ECRONICON OPEN ACCESS

EC NUTRITION
Review Article

Characteristic of the Biological Factor of the Production Environment of Medical Organizations Containing the Risk of Development of Hospital Infections

GG Badamshina[1,2]*, VB Ziatdinov[1,2], LM Fatkhutdinova[2], BA Bakirov[3], SS Zemskova[1], MA Kirillova[1]

[1]*Center for Hygiene and Epidemiology in the Republic of Tatarstan, Russia*

[2]*Kazan State Medical University, Kazan, Russia*

[3]*Bashkir State Medical University, Ufa, Russia*

***Corresponding Author:** GG Badamshina, Center for Hygiene and Epidemiology in the Republic of Tatarstan, Russia.

Received: April 20, 2021; **Published:** June 29, 2021

Abstract

The study is determined by the high relevance of the study of a biological factor that affects the health status of medical workers and determines the risk of the development of hospital infections, including the number of patients. By well-known methods, microbiological studies have been carried out aimed at the isolation, identification of microorganisms circulating in the hospital environment. Microorganisms isolated from the working area of medical workers were identified using chromogenic nutrients and microbiological analyzers. For a complete characterization of microorganisms, tests were carried out to determine the sensitivity of the isolated strains to the main antibacterial drugs. As a result of the research, it was revealed that the priority microorganisms isolated from the air of medical organisms were representatives of the families Staphylococcaceae and Micrococcaceae, causing a high risk of the development of purulent-septic infections. Representatives of normal human microflora - *Acinetobacter* spp. and *Streptococcus* spp., game-negative bacteria - *Stenotrophomonas maltophilia*, *Ochrobacterium* spp., *Pantoea* spp., *Pasteurella* spp. The noted resistance of *Staphylococcus* spp. and *Micrococcus* spp. In relation to oxacillin and erythromycin, gram-negative bacteria - ceftazidime and amikacin, representatives of non-fermenting bacteria and representatives of the Enterobacteriaceae family - the combination of antibacterial drugs indicates the need to study biological and qualitative characteristics. Resistance identified for *Streptococcus* spp. campicillin, clindamycin, imipenem, cefepime; *Acinetobacter* spp. cephalosporins (ceftazidime, cefepime) and moderate resistance to monobactam (aztreonam); *Stenotrophomonas maltophilia* - ceftazidime aztreonam, in some cases, cefepime, amikacin, imipenem, gentamicin or ciprofloxacin; *Ochrobacterium* spp. cefepime, aztreonam, ciprofloxacin, amikacin, gentamicin, imipenem, ceftazidime; *Pantoea* spp. and *Pasteurella* spp. - different degrees of resistance - indicates a greater resistance of the indicated strains circulating under the conditions of a medical organization, in comparison with data from literary sources.

Keywords: *Microorganisms; Air Environment; Biological Factor; Medical Workers; Antibiotic Resistance; Microbiological Research; Antibiotics; Medical Organizations; Nosocomial Infections; Microorganism Resistance*

Introduction

Biological factor, or biological agent - the spectrum of microorganisms, pathogenic and opportunistic bacteria, viruses, fungi, helminths, protozoa, living cells and spores, etc. which have a harmful effect on human health. Microbiological monitoring of the species

composition of pathogens of infectious diseases, the resistance of microorganisms to antibacterial drugs in medical institutions can be a reliable tool for assessing the biological factor, its qualitative characteristics, in order to establish its effect on the body of medical personnel and select adequate anti-microbial therapy. for patients in a specific medical institution [1]. Inappropriate use of antibacterial drugs (in Canada, USA, Vietnam, 50 - 70% of prescribing these drugs to patients was found unjustified) [2]; the use of antibiotics in animal husbandry, the activation of adaptive mechanisms in nosocomial bacterial communities (mutations, transmission of extrachromosomal hereditary factors) - lead to an ever-increasing resistance of microorganisms - causative agents of various infectious diseases and the circulation of resistant strains on the territory of medical organizations that determine the development of professional diseases in medical workers and infections associated with the provision of medical care [3,4]. Over the past years, there have been changes in the structure of etiologically significant pathogens of infections, purulent, surgical diseases, today there is an increase in the number of species and changes in the properties of microorganisms that cause postoperative and post-injection complications, the prevalence of poly-etiological diseases in the structure of purulent septic is increasing. -infections, including nosocomial infections [1].

The problem of circulation of resistance to antibiotics of hospital strains of opportunistic flora, despite a number of ongoing measures, is becoming more and more urgent [5,6]. Currently, resistance to antibacterial drugs is considered as an objective indicator of the genotypic and phenotypic characteristics of a certain microorganism, which determines the biological risk of developing infections associated with the provision of medical care (HAI) and occupational diseases [3].

Materials and Methods

To study the characteristics of the biological factor in medical organizations (MO) of the city of Kazan, carried out microbiological studies of the air environment within the framework of the state supervision of the Federal Service for Supervision of Consumer Rights Protection and Human Welfare. Air sampling was carried out before and during work in accordance with MUK 4.2.2942-11 “Methods for sanitary and bacteriological studies of environmental objects, air and sterility control in medical institutions” 1. Microorganisms isolated from the air of treatment rooms and manipulation rooms of various medical organizations were identified to a species (n = 62). Identification was carried out using chromogenic nutrient media produced in India and Spain, tests produced in the Czech Republic and France with the use of microbiological analyzers. The sensitivity of microorganisms to antibacterial drugs was investigated by the disk-diffusion method according to MUK 4.2.1890-04 “Determination of the sensitivity of microorganisms to antibacterial drugs” 2.

Results and its Discussion

The structure of microorganisms isolated from the air of medical organizations is shown in figure.

Representatives of the genus *Staphylococcus*, identified in the amount of 28 strains and represented by the species *S. hominis* (11.3%), *S. epidermidis* (9.7%), *S. haemolyticus* (8,1%), *S. saprophyticus* (4.8%), *S. aureus* (1.6%) and other species (6.4%). The data on the resistance of staphylococci in institutions of various types differed significantly, which in most cases, according to Afanasyev., *et al*. [2], is determined by the policy of using antibacterial drugs. Characterizing the biological factor in medical organizations (MO), it should be noted that *Staphylococcus* spp. were resistant to erythromycin (in 50.0% of cases), oxacillin (in 28.6%) and fluoroquinolones (up to 7.1%). This leads to a high risk of developing infections from resistant strains, including MRSA. Catalase-positive cocci of this genus were most sensitive to vancomycin, clindamycin and gentamycin (96.4 - 100% of cases). Our data are consistent with the studies of most authors, in which it was found that Staphylococcus spp. possesses resistance to erythromycin and oxacillin and sensitivity to vancomycin and clindamycin [7-10]. Oxacillin resistance, studied by many studies, is a marker of the presence of penicillin-binding protein in *Staphylococcus*. There is a statement based on research data on the reservoirs of genetic information for *S. aureus* coagulase-negative *S. haemolyticus* and *S. epidermidis* due to the spread of antibiotic resistance genes in the population [3].

The high degree of resistance of staphylococci to oxacillin as a marker of the presence of MRSA (Methicillin Resistant *Staphylococcus aureus*) indicates the ineffectiveness of all β-lactams in infections caused by this microorganism, and the need to improve the therapeutic

and anti-epidemic measures carried out in the MO [1,10]. Along with *Staphylococcus* spp. significant place in the structure of identified microorganisms in our study belonged to bacteria of the Micrococcaceae family (40.4%). *Micrococcus* spp., According to foreign researchers [11-13], they, often isolated from objects of the hospital environment, were sensitive in all cases to ciprofloxacin and clindamycin, less often to vancomycin, levofloxacin, gentamycin (92.3% cases of sensitivity) and erythromycin (84.6%) and are resistant to oxacillin (69.2% of strains). This circumstance indicates the circulation in the territory of medical organizations of representatives of normal air microflora, which has a high degree of resistance to oxacillin, which requires further study of the biological risk of developing infections from *Micrococcus* spp. *Kocuria* spp. - one of the representatives of the family, which, according to foreign scientists, cause the development of catheter-associated endocarditis, urinary tract infections, peritonitis and other purulent-septic infections and are resistant [14-16] to fluoroquinolones, tetracyclines, oxacillin and cefazolin and intermediate resistance to cefotaxime [17], in our study they were most resistant to oxacillin (62.5% of cases), erythromycin (37.5%) and, rarely, to fluoroquinolones (12.5 % to levofloxacin). The presence in the hospital environment of strains resistant to oxacillin determines the biological risk of developing infections from methicillin-resistant microorganisms.

Other members of the Micrococcaceae family, *Dermacoccus* spp., Isolated from the air in four cases, were also the most resistant to oxacillin (resistance in all four cases), erythromycin (one case), and levofloxacin (one case). The data on the antibiotic susceptibility of dermaccocci in the literature available to us were poorly covered, however, a study by a Polish scientist (2003) showed that representatives of this genus were resistant to erythromycin [18]. *Streptococcus mitis*, in one case identified from the air, as in the studies of other scientists [3,7], was resistant to ampicillin, clindamycin, imipenem and cefepime and is sensitive to vancomycin and levofloxacin.

The development in *Streptococcus* of various types of resistance to drugs of the penicillin series, as well as to cephalosporins, according to Afasyev., *et al*. [3], the authors associate it with a decrease in the affinity of penicillin-binding proteins due to the development of mutations in the genome of bacteria. It has been proven that the interspecies transfer of material observed between commensal species of the genus *Streptococcus* and *S. pneumonia* plays a role in the selection and formation of penicillin-resistant strains of the latter [3]. In the structure of causative agents of various infectious diseases, including nosocomial infections, in recent years, the second place after gram-positive cocci is occupied by gram-negative non-fermenting bacteria, which is confirmed by our studies [19].

Characterizing the biological factor as a source of the development of HAI, it is worth noting that the gram-negative representatives of the normal human microflora - *Acinetobacter* spp., Isolated from the air of medical and prophylactic institutions (HCI), showed sensitivity (57.1%) to ciprofloxacin, amikacin, imipenem and gentamicin, moderate resistance to monobactam (aztreonam) and high resistance to cephalosporins (ceftazidime, cefepime). Studies carried out by many authors indicate the highest resistance of *Acinetobacter* spp. Isolated in human biomaterial to cephalosporins [19,20]. We did not find resistance to carbapenems and monobactams, revealed by the authors in 35.6 - 70.5% of bacteria of various human biotopes, in this genus [1,6,9,19,21]. The presence of resistant microorganisms of this type can lead to the development of infections in both medical personnel and patients.

Other gram-negative non-fermenting bacteria - *Stenotrophomonas maltophilia*, to which a large number of studies abroad are devoted, are often multi-resistant, including to cephalosporins, causative agents of nosocomial infections [22], in both cases studied by us, they were resistant to ceftazidime and aztreonam, in one - to cefepime, amikacin, imipenem, gentamicin and ciprofloxacin. The sensitivity of this microorganism, contrary to the studies of Y.W. Huang., *et al*. [23], in both cases it was identified only for erythromycin *Ochrobacterium* spp.

With a low degree of virulence in healthy people and more - for people with weakened immunity [8,24], stood out from the air of medical institutions in two cases. One strain showed resistance to antibacterial drugs in all cases (cefepime, aztreonam, ciprofloxacin, amikacin, gentamicin, imipenem, ceftazidime), the other - only to amikacin. *Pantoea* spp. and *Pasteurella* spp., causing various diseases, a considerable number of studies in European countries and countries of the American continents have been devoted, in our study they had

varying degrees of resistance to antibacterial drugs.

For *Pantoea* spp. in one case, resistance to ampicillin, ceftazidime, amikacin and imipenem was found [25,26]. The presence of multi-drug resistance of these strains indicates the need for further study of the qualitative characteristics of the biological factor that affects the medical staff and patients in the MO.

Conclusion

1. Priority microorganisms isolated from the air of medical organizations in Kazan in 2016 were representatives of the families Staphylococcaceae (45.2%) and Micrococcaceae (40.4%).

2. The greatest resistance of *Staphylococcus* spp. and *Micrococcus* spp. showed to oxacillin (28.6 - 100.0% of cases) and erythromycin (5.4 - 50.0%). Gram-negative bacteria isolated from the air of medical organizations in isolated cases were most resistant to ceftazidime (*Acinetobacter* spp., *Stenotrophomonas* spp., *Pantoea* spp.) And amikacin (*Ochrobacterium* spp. and *Pantoea* spp.); some non-fermenting bacteria and members of the Enterobacteriaceae family are characterized by resistance to various combinations of antibacterial drugs.

3. The presence of strains resistant to various antibacterial drugs circulating in the air of medical organizations causes a high biological risk of nosocomial infections and occupational diseases of medical workers, including the development of infections from MRSA (methicillin-resistant *Staphylococcus aureus*).

Financing Support

The study had no sponsorship.

Conflict of Interest

The authors of this article declare no conflicts of interest.

Bibliography

1. ЛВ Жарова., *et al*. "Характеристика видового состава и антибиотикочувствительность возбудителей раневой инфекции в разных отделениях хирургического профиля". *Вестник Челябинского Государственного Университета* 376.21 (2015): 59-64.

2. Annual Epidemiological Report. "Reporting on 2009 surveillance data and 2010 epidemic intelligence data. – Stockholm: European Centre for Disease Prevention and Control (2011): 239.

3. СС Афанасьев., *et al*. "Мониторинг антибиотикорезистентности как объективный диагностический и эпидемиологический критерий инфекционного процесса". *Иммунопатология, аллергология, инфектология* 4 (2014): 61-69.

4. Stokes HW and Gillings MR. "Gene flow, mobile genetic elements and the recruitment of antibiotic resistance genes into Gram-negative pathogens". *FEMS Microbiology Reviews* 35.5 (2011): 790-819.

5. НИ Габриэлян., *et al*. "Исследование антибиотико- и фагочувствительности нозокомиальных штаммов микробов, выделенных от па-циентов трансплантологической клиники". *Вестник трансплантологии и искусственных органов* 13.3 (2011): 26-32.

6. Gonzalez-Villoria AM and Valverde-Garduno V. "Antibiotic-Resistant Acinetobacterbaumannii Increasing Success Re-mains a Challenge as a Nosocomial Pathogen". *Journal of Pathogens* (2016): 7318075.

7. Боконбаева СД and Апсаматова НМ. "Антибиотикочувствительность этиологически значимой микробной флоры при остром обструктивном бронхите у детей раннего возраста 6 (2016): 104-108.

8. IA Al Tayyar. "Prevalence and antimicrobial susceptibility pattern of coagulase-negative staphylococci (CoNS) isolated from clinical specimens in Northern of Jordan". *Iranian Journal of Microbiology* 7.6 (2015): 294-301.

9. S Jahani-Sherafat., *et al*. "Device-associatedinfection rates and bacterial resistance in six academic teaching hospitals of Iran: Findings from the International Nocosomial Infection Control Consortium (INICC)". *Journal of Infection and Public Health* 8.6 (2015): 553-561.

10. RK Panda., *et al*. "Evaluation of Genotypic and Phenotypic Methods for Detection of Methicillin Resistant Staphylococcus aureus in a Tertiary Care Hospital of Eastern Odisha". *Journal of Clinical and Diagnostic Research* 10.2 (2016): 19-21.

11. Abdollahi A and Mahmoudzadeh S. "Microbial Profile of Air Contamination in Hospital Wards". *Iranian Journal of Pa-thology* 7.3 (2012): 177-182.

12. B Sap-kota., *et al*. "Microbiological burden in air culture at various units of a tertiary care government hospital in Nepal". *Australasian Medical Journal* 9.1 (2016): 1-7.

13. DF Wolfe., *et al.* "Bacterial colonization of respiratory therapists pens in the intensive careunit". *Respiratory Care* 54.4 (2009): 500-503.

14. G Brändle., *et al*. "First report of Kocuria marina spontaneous peritonitis in a child". *BMC Infectious Diseases* 14.1 (2014): 3835.

15. JS Moreira., *et al*. "Endocarditis by Kocuria rosea in an immunocompetent child". *The Brazilian Journal of Infectious Diseases* 19.1 (2015): 82-84.

16. KM Sohn., *et al*. "Catheter-related bacteremia caused by Kocuria salsicia: the first case". *The Journal of Infection and Chemotherapy* 21.4 (2015): 305-307.

17. D Moissenet., *et al*. "Persistent bloodstream infection with Kocuria rhizophila related to a damaged central catheter". *Journal of Clinical Microbiology* 50.4 (2012): 1495-1498.

18. Szczerba I. "Susceptibility toantibiotics of bacteria from genera Micrococcus, Kocuria, Nesterenkonia, Kytococcus and Dermacoccus". *Medicine Dosw Mikrobiology* 55.1 (2003): 75-80.

19. НА Гординская., *et al*. "Антибиотикочувствительность и молекулярные механизмы резистентности Acinetobacter baumanii, возбудите-лей раневой ожоговой инфекции". Ме-дицинский альманах 40.5 (2015): 99-101.

20. K Kishii., *et al*. "The first cases of human bacteremia caused by Acinetobacter seifertii in Japan". *The Journal of Infection and Chemotherapy* 22.5 (2016): 342-345.

21. SM Mitharwal., *et al*. "Intensive care unit-acquired infections in a tertiary care hospital: An epidemiologic survey and influence on patient outcomes". *American Journal of Infection Control* 44.7 (2016): 113-117.

22. Brooke JS. "Stenotrophomonas maltophilia: an emerging global opportunistic pathogen". *Clinical Microbiology Reviews* 25.1 (2012): 2-41.

23. YW Huang., *et al*. "Overexpression of Sme DEF Efflux Pump Decreases Aminoglycoside Resistance in Stenotrophomonas maltophilia". *Antimicrobial Agents and Chemotherapy* 61.5 (2017): e02685-e02716.

24. Ashraf F. "A case of Ochrobactrum anthropi-induced septic shock and infective endocarditis". *The Rhode Island Medical Society* 99.7 (2016): 27-28.

25. M Seki., *et al*. "A Chronic Respiratory Pasteurella multocida Infection Is Well-Controlled by Long-Term Macrolide Therapy". *Internal Medicine* 55.3 (2016): 307-310.

26. K Yamada., *et al*. "Pantoea calida bacteremia in an adult with end-stage stomach cancer under inpatient care". *The Journal of Infection and Chemotherapy* 23.6 (2017): 407-409.

Volume 16 Issue 7 July 2021