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ANALYSIS OF RISK FOR INFECTIONS RELATED TO PROVIDING MEDICAL ASSISTANCE

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Our research goal was to assess risks for infections related to providing medical assistance in places where air samples conform or don't conform to hygienic standards as per microbiological parameters. We performed bacteriological and mycological examination of air samples (n=44) in a medical organization (inside it) in conformity with methodical guidelines "Techniques for sanitary-bacteriologic examination of environmental objects, air, and sterility control in medical organizations" and sanitary rules and standards "Sanitary-epidemiologic requirements to organizations dealing with medical activities". We identified all types of microorganisms detected in air samples using conventional microbiological techniques. Bacteria belonging to 3 families, 4 stems, and 7 species, were detected in samples deviating from standards; bacteria of 7 families, 9 stems, and 12 species, were detected in samples conforming to standards. We found a great species variety of molds and bacteria such as staphylococcus spp., Micrococcus spp., Acinetobacter spp., Neisseria spp., Pausterella spp., Stenotrophamonas spp., which were considered to be conditionally pathogenic and causing infections related to providing medical assistance. We calculated relative risks parameters for infections caused by various microorganisms. We revealed that risks for infections caused by staphylococcus were higher in rooms where air samples didn't conform to sanitary-hygienic standards than in "clean rooms" (RR=2.1; OR=3.6). Risks for infections caused by micrococcus and molds were still substantially high both in "clean" rooms and in rooms where air samples didn't conform to sanitary-hygienic standards (). All this makes it absolutely necessary to improve activities aimed at monitoring infections related to providing medical assistance and caused by bacterial and mycotic agents as well as to develop existing hygienic standards and to apply new advanced disinfectants.

***Key words:** microflora, air, microbiological monitoring, relative risk, conditionally pathogenic microorganisms, bacteria, infections, related to providing medical assistance, hygienic standardization*

Hospital environment is one of the most favorable for colonization of air and environmental objects with conditionally pathogenic and pathogenic microorganisms [10, 11]. Via airborne, community-acquired, fecal-oral routes and transmissions, causative agents of infectious diseases get into environment of medical organizations from patients [10]. Accumulation and circulation of microorganisms in the air and on the objects of medical premises can subsequently become a source of healthcare-associated infections (HAI) [1, 3, 10, 13].

According to recent data, in the structure of HAI causative organisms of bacterial nature, the conditionally pathogenic and rare-

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ly pathogenic microflora is prevalent. References are made more often to gram-positive flora of *Staphylococcus, Streptococcus, Enterococcus, Bacillus, Clostridium Staphylococcus, Streptococcus, Enterococcus, Bacillus, Clostridium* stem [5, 6, 8, 11, 13, 14], gram-negative flora of *Enterobacteriacea* family, non-fermentative bacteria of *Pseudomonas, Acinetobacter* stem [4, 7, 11, 12, 15-17], yeast and molds [13] and viruses, particularly B, C, D hepatitis viruses, noroviruses, respiratory syncitial viruses, rhinoviruses, coronaviruses, adenoviruses, enteroviruses and others [9, 10]. The up-to-date Russian practical policies do not regulate content of the above kinds of microorganisms under the existing sanitary rules and hygienic standards. Methodological guidelines do not specify techniques for isolating and identifying certain types of nosocomial infections pathogens from environmental objects. However, ambient air in medical organizations, being in compliance with the sanitary rules and regulations 2.1.3.2630-10 "Sanitary-epidemiologic requirements to organizations dealing with medical activities" may be contaminated with HAI pathogens in amounts below the maximum permissible values.

Research goal was to assess risks for infections related to providing medical assistance in places where air samples conform or don't conform to hygienic standards as per microbiological parameters.

Materials and methods. We performed air sampling (n = 44) from January to December 2016, before and during the working hours, according to the methodological guidelines MUK 4.2.2942-11 "Techniques for sanitary-bacteriologic examination of environmental objects, air, and sterility control in medical organizations ". In medical treatment and procedural rooms, the total bacterial contamination of air or the total microbial count (MBC) was determined. The obtained values of air MBC were compared with the values established in Appendix 3, SanPiN 2.1.3.2630-10 "Sanitary-epidemiologic requirements to organizations dealing with medical activities". We carried out complete identification of microorganisms up to species using the advanced chromogenic nutrient media made in India and Spain, biochemical tests of Czech and France production with Multiscan analyzer.

The obtained results were processed applying methods of parametric and nonparametric statistics using Microsoft Excel software package. With values normal distribution in uniform arrays of the set sampling, we determined mean values (M) and standard error of the mean (m) to estimate the number of microorganisms in 1 m^3 of air, with the significance of difference estimated by Student's criterion (t). In the absence of the normality of distribution law in effect, taking into account small sample for the research ($n < 30$), we used Mann-Whitney (U) criterion to compare the prevalence of different microorganisms in the air. The differences were considered reliable at a significance level of $p < 0.05$.

On the ground of the previous studies, direct correlation was found between total air contamination and HAI incidence rates in patients of healthcare institutions in the Republic of Tatarstan [2]. In this regard, the probability (risk) for progressing infections related to providing medical assistance is established based on the calculation of relative risk (RR) and odds ratio (OR).

Results and discussion. Based upon results of an in-depth microbiological study of air and swabs, it was found that 27.3% of samples did not meet sanitary and hygienic standards. Thus, the mean MBC value in non-standard samples (incompliant with sanitary and hygienic standards) was 400.0 ± 85.2 CFU/cm^3; The mean MBC value in standard samples (compliant with standards) was 115.0 ± 27.9 CFU/cm^3. At the same time, there were no significant differences revealed in MBC level.

Complete identification of microorganisms showed wide variety of species in the studied samples (please, see Fig.). We established that in the air samples corresponding to sanitary and hygiene standards, there was a wider species diversity of microorganisms. Thus, in the non-standard samples, bacteria of

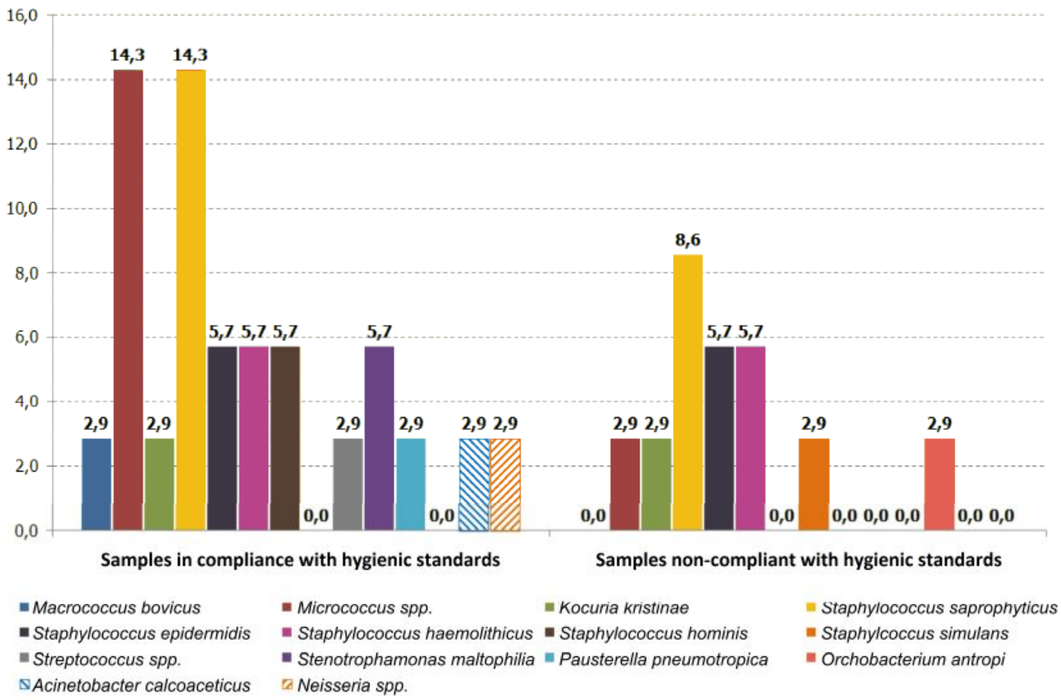

Fig. Air samples contamination with microorganisms in medical organization (%)

3 families, 4 stems, and 7 species were detected; in the samples conforming to the standards, 7 families, 9 stems, 12 species. To assess the risk for developing infections related to providing medical assistance from different microbial genera, we compared bacterial and fungal prevalence rates in rooms where air samples conformed and did not conform to sanitary and hygienic standards as per microbiological parameters.

Comparing the indices of air contamination in standard and non-standard samples, we noted statistically significant differences in the mean value of staphylococci (20.4 ± 6.1% and 38.6 ± 7.4%, respectively, $p < 0.05$) and micrococci (47.5 ± 7.6% and 26.0 ± 6.8%, $p < 0.05$). The comparative assessment of air contamination with staphylococci did not reveal any statistically significant differences.

Attention is drawn to the fact that in the organized bandaging rooms of surgery department, the purulent surgery suite, the small operating examination room, the manipulative female consultation department, from the air of "clean" rooms there were detected: *Micrococcus spp.* in amounts of 5 to 100 CFU/cm^3, including *Kocuria kristinae* (12.5 ± 5.0%); *Staphylococcus* of various species in the amounts of 5 to 80 CFU/cm^3 (267.0 ± 32.2% and 150.0 ± 13.2% respectively, considering two types of staphylococci and more present in one sample); *Stenotrophamonas maltophilia* in the amount of 10 CFU/cm^3 (25.0 ± 6.6%); *Acinetobacter calcoaceticus* in the amount of 30 CFU/cm^3 (12.5 ± 5.0%); *Neisseria flava* in the amount of 30 CFU/cm^3 (12.5 ± 5.0%). Also various species molds were found in the amounts from 20 to 340 CFU/cm^3 (50.0 ± 7.6%). All this can cause infectious and allergic diseases [1, 7, 13, 16].

While working with a patient in the hospital at various locations, such as: surgery suite, intensive care unit and resuscitation, operating clinics and surgical room, in the air compliant with the sanitary and hygienic standards by MBC level, we found *Staphylococcus* of various types (16 cases), *Streptococcus spp.* (4); *Stenotrophamonas maltophilia* (4); *Macrococcus bovicus* (2); *Pausterella pneumotropica* (2) and molds (4) [6].

When calculating the risk indices for infections associated with providing medical assistance, it's established that probability of contamination with staphylococci in rooms where air samples do not meet sanitary-hygienic standards is higher than in rooms where air is considered as "relatively clean ". This corresponds to the data obtained earlier, and the standard values approved in sanitary regulations. Thus, the probability of HAI due to *S. saprophythicus, S. haemolithycus, S. epidermidis* in "infectious" rooms is higher than in "clean" ones, as evidenced by the values of ***RR*** = 2.1 (CI 0.8-4.2) and ***OR*** = 3.6 (CI 0.7-18.0).

The probability for infectious process development due to micrococci is still high also in the premises subject to strict requirements to air quality. So, before starting patient treatment in surgery department bandaging rooms and in small operating examination room, where the air samples complied with sanitary and hygiene standards, the risk for developing HAI due to *Micrococcus spp.* was ***RR*** = 1.2 (CI 0.4-3.1) and ***OR*** = 1.3 (CI 0.3-6.3). The same risk ratio was established during operations in the surgery room, in the intensive care unit, in the surgery room at polyclinic.

The higher contamination risk in "clean" rooms is also indicated by the high air contamination with *Stenotrophamonas maltophilia* and *Acinetobacter calcoaceticus*. This bacteria's presence was recorded prior to starting work in a relatively safe air environment in the rooms prepared for operations – the manipulative female consultation and surgery room. The high probability of HAI caused by micromycetes is indicated by mold present in the air of the vaccination room prior to work, which can be related either to the lack of sanitary and anti-epidemic activities, or the inefficiency of disinfection [1, 3].

Conclusions. The relative risk for HAI developing from *Staphylococcus spp.* in the rooms where air samples do not meet sanitary and hygienic standards is higher than in "clean rooms" (***RR*** = 2.1 (CI 0.8-4.2) and ***OR*** = 3.6 (CI 0.7-18.0).

We noted dangerous tendencies to the formation of risk for HAI developing from *Micrococcus spp.* both in "clean" rooms, as well as and in the rooms where air samples do not meet sanitary and hygienic standards (***RR*** = 1.2 (CI 0.4-3.1) and ***OR*** = 1.3 (CI 0.3-6 , 3)).

The relative risk for HAI developing due to mold is high both in the rooms with safe air, and in the rooms where air does not meet sanitary and hygienic standards requirements (***RR*** = 0.5 (CI 1.0-1.94), ***OR*** = 0.1 (CI 0.7-4.5)).

The obtained results dictate the need to improve the existing hygienic standards and to apply new advanced disinfectants.

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