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ASSESSMENT OF THE EXTERNAL ENVIRONMENT OF ONCOLOGIC IN-PATIENT DEPARTMENT AS THE FACTOR OF RISK FOR THE DEVELOPMENT OF INFECTIONS IN PATIENTS

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We studied the frequency of non-standard swabs taken within the production microbiological control and under the epidemic indications at the oncologic in-patient department. The assessment of the impact of hospital environment factors on the infectious diseases formation is conducted. It was detected that the frequency of samples with potentially pathogenic and pathogenic micro flora under the epidemic indications exceeded by several times the share of non-standard samples during the investigation of the external environment objects. The highest frequency of non-standard samples within the production control was detected in the operating rooms and dressing rooms of the departments of surgery, and under the epidemic indications – in the anesthesiology and resuscitation as well as dressing rooms. The mitigation of risk of hospital infections due to the hospital hygiene improvement is the main element for increasing the safety of patients.

Key words: internal hospital environment, oncologic in-patient department, production microbiological control, epidemic indications.

The infection development risk for oncologic patients is significantly increased due to the availability of tumor intoxication, undernutrition, anemia, duration and volume of surgical interventions, extensive blood loss during surgery as well as preceding chemotherapy and radiotherapy and/or use of glucocorticoids. Herewith, in most cases the infections are of "hospital" origin, extremely seriuos and hardly treated with high resistivity of originators [1, 8].

The infections in the field of surgical intervention prevail in the oncologic in-patient department. The frequency of infectious complications in the surgical patients depends on a number of factors such as the immunity of patient, his autoflora, etc. These factors are endogenic, but the exogenic contagion is also possible. The exogenic factors of the development of complications include the microbial contamination of operating room, dressing rooms, surgical instruments, materials, bacterial content of the surrounding objects and hands of medical staff. More often the significance of environment as the reservoir for microorganisms participating in the transfer of indections in hospitals is recognized as important and urgent. The modern literature pays close attention to the hospital hygiene violations that results in the development and distribution of infectious diseases at the in-patient departments [1].

In this context, at the oncologic in-patient department where the surgical patients are located it is important to detect the circulating strains of microorganisms extracted from the epidemically significant objects of environment. The statement on the belonging of extracted strains to the hospital strain is based on the data about the ethiological significance of this microorganism in the origination of pathologic process, results of typing and epidemiological confirmation of its role in the distribution of diseases [3].

The purpose of work is to carry out the retrospective analysis of bacteriological studies of the internal hospital environment in the surgical departments and operating rooms in order to determine the most epidemiologically significant objects and zones of "secure premises".

Materials and methods. In 2010-2013 the microbiological studies of the air and objects of environment were performed at the surgical departments, operating rooms, rooms of anesthesiology and intensive care department. The microbiological control of microbial content of the air environment, objects of environment and sterility of medical products was carried out according to the approved normative and technical documentation of in-patient department. The taking of samples from the surfaces of different objects of environment was conducted using the swab

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method; the air bacterial content was determined by the aspiration method according to the applicable instructions.

The extracted cultures of microorganisms were identified under the universally accepted techniques used at the microbiological laboratories with studying the set of features and using the automatic microbiological analyzer VITEK-2 Compact. Durring statistical processing the statistical package IBM SPSS Statistics 19 was used.

Results and their discussion. The internal hospital environment can be a significant source of internal hospital pathogenic microorganisms attacking the patients included into the high risk group [5, 6].

Notwithstanding that the soil, water, etc. is the primary natural reservoirs for the originators of many infections, the most significant manifestations of these originators (Klebsiella, Proteus, serratia, Pseudomonadaceae, Clostridia) are associated with the in-patient healthcare institutions where the secondary epidemically significant reservoirs of pyoinflammatory disease originators can be formed and the opportunistic originators can be preserved there for the long time [3, 7].

The term “internal hospital environment” is applied to the air, water, surfaces of items, surrounding patients, medical equipment and products used during the provision of medical assistance at the in-patient department [3, 7]. The bacteriological laboratory control of the objects of environment at the structural subdivisions was carried out at the oncologic center as the stage of microbiological monitoring in order to study the circulation of pathogen and opportunistic microorganisms. The sanitary and biological studies were conducted according to the production control plan. Under the epidemic indications the list and scope of studies were determined in accordance with certain epidemic situation.

We conducted the retrospective analysis of the microbiological control data for the objects of hospital en vironment, air, sterility of medical products and conditions for sterilization of medical products for 2010–2013. In total at the clinical departments for 4 years we samples 18017 swabs from the objects of environment, including within the production control – 17419 (96.7%) and under the epidemic indications – 592 (3.3%).

The biggest number if control studies on the microbial content of environment is conducted at the surgical department and operating unit. Herewith, the share of the scheduled studies at the surgical departments was from 25% in 2013 to 44.2% in 2010, and the share of off-schedule examinations at these departments was practically 2 times bigger from all the studies under the epidemical indicatons and was from 76.5% in 2010 to 82.4% in 2011, in 2012-2013 no off-schedule examinations were performed at the surgical departments. The share of scheduled studies at the operating unit was from 31.9% in 2012 to 55.3% in 2013; the studies under epidemical indications were not conducted during this period of study. The biggest number of the off-schedule examinations in 2010-2013 was conducted at the anesthesiology and intensive care department – from 5.9% in 2011 from all the studies under the epidemial indications at the departments to 100% in 2013. The frequency of swabs with extracted opportunistic and pathogen microflora at the clinical departments varied from 3.2% in 2012 (175 nonstandard samples of 5459) to 6.4% in 2013 (378 nonstandard samples of 5901) (table 1).

The share of nonstandard samples when studying the objects of external environment during the production control performance was 2.7% in 2012 and 5.7% in 2011 and 2013; herewith the frequency of samples with opportunistic and pathogen microflora under the epidemical indications was from 10.1% in 2011 to 33.3% in 2013.

Among 2902 samples of air taken at the clinical departments before work for 4 years 162 samples did not meet the rated indicators; among them 137 (84.6%) – under the molds and yeasts, 9 (5.6%) – under the total microbial count, 18 (9.8%) – under Staphylococcus aureus.

Table 1

The frequency of nonstandard samples detected during the microbiological control of the microbial content of air envitonment, objects of external environment and sterility of medical products

Microbiological studies	2010			2011			2012			2013		
	Total	Nonstandard samples		Total	Nonstandard samples		Total	Nonstandard samples		Total	Nonstandard samples	
		abs.	%		abs.	%		abs.	%		abs.	%
Total swabs taken:	3393	178	5,2	2962	187	6,3	5459	175	3,2	5901	378	6,4
– during the production control performance	3261	145	4,4	2792	160	5,7	5313	145	2,7	5751	328	5,7
– under epidemical indications	132	33	25	170	17	10,1	146	30	20,5	150	50	33,3
Total air samples taken:	858	40	4,7	765	40	5,2	698	33	4,7	581	49	8,4
– not meeting the total quantity of microflors per 1 m^3		8	0,9		1	0,13		0	0		3	0,5
– not meeting the content of *S. aureus* per 1 m^3		0	–		1	0,13		4	0,57		13	2,2
– not meeting the content of molds and yeasts per 1 m^3		32	3,7		38	5,0		29	4,15		38	6,5

No nonstandard samples were detected during the examination of instruments for sterility.

The highest frequency of swabs with opportunistic and pathogen microflora within the production control performance was observed at dressing rooms – from 7.7% in 2013 to 51.7% in 2012, operating rooms (with pre-operating rooms) – from 11.0% in 2012 to 41.3% in 2013, in the rooms of anesthesiology and intensive care department – from 8.3% in 2012 to 37.7% in 2013 (table 2).

The highest frequency of swabs with opportunistic and pathogen microflora at the premises of departments in 2010-2013 under the epidemical indications is detected at the dressing rooms of surgical departments: from 5.9% in 2011 to 33.3% in 2010, rooms of anesthesiology and intensive care department – 66.7% in 2010, 100% in 2013 (table 3).

To determine the most epidemically significant objects of external environment of the oncologic inpatient department for contamination of patient with pathogen and opportunistic microflora during the provision of medical assistance we used the classification of the patient care items and equipment subject to disinfection and sterilization proposed by Erle Spaulding [4] aaccording to which three categories of the patient care items are distinguished: “critical”, “semi-critical” and “non-critical”.

Table 2

The frequency of nonstandard samples detected during the microbiological control of the microbial content of the objects of external environment under the types of premises within the production control performance

Types of premises	Frequency of nonstandard samples							
	2010		2011		2012		2013	
	abs.	%	abs.	%	abs.	%	abs.	%
Dressing rooms	25	17,2	31	26,7	75	51,7	23	7,7
Medical treatment rooms	17	11,7	40	34,5	0	0	11	3,7
Procedure rooms	3	2,1	2	1,7	18	12,4	3	1
Examination rooms	3	2,1	–	–	–	–	–	–
Dental offices	2	1,4	–	–	–	–	–	–
Gynecological rooms	8	5,5	2	1,7	–	–	5	1,7
Rooms of surgical departments	1	0,7	–	–	–	–	–	–
Rooms of intensive care department and intensive care unit	51	35,2	–	–	12	8,3	113	37,7
Offices of the department of endoscopy	2	1,4	1	0,9	12	8,3	17	5,7
Room for angiography	2	1,4	–	–	–	–	–	–
Operating rooms of the central surgical department (with pre-operating rooms)	29	20	38	32,8	16	11,0	124	41,3
Other secure offices	2	1,4	2	1,7	12	8,3	4	1,3
Total	145	100	116	100	145	100	300	100

Table 3

The frequency of nonstandard samples detected during the microbiological control of the microbial content of the objects of external environment under the epidemical indications

Types of premises	Frequency of nonstandard samples							
	2010		2011		2012		2013	
	abs.	%	abs.	%	abs.	%	abs.	%
Dressing rooms	11	33,3	1	5,9	2	6,7	–	–
Medical treatment rooms	–	–	–	–	4	13,3	–	–
Procedure rooms	–	–	–	–	5	16,7	–	–
Rooms of intensive care department and intensive care unit	22	66,7	–	–	–	–	50	100
Distribution rooms	–	–	16	94,1	4	13,3	–	–
Other premises	–	–	–		15	50	–	–
Total	33	100	17	100	30	100	50	100

"Critical items" – if contaminated with any microorganisms, including the spores of bacteria, they stipulate the high level of the patient contagion risk, i.e. these are the instruments and other objects penetrating the sterile tissues and vessels (surgical instruments, cardiac catheters, catheters of urinary tracts, implants, needles, etc.). Sterilization is required.

"Semi-critical" items are the items contacting with mucous membranes or damaged skin. This category includes the equipment for inhalations and anesthesia, endoscopes and thermometers. At least, the high level disinfection is required.

"Non-critical items" are the items contacting with non-damaged skin, but not with mucous membranes. This category includes the bed-pans, cuffs of the blood pressure measuring devices, crutches, bedrails, linen, dishware, bed-side tables and some types of hospital furniture. They does not constitute a high danger in terms of the transfer of infections but can be the source at the expense of secondary transmission due to the bacterial content of the hospital employees and during the contact with medical equipment which then will be used during the work with patients. The low level disinfection is required [4].

No nonstandard samples with "critical items" of "secure rooms" in 2010-2013 were detected at the objects of hospital environment within the production microbiological control performance. The growth of opportunistic microflora from "semi-critical items" was observed during all the years of the analyzed period, except for 2011.

The highest frequency of nonstandard samples in the category of "semi-critical" items is obtained from endoscopeы: from 1.7% in 2010 to 10.1% in 2013, and from consumables and the artificial lung ventilation devices (including manual) – from 1.7% in 2010 to 11.4% in 2013.

The highest frequency in the category of "non-critical" items is detected among the following groups of objects: medical furniture for storage and transportation of sterile materials and drugs – from 5.1% in 2011 to 23.3% in 2012; medical furniture for storage of consumables and drugs – from 2.6% in 2010 to 20.5% in 2012; medical furniture for preparation to medical manipulations – from 12.7% in 2013 to 37.1% in 2010; furniture for the patient body fixation during the performance of manipulations – from 9.3% in 2013 to 15.5% in 2010; means for hygienic treatment of the medical staff hands (liquid soap) – from 5.7% in 2012 to 12.4% in 2013.

No nonstandard samples from the "critical" items at "secure rooms" are detected in 2010-2013 under the epidemical indications (table 4).

The frequency of nonstandard samples with opportunistic microflora under the epidemical microflora in 2013 for the category of "semi-critical" items was: from endoscopes – 20%, from the manual artificial lung ventilation devices – 6%. The highest frequency of nonstandard samples in the category of "non-critical" items is detected among the following groups of objects: medical furniture for storage and transportation of sterile materials and drugs – from 5.9% in 2011 to 36.4% in 2012; means for hygienic treatment of the medical staff hands (liquid soap) – from 4% in 2012 to 90% in 2013; surface of intravenous infusion equipment – 14% in 2013.

Table 4

The frequency of nonstandard samples detected during the off-schedule microbiological control of the microbial content of the objects of external environment at the "secure rooms" under categories of items

Category of items	Group of items and objects	Frequency of nonstandard samples for							
		2010		2011		2012		2013	
		abs.	%	abs.	%	abs.	%	abs.	%
Critical items	Medical instruments	1	3,0	–	–	–	–	–	–
Semi-critical items	Endoscopes	–	–	–	–	–	–	10	20
	Artificial lung ventilation devices (manual)	–	–	–	–	–	–	3	6
Non-critical items	Medical furniture for storage and transportation of sterile materials and drugs	12	36,4	1	5,9	–	–	5	10
	Illuminators	1	3,0	–	–	–	–	–	–
	Medical furniture for preparation to manipulations	2	6,0	–	–	–	–	4	8
	Working wear, soft fixtures of medical staff	1		–	–	1	3,3	–	–
	Sanitary and technical equipment	6	3,0	–	–	–	–	–	–
	Furniture for rooms	–	–	–	–	–	–	–	–
	Furniture and equipment for distribution rooms	–	–	16	94,1	2	6,7	–	–
	Means for hygienic treatment of the medical staff hands (liquid soap)	–	–	–	–	27	90	2	4
	Equipment for the medical staff hands treatment	–	–	–	–	–	–	2	4
	Medical staff hands before the performance of manipulations	1	3,0	–	–	–	–	2	4
	Surfaces of intravenous infusion equipment (infusion pumps)	–	–	–	–	–	–	7	14
	Furniture for storage and transportation of clean linen for patients	–	–	–	–	–	–	4	8
	Patient care items	–	–	–	–	–	–	8	16
	Surfaces of equipments in rooms (intensive care department)	2	6,0	–	–	–	–	3	6
	Lighting equipment	2	6,0	–	–	–	–	–	–
	Surfaces in premises, irradiators	2	6,0	–	–	–	–	–	–
	Soft fixtures for patients	3	9,1						
Total		33	100	17	100	30	100	50	100

No nonstandard samples from the "critical" items at the operating rooms were detected in 2010-2013 at the objects of hospital environment within the production microbiological control performance. The growth of opportunistic microflora from the "semi-critical" items was observed in all the years of the analyzed period from the consumables for the artificial lung ventilation conduction (table 5).

The highest frequency of nonstandard samples in the category of "non-critical" items is detected among the following groups of objects: surface of equipment for the surgical interventions performance – from 0.5% in 2011 to 18.5% in 2012; surface of anesthesia apparatus – up to 19.8% in 2013; furniture for sterile material of nurses – from 6.9% in 2010 to 26.1% in 2013.

The morbidity with purulent-septi infections (PSI), incuding pneumonia, at the oncologic center under the data of official registration at the departments of all the profiles of oncologic center in 2013 was 6.09 per 1000 patients; herewith predominantly we registered the infections in the organ/cavity surgical intervention area – morbidity of 3.21 per 1000 patients, surface surgical wound infections – 1.05 per 1000 of patients, pneumonia – morbidity of 1.42 per 1000 patients. PSIs were registered mainly at the surgical departments where in 2013 the morbidity with the infections in the organ/cavity surgical intervention area was 3.45 per 1000 of patients, surface surgical wound infections – 1.13 per 1000 of patients, pneumonia – 1.42 per 1000 of patients.

Table 5

The frequency of nonstandard samples detected during the scheduled microbiological control of the microbial content of the objects of external environment at the operating and pre-operating rooms "under the categories of items"

Types of items	Group of items and objects	2010		2011		2012		2013	
		abs.	%	abs.	%	abs.	%	abs.	%
Semi-critical items	Consumables for the artificial lung ventilation performance	7	24,1	3	7,9	5	31,3	5	4,5
Non-critical items	Surfaces in premise, bactericidal irradiators	2	6,9	2	5,3	0	0	5	4,5
	Surfaces of equipment for the surgical interventions performance	4	13,8	4	10,5	3	18,7	15	13,5
	Means for transportation of sterile materials and drugs	1	3,4	5	13,2	2	12,5	1	0,9
	Furniture for the patient body fixation during the surgical intervention performance	3	10,3	5	13,2	2	12,5	10	9,0
	Furniture for the operating room of anaesthetists	7	24,1	4	10,5	2	12,5	18	16,2
	Furniture for sterile material of nurses	2	6,9	9	23,7	2	12,5	29	26,1
	Surfaces of anesthesia apparatus	1	3,4	5	13,2	0	0	22	19,8
	Illuminators	2	6,9	1	2,6	0	0	4	3,6
	Means for medical waste	0	0	0	9	0	0	1	0,9
Total nonstandard swabs		29	100	38	100	16	100	111	100

According to the data of epidemiological analysis in the first quarter we observed in the center the unstabl epidemical situation in relation to the infections of the organ/cavity surgical interventions area (morbidity 2.5, 3.6m 4.1 per 1000 of pateient in January-March, respectively) and pneumonia (morbidity 6.9, 5.3 per 1000 o patients in January-March, respectively).

To establish the relationship of the leading originator of infections of the low respiratory tracts at the anesthesiology and intensive care department during the investigation of one of the epidemiological cases and determination of the probable infection transfer factors we analyzed 10 strains of microorganisms obtained as a result of microbiological studies of the bronch flushing water from 8 patients and 50 strains of microorganisms insulated as a result of microbiological studies of swabs from the objects of external environment under the epidemical indications.

In total we extracted and identified from the flushing water of patients 3 different species and types of microorganisms, but 90% of positive seedings were taken by two leading originators: *Acinetobacter baumanii* и *Burkholderia cepacia*.

From the swabs of the objects of external environment taken under the epidemical indications we extracted and identified 6 different species and types of microorganisms, among them 9 strains of *B. cepacia* – from the different parts of bronchoscopes (internal surfaces of valves, illuminator, optics, external surfaces of equipment), channels and internal surfaces of bags for the artificial lung ventilation, 4 strains of *A. baumanii* – from the channels and internal surfaces of bags for the artificial lung ventilation, external surfaces of breathing circuits of the artificial lung ventilation device, pipes of suction guns.

The assessment of antibiotic sensitivity of the leading pathogen was carried out in relation to the wide range of antibiotics. In this work we specify the most significant of them due to the problems of increasing resistance. Thus, the share of resistant strains *A. baumanii* extracted for the patients from the flusing water of bronhi was: to amikacin 100%, ampicillin / clavulanate – 100%, cefazolin – 100%, cefepime – 100%, imipenem – 100%. The share of sensitive strains *A. baumanii* to gentamycin is 100%.

The frequency of resistant strains *A. baumanii* extracted from the objects of external environment to amikacin is 100%, ampicillin / clavulanate – 100%, cefazolin – 100%, cefepime – 100%, imipenem – 100%. The share of sensitive strains *A. baumanii* to gentamycin is 100%.

The share of resistat strains *B. cepacia* extracted for patients from the flushing water of bronchi was: to amikacin – 100%, ampicillin / clavulanate – 100%, cefazolin – 100%, cefepime – 100%, imipenem – 100%, gentamycin – 100%.

The share of resistat strains *B. cepacia* extracted from the objects of external environment of the anesthesiology and intensive care department

was: to amikacin – 100%, ampicillin / clavulanate – 100%, cefazolin – 100%, cefepime – 100%, imipenem – 100%, gentamycin – 100%.

Conclusions:

1. The morbidity with PSIs, including pneumonia, at the oncologic center under the departments under all the profiles in 2013 was 6,09‰ with prevalence of the infections in the organ/cavity surgical intervention area – 3,21‰, surface surgical wound infections – 1.05‰, pneumonia – 1.42‰ per 1000 of patients.

2. The frequency of samples with opportunistic and pathogen microflora under the epidemical indications exceeded by several times the share of nonstandard samples when studying the objects of external environment during the production control performance.

3. The highest frequency of nonstandard samples within the production control performance was detected in the operating and dressing rooms of surgical departments, and under the epidemical indications – in the anesthesiology and intensive care rooms as well as dressing rooms.

4. We recorded the increase in the frequency of samples with opportunistic and pathogen microflora both within the production control performance and under the epidemical indications from the objects of hospital environment requiring, at least, the high level disinfection.

5. When assessing the antibiotic resistance of priority pathogens detected during the epidemiological study of low respiratory tracts in the patients treated at the anesthesiology and intensive care department it was established that strains *Acinetobacter baumanii и Burkholderia cepacia* are panresistant.

6. The conduction of microbiological studies of the objects of external environment under the epidemical indications with determining the antibiotic resistance profiles for the extracted microorganisms allows for operative detection of the transition factors and source of infections at the in-patient depertment.

Therefore, studying the violations of the hospital hygiene rules as the factor affecting the development of diseases at the in-patient departments is performed in order to study the impact of the different factors of hospital environment on the formation of infectious diseases and development of the set of prevention measuresThe mitigation of risk of internal hospital infections at the expense of the hospital hygience improvement is the main element for increasing the safety of patients.

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