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Research Article

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Surgical Site Infections: Risk Factors for Multiple Antibiotic Resistance in Abdominal Surgery

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INTRODUCTION Multidrug-resistant (MDR) organisms are increasingly becoming a major surgical site infection (SSI); however, the clinical outcomes and risk factors associated with resistant pathogens in general surgery remain poorly understood.

THE AIM of the present research is to study the risk factors and consequences of infections in patients with SSI caused by antibiotic resistant pathogens with MDR.

MATERIAL AND METHODS A single-center, retrospective case-control study was carried out. The results of the examination and treatment of 50 patients with SSI + MDR, who made up the main group, and two control groups — non-MDR SSI and no SSI, 50 patients each, were analyzed. A total of 38 risk factors were used: pre- and surgical criteria, clinical, biochemical, instrumental data, postoperative complications and treatment features. The microbial landscape was studied in SSI+MDR. Single- and multivariate analysis was carried out, binary and multinomial logistic regression was performed. P-values <0.05 were considered significant at 95% CI.

RESULTS Significant risk factors were as follows: previous hospitalization, previous antibiotic therapy, terms of preoperative stay of the patient in the department, emergency surgery, class of surgery, decrease in the ratio of ALP/ ALPI, MEI and EMFC ($p<0.01$); elevated ASA score, obesity, low levels of plasma proteins and albumin, ($p<0.05$). Among the pathogens, there were more gram-negative enterobacteria (61%) than gram-positive ones (30.5%). Escherichia coli (36.3%) was the most commonly found bacterium, followed by Enterococcus faecium (9.09%), Morganella morganii (7.58%), Staphylococcus aureus (6%), and Pseudomonas aeruginosa (6%). In SSSI, Staphylococcus spp. prevailed. (>80%); in DSSI — Echerichia, Acinetobacter (>70%); and in OSSSI — Enterobacter spp., Acinetobacter and Citrobacter (>90%). SSI+MDR were characterized by serious surgical complications (Clavien Dindo Classification grade 3–5), wound dehiscences and OSSSI, reoperations ($p<0.05$).

CONCLUSION 1. The primary risk factors for multiple antibiotic resistance were as follows: previous hospitalization, previous antibiotic therapy, the duration of the patient's preoperative stay in the department, emergency surgery, surgery class, reduced ALP/ALPI ratio, MEI and EMFC. In addition to the above, the following were also of great importance: increased ASA score, obesity, low plasma proteins, albumin.

2. When identifying risk factors for multiple antibiotic resistance in surgical patients, the development of severe postoperative complications, sepsis and multiple organ failure can be predicted.

3. Perioperative medical and preventive measures require a multidisciplinary approach involving the microbiologist, pharmacologist, immunologist, nutrition specialist, and other expert consultants.

Keywords: antibiotic resistance, surgical site infections, risk factors for surgical infection, abdominal surgery, multidrug resistance of microorganisms, multiple antibiotic resistance

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ALP — total alkaline phosphatase
AR — antibiotic resistance
BMI — body mass index
CAUTI — catheter-associated urinary tract infections
CLABSTI — central line-associated bloodstream infection
DSSI — deep surgical site infection
EDR — extended drug resistance
EMFC — enteral morphofunctional coefficient
GIT — gastrointestinal tract
IAP — intestinal alkaline phosphatase
ICU — intensive care unit
MDR — multidrug resistance
MEI — microcirculation efficiency index
MOF — multiple organ failure
OSSSI — organ/space surgical site infection
PDR — pandrug resistance
qSOFA — sequential organ failure assessment (quick)
SSI — surgical site infections
SSSI — superficial surgical site infection

The emergence of antibiotic resistance (AR) to multiple antimicrobial agents in pathogenic bacteria has become a major public health threat, as there are few or no effective antimicrobial agents against infections caused by these bacteria [1–5]. A WHO report published in April 2023 states that as antibiotic-resistant bacteria continue to emerge, further efforts are needed to improve infection prevention and control practices, reduce unnecessary use of antimicrobials, develop and implement antimicrobial drugs, programs for the rational use and ensuring adequate microbiological capacity [6]. In recent years, there have been studies on the creation of predictive models, including those using machine learning [7–10].

Multidrug-resistant (MDR) microorganisms are increasingly becoming a serious surgical site infection (SSI), but the clinical outcomes and risk factors associated with resistant pathogens in general surgery are poorly understood [11–14]. Previous hospitalization, antibiotic treatment, preoperative infections, etc. are risk factors for antibiotic resistance [15–17]. According to the European Centre for Disease Prevention and Control,

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AR bacteria can be classified as MDR, extended drug resistant (EDR) and pan-drug resistant (PDR) microorganisms [18].

The current assumption that the majority of SSIs occurring after surgery using standard antisepsis techniques are related to intraoperative contamination remains unproven. A growing number of recent human genome, gut microbiome, and proteomics studies suggest that loss of mucosal barrier function, particularly in the gastrointestinal tract (GIT), can significantly affect antigen transfer, ultimately influencing the close bidirectional interactions between the gut microbiome and the immune system [19]. These cross-talks have a major impact on the host immune function and ultimately on the outcome of interventions. Available data suggest that pathogens originating from the intestinal microbiota can cause postoperative infection through a process where they secretly move within the immune cell and affect the surgical site, the so-called Trojan horse hypothesis [20]. In this regard, interest has arisen in diagnostic biomarkers of intestinal failure, such as intestinal alkaline phosphatase (IAP), a regulator of intestinal barrier function [21, 22]. In addition, some instrumental methods allow us to assess the degree of intestinal microcirculation disorders: peritoneal laser Doppler flowmetry [23–26], as well as ultrasonographic determination of morphofunctional intestinal disorders [27–29].

Despite advances and growing knowledge on this topic, multiple AR remain an important consideration for the clinician and a significant barrier to successful SSI prevention.

The aim of the study was to investigate the risk factors and consequences of infections in patients with SSI caused by AR pathogens with MDR.

MATERIAL AND METHODS

A single-center retrospective case-control study was conducted for the period 2020–2022. We analyzed a total of 1970 surgical interventions, including: 472 (23.9%) operations for inflammatory diseases of the GIT (ICD-10: K35.1, K35.2, K35.3, K56.0, K56.1, K56.2, K56.5, K56.7, K57.3, K66.0, K91.3); 355 (18.0%) — for gastrointestinal cancer (C16, C18, C19, C20, C22, C23, C25, C26); 158 (8.0%) — hernioplasty (K40.3, K40.4, K40.9, K41.3, K41.4, K41.9, K42.0, K42.1, K42.9, K43.0, K43.1, K43.2); 700 (35.5%) — cholecystectomy and surgery on extrahepatic bile ducts (K80.0, K80.3, K80.4, K81.1); and 285 (14.5%) - emergency operations for closed abdominal trauma, perforations of hollow organs complicated by diffuse peritonitis (S36.0, S36.1, S36.2, S36.4, S36.5, S35.7, S35.8, K25.9, K26.1, K57.4).

A systematic microbiological study of all patients with SSI was performed to assess the incidence, risk factors, and impact on the clinical course of AR-associated infections in surgical patients. SSI was defined as any infection occurring within 30 days after surgery and classified as superficial (SSSI), deep (DSSI), or organ/space (OSSSI). The primary endpoints were morbidity and mortality, classified according to the Clavien-Dindo classification. Secondary endpoints were identification of risk factors for AR pathogen infection.

Major complications were very common in patients with MDR SSI (>50%) and very rare in patients with non-MDR SSI (<10%) or no SSI (≈1%). Based on the Feigl nomogram, with a 95% confidence limit and a 50% interval, the number of observations equal to 35 in each group was considered sufficient for the analysis. The number of SSI–MDR observations was 50, and two comparison groups were formed: one group of patients with non-MDR SSI (n=50), and the second group of patients without SSI (n=50). The comparison groups were recruited at the same time points as MDR patients, and were standardized for age, male/female ratio, diagnosis, and surgical treatment.

The following preoperative risk factors were taken into account for the analysis: previous hospitalization within 12 months; previous antibiotic

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therapy within 3 months; preoperative hospital stay (days); BMI<18.5 or>30; ASA, physical status>2; blood parameters: total protein (g/L), albumin (g/L), total alkaline phosphatase/intestinal alkaline phosphatase (ALP/IAP, %) ratio. The study took into account perioperative surgical data: indications for surgery; emergency and urgent interventions; open or laparoscopic approach; pre-existing infections; class of surgical wounds; duration of surgery (min); microcirculation efficiency index (MEI, conventional units); enteral morphofunctional coefficient (EMFC, points); abdominal drainage; open abdomen technique; number of reoperations. To assess the clinical course of patients with MDR, the following postoperative parameters were recorded: duration of postoperative hospital stay; total hospital stay; incidence of surgical SSI (suture dehiscence, fistula, infected hematoma) and non-surgical (cardiovascular and respiratory) complications; hospitalization in the intensive care unit (ICU) and its duration; parenteral and/or enteral nutrition; blood transfusion; central venous catheter (CLABSTI); urinary catheter (CAUTI).

All the patients received broad-spectrum antibiotic prophylaxis, except for patients with intraoperative infection, who received empirical interval antibacterial therapy until microbiological test results were available. Patients with SSI underwent culture of wound discharge, blood, urine, bronchoalveolar discharge obtained during lavage (as indicated). Isolation and identification of pathogen cultures were performed using a VITEK 2 Compact 30 4700733 analyzer (France). The tests were performed according to the EUCAST recommendations (version 6.0, 2017). The main resistance categories were: methicillin-resistant *Staphylococcus aureus* (MRSA); vancomycin-resistant *Staphylococcus aureus* (VRSA); vancomycin-resistant *Enterococcus faecium* (VRE); *Escherichia coli* and *Klebsiella* species producing extended-spectrum beta-lactamases (*Enterodacter* ESBL+); *Pseudomonas aeruginosa* and *Acinetobacter* species resistant to third-generation cephalosporins and carbapenems (non-fermenting MDR); carbapenem-resistant Enterobacteriaceae (CRE) and MDR fungi. Thus, 100 patients with SSI were examined, which formed two groups - SSI+MDR and non-MDR SSI. A total of 475 bacterial cultures were taken, 1276 isolates were isolated.

Differences between the groups were calculated using two-tailed Fisher's exact test for categorical variables, and Student's t test or Mann–Whitney U test where appropriate. Binary and multinomial logistic regression were also performed. For multivariate statistical analysis, biochemical continuous variables were transformed into categorical variables using laboratory reference cutoff values. Results were reported as odds ratios with 95% confidence intervals (CI). Values of $p < 0.05$ were considered statistically significant. Statistical analysis was performed using IBM SPSS Statistics v.25.

RESULTS AND DISCUSSION

Among all the patients, SSI were diagnosed in 155 cases (7.86%), SSI+MDR was detected in 50 (2.53%). Most frequently, SSI+MDR were registered after emergency interventions for blunt abdominal trauma, perforations of hollow organs complicated by diffuse peritonitis (17/285 cases, 5.96%), when the infection was present at the time of surgery. Operations for oncological pathology of the gastrointestinal tract were the second most common (11/355 cases, 3.09%). Inflammatory gastrointestinal diseases were registered in 14/472 cases (2.96%), followed by hernioplasty (3/158 cases, 1.9%). The lowest percentage was observed after cholecystectomy and operations on extrahepatic bile ducts (5/700 cases, 0.71%). Patients with MDR had a mean age of 59.8±17.4 years, M/F ratio of 1.23; the same surgical indications as in the comparison groups. In the MDR group, there were more emergency surgeries (72.3%), laparotomy access (61.7%), and contaminated surgeries – “dirty” surgeries (59.5%) (Table 1).

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Table 1

Factors associated with surgery (abs; %; M±m)

Surgical features	SSI+MDR, (n=50)	non-MDR SSI, (n=50)	No SSI, (n=50)
Elective/emergency surgery, n	14/36	16/34	15/35
Laparotomy/laparoscopy, n	31/19	31/19	17/33*
Surgery class (Altemeier's classification), 1/2/3/4	16/4/20/11	20/6/17/7	36/5/9/0
Time, min (M±m)	212±65	198±64	125±83*
Abdominal drainage, n (%)	50 (100)	46 (92.0)	34 (68.0)**
Repeated operations, n (%)	26 (52.0)***	1 (2.0)	0
Open abdomen, n (%)	7 (14.0)	0	0

Notes: * — p<0.05 compared with SSI+MDR; ** — p<0.01 compared with SSI+MDR; *** — p<0.01 compared with non-MDR SSI. MDR — multidrug resistance; SSI — surgical site infection.

The SSI+MDR group had a higher rate of reoperation and open abdomen treatment; while patients without SSI had significantly shorter operative times, more laparoscopic procedures, less use of abdominal drains, and no iterative surgery or open abdomen treatment.

Several clinical and biochemical parameters were found to be risk factors associated with SSI. In the multinomial logistic regression analysis, there were several variables: MEI, ALP/IAP, and EMFC, which reached statistical significance between SSI+MDR patients and non-MDR SSI patients. The length of hospital stay in patients without SSI, with non-MDR SSI, and with SSI+MDR was 12.19±5.2, 18.3±8.2, and 47.8±42 days, respectively (Table 2).

In multivariate analysis, the postoperative course of SSI+MDR was characterized by a higher rate of reoperations and complications (CD III–IV). The association between MDR and multimicrobial infection was a predictor of severe surgical complications. In addition, patients with SSI+MDR had a higher rate of dehiscence and OSSSI, which increased the risk of further complications after surgery, such as reoperations, septic shock, and multiple organ failure (MOF) (Table 3).

Table 2

Clinical, biochemical and instrumental risk factors for MDR in the study groups (abs; %; M±m)

Risk factors	Univariate analysis			Multivariate analysis			
	SSI+MDR (n=50)	non-MDR SSI (n=50)	no SSI (n=50)	SSI+MDR vs. non-MDR SSI OR [CI 95%]	Sig	SSI+MDR vs. no SSI OR [CI 95%]	Sig
Previous hospitalization, n (%)	29 (58.0)**	22 (44.0)**	7 (14.0)	2.1 [0.46; 9.68]	0.337	1.62 [0.23; 11.39]	0.027
Previous antibiotic therapy, n (%)	17 (34.0)§§	19 (38.0)**	5 (10.0)	0.24 [0.05; 2.54]	0.084	2.38 [0.25; 21.5]	0.045
Body mass index, n (%)	12 (30)*	7 (14.0)	4 (8.0)	1.42 [0.38; 5.28]	0.049	1.46 [0.246; 8.68]	0.076
ASA, n (%)	22 (44.0)*§	11 (22.0)	5 (10.0)	2.52 [0.77; 8.24]	0,127	4.74 [1.02; 22.5]	0.047
Preoperative stay, days (M±m)	8±10.5**§	3.1±4.3	2.6±4.8	2.99 [0.89; 10.8]	0.094	0.68 [0.138;3.39]	0.044
Total protein, g/l, (M±m)	60.3±7.9*§	64.1±5.6*	66.9±5.6	1.02 [0.25; 4.08]	0.979	4.28 [0.68; 26.8]	0.12
Albumin, g/l, (M±m)	30.7±6.7*§	33.6±5.9*	36.6±3.9	1.9 [0.29; 13.32]	0.499	1.09 [0.047;25.5]	0.955
ALP/ALP (N 1.27–2.17), %, (M±m)	0.09±0.01**§§	0.98±0.21*	1.73±0.45	8.56 [1.1; 64.5]	0.032	164 [0,4; 642,2]	0.005
MEI (N 1.24–2.34), perfusion units, (M±m)	0.54±0.1**	0.86±0.2*	1.44±0.2	4.62 [0.36; 8.62]	0.039	22.1 [0.32 ;12.3]	0.009
EMFC (N<5), points, (M±m)	11.2±3.2**	6.3±1.1*	2.6±0.3	18.34 [1.2; 26.8]	0.042	27.3 [1.14 29.8]	0.008

Notes: * — p <0.05 compared with absence of SSI; **— p <0.01 compared with absence of SSI; § — p <0.05 compared with non-MDR SSI. §§ — p <0.01 compared with non-MDR SSI. CI — confidence interval; MEI — microcirculation efficiency index; SSI — surgical site infection; IAP — intestinal alkaline phosphatase; MDR — multidrug resistance; OR — odds ratio; ALP — total alkaline phosphatase; EMFC — enteral morphofunctional coefficient

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Table 3

Postoperative complications (abs; %; M±m)

Complications	SSI+MDR (n=50)	non-MDR SSI (n=50)	Multivariate analysis OR[CI 95%]	Sig
Minor CD 0/I, II, n (%)	0/19 (38)	0/42 (84)	5.42 [1.48; 19.3]	0.007
Severe CD III–IV, n (%)	24 (48)**	7 (14)		
CD V (mortality), n (%)	7 (14)	1 (2)		
General complications				
Cardiovascular, n (%)	7 (14)	0	–	0.048
Respiratory, n (%)	11 (22)	0		
Surgical complications				
Hematoma, n (%)	5 (10)	4 (8)	4.42 [2.34; 17.3]	0.009
Suture failure, n (%)	16 (32)**	3 (6)		
Infectious complications				
SSSI, n (%)	20 (40)	39 (78)	6.42 [1.78; 29.4]	0.049
DSSI, n (%)	19 (38)	8 (16)		
OSSSI, n (%)	6 (12)*	3 (6)		
CLABSTI, n (%)	7 (14)	5 (10)	–	0.079
CAUTI, n (%)	10 (20)	5 (10)		
qSOFA>2, n (%)	50 (100)**	17 (34)	6.42 [3.61; 13.4]	0.007
Septic shock	3 (6)*	2 (4)	–	0.037
MOF, n (%)	6 (12)*	0	–	0.027
mix-infection, n (%)	12 (24)*	1 (2)	–	0.033
Repeated operations, n (%)	20 (40)**	1(2)	12.2 [1.37; 109.2]	0.002
Bed days in ICU, days (M±m)	12.8±15.9	1.2±0.45	4.5 [1.52; 29.2]	0.004
Hospital bed days, days (M±m)	46.9±42**	16.3±8.2	24.2 [8.34; 79.2]	0.003

Notes: * — p <0.05 compared with non-MDR SSI. ** — p <0.01 compared with non-MDR SSI. CI — confidence interval; SSI — surgical site infection; MDR — multidrug resistance; ICU — intensive care unit; OR — odds ratio; MOF — multiple organ failure; DSSI — deep surgical site infection; CAUTI — catheter-associated urinary tract infection; CLABSI — central line-associated bloodstream infections; OSSSI — organ/space surgical site infections; SSSI — superficial surgical site infection; qSOFA — quick Sequential Organ Failure Assessment

During the postoperative period, patients in the SSI+MDR group required blood transfusion and mechanical ventilation more often than non-MDR SSI patients, and tracheostomy was performed in 3 cases. The use of parenteral nutrition was significantly more frequent and its duration was longer in patients with SSI+MDR compared with non-MDR SSI and uninfected patients. Enteral nutritional support was used more frequently in patients with SSI+MDR than in patients with non-MDR SSI, but with no significant difference in duration. Patients with MDR infections were admitted to the intensive care unit more often and for a longer period than patients with non-MDR SSI. The overall duration of the postoperative period and hospital stay were significantly longer in patients with SSI+MDR. According to the multivariate regression analysis, a statistical difference was noted only for the indicators of parenteral and enteral nutritional support (Table 4).

Table 4

Postoperative treatment (abs; %; M±m)

Therapeutic measures	SSI+MDR (n=50)	non-MDR SSI (n=50)	Multivariate analysis OR [CI 95%]	Sig
Open abdomen, n (%)	7 (14)	0	–	0.343
Mechanical ventilation for more than 48 hours, n (%)	20 (40)	2 (4)	–	0.411
Tracheostomy, n (%)	3 (6)	0	–	0.347
Hemotransfusions (course), n (%)	31(62)*	14 (28)	–	0.352
Parenteral nutrition, n (%)	32(64)*	11 (22)	3.86 [1.42; 10.47]	0.008
Parenteral nutrition, days (M±m)	32.9±39.9**	9.18±2.75	–	–
Artificial enteral nutrition, n (%)	21(44)**	2 (4)	10.02 [2.03; 49.4]	0.005
Artificial enteral nutrition, days (M±m)	24±22.2	20±14.14	–	–

Notes: * — p <0.05 compared with non-MDR SSI. ** — p <0.01 compared with non-MDR SSI. CI — confidence interval; SSI — surgical site infection; MDR — multidrug resistance; OR — odds ratio

Mortality rate (CD V) in the non-MDR SSI group was 2%, and among patients with SSI+MDR it was 14%.

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In patients with SSI+MDR, there were more Gram-negative *Enterobacteriaceae* (61%) than Gram-positive ones (30.5%). *E. coli* (36.3%) was the most frequently isolated bacterium, followed by *E. faecium* (9.09%), *Morganella morganii* (7.58%), *S. aureus* (6%), and *P. aeruginosa* (6%). Yeast (Candida albicans) were isolated in two cases (3%). In patients with SSI+MDR, *Staphylococcus* MRSA strains were isolated in 21 cases (27.6%), *E. coli* (ESBL+) in 20 (26.1%), *K. pneumoniae* (ESBL+) in 17 (22%), and *P. aeruginosa* (MDR) in 6 (7.89%). In a limited number of cases, *Enterococcus* species (VRE), *Acinetobacter baumani* (MDR), and *Candida glabrata* (MDR) were isolated. Extended-spectrum beta-lactamase resistance was the most common type (31.5%) followed by resistance to methicillin (27.6%), carbapenem (18.4%) and vancomycin (11.8%). There were 46 patients (92%) with MDR, 3 (6%) with EDR, and only 1 had PDR (Fig. 1).

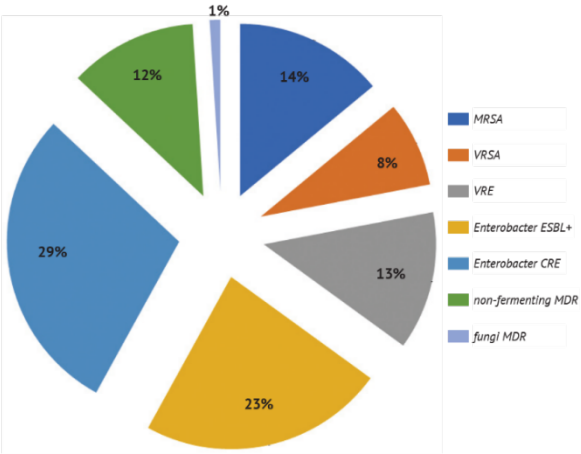

Fig. 1. Distribution of SSI pathogens by type of antimicrobial resistance (%)
Notes: ESBL+ — extended spectrum beta-lactamase; *Enterobacter* CRE — Carbapenem-resistant *Enterobacteriaceae*; MRSA — methicillin-resistant *Staphylococcus aureus*; fungi MDR — multi-drug resistant fungi; non-fermenting MDR — non-fermenting multidrug-resistant bacteria; VRE — vancomycin-resistant *Enterococci;* VRSA — vancomycin-resistant *Staphylococcus aureus*

In superficial SSIs, *Staphylococcus spp.* (>80%) prevailed, in cases of deep SSIs - *Escherichia*, *Acinetobacter* (>70%), and in cases of organ/space SSIs - *Enterobacter spp*., *Acinetobacter* and *Citrobacter* (>90%) (Fig. 2).

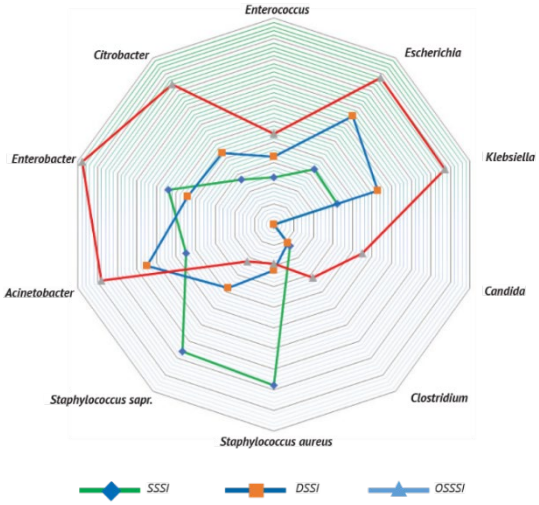

Fig. 2. Changes in the microbial landscape depending on the class of SSI (%)
Notes: DSSI — Deep Incisional Surgical Site Infection; OSSSI — Organ/Space Surgical Site Infection; SSSI — Superficial Surgical-Site Infection

Antibiotic resistance is a typical characteristic of bacteria. It can be initial and activated by antibiotics, pass from resistant to non-resistant bacteria while the source of infection remains, and intensify due to the suppression of expansion-sensitive resistant strains. Thus, the routes of MDR infection are multifactorial, and some clinical conditions can cause this negative effect. There is no doubt that previous antibiotic therapy, previous hospitalization and the duration of preoperative hospital stay are risk factors for MDR. In this study, risk factors for SSI associated with MDR were identified: emergency surgery, presence of abscess and "dirty" operations, class of surgery, etc. Increased ASA score, obesity, low plasma protein, albumin, a decrease in the ALP/AKP ratio, MEI and EMFC, which characterize the state of the intestine, also turned out to be risk

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factors for SSI+MDR. It should be noted that EDR or PDR to antibiotics were rare, and did not cause a worsening of the prognosis.

It is certain that only culture-guided antibiotic use can reduce inappropriate prescribing and the risk of MDR development. A further approach could be to identify patients at risk for MDR before culture to be able to influence risk factors. However, the risk factors for SSI+MDR and non-MDR SSI infections are similar, and their correction often requires a longer hospital stay, which in turn is another risk factor for MDR infections, as confirmed by numerous meta-analyses [30–32].

When considering surgical factors associated with SSI+MDR, it is always difficult to differentiate between the causes and consequences of infection. We know that the risk of SSI is higher after "dirty" operations, in emergency observations, and after open laparotomy. When selecting patients for the comparison group, we compensated for these factors, and found that SSI+MDR was associated with serious surgical complications (grade 3-5 Clavien-Dindo), suture dehiscence, and OSSSI.

CONCLUSIONS

1. The primary risk factors for the development of multiple antibiotic resistance were: previous hospitalization, previous antibiotic therapy, duration of preoperative patient stay in the department, emergency surgery, class of surgery, decreased total alkaline phosphatase/intestinal alkaline phosphatase ratio, microcirculation efficiency index and enteral morphofunctional coefficient. In addition to the above, the following were also of great importance: elevated ASA score, obesity, low plasma protein and albumin levels.

2. By identifying risk factors for multiple antibiotic resistance in surgical patients, it is possible to predict the development of severe postoperative complications, sepsis and multiple organ failure.

3. Perioperative treatment and prophylactic measures for multiple drug resistance require a multidisciplinary approach involving the microbiologist, pharmacologist, immunologist, nutritionist, and other expert consultants.

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