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Features of the course of coronavirus infection in patients after thoracic and cardiac surgery

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Abstract
Objective: To study the features of the coronavirus infection course in cardiosurgical and thoracic patients to determine the factors potentially affecting the possibility of lethal outcome. To identify the predictors of fatal outcome based on the analyses of the features of the coronavirus infection course in this category of patients.
Material and methods: During the analyzed period 80 patients from the departments of thoracic surgery and cardiac surgery were transferred to the infectious diseases department: 20 patients from the cardiac surgery department (CSD) – group 1; 60 patients from the thoracic surgery departments (TSD) – group 2. A control group number 3 consisting of 59 non-thoracic and non-cardiosurgical patients was also formed. According to the disease outcome the patients were divided into two groups: group 1 – fatal outcome, group 2 – recovery.
Results: Out of 80 patients, lethal outcome was recorded in 25 cases: 22 patients of the thoracic profile (36% of the total number of transferred from this department) and 3 patients of the cardiosurgical profile (15% of the total number of those transferred from the cardiac surgery department). 20 out of 20 cardiac patients had been operated on the day before, 49 out of 60 thoracic patients also underwent surgery. 3 people from the group of non-operated patients transferred from departments of thoracic surgery died. Moreover, after pneumonectomy, fatal outcome was recorded in 7 out of 8 cases (87.5%).
Conclusion: During the analyses of indicators it was revealed that the number of fatal outcomes in patients of the thoracic profile with COVID-19 infection is higher than of the cardiosurgical profile and in the infectious diseases department. Presumably, this is due to the fact that coronavirus infection affects the lungs to a greater extent, and in patients with a thoracic profile (in particular, those who have undergone resection interventions), the volume of the lung parenchyma is initially reduced. This is confirmed particularly by the highest percentage of fatal outcomes after pneumonectomy. Cardiosurgical patients after surgical interventions do not have a reduction in the functioning lung parenchyma, which creates an additional "reserve" for recovery. Moreover, men predominate among patients of the thoracic profile, with the survival rate lower in all groups compared to women. Patients transferred from thoracic departments showed higher rates of systemic inflammation, which indicates a more severe course of the viral infection and the possible development of complications.
When analyzing the predictors of lethal outcome, the following factors were identified: male gender and, in general, a more severe course of a viral infection (low saturation, a high percentage of lung lesions on CT, more pronounced changes in laboratory screening). The studied factors are associated with a large number of fatal outcomes in thoracic and cardiac surgery patients. Among the factors that do not affect the prognosis are diabetes mellitus, stroke and myocardial infarction in history.
Thus, patients diagnosed with coronavirus infection that developed after thoracic surgery had the most unfavorable prognosis. The revealed patterns are of interest for optimizing the routing of this category of patients in order to prevent coronavirus infection.
Keywords: coronavirus, coronavirus infection, COVID-19, cardiac surgery, thoracic surgery, pneumonectomy, fatal outcome
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Особенности течения коронавирусной инфекции у пациентов, перенесших торакальные и кардиохирургические операции

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Резюме

Цель: Изучить особенности течения коронавирусной инфекции у пациентов кардиохирургического и торакального профиля для установления факторов, потенциально влияющих на наступление летального исхода.

Выявить предикторы летального исхода на основе анализа особенностей течения коронавирусной инфекции у данной категории пациентов.

Материал и методы: За анализируемый период в инфекционное отделение переведено 80 пациентов из отделений торакальной хирургии и кардиохирургии: 20 – из кардиохирургического отделения – группа 1; 60 пациентов из отделений торакальной хирургии – группа 2. Контрольная группа сформирована из 59 пациентов не торакального и не кардиохирургического профиля – группа 3. Пациенты по исходу заболевания разделены на две группы: группа 1 – наступление летального исхода, группа 2 – выздоровление.

Результаты: Из 80 больных летальный исход зафиксирован у 25: у 22 пациентов торакального профиля (36% от общего числа переведенных из данного отделения) и 3 пациентов кардиохирургического профиля (15% от общего количества переведенных из отделения кардиохирургии). 20 из 20 кардиохирургических пациентов были накануне прооперированы, 49 из 60 торакальных пациентов также перенесли хирургическое вмешательство. Из неоперированных пациентов, переведенных из отделений торакальной хирургии, умерли 3 человека. Причем после пневмонэктомии летальный исход зафиксирован в 7 из 8 случаев (87,5%).

Заключение: При анализе показателей выявлено, что число летальных исходов пациентов торакального профиля в условиях ковидной инфекции выше, чем кардиохирургического профиля и в инфекционном отделении. Предположительно данный факт обусловлен тем, что коронавирусная инфекция в большей степени поражает легкие, а у пациентов торакального профиля (в частности, перенесших резекционные вмешательства) объем легочной паренхимы изначально уменьшен. В частности, это подтверждается наибольшим процентом летальных исходов после пневмонэктомии. У кардиохирургических пациентов после оперативных вмешательств нет редукции функционирующей паренхимы легких, что создает дополнительный «резерв» для выздоровления. Кроме того, среди пациентов торакального профиля преобладают мужчины, уровень выживаемости которых ниже во всех группах по сравнению с женщинами. У пациентов, переведенных из торакальных отделений, выявлены более высокие показатели системного воспаления, что свидетельствует о более тяжелом течении вирусной инфекции и возможном развитии бактериальных осложнений.

При анализе предикторов летального исхода выявлены следующие факторы: мужской пол и в целом более тяжелое течение вирусной инфекции (низкая сатурация, высокий процент поражения легких по КТ, более выраженные изменения при лабораторном скрининге). Исследуемые факторы ассоциированы с бóльшим числом летальных исходов пациентов торакального и кардиохирургического профиля. Из факторов, не влияющих на прогноз, – сахарный диабет, острое нарушение мозгового кровообращения и инфаркт миокарда в анамнезе.

Таким образом, у пациентов с диагностированной коронавирусной инфекцией, развившейся после перенесенных торакальных оперативных вмешательств, выявлен наиболее неблагоприятный прогноз. Полученные закономерности представляют интерес для оптимизации маршрутизации данной категории пациентов с целью профилактики коронавирусной инфекции.

Ключевые слова: коронавирус, коронавирусная инфекция, COVID-19, кардиохирургические операции, торакальная хирургия, пневмонэктомия, летальный исход

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Introduction

COVID-19 (short for COronaVIrus Disease 2019 – coronavirus infection of 2019) – is an acute respiratory infection caused by the SARS-CoV-2 coronavirus [1]. It is a disease [2] with various forms of course – both mild [3–5] and severe [9]. The virus infects various human organ systems through direct infection [6] or through the body's immune system response [7]. The most frequent way of development of the disease course is viral pneumonia, which can lead to acute respiratory distress syndrome (ARDS) and acute respiratory failure, which requires oxygen therapy and respiratory support [8]. Complications include multiple organ failure, septic shock, and venous thromboembolism [9]. The symptom complex includes fever, general weakness and dry cough. Also, after an infection, the formation of a post covid syndrome is possible [10, 11].

Due to the WHO declaration of a pandemic on January 30, 2020, by order of the chief physician, an infectious diseases department was created at the Scientific Research Institute – Ochapovsky Clinical Hospital no. 1. The number of hospital beds changed dynamically from 90 to 310, including the beds in intensive care unit – from 25 to 110, depending on the epidemiological situation in the Krasnodar Region. The purpose of the infectious diseases hospital is to provide high-quality and qualified medical care to patients who have been diagnosed with coronavirus infection. Since the Scientific Research Institute – Ochapovsky Clinical Hospital no. 1 is the center of thoracic and cardiac surgery in the region, it was decided to conduct a retrospective analysis of the medical histories of patients diagnosed with coronavirus infection, that developed after thoracic and/or cardiac surgery, in order to determine the characteristic features of the course of coronavirus infection in this category of patients.

Objective

To study the features of the coronavirus infection course in cardiosurgical and thoracic patients based on a retrospective analysis of the medical histories of infectious diseases hospital patients as well as to conduct a comparative analysis of factors potentially affecting the possibility of fatal outcome. To identify the predictors of

lethal outcome based on the analysis of the features of the coronavirus infection course in this category of patients.

Material and methods

A retrospective analysis of the case histories of patients transferred to the infectious diseases department from the thoracic department and the department of cardiac surgery of the Scientific Research Institute – Ochapovsky Clinical Hospital no. 1 during the period from May 2020 till September 2021 has been carried out. During the analyzed period 80 patients from the departments of thoracic surgery and cardiac surgery were transferred to the infectious diseases department: 20 patients from the cardiac surgery department (CSD) – group 1; 60 patients from the thoracic surgery departments (TSD) – group 2. A control group number 3 consisting of 59 non-thoracic and non-cardiosurgical patients was also formed. According to the disease outcome the patients were divided into two groups: group 1 – fatal outcome, group 2 – recovery.

An analysis was carried out with the following comparison of groups of patients according to such indicators as gender, age, total percentage of lung parenchyma damage on admission (CT scan of chest $_1$) to the infectious diseases department and the highest during hospitalization (CT scan of chest $_2$), oxygen saturation upon admission (SpO_1) and the lowest indicator during the period of hospitalization (SpO_2). The presence of concomitant pathologies in the anamnesis was also taken into account: myocardial infarction (MI), diabetes mellitus (DM), acute cerebrovascular accident (CVA). The glomerular filtration rate was calculated using the Cockcroft-Gault formula (GFR), along with the body mass index (BMI). Based on the results of laboratory examination, a comparative analysis of the following data was carried out: the total number of leukocytes at the time of admission ($Leukocytes_1$) and also the highest index ($Leukocytes_2$), the total number of lymphocytes at the time of admission ($Lymphocytes_1$) and the lowest rate during the period of hospitalization ($Lymphocytes_2$), the level of C-reactive protein at admission (CRP_1) and highest level during the period of hospitalization (CRP_2), lactate dehydrogenase level at admission (LDH_1) and highest result during the hospitalization period (LDH_2), ferritin level at admission ($Ferritin_1$) and highest indicator during the hospitalization period ($Ferritin_2$), the number of hospital bed-days (BD), whether the patient was in the intensive care unit or not (ICU), the number of bed-days in the intensive care unit (duration of stay in ICU), the need for non-invasive (NIV: high-flow oxygen therapy and/or CIPAP), and/or invasive ventilation (IV), mortality (yes, no).

Statistical analysis of the study results was carried out using Statistica 13.3 (USA, Tibco). For paired intergroup comparisons the Mann-Whitney U test was used. Statistical significance is determined at $p < 0.05$, the values of p rounded to two decimal places. Additionally, the Wald-Wolfowitz test was applied to derive average values. Span charts were used to graphically illustrate the differences and similarities of mean scores.

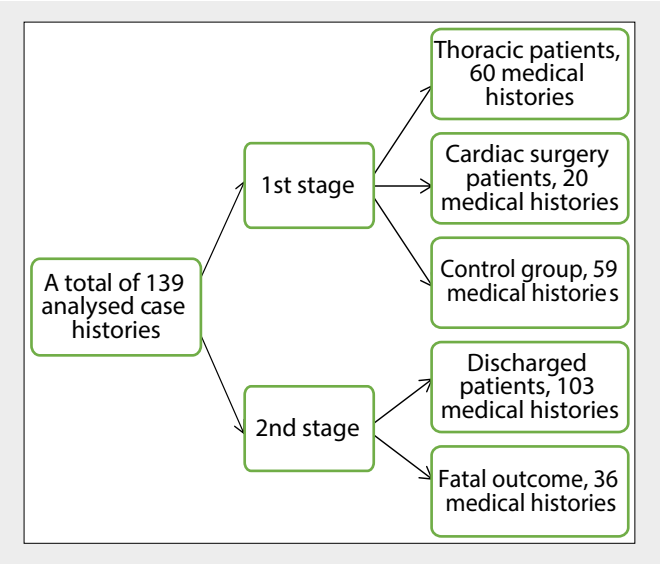

Figure 1. Study design scheme
Рисунок 1. Схема дизайна исследования

Results and discussion

During the period from May 2020 to September 2021, 3414 patients were treated in the infectious diseases department. There were 645 cases of fatal outcome. Out of the 80 patients transferred from the departments of thoracic surgery and cardiac surgery, lethal outcome was recorded in 25 people: 22 patients of the thoracic profile (36% of the transferred), and 3 patients of the cardiac surgery department, which equals 15%. 20 out of 20 cardiosurgical patients were operated on, as well as 49 out of 60 people of thoracic profile. Out of the patients that didn't receive surgical treatment, transferred from the departments of thoracic surgery, 3 people died. After pneumonectomy there were 7 out of 8 lethal cases reported (87.5%).

The general characteristics of the quantitative indicators of patients during their stay in the infectious diseases department are demonstrated in Table 1.

Based on the comparative characteristics, it can be concluded that the cardiosurgical and thoracic groups are more different from the control group and the differences between the first two are less pronounced. The groups differ statistically remarkable in age: control (55.07) and thoracic (62.95), control and cardiac surgery (64.05). The patient of the greatest age is in the cardiosurgical group (84 years old), the youngest – in the control group (21 years old). The need for NIV is the highest in the thoracic group (63.3%), the lowest – in the control group (30.3%), and rather high in the cardiac surgery group (50%). The statistical significance of the index difference

Table 1

Summary table of quantitative indicators of patients of group 1 – cardiac surgery patients, group 2 – thoracic patients, 3 – control group

Таблица 1

Итоговая таблица количественных показателей пациентов: группа 1 – кардиохирургические больные, группа 2 – торакальные больные, 3 – контрольная группа

	Group 1 (*n* = 20)	**Group 2 (*n* = 60)**	**Group 3 (*n* = 59)**	$p_{1,2}$	$p_{1,3}$	$p_{2,3}$
Age	64,05 ± 8,10 (42, 84)	62,95 ± 10,27 (29, 81)	55,06 ± 14,94 (21, 89)	1,00	**0,02**	**0,00**
BMI, kg/m^2	30,01 ± 9,87	28,71 ± 8,67	29,42 ± 10,34	0,33	0,28	0,56
Concomitant pathology						
GFR, ml/min	104,38 ± 42,15	124,8 ± 38,42	113,4 ± 64,12	0,46	0,21	0,18
Clinical characteristics						
$SpO_{2\,1}$, %	91,75 ± 5,07 (85, 98)	92,53 ± 5,62 (76, 99)	87,47 ± 10,08 (68, 98)	0,88	1,00	**0,02**
$SpO_{2\,2}$, %	86,55 ± 8,87 (68, 97)	87,65 ± 7,87 (68, 97)	82,94 ± 11,05 (68, 98)	1,00	0,66	0,08
Need for NIV, %	50,0% (10 ppl.)	63,3% (38 ppl.)	30,5% (18 ppl.)	0,29	0,10	0,00
Laboratory indicators						
CRP_1, g/l	102,37 ± 59,26 (16,2, 276)	105,67 ± 75,68 (3,92, 320)	50,74 ± 50,16 (0,6, 196,88)	1,00	**0,00**	**0,00**
CRP_2, g/l	112,23 ± 59,71 (20, 276)	138,55 ± 94,72 (14, 200)	79,53 ± 63,12 (4, 208)	1,00	0,19	**0,00**
LDH_1, IU/l	440,30 ± 284,54 (195, 1329)	455,12 ± 296,89 (130, 2172)	658,07 ± 386,75 (213, 1898)	1,00	0,00	**0,00**
LDH_2, IU/l	579,65 ± 376,60 (195, 1635)	813,61 ± 509,21 (233, 670)	1352,94 ± 1335,2 (213, 9406)	0,18	**0,00**	**0,02**
$Ferritin_1$, ng/ml	685,85 ± 589,14 (134, 2604)	652,45 ± 481,88 (13,4, 2494)	855,08 ± 927,66 (94,9, 5395)	1,00	1,00	1,00
$Ferritin_2$, ng/ml	1071,90 ± 804,80 (134, 2867)	1279,12 ± 1384,16 (60, 2669)	1313,37 ± 1702,49 (26, 2742)	1,00	1,00	1,00
$Leukocytes_1$, 10^9/l	7,27 ± 2,65 (2,8, 12,79)	7,81 ± 5,40 (1,8, 31,04)	8,69 ± 6,55 (2,0, 46,9)	1,00	1,00	0,82
$Leukocytes_2$, 10^9/l	14,16 ± 8,67 (5,57, 34,22)	18,45 ± 10,73 (3,3, 45,67)	14,88 ± 8,95 (4,6, 54,76)	0,21	1,00	0,3
$Lymphocytes_1$, 10^9/l	1,25 ± 0,63 (0,38, 2,87)	1,11 ± 0,68 (0,22, 3,67)	1,11 ± 0,57 (0,4, 3,65)	0,49	0,94	1,00
$Lymphocytes_2$, 10^9/l	0,69 ± 0,35 (0,21; 1,35)	0,67 ± 0,46 (0,05; 1,3)	0,65 ± 0,47 (0,12; 3)	1,00	1,00	1,00
Instrumental methods of examination						
CT Scan of $chest_1$, %	13,87 ± 10,13 (4, 25)	26,88 ± 19,35 (5, 80)	45,91 ± 30,45 (4, 100)	0,32	**0,00**	0,01
CT Scan of $chest_2$, %	51,78 ± 32,21 (5, 90)	46,22 ± 26,42 (5, 95)	61,27 ± 27,96 (5, 100)	1,00	**0,02**	0,76
Hospitalization results						
BD, bed-days	15,80 ± 9,34 (6, 44)	13,45 ± 7,47 (6, 31)	12,49 ± 9,48 (4, 36)	0,81	0,65	1,00
Duration of stay in ICU, bed-days	10,00 ± 2,58 (6, 14)	10,23 ± 7,51 (1, 31)	11,82 ± 13,29 (2, 69)	1,00	1,00	1,00

Note: * The minimum and maximum values of indicators are indicated in parentheses; $p_{1,2}$, $p_{1,3}$, $p_{2,3}$ – significance levels of the Kruskal–Wallis test for comparing indicators, respectively, in groups 1 and 2, 1 and 3, 2 and 3; $p < 0.05$ are in bold italics, p is rounded to two decimal places

Прим.: * В скобках указано минимальное и максимальное значение показателей; $p_{1,2}$, $p_{1,3}$, $p_{2,3}$ – уровни значимости критерия Краскела – Уоллиса сравнения показателей, соответственно в группах 1 и 2, 1 и 3, 2 и 3; $p < 0,05$ выделены жирным курсивом, p округлены до второго знака после запятой

was achieved only when comparing the thoracic and cardiosurgical groups.

According to the results of the chest organs CT scan the average percentage of lung damage on admission is statistically notably higher in the control group (45.91%), compared to the thoracic (26.88%) and cardiac surgery (13.87%) groups. This probably has to do with the fact that patients are transferred from the cardiac and thoracic departments in the early stages of the disease, in comparison to the control group. According to the average value of the worst result of the lung parenchyma involvement percentage during the period of hospitalization, the control (61.27%) and thoracic (46.22%) groups are statistically significantly different. The difference between the cardiac surgery (51.78) and control groups is not considered to be significant. The lower average value of the lung parenchymal lesions percentage in the thoracic group is probably due to the peculiarities of calculating the lesion volume. After undergoing a resection intervention, the remaining lungs parenchyma is considered to be 100%, while the parenchyma lost as the result of operation is not taken into account.

In the thoracic and cardiac surgical groups, in comparison to the control group, substantially higher levels of C-reactive protein were found at admission, which is probably due to the early postoperative period [12]. Also, the level of the average worst indicator of C-reactive protein is notably higher in the thoracic group than in the control group, which may indicate a more severe course of the viral infection and possible complications. At the same time, from the diagrams presented in figure 1 it can be seen that the values of CRP_1, CRP_2, determined by the lower (25%) and upper (75%) quartiles and ranges, are drastically higher in the thoracic group than in the other two.

Table 2 reflects the final characteristics of the categorical indicators of the 3 groups. The correlation between the gender of the patient and belonging to groups 1, 2, 3 is moderate, statistically significant. It is reflected through the fact that women predominate in the control group (68.42%), represent a considerably smaller number in the cardiac surgery group (5.26%) and an intermediate value in the thoracic group (26.32%). Men show a more evenly spread distribution.

During the analyses of publications with similar problems [13] a pattern was revealed (figure 2), that is represented in a greater number of identified complications in postoperative diagnosis of COVID than in preoperative diagnosis. Mostly the complications are in the form of pneumonia – 42%, and acute kidney injury – 20.3%; mortality in postoperative diagnosis of COVID was 20.8%.

When conducting a comparative analysis (table 3) of patients, divided into the groups fatal outcome and of survival, it was established that they were statistically

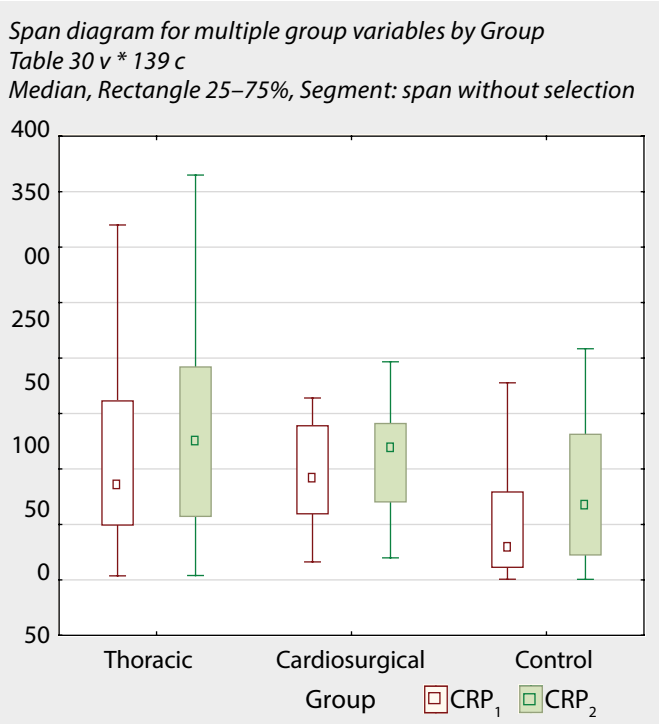

Figure 2. Diagrams of CRP_1 and CRP_2 ranges
Рисунок 2. Диаграммы размаха $СРБ_1$ и $СРБ_2$

essentially different in the average values of all indicators except for $Lymphocytes_1$ and BD. The average age in the "yes" group was higher (64.47) than in the "no" group (58.11). The average saturation level at admission in the "yes" group (87.25) was lower than in the "no" group (91.33), the average worst saturation level in the "yes" group (77.05) was lower than in the group "no" (88.44). According to the CT scan of the chest at admission the average values of the lung damage percentage in the "yes" group (48.73) were higher than in the "no" group (31.73). The worst result of chest lesion percent in the "yes" group (74.21) is higher than in the "no" group (46.83).

During the analyses of the laboratory research methods data at admission, the level of $leukocytes_1$ (10.99), CRP_1 (113.41), LDH_1 (719.17), $ferritin_1$ (2543.31) is higher in the "yes" group than the level of $leukocytes_1$ (7.11), CRP_1 (70.86), LDH_1 (476.21), $ferritin_1$ (590.25) in the "no" group. According to laboratory methods of examining the average values of the worst indicators it was established that the level of $leukocytes_2$ (27.1), CRP_2 (190.59), LDH_2 (1453.81), $ferritin_2$ (2543.31) is higher in the "yes" group than the level of $leukocytes_2$ (12.5), CRP_2 (81.45), LDH_2 (853.37), $ferritin_2$ (816.65) in the "no" group. The level of $lymphocytes_1$ at admission in the "yes" group (1.00) is lower than in the "no" group (1.17). Length of stay in the ICU in the "yes" group is higher (12.97) than in the "no" group (8.83). The total duration of stay in the infectious diseases department (number of bed-days) did not differ significantly in both groups ($p > 0.05$).

Table 2

Summary table of categorical indicators of patients: group 1 – cardiac surgery patients, group 2 – thoracic patients, 3 – control group

Таблица 2

Итоговая таблица категориальных показателей пациентов: группа 1 – кардиохирургические больные, группа 2 – торакальные больные, 3 – контрольная группа

	Group 1 (*n* = 20)	**Group 2 (*n* = 60)**	**Group 3 (*n* = 59)**	**Pearson's X^2 *p***	**Max Pearson's X^2 *p***	**Phi co-efficient**	**Contingency coefficient**	**Cramer's *V***	**Spearman's correlation**
Sex female male	2 (5,26%) 18 (17,82%)	10 (26,32%) 50 (49,50%)	26 (68,42%) 33 (32,67%)	**0,00**	**0,00**	0,33	0,31	0,33	0,28
DM, %	No			0,04	0,04	0,21	0,21	0,21	0,21
	16 (14,81%)	52 (48,15%)	40 (37,04%)						
	Yes								
	4 (12,90%)	8 (25,81%)	19 (61,29%)						
MI, %	No			0,00	**0,00**	0,51	0,45	0,51	-0,03
	6 (5,41%)	52 (46,85%)	53 (47,75%)						
	Yes								
	14 (50,00%)	8 (28,57%)	6 (21,43%)						
Stroke, %	No			0,19	0,26	0,09	0,09	0,08	-0,08
	19 (14,18%)	57 (42,54%)	58 (43,28%)						
	Yes								
	1 (20,00%)	3 (60,00%)	1 (20,00%)						
SpO_1	RF 0			**0,00**	**0,00**	0,41	0,38	0,29	0,15
	5 (12,50%)	22 (55,00%)	13 (32,50%)						
	RF I								
	13 (19,12%)	30 (44,12%)	25 (36,76%)						
	RF II								
	2 (11,76%)	8 (47,06%)	7 (41,18%)						
	RF III								
	0 (0,00%)	0 (0,00%)	14 (100,00%)						
SpO_2	RF 0			**0,00**	**0,00**	0,39	0,37	0,28	0,23
	2 (14,29%)	8 (57,14%)	4 (28,57%)						
	RF I								
	10 (14,49%)	32 (46,38%)	27 (39,13%)						
	RF II								
	6 (21,43%)	16 (57,14%)	6 (21,43%)						
	RF III								
	2 (7,14%)	4 (14,29%)	22 (78,57%)						

Table 2 continuation
Продолжение Таблицы 2

	Group 1 (*n* = 20)	**Group 2 (*n* = 60)**	**Group 3 (*n* = 59)**	**Pearson's X^2 *p***	**Max Pearson's X^2 *p***	**Phi coefficient**	**Contingency coefficient**	**Cramer's *V***	**Spearman's correlation**
CT Scan of chest$_1$	Mild			**0,00**	**0,00**	0,43	0,39	0,31	0,16
	8 (16,67%)	21 (43,75%)	19 (39,58%)						
	Average								
	0 (0,00%)	7 (33,33%)	14 (66,67%)						
	Severe								
	0 (0%)	6 (31,58%)	13 (68,42%)						
	Extremely severe								
	0 (0%)	1 (7,69%)	12 (92,31%)						
CT Scan of chest$_2$	Mild			0,23	0,20	0,25	0,24	0,18	-0,15
	4 (16,67%)	13 (54,17%)	7 (29,17%)						
	Average								
	3 (9,38%)	15 (46,88%)	14 (43,75%)						
	Severe								
	2 (7,41%)	12 (44,44%)	13 (48,15%)						
	Extremely severe								
	5 (12,82%)	10 (25,64%)	24 (61,54%)						
ICU	Yes			0,19	0,19	0,15	0,15	0,15	0,15
	10 (13,16%)	38 (50,00%)	28 (36,84%)						
	No								
	10 (15,87%)	22 (34,92%)	31 (49,21%)						
Fatal outcome, %	Yes			**0,04**	**0,04**	0,21	0,21	0,21	0,19
	3 (8,33%)	22 (61,11%)	11 (30,55%)						
	No								
	17 (6,66%)	38 (36,89%)	48 (46,6%)						

Certain patterns were established using contingency tables (crosstabulation) in the analysis of correlation between categorical indicators of patients and mortality (table 4).

The correlation between the gender of the patient and belonging to groups 1 and 2 is weak, statistically significant (table 4). The distribution of mortality rates ("yes" and "no") in the group of men corresponds to 31.68 and 68.32%, in the group of women – 10.53 and 89.47% respectively. Therefore, the fatality rate is higher among men. The correlation between the patient's belonging to groups 1 and 2 and subgroups of the categorical indicator is not fundamental for indicators of DM, MI, CVA.

In all cases of the thoracic, cardiac surgery and control groups the difference in survival in the subgroups did not reach statistical significance in accordance with the Gehan-Wilcoxon test ($p > 0.05$), which is explained by the small number of patients in the subgroups.

Conclusions

When analyzing the indicators, it was revealed that the number of fatal outcomes of patients of the thoracic profile in conditions of a COVID infection is at a higher level than that of patients of a cardiosurgical profile, and in the infectious diseases department. Probably, this has to do with the fact that coronavirus infection affects the lungs to a greater extent, and in patients of the thoracic profile (in particular, those who have undergone resection interventions), the volume of the lung parenchyma is initially reduced. This is confirmed

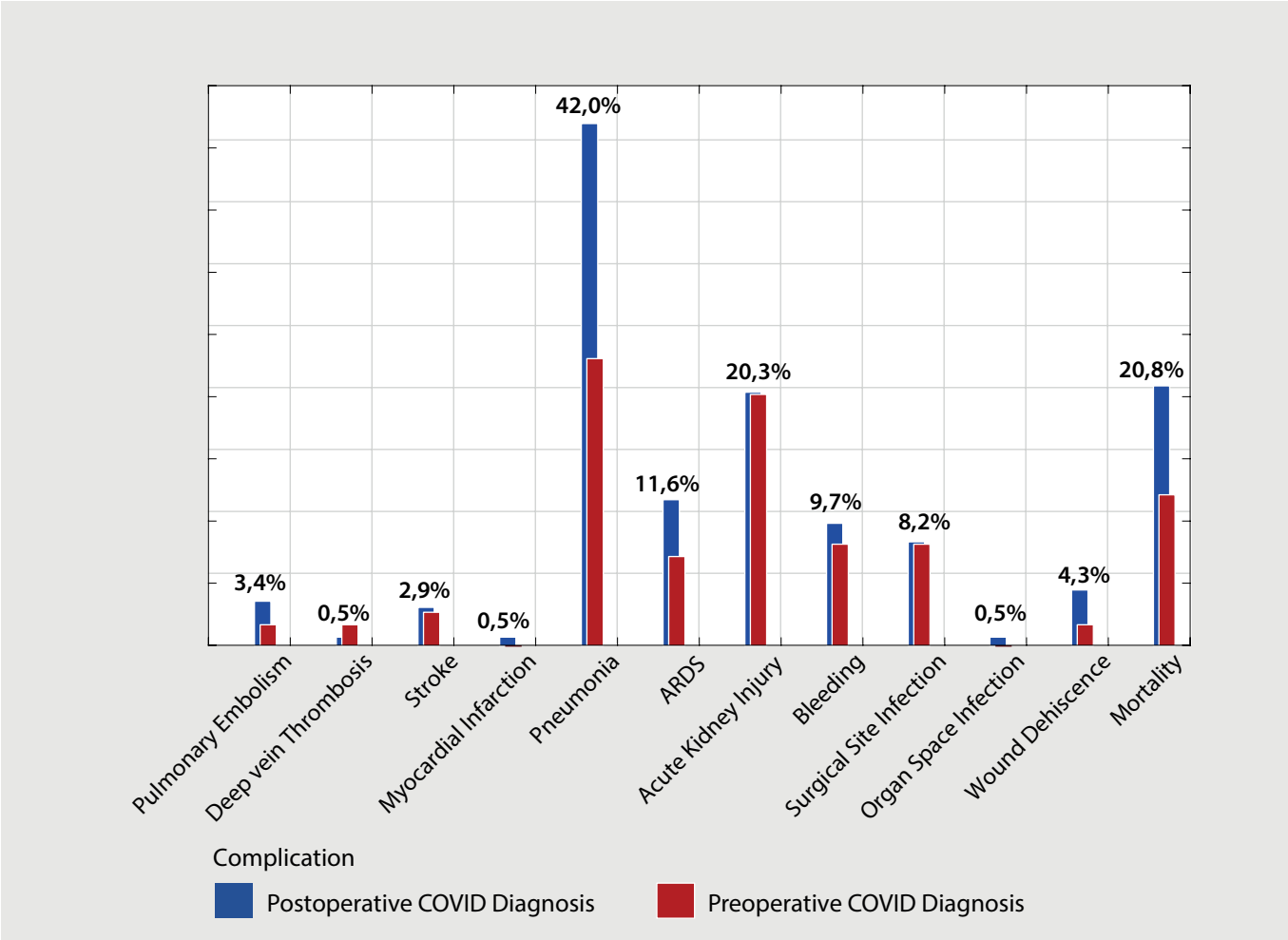

Figure 3. Total number of complications in the preoperative and postoperative period
Рисунок 3. Общее число осложнений в предоперационном и постоперационном периоде

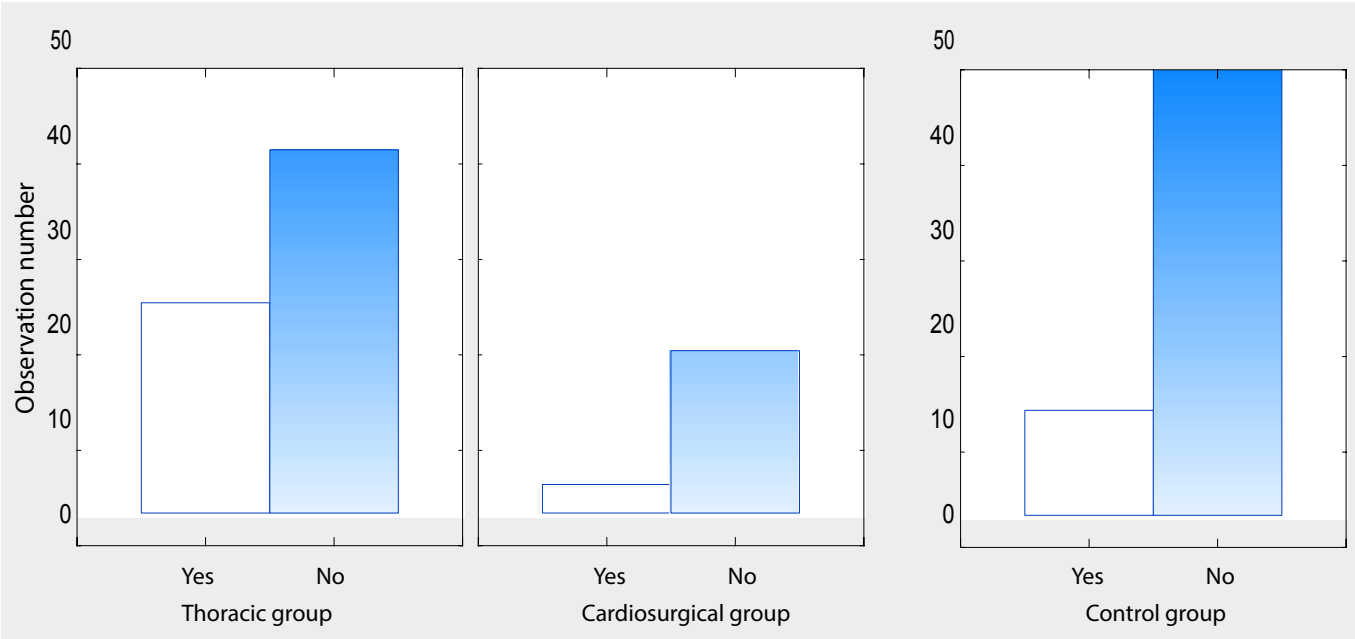

Figure 4. Distribution of mortality rates by groups
Рисунок 4. Распределение частот летальности по группам

Table 3

Summary table of the data of patients with lethal outcome and in control group (discharged patients)

Таблица 3

Итоговая таблица данных пациентов группы с летальным исходом и контрольной группы (выписанные пациенты)

	Fatal outcome yes (*n* = 36)	**Fatal outcome no (*n* = 103)**	***p***
Age	64,47	58,11	**0,01**
Clinical characteristics			
SaO_1, %	87,25	91,33	**0,02**
SaO_2, %	77,05	88,44	**0,00**
Laboratory indicators			
$Leukocytes_1$, 10^9/l	10,99	7,11	**0,01**
$Leukocytes_2$, 10^9/l	27,1	12,5	**0,00**
$Lymphocytes_1$, 10^9/l	1,00	1,17	0,18
$Lymphocytes_2$, 10^9/l	0,30	0,79	0,00
CRP_1, g/l	113,41	70,86	**0,00**
CRP_2, g/l	190,59	81,45	**0,00**
LDH_1, IU/l	719,17	476,21	**0,00**
LDH_2, IU/l	1453,81	853,37	**0,00**
$Ferritin_1$, ng/ml	1181,08	590,25	0,00
$Ferritin_2$, ng/ml	2543,31	816,65	**0,00**
Instrumental methods of examination			
CT Scan of $chest_1$, %	48,73	31,73	**0,01**
CT Scan of $chest_2$, %	74,21	46,83	**0,00**
Hospitalization results			
BD	14	13	0,54
ICU, %	12,97	8,83	**0,03**

Note: * *p* is the significance level of the Mann—Whitney U test
Прим.: * *p* – уровень значимости критерия Манна—Уитни

Table 4

Summary table of categorical values of patients with lethal outcome and in control group (discharged patients)

Таблица 4

Итоговая таблица категориальных показателей пациентов группы с летальным исходом и контрольной группы (выписанные пациенты)

	Fatal outcome yes (*n* = 36)	**Fatal outcome no (*n* = 103)**	**Pearson's χ^2 *p***	**Max Pearson's χ^2 *p***	**Phi coefficient**	**Contingency coefficient**	**Spearman's correlation**
Sex female male	4 (10,53%) 32 (31,68%)	34 (89,47%) 69 (68,32%)	**0,01**	**0,00**	0,21	0,21	0,21
DM, %	No		0,98	0,98	0,00	0,00	0,00
	28 (25,93%)	80 (74,07%)					
	Yes						
	8 (25,81%)	23 (74,19%)					
MI, %	No		0,71	0,72	-0,03	0,03	-0,03
	28 (25,23%)	83 (74,77%)					
	Yes						
	8 (28,57%)	20 (71,43%)					
Stroke, %	No		0,75	0,75	0,02	0,02	0,02
	35 (26,12%)	99 (73,88%)					
	Yes						
	1 (20,00%)	4 (80,00%)					

particularly by the highest percentage of lethal outcomes after pneumonectomy. In cardiac surgery patients, after surgical interventions, there is no reduction in the functioning lung parenchyma, which creates an additional "reserve" for recovery. In addition, men predominate among the patients of a thoracic profile and their survival rate is lower in all groups, compared with that of women.

In patients transferred from the thoracic departments, higher acute phase indicators were detected, which demonstrates a more severe course of the viral infection and the possible development of bacterial complications.

When analyzing the predictors of lethal outcome, the following factors were identified: male gender and, in general, a more severe course of a viral infection (low saturation, a high percentage of lung lesions on CT, more pronounced changes in laboratory screening). The studied factors are associated with a large number of fatal outcomes in thoracic and cardiac surgery patients. Among the factors that do not affect the prognosis are diabetes mellitus, stroke and myocardial infarction in history.

Thus, patients diagnosed with coronavirus infection that developed after thoracic surgery had the most unfavorable prognosis. The revealed patterns are of interest for optimizing the routing of this category of patients in order to prevent coronavirus infection.

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Конфликт интересов

Авторы заявляют об отсутствии конфликта интересов.