%	100%	N	100%	50%	100%	100%	N	N

1 Information on sensitivity of drugs is not available

Table 3. Table of MDR and XDR microorganisms.

Total Frequency	XDR Frequency	MDR Frequency	Microorganism Type
36	19th	17	*Enterobacter*
28	15	13	*E.coli*
12	5	7	*Pseudomonas*
10	5	5	*Acinetobacter*
4	3	1	*Klebsiella*
90	47	43	*Total*

Discussion

According to the results of this study, on average, 10.2% of all patients admitted to the intensive care unit were infected with HAP and VAP. Also During a study in the United States, Rello et al., showed the rate of respiratory infection to be 9.3% (8). Consistently to one another study on patients admitted to the intensive care unit at Imam Khomeini Hospital in Sari, Ibrahim Salehifar et al., reported that the incidence rate of pneumonia was 11.4% (11). Furthermore, in another similar investigation by Chawla R. the incidence of hospital pneumonia in Asian countries is reported 7.5% (12). Makhloghi et al., reported a mortality rate of 45.9% in hospitalized patients with pneumonia. However, in two studies conducted by Sabery et al., in Kashan and Afkhamzade et al., in Sanandaj, the incidence rate of pneumonia was reported to be 19% and 32.2%, respectively, which were shown to be higher compared to our study (13, 14).

Among all ICU admitted patients, the total incidence of hospital acquired infections (nosocomial infections) were 231 cases and 154 cases (67%) were respiratory infection of pneumonia.

According to the average age of women with pneumonia we can deduce that respiratory infection is more common in older women. But it should be mentioned that a prior cohort study, concluded that VAP did not occur in elder people, but the mortality rate was higher in these individuals (15). Also, Rello et al., during a study, concluded that male sex is considered as an independent risk factor in the onset of VAP (8).

In this study 47.3% of subjects were ICU admitted because of severe injury consistent with the previous study done by Rello et al., which was mentioned that, admission due to severe injury is considered as an independent risk factor in the onset of pneumonia (8)

In study of Ibrahim Salehifar et al., the incidence of VDF was 89.5% and also HAP was 10.5% compared with 92% VAP in prior investigation (11).

Our analysis showed that, among 90 cases of gram-negative microorganisms isolated from respiratory cultures, 43 cases (47.7%) were MDR and 47 cases (52.2%) were XDR microorganisms. The highest frequency among microorganisms was related to Enterobacter with 36 cases (39.5%), following were E. coli and Pseudomonas respectively. This result is consistent with Afkhamzadeh et al., previous study which was concluded that Enterobacter was the most frequent microorganism and it was the cause of HAP infection in 45% of the cases (13). However in Craven et al. study, Pseudomonas aeruginosa, Acinetobacter and Staphylococcus aureus were the most common causes of respiratory infections, respectively (6). Also James et al., during a study on patients with respiratory infections, reported that Staphylococcus aureus, Acinetobacter baumannii, and Pseudomonas aeruginosa, with 38%, 25%, and 19%, respectively are considered as the main causes of pneumonia. Due to the drug resistance pattern of microorganisms at the local level of Golestan Medical Education Center, with more supervision on the administration of antibiotics and the implementation of an antimicrobial stewardship program, it is possible to prevent the prescription of irrational antibiotic use, control the costs, and ultimately avoid the increase microorganism resistance.

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