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# SOME ASPECTS OF INFECTIOUS COMPLICATIONS IN PATIENTS WITH SURGICAL DISEASES

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## Niektoré aspekty infekčných komplikácií u pacientov s chirurgickými chorobami

Multicentrická štúdia

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### SUMMARY

**Background:** At present postoperative infectious complications are reported worldwide to be the commonest in inpatients at surgical and intensive care units. Based on statistics on the infection control prevention, WHO has raised concerns over a high risk of infectious complications, which may occur following the delivery of health care at any medical settings. According to WHO reports the incidence of infectious complications among patients in high-income countries reaches 7 – 10 %, while in low-income countries, this figure reaches up to 20 %. In recent decades, the etiological structure of postsurgical infectious complications has been remaining almost unchanged. The aim of this study is to identify the leading causative agents of infectious complications in patients with surgical diseases.

**Patients and methods:** The study involved 137 middle-aged inpatients (mean age –  $56 \pm 3$  years) with post-surgical infectious complications of various localization who underwent the surgeries at the Surgical Department of M. Pirogov Vinnitsa Regional Clinical Hospital for 2007 – 2019. To investigate aerobic and opportunistic anaerobic microflora, samples were collected using sterile cotton swabs from each patient suspected to have infected areas prior the beginning of antibiotic therapy. Statistical analysis of the results obtained was performed by standard software packages "Microsoft Excel 2010" and "IBM SPSS Statistics 22".

**Results:** Gram-positive cocci have been found out as the commonest causative agents for postoperative infectious complications in the patients with surgical diseases as evidenced by the isolation rate over 60 % in the samples studied. It should be noted that the overwhelming majority of isolates

are constituted by opportunistic microorganisms, representatives of the genus *Staphylococcus* ( $n = 45$ ) with the prevalence of coagulase-negative species. *Enterococcus* spp. cause about 16 % of complications in the patients at the surgical wards. Gram-negative microorganisms have been found out as significantly rarer (35.3 %) compared with gram-positive microorganisms in the patients studied. Non-fermenting gram-negative bacteria were isolated in 34 patients out of 137 patients, and *A. baumannii* was found as the dominant causative agent of postoperative complications in 27 patients that is 10 times more common than *Staphylococcus aureus*. *P. aeruginosa* bacteria and *Candida* yeast-like fungi were detected to cause infectious complications in the patients with surgical pathology in only 3 % of cases.

**Conclusion:** Etiological structure of postoperative infectious complications differs depending on the type of complication itself. In cases of abscess, mediastinitis, infectious complications in oesophageal perforations, gram-positive cocci have been found out as a leading etiological factor, while gram-negative microorganisms are the commonest causative agents for phlegmons. Despite the almost unchanged spectrum of the primary causative agents of infectious complications in patients at surgical wards, recently there have been observed some deviations from the conventional etiological structure. Therefore, it is of great clinical importance to monitor and detect even slight changes occurring in the spectrum of microorganisms that cause complications, depending on the types of surgical intervention, its location and some others.

**Key words:** antibiotics, complications, mediastinitis, phlegmons, post-surgical infection, resistance.  
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## Introduction

At present postoperative infectious complications are reported worldwide to be the commonest in inpatients at surgical and intensive care units. Based on statistics on the infection control prevention, WHO has raised concerns over a high risk of infectious complications, which may occur following the delivery of health care at any medical settings. According to WHO reports the incidence of infectious complications among patients in high-income countries reaches 7 – 10 %, while in low-income countries, this figure reaches up to 20 % (9, 11).

In recent decades, the etiological structure of post-surgical infectious complications has been remaining almost unchanged (7). According to the relevant published literature the microbiota typically associated with complications registered at surgical inpatient departments is represented by limited list of opportunistic microorganisms, in particular, *Staphylococcus* spp., *Enterococcus* spp., *Klebsiella* spp. and *Pseudomonas* spp. (2, 3, 7, 10). At the same time, it is known that the spectrum of microorganisms differs depending on the location (site) and type of incision, the type of surgical intervention, treatment tactics and the type of ward (unit), where patients have to stay following the surgery (6, 8). The European Centre for Infectious Disease Prevention and Control asserts that gram-positive cocci are found to be the commonest causative agents for complications following knee and hip joint prosthetics, coronary bypass surgery, while gram-negative microorganisms play a leading role in the development of infectious complications following cholecystectomy, surgical intervention on lower intestinal segment, Caesarean delivery, laminectomy, etc. Moreover, some shifts in the spectrum of the main pathogens are registered annually (1, 5, 6). This generates commitment from WHO, surgeons, researchers and clinicians to reduce the rate of postoperative infectious complications and a careful study of changes in the species composition of predominant causative agents is in the focus of their close attention.

The aim of this study is to identify the leading causative agents of infectious complications in patients with surgical diseases.

## Materials and methods

The study involved 137 middle-aged inpatients (mean age  $56 \pm 3$  years) with post-surgical infectious complications of various localization who underwent the surgeries at the Surgical Department of M. Pirogov Vinnitsia Regional Clinical Hospital for 2007 – 2019.

To investigate aerobic and opportunistic anaerobic microflora, samples were collected using sterile cotton swabs from each patient suspected to have infected areas prior the beginning of antibiotic therapy. The samples were inoculated on thioglycol nutrient medium with added 1.5 % Difco agar, 5 % blood and 0.5 – 1 % yeast hydrolyzate applied as microbial growth booster, 5% blood agar and CHRO Magar Acinetobacter (Paris,

France) with subsequent cultivation for 24 – 48 hours at 37 °C. The final species identification was carried out by studying the morphological, tinctorial and biochemical properties of microorganisms using the STAFI test-16, ENTERO-24 and NEFERM test-24 (Brno) and by using automatic bacterial analyzer Vitec-2 compact bio-Mérieux (France).

The study was performed in accordance with ethical principles of the Declaration of Helsinki for medical research involving human subjects, adopted by the General Assembly of the World Medical Association; Council of Europe Convention on Human Rights and Biomedicine and related laws, as well as in accordance to the orders of the Ministry of Healthcare of Ukraine (minutes No 1 of the meeting of the Committee on Bioethics, M.I. Pirogov Vinnitsia National Medical University, signed 31.1.2007).

Statistical analysis of the results obtained was performed by standard software packages “Microsoft Excel 2010” and “IBM SPSS Statistics 22”.

## Results and discussion

Having investigated the samples taken from the patients with post-surgical infectious complications we have isolated and identified 137 clinical microbial strains (Tab. 1).

**Table 1. General characteristics of microbiota species composition obtained from patients with infectious post-surgical complications.**

Microorganism	Number of isolates taken from patients with post-surgical infectious complications (n = 137), 100 %	
	Total	%
<b>Gram-positive cocci (%)</b>	<b>83</b>	<b>60.6</b>
<i>Staphylococcus aureus</i>	17	12.4
<i>Staphylococcus haemolyticus</i>	17	12.4
<i>Staphylococcus epidermidis</i>	11	8.0
<i>Streptococcus pneumoniae</i>	6	4.4
<i>Streptococcus pyogenes</i>	6	4.4
<i>Streptococcus constellatus</i>	4	2.9
<i>Enterococcus faecalis</i>	22	16.1
<b>Gram-negative bacilli (%)</b>	<b>13</b>	<b>9.5</b>
<i>Escherichia coli</i>	2	1.5
<i>Klebsiella pneumoniae</i>	11	8.0
<b>Non-fermenting gram-negative bacilli (%)</b>	<b>34</b>	<b>24.8</b>
<i>Acinetobacter baumannii</i>	27	19.7
<i>Acinetobacter lwoffii</i>	3	2.2
<i>Pseudomonas aeruginosa</i>	4	2.9
<b>Other species</b>	<b>7</b>	<b>5.1</b>
<i>Candida albicans</i>	4	2.9
<i>Bacillus cereus</i>	3	2.2

Source: Authors' own processing

Gram-positive cocci have been found out as the commonest causative agents for postoperative infectious complications in the patients with surgical diseases.

es as evidenced by the isolation rate over 60 % in the samples studied. It should be noted that the overwhelming majority of isolates are constituted by opportunistic microorganisms, representatives of the genus *Staphylococcus* (n = 45) with the prevalence of coagulase-negative species. *Enterococcus spp.* cause about 16 % of complications in the patients at the surgical wards.

Gram-negative microorganisms have been found out as significantly rarer (35.3 %) compared with gram-positive microorganisms in the patients studied. Non-fermenting gram-negative bacteria were isolated in 34 patients out of 137 patients, and *A.baumannii* was found as the dominant causative agent of postoperative complications in 27 patients that is 10 times more common than *Staphylococcus aureus*. *P. aeruginosa* bacteria and *Candida* yeast-like fungi were detected to cause infectious complications in the patients with surgical pathology in only 3 % of cases.

The study has demonstrated that the spectrum of the predominant causative agent of infectious post-surgical complications in the patients differed significantly depending on the type and localization of complications (Tab. 2).

**Table 2. Characteristics of microbiota species composition in relation to the type of infectious post-surgical complications.**

	Mediastinitis	Phlegmon	Abscess	Oesophageal perforation	Large oesophageal hiatus hernia
Sex male/female	19/10	28/12	18/12	16/13	6/3
Number of infectious complications	29	40	30	29	9
<b>Microorganisms</b>	<b>Total</b>				
<i>Staphylococcus aureus</i>	3	4	6	2	1
<i>Staphylococcus haemolyticus</i>	6	2	6	1	2
<i>Staphylococcus epidermidis</i>	6	1	-	4	-
<i>Streptococcus pneumoniae</i>	5	1	-	-	-
<i>Streptococcus pyogenes</i>	-	4	-	1	1
<i>Streptococcus constellatus</i>	3	1	-	-	-
<i>Enterococcus faecalis</i>	3	5	6	7	1
<i>Escherichia coli</i>	-	-	-	2	-
<i>Klebsiella pneumoniae</i>	-	6	-	4	1
<i>Acinetobacter baumannii</i>	3	9	12	2	2
<i>Acinetobacter lwoffii</i>	-	1	-	2	-
<i>Pseudomonas aeruginosa</i>	-	3	-	-	1
<i>Candida albicans</i>	-	-	-	4	-
<i>Bacillus cereus</i>	-	3	-	-	-

Source: Authors' own processing

It has been revealed the etiological structure of phlegmon among the surveyed group was the most heterogeneous and included 12 species of microorgan-

isms, and *A. baumannii* (n = 9) and *K. pneumoniae* (n = 6) were found as the most numerous. *A. baumannii* species were also found out as the predominant causative agents of abscesses developed in the patients after surgeries (n = 12). However, the spectrum of major pathogens included only 4 microbial species except the above mentioned *S. aureus*, *S. haemolyticus* and *E. faecalis* acinobacteria demonstrating the identical isolation rate (n = 6). That is, gram-negative microorganisms play a key role in the development of phlegmons in the patients of surgical wards, while gram-positive cocci more often result in the development of abscesses.

*Staphylococcus spp.* (n = 15) and *Streptococcus spp.* (n = 8) were more often isolated in the samples from the patients with mediastinitis. At the same time, among 29 patients with this infectious complication, the etiological role of *E. faecalis* and *A. baumannii* was revealed in 6 patients, i.e. three cases for each of these two species.

The structure of the species composition of the dominant causative agents in cases of oesophageal perforations is quite diverse and consisted of 7 genera and 10 species of pathogens, with *E. faecalis* being the most prevalent among them (n = 7). It is significant that *E. coli* and *C. albicans* isolates were only detected in the patients with oesophageal perforations. Overall among 29 patients with oesophageal perforations, gram-positive cocci were isolated from 15 individuals that make up 52 % of cases.

The following species as *S. haemolyticus*, *A. baumannii*: *aeruginosa*, *K. pneumoniae*, *S. aureus*, *S. pyogenes* and *E. faecalis* have been revealed as an etiological factor for infectious complications in the patients with large oesophageal hiatus hernia. The species demonstrate the similar isolation rate.

## Conclusions

The results obtained from the study show that opportunistic microorganisms, and namely *Staphylococcus*, *Enterococcus* and *Acinetobacter* are predominant etiological factors for post-surgical infectious complications. In general, gram-positive cocci and non-fermenting gram-negative bacteria act as leading causative agents in the most cases of post-surgical complications.

Etiological structure of postoperative infectious complications differs depending on the type of complication itself. In cases of abscess, mediastinitis, infectious complications in oesophageal perforations, gram-positive cocci have been found out as a leading etiological factor, while gram-negative microorganisms are the commonest causative agents for phlegmons.

Despite the almost unchanged spectrum of the primary causative agents of infectious complications in patients at surgical wards, recently there have been observed some deviations from the conventional etiological structure. Therefore, it is of great clinical importance to monitor and detect even slight changes occurring in the spectrum of microorganisms that cause complica-

tions, depending on the types of surgical intervention, its location and some others.

Meanwhile, antibiotics play a crucial role in clinical practice and measures are needed to extend their useful life, thus avoiding widespread multi-resistance. The key to achieving this goal should be the rational use of antibiotics and the reduction of their consumption in both medicine and agriculture (4).\*

**\*Compliance with Ethics Requirements:** The authors declare no conflict of interest regarding this article. The authors declare, that all the procedures and experiments of this research respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008 (5), as well as the national law.

**Conflict of interest:** The authors declare no conflict of interest.

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