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The Evaluation of the Provision of Specialized Medical Care to Patients with COVID-19 in the Russian Central District Hospital

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Abstract

Background: The study aims to help to determine the optimal burden on medical workers, to establish factors that affect the duration of hospitalization and determining the outcomes of the disease among patients with COVID-19.

Methods: We used a database of 7,576 patients with COVID-19 hospitalized in one of the hospital in the Russia (Noginsk Central District Hospital, Moscow region). We analyzed of the duration of hospitalization, dependency and the results of hospitalization by gender and age, as well as the impact on this indicator of the severity of the course of the disease (using Pearson's linear correlation coefficient (r-Pearson)) and a Kaplan-Meier estimator survival analysis.

Results: The results of the analysis showed that the average number of patients per doctor per month was 28.23 ± 13.27 patients [IQR: 16.93; 41.25]. The dependence of the duration of hospitalization on sex and age showed the absence of statistical significance between these indicators (r-Pearson =0.079; p<0.001). The dependence of the duration of hospitalization on the severity of the course of the disease showed no statistical significance between these indicators (r-Pearson =0.04; p<0.001). The risk of death was increased with the length of hospitalization.

Conclusion: The results of study are relevant for public health specialists who plan the resources of medical organizations and assess the possibilities of using the bed fund.

Keywords: COVID-19; Length of stay; Hospital workload; Resources of a medical organization; Russia

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Introduction

The biological challenges that humanity has regularly faced throughout its existence make it necessary to transform approaches to organizing sanitary and epidemiological control, building healthcare systems, and building forces and means aimed at minimizing possible negative consequences both for the population and for various sectors of socioeconomic life in individual states or at the global level.

Despite the vast amount of accumulated knowledge and experience in the fight against infectious diseases and the availability of effective means of immunization, many infections still pose serious problems for national health systems.

In the context of the ongoing epidemic of a new coronavirus infection (COVID-19), which has revealed severe shortcomings in the organization of medical care, primarily specialized and requires a more systematic approach that takes into account the resource capabilities of medical organizations of the existing healthcare system, redesigned for an infectious diseases hospital and working around the clock, it is necessary to develop an integrated model of their functioning, involving various options for the use of available resources about the emerging flows of patients (based on their characteristics, including gender and age characteristics, the presence of concomitant diseases, the

severity of the course of the disease and others).

One of the most critical health system resources studied as part of the response assessment work was the bed fund capacity of medical organizations involved in providing medical care to patients with COVID-19.

Canadian scientists Giannakeas et al. [1] propose an analytical tool to assess the dynamics of patient flow, limited by the number of emergency beds, intensive care beds, and ventilators available for COVID-19 infected patients seeking medical care during a pandemic.

Planning for the need for a bed fund and its redistribution against the backdrop of a developing epidemic has also become the subject of study by specialists from Brazil [2]. The study included 88 of the most important hospitals and health centers based on the number of hospitalizations. They calculated the number of beds that can be additionally allocated or reallocated for new cases of COVID-19 within one year, considering that the remaining underperforming units formalize new service protocols, postpone elective surgeries, and reduce the length of stay patients in hospitals. A study in Switzerland of seriously ill patients with COVID-19 suggested a method for predicting the individual length of stay of patients in intensive care units based on a retrospective analysis of data from a specialized registry, namely, data from patients with Acute Respiratory Distress Syndrome (ARDS) [3].

Assessing the effect of gender and age on respiratory support and duration of stay of 1,792 patients with COVID-19 in Wuhan, China showed that the average length of hospital stay among deceased patients was 11 (IQR: 6-20) days. The duration of hospitalization among discharged patients was age dependent and increased from 22 (IQR: 14-31.3) days for patients <40 years of age to 34 (IQR: 24–43.8) days for patients aged 80 years and older [4].

Another study in China in Sichuan province found that the median duration of hospitalization was 19 (IQR: 14-23) days, while for people aged 45 years and older, it was 21 (IQR: 14–24) days, and for patients under 45 years of age, it was 18 (IQR: 13–22) days [5].

Scientists from Bologna, Italy, showed that when comparing with the age group 50 to 60 years selected as a control group, the average duration of hospitalization decreased in the age groups 0 to 10 years, 30 to 40 years, and 40 to 50 years, with the most prolonged hospital stay in the oldest age group from 80 to 102 years [6].

A large study conducted between March and September 2020 in Ontario, Canada, with a sample of 56,476 people who tested positive for SARS-CoV-2, found that the average length of hospital stay was 12.8 days. Individuals requiring care in the ICU had an average length of stay of about 14.6 days (8.5 days in the ICU, 1.9 days in the pre-ICU, and 4.2 days after the ICU). Individuals requiring invasive mechanical ventilation had a mean length of stay in hospital of 29.7 days (20.5 days in the ICU with invasive mechanical ventilation, 1.2 days in the ICU before or after ventilation, 1.6 days in pre-ICU, and 6.3 days after ICU) [7].

In a retrospective cohort study of 987 patients with COVID-19 (confirmed by real-time PCR) at SMS Medical College and Hospital, Jaipur, Rajasthan, India, a survival analysis was performed to assess mean hospital stay and mean survival time (after hospital discharge and during the stay in the hospital) [8]. The effect of age and gender on survival patterns was assessed using Cox proportional hazards regression analysis. In addition, mortality, mortality, recovery, and hospitalization rates were also assessed. Kaplan-Meier estimates for the length of hospital stay (median = 10 days, IQR= 5-15 days) and median survival were obtained.

Scientists from South Korea showed in their study conducted on 7,590 patients with a confirmed diagnosis of COVID-19 that a more significant number of comorbidities correlate with a longer duration of hospitalization. For COVID-19 patients with oncological diseases, this indicator was 26.0 ± 16.1 days, COPD 23.0 ± 14.3 days, coronary heart disease 26.3 ± 18.5 days, arterial hypertension 25.2 ± 16.9 days, and diabetes mellitus 25.8 ± 17.6 days, while in patients without these diseases, the length of stay in bed was less [9].

In a study conducted on 687 patients in the USA, it was found that the distribution of the duration of hospitalization was strongly shifted to the right with a median of 7.18 days (IQR: 3.86-12.15). The median duration of hospital stay was 12.34 days (IQR: 8.68-20.10) for patients in the intensive care unit and 5.72 days (IQR: 3.40-20.10) for patients not in the intensive care unit [10].

One study conducted in Turkey on 1,056 patients found an average length of stay of 9.1 days (SD 6.9). The mean length of hospital stay was 8.0 days (SD 4.7) compared with 14.8 days (SD 12.0) for patients admitted to the intensive care unit [11].

The objectives of our study included assessing the duration of hospitalization of patients with COVID-19 and factors influencing the value of this indicator.

Methods

Our study was conducted on a continuous sample of 7,576 people with COVID-19 hospitalized at the Noginsk Central District Hospital from April 2020 to June 2021. For each hospitalized patient, we compiled a table containing data on his gender and age, dates of admission and release from the hospital (discharge, death), hospitalization department, the presence of concomitant diseases, the severity of the disease, the doctor who provided medical care and his specialty, appointment artificial lung ventilation in the period of stay in the hospital, the results of laboratory and diagnostic studies, the results of hospitalization.

In the first stage of the study, we differentiated doctors by the duration of their work in the hospital. We correlated them with the number of patients they provided medical care to. For each doctor, we determined the total number of patients for the period of their work and the average number of patients for 1 month of work in the hospital.

In the second stage of the study, we assessed the dynamics of hospitalizations with an assessment of the number of admitted and discharged patients for the entire period of observation and an assessment of the level of occupancy of the bed fund and its reserve capacity.

In the third stage of the study, we stratified patients into 15 age groups, separately for men and separately for women, determining the average duration of hospitalization of patients in each of these groups.

At the fourth stage of the study, we assessed the dependence of the duration and results of hospitalization on gender and age and the impact on this indicator of the severity of the course of the disease using the Pearson linear correlation coefficient (r-Pearson). The evaluation results were also presented in a classification tree model.

We used a Kaplan-Meier estimator survival analysis to test the hypothesis that patients with more severe disease have lower survival rates and shorter hospital stays.

Statistical processing of information was carried out on a personal computer using the statistical software package IBM SPSS Statistics 28.0 (USA), STATISTICA 12.0® from Statsoft® Inc. (USA), and Microsoft Office EXCEL 2020 tools.

Results

To provide medical care to patients with a new coronavirus infection (COVID-19), 72 doctors were involved, including doctors who provide primary health care, but were employed for the period of the epidemic to work in hospitals of the Noginsk Central District Hospital.

These specialist doctors were distributed as follows: trainee doctors (15 people), general practitioners (10 people), district general practitioners (6 people), surgeons (5 people), cardiologists and phthisiatricians (4 people each), dermatovenereologists, neurologists and district pediatricians (3 people each), doctors of ultrasound diagnostics, anesthesiologists-resuscitators, infectious disease specialists, otorhinolaryngologists, pediatricians and traumatologists-orthopedists (2 people each of them), as well as 1 doctor of functional diagnostics, a gastroenterologist, a methodologist, an ophthalmologist, a district psychiatrist, a urologist, and physiotherapist.

For each doctor, the monthly workload was calculated by the number of patients admitted for curation and who dropped out as a result of hospitalization (discharged, transferred to other medical organizations, or deceased), the duration of work in the Noginsk Central District Hospital was estimated with the total, the minimum and the maximum number of used patients (Table 1).

In order to minimize errors in assessing the average monthly workload for doctors, the results of the work of doctors were excluded from the general analysis in cases where the period of work of the doctor was less than 3 months or the number of treated patients was less than 50 people (Table 1, symbol*).

After applying the exclusion criteria, the analysis was performed for the 44 remaining doctors, which found that the average number of patients per doctor per month ± SD was 28.23 ± 13.27 patients [IQR: 16.93; 41.25] (min =9.67 patients; max =61.33 patients). The average duration of hospital treatment ± SD per physician was 10.65 ± 2.02 days [IQR: 8.77; 12.55] (min =7.3 days; max =14.71 days).

The dynamics of hospitalization and hospital occupancy for the period from April 2020 to June 2021 (Figure 1) were characterized by relative stability, reaching peak values both in terms of the number of admitted and discharged patients in November 2020 (1,432 patients were admitted, - 1,247 patients), December 2020 (1,652 patients were admitted, 1,716 patients dropped out), January 2021 (1,028 patients were admitted, 1,208 patients dropped out).

The average daily hospitalization during the follow-up period (15 months) was 18 patients, with the maximum values recorded in November 2020 (48 patients/day), December 2020 (53 patients/day), and January 2021 (33 patients/day), and the minimum values - in July 2020 (6 patients/day) and August 2020 (6 patients/day).

From April 2020 to June 2021, 7,576 people were hospitalized in the Noginsk Central District Hospital, including 3 patients for whom hospitalization in this medical organization was an intermediate stage of hospitalization during transportation to another medical organization. The proportion of hospitalized women was 57.8% (4,374 cases), and the proportion of men was 42.2% (3,199 cases).

The largest number of hospitalizations among women was noted in the age groups of 60 to 64 years (763 cases), 65 to 69 years (727 cases), 70 to 74 years (625 cases), 55 to 59 years (531 cases); among men - in the age groups of 60 to 64 years (531 cases), 65 to 69 years (446 cases), 70 to 74 years (352 cases), 50 to 54 years (312 cases).

The average length of stay in bed, taking into account interquartile

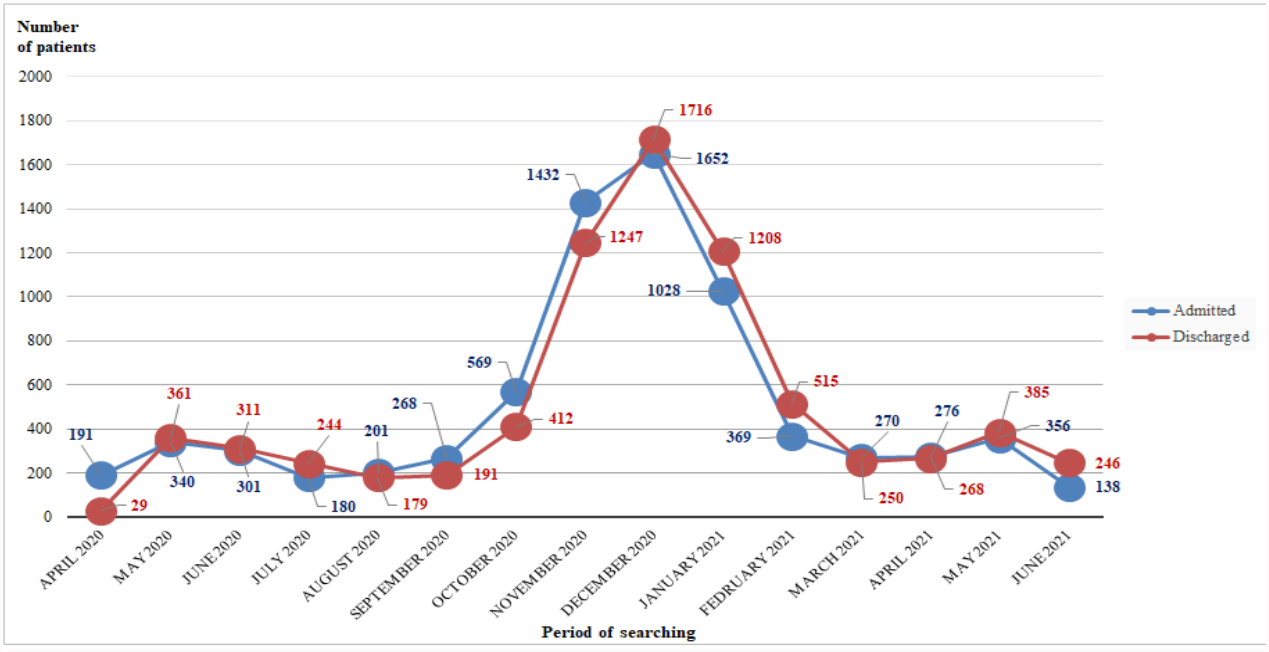

Figure 1: The values of the indicators of admitted and discharged patients with a new coronavirus infection in the Noginsk Central District Hospital for the period from April 2020 to June 2021.

Table 1: The results of the work of doctors of the Noginsk Central District Hospital, who provided specialized medical care to patients with a new coronavirus infection COVID-19 for the period from April 2020 to June 2021.

No. of doctor	Average number of patients per doctor per month (taking into account the period of work), people	SD number of patients per doctor per month pers.	Period of work in a medical organization, months	Total number of used patients, pers.	MIN number of used patients per month, pers.	MAX number of used patients per month, pers.	_25th%	_75th%	Duration of hospitalization 1 patient ± SD, days
1	2	3	4	5	6	7	8	9	10
1	15.75	9.09	12	189	2	29	7.5	22	12.98 ± 5.64
2*	1.00		1	1	1	1	1	1	1
3	34.60	25.35	5	173	4	62	12	52	9.2 ± 3.79
4	15.60	6.31	15	234	1	27	12	21	12.61 ± 5.55
5	21.83	8.81	12	262	11	34	14	30.5	12.65 ± 5.54
6*	4.50	2.12	2	9	3	6	3	6	5.44 ± 3.0
7	43.33	36.91	3	130	10	83	10	83	9.4 ± 4.4
8	19.73	6.15	15	296	8	30	16	26	11.72 ± 5.08
9	9.67	8.49	12	116	1	29	2	14	10.3 ± 2.22
10	19.67	16.44	3	59	1	32	1	32	8.52 ± 5.8
11	14.43	6.27	14	202	2	23	9	20	13.27 ± 7.24
12	18.60	12.43	15	279	1	46	8	29	13.1 ± 4.7
13*	2.33	1.15	3	7	1	3	1	3	6 ± 5.23
14*	3.33	4.04	3	10	1	8	1	8	8.5 ± 2.88
15*	1.00		1	1	1	1	1	1	4
16*	8.00	10.27	5	40	1	26	2	6	14.45 ± 3.06
17*	9.00		1	9	9	9	9	9	5.44 ± 2.18
18	16.53	7.25	15	248	9	36	11	20	12.5 ± 4.48
19	45.00	17.09	3	135	29	63	29	63	8.15 ± 4.8
20*	1.00		1	1	1	1	1	1	1
21	41.00	56.57	2	82	1	81	1	81	7.52 ± 3.49
22*	1.50	0.71	2	3	1	2	1	2	1
23	46.00	31.84	4	184	1	76	26.5	65.5	8.78 ± 4.33
24*	6.00	5.35	4	24	1	12	1.5	10.5	9.37 ± 4.31
25*	4.00	4.66	9	36	1	12	1	4	10.47 ± 4.19
26	20.00	6.22	15	300	12	33	16	25	11.74 ± 4.78
27*	20.50	4.95	2	41	17	24	17	24	8.46 ± 3.83
28*	1.50	0.71	2	3	1	2	1	2	10 ± 6.08
29	27.33	14.57	3	82	12	41	12	41	9.96 ± 5.46
30	42.67	20.79	3	128	19	58	19	58	7.37 ± 2.86
31	32.60	22.19	5	163	3	54	18	53	11.78 ± 8.05
32	45.33	29.37	3	136	25	79	25	79	8.1 ± 3.73
33*	23.50	7.78	2	47	18	29	18	29	11.66 ± 5.55
34	9.90	6.06	10	99	2	18	4	15	12.77 ± 6.38
35	34.67	40.77	3	104	1	80	1	80	9.55 ± 4.66
36	15.00	8.00	10	150	3	29	7	19	12.71 ± 4.59
37	44.00	22.23	5	220	18	66	24	64	10.09 ± 4.45
38*	1.50	0.71	2	3	1	2	1	2	2.33 ± 1.53
39*	3.00	2.45	4	12	1	6	1	5	10.5 ± 5.96
40	21.40	7.47	10	214	10	34	16	25	12.2 ± 6.72
41*	9.00	7.07	2	18	4	14	4	14	6.39 ± 2.57
42	17.86	8.56	14	250	4	32	11	25	11.8 ± 3.61
43	15.60	8.67	10	156	2	24	5	24	12.09 ± 4.16

44*	1.00		1	1	1	1	1	1	10
45	47.33	55.81	3	142	3	110	3	110	8.75 ± 5.12
46	41.60	21.79	5	208	20	68	20	58	10.5 ± 6.89
47	41.50	28.90	4	166	2	71	22.5	60.5	8.16 ± 4.99
48	30.50	7.78	2	61	25	36	25	36	7.98 ± 3.47
49	61.33	26.69	3	184	33	86	33	86	7.3 ± 3.58
50	15.31	6.74	13	199	5	27	10	20	11.7 ± 5.8
51*	1.00		1	1	1	1	1	1	3
52*	4.00	1.41	2	8	3	5	3	5	7.75 ± 2.55
53*	6.00	5.66	2	12	2	10	2	10	6.5 ± 2.75
54	29.75	22.50	4	119	5	53	11	48.5	9.19 ± 4.03
55	20.75	15.52	4	83	5	42	10.5	31	14.71 ± 4.8
56*	5.75	6.18	4	23	1	14	1	10.5	14.39 ± 7.56
57	18.57	13.54	7	130	2	43	8	26	13.15 ± 3.75
58	40.50	27.33	4	162	6	71	20.5	60.5	9.95 ± 6.39
59	53.50	0.71	2	107	53	54	53	54	9.74 ± 4.88
60*	2.00		1	2	2	2	2	2	14
61	21.67	29.74	3	65	4	56	4	56	7.97 ± 3.22
62	28.17	34.99	6	169	2	97	7	29	12.9 ± 3.42
63	17.33	8.39	3	52	12	27	12	27	10.83 ± 4.37
64	25.40	17.12	15	381	8	68	12	32	1.37 ± 5.75
65	14.54	11.32	13	189	1	40	5	20	11.42 ± 5.3
66*	1.00		1	1	1	1	1	1	1
67*	2.00		1	2	2	2	2	2	1
68	34.00	12.73	2	68	25	43	25	43	8.5 ± 4.74
69*	6.75	6.75	4	27	1	14	1	12.5	14.63 ± 4.26
70*	50.00		1	50	50	50	50	50	9.86 ± 5.85
71	12.38	7.21	8	99	1	21	8.5	20	12.82 ± 5.6
72*	7.00		1	7	7	7	7	7	7.86 ± 1.68

interval, outliers, and extreme values, as well as a non-outlier range of values typical for the corresponding age group, separately for men and separately for women, are shown in Figure 2.

According to the analysis of the average length of stay in bed, it was found that in 11 out of 15 age groups, this indicator was higher in men than in women. In contrast, the difference in the indicator reached 0.09 days (age group 75 to 79 years, n=408) up to 3.18 days (age group 18 to 24 years, n=38) (Table 2).

An analysis of the distribution built according to the classification tree model (Figure 3) and adjusted for 7 more significant gender and age groups showed that with an average length of stay in a bed equal to 11.056 ± 5.43 days, the difference between these groups in terms of the minimum and maximum values of the indicator is 1, 95 bed-days (min =9.87 ± 4.5 days, age up to 43 years; max =11.82 ± 6.0 days, age from 69 to 80 years), while the standard deviation in the group of patients older than 69 years more than in all age groups up to 69 years for 1 bed-day, which may indicate a longer treatment or earlier withdrawal, most likely due to death.

The results of the correlation analysis of the dependence of the duration of hospitalization on sex and age showed the absence of statistical significance between these indicators (r-Pearson =0.079; $p<0.001$; n=7573 (hospital cases)), which worsens the possibilities of predictive analytics and modeling of the need for resources of a medical organization for the treatment of patients in specific gender and age groups.

Another important criterion used to evaluate the length of stay in bed in patients with a new coronavirus infection in the Noginsk Central District Hospital hospitals was the severity of the disease. The results of a correlation analysis of the dependence of the duration of hospitalization on the severity of the course of the disease showed no statistical significance between these indicators (r-Pearson =0.04; $p<0.001$; n=83238 (bed days)). When adjusting these indicators and excluding cases of treatment lasting 1 day and deaths within 10 days of inpatient treatment, inclusive, the correlation coefficient changed slightly (r-Pearson =0.1; $p<0.001$; n=81309 (bed-days)). An analysis of the distribution constructed according to the classification tree model (Figure 4) showed that the standard deviation of the average length of stay in bed is relatively comparable (mean value-5.28 days) for patients with a mild (satisfactory) course of the disease ("0"), moderate ("1"), severe ("2") and terminal ("4"), turning into a state of clinical death ("5"). At the same time, patients with highly severe ("3") severity had a maximum value of the standard deviation of the average length of stay in bed, equal to 7.7 days (Figure 4).

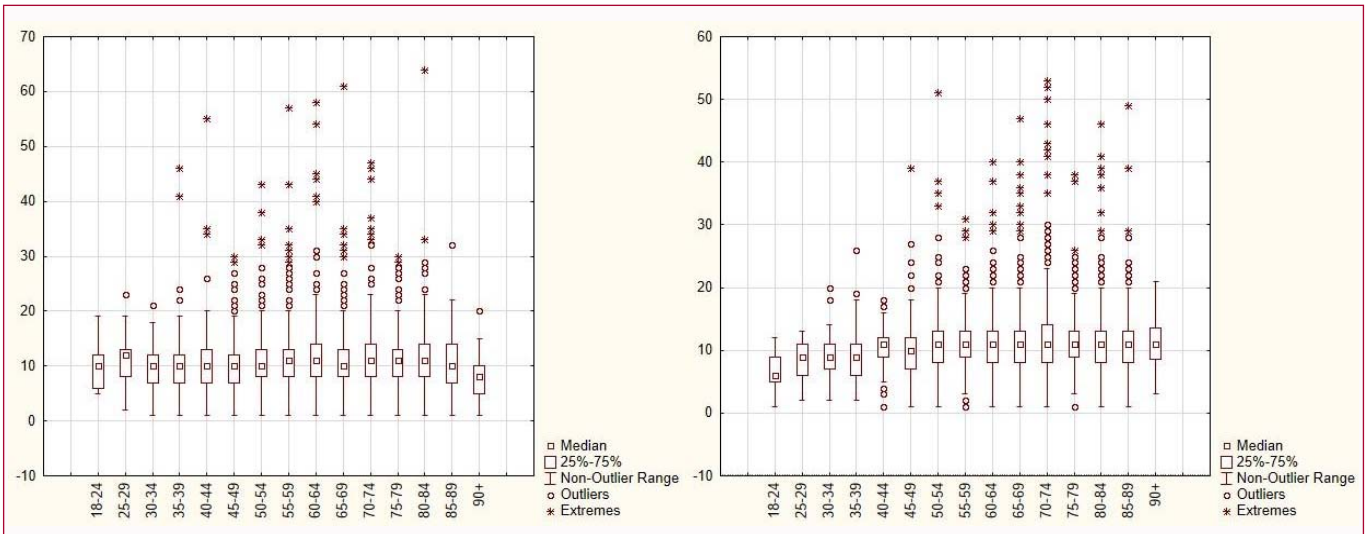

Figure 2: Indicators characterizing the average length of stay in bed for men (left) and women (right) in different age groups in the Noginsk Central District Hospital.

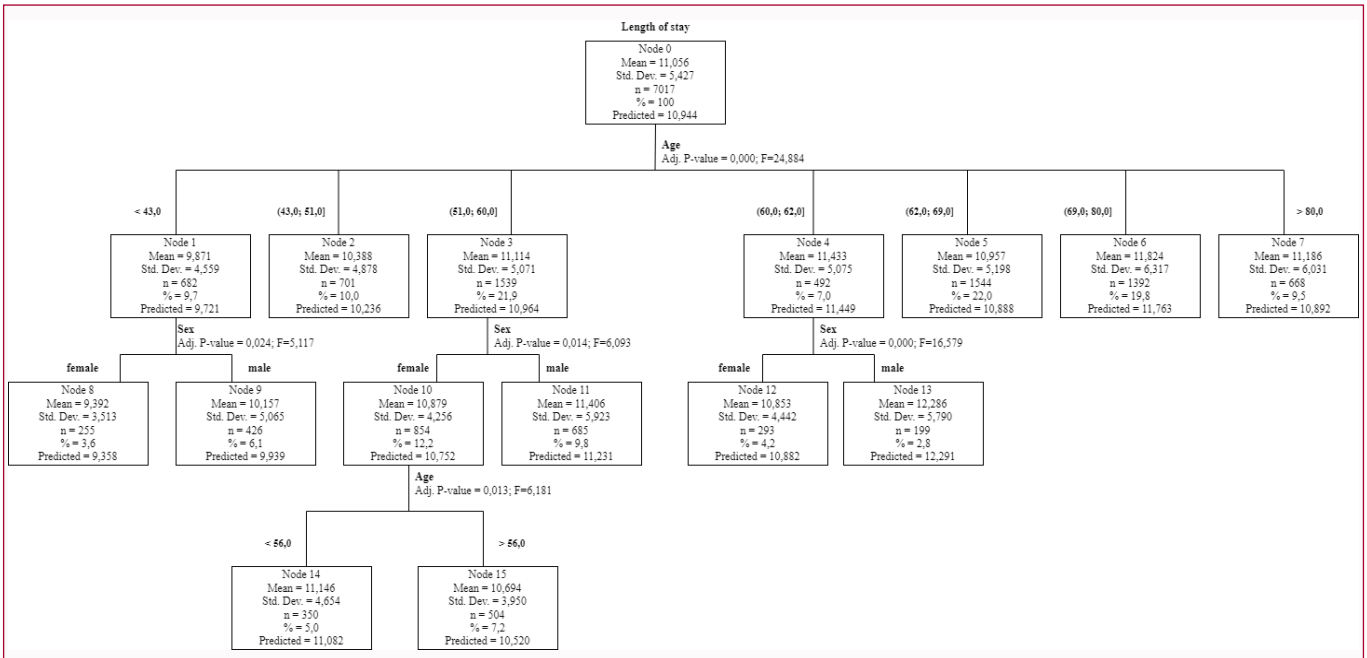

Figure 3: Distribution of patients of the Noginsk Central District Hospital based on the model of the classification tree according to the length of stay in bed, depending on the sex and age.

Survival analyses by disease severity compared to the length of stay were performed using the Kaplan-Meier method to test the hypothesis that patients with more severe disease have lower survival rates and a shorter stay in the hospital.

A total of 7,466 cases of hospitalization were analyzed (506 with mild, 1,486 with moderate, 4,883 with severe, 581 with highly severe, and 10 with critical). For all cases, mean and median estimates of the length of stay in bed for each severity were calculated (Table 3) and interquartile intervals (Table 4).

The average length of stay in patients with mild severity is 10.46. A median score of 10.0 for mild severity indicates that after 10 days, only half of the group will remain under observation, and the rest of the patients will be considered dropouts. After 13 days from the moment of hospitalization, 25% of the sample will remain under observation in the hospital.

For the analyzed samples of patients, we also calculated the Log Rank (Mantel-Cox) test, which confirms the difference in survival rates depending on the severity of the disease (Chi-square =19.7, $p<0.001$).

The survival graph, which reflects the probability that the patient will survive the following period (will not die on a specific day of hospitalization if he has one or another degree of severity of the disease), is shown in Figure 5. According to the data presented in the graph, it can be seen, for example, that for patients with severe severity, the probability of surviving on the 10th day of hospitalization was about 35%. For patients in the critical/terminal stage of the development of the disease from 10 to 12 days of hospitalization, the probability of surviving was reduced from 50% to 20%.

The risk of death (Figure 6) also increased with the length of hospital stay (e.g., with moderate disease, the risk of death increased

Table 2: The results of the analysis of the average duration of hospitalization of patients with a new coronavirus infection in the Noginsk Central District Hospital for the period from April 2020 to June 2021, differentiated by age and sex groups.

Age, years	Sex	Average duration of hospitalization, days	SD	Number of hospitalizations, cases	Number of bed-days in total	MIN number of bed-days	MAX number of bed-days	_25th% bed-days	_75th% bed-days
18-24	Male	9.71	3.77	21	204	5	19	6	12
	Female	6.53	2.98	17	111	1	12	5	9
25-29	Male	11.00	4.42	32	352	2	23	8	13
	Female	8.28	3.43	18	149	2	13	6	11
30-34	Male	9.70	4.05	91	883	1	21	7	12
	Female	9.18	3.28	55	505	2	20	7	11
35-39	Male	9.93	5.51	166	1648	1	46	7	12
	Female	9.32	4.00	78	727	2	26	6	11
40-44	Male	10.41	5.68	197	2050	1	55	7	13
	Female	10.29	3.35	152	1564	1	18	9	12
45-49	Male	10.13	4.96	237	2400	1	30	7	12
	Female	9.97	4.54	216	2153	1	39	7	12
50-54	Male	10.74	5.23	312	3350	1	43	8	13
	Female	11.07	5.59	304	3366	1	51	8	13
55-59	Male	11.41	5.71	438	4997	1	57	8	13
	Female	10.87	3.88	531	5774	1	31	9	13
60-64	Male	11.45	5.94	531	6082	1	58	8	14
	Female	10.67	4.35	763	8145	1	40	8	13
65-69	Male	10.96	5.51	446	4888	1	61	8	13
	Female	11.07	5.15	727	8047	1	47	8	13
70-74	Male	12.05	6.69	352	4241	1	47	8	14
	Female	11.85	6.49	625	7404	1	53	8	14
75-79	Male	11.57	5.70	141	1631	1	30	8	13
	Female	11.48	5.13	267	3065	1	38	9	13
80-84	Male	11.67	7.15	153	1786	1	64	8	14
	Female	11.00	5.90	419	4611	1	46	8	13
85-89	Male	10.54	5.53	57	601	1	32	7	14
	Female	11.44	6.59	158	1807	1	49	8	13
90+	Male	8.20	4.79	25	205	1	20	5	10
	Female	11.18	3.71	44	492	3	21	8.5	13.5

4.2-fold after treatment for 30 days).

The effect of age and gender on hospital outcomes (1-recovery; 2-transfer to another medical organization; 3-death) was assessed using a correlation coefficient. The results of the analysis showed no statistically significant dependence of the results of hospitalization on gender (r-Pearson =0.038; p<0.001; n=7573 (hospitalizations)) and a weak direct dependence on age.

(r-Pearson =0.182; p<0.001; n=7573 (hospitalizations)). Based on the classification tree model (Figure 7), it was found that the mortality rate of patients with a new coronavirus infection in the Noginsk Central District Hospital was 8.14% (617 cases out of 7,576 hospitalizations). The largest number of deaths was noted in age groups from 64 to 87 years (430 patients out of 617), with a predominance of women over men (57% and 43%, respectively).

The usage of the correlation coefficient in assessing the impact of the severity of the course of the disease on the results of hospitalization (1-recovery; 2-transfer to another medical organization; 3-death) showed a direct relationship of moderate strength (r-Pearson =0.307; p<0.001; n=7573 (hospitalizations)). Based on the classification tree model (Figure 8), it was found that among 617 deceased patients, 429 people (69.5%) had highly severe ("3") and terminal ("4"), turning into a state of clinical death ("5") the severity of the course of the disease. The most significant proportion (64.8%) (4,908 patients out of 7,576) among all hospitalized patients were patients with severe severity.

Discussion

Our study presents the results of an assessment of the activities of one of the largest hospitals in the Moscow region that provided medical care to patients with COVID-19 from April 2020 to June 2021, showing the average number of patients per doctor per month and the average duration treatment in a hospital for 15 differentiated sex and age groups. We also assessed the dependence of the duration and results of hospitalization on gender and age and the impact on this indicator of the severity of the course of the disease. In addition, based on statistical data, we assessed the probability of death in patients with

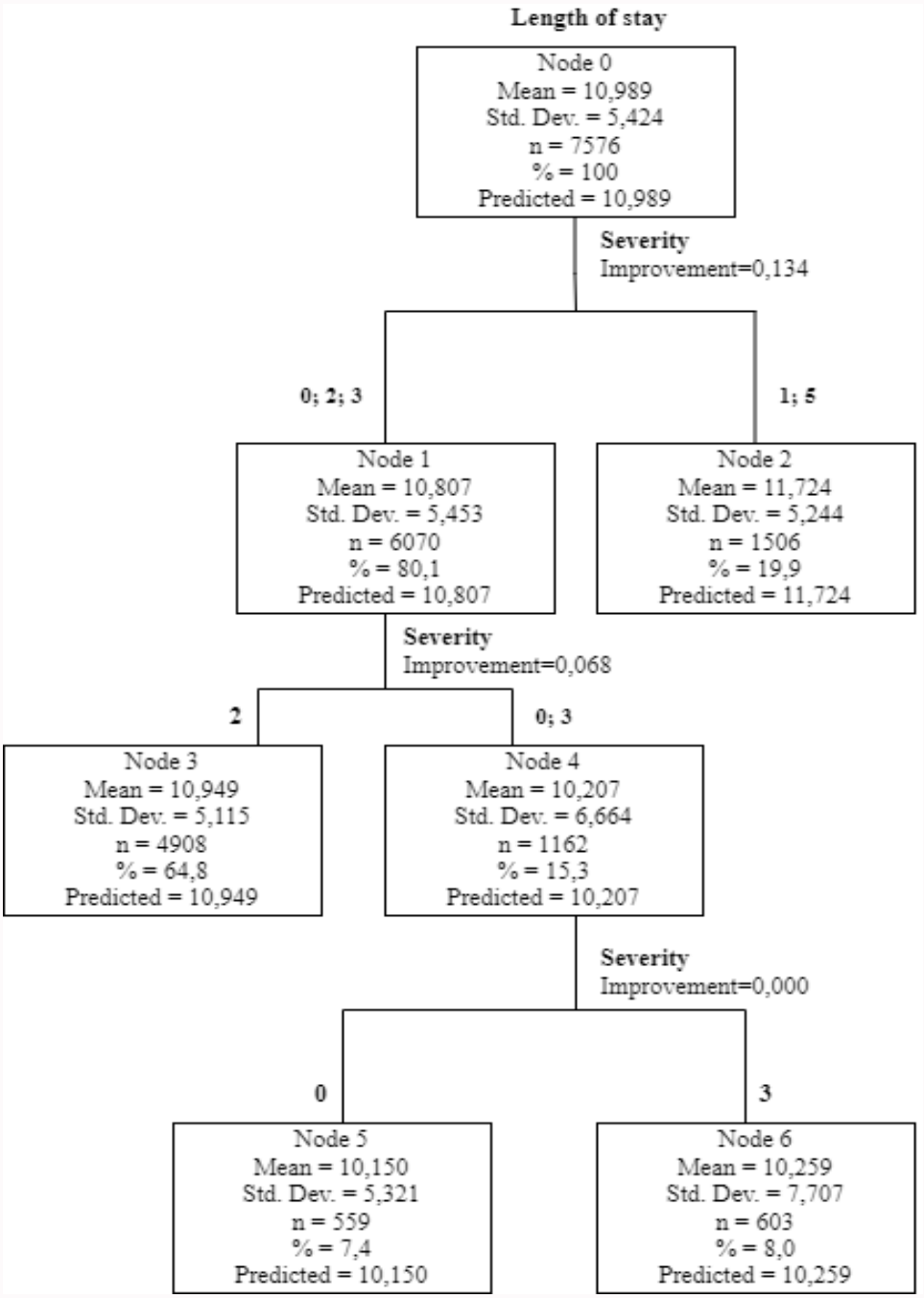

Figure 4: The distribution of patients of the Noginsk Central District Hospital based on the model of the classification tree according to the length of stay in bed, depending on the severity of the course of the disease.

Table 3: Mean and median length of stay in bed by severity of COVID-19.

Severity	Mean				Median			
	Value	SD	95% CI		Value	SD	95% CI	
			Lower	Upper			Lower	Upper
Light	10.46	0.23	10.00	10.91	10.00	0.17	9.66	10.34
Medium	11.77	0.13	11.51	12.04	11.00	0.09	10.82	11.18
Medium-heavy	10.94	0.07	10.79	11.08	11.00	0.06	10.87	11.13
Heavy	10.31	0.32	9.69	10.94	9.00	0.29	8.44	9.56
Critical/Terminal	11.40	2.72	6.07	16.73	8.00	1.89	4.28	11.72
All	11.03	0.06	10.90	11.15	1.00	0.05	10.90	11.10

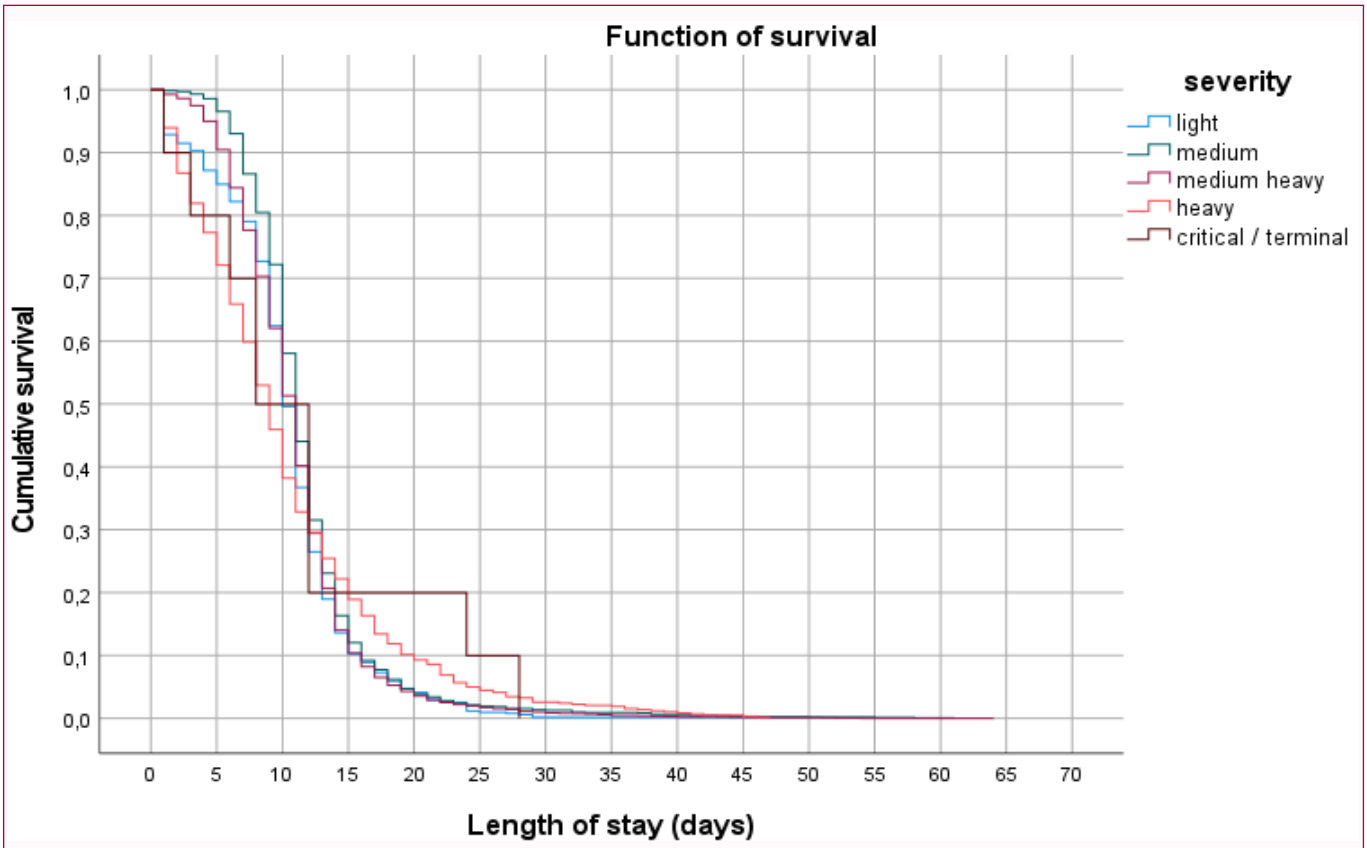

Figure 5: Function of survival during the period of hospitalization depending on the severity of the course of the disease.

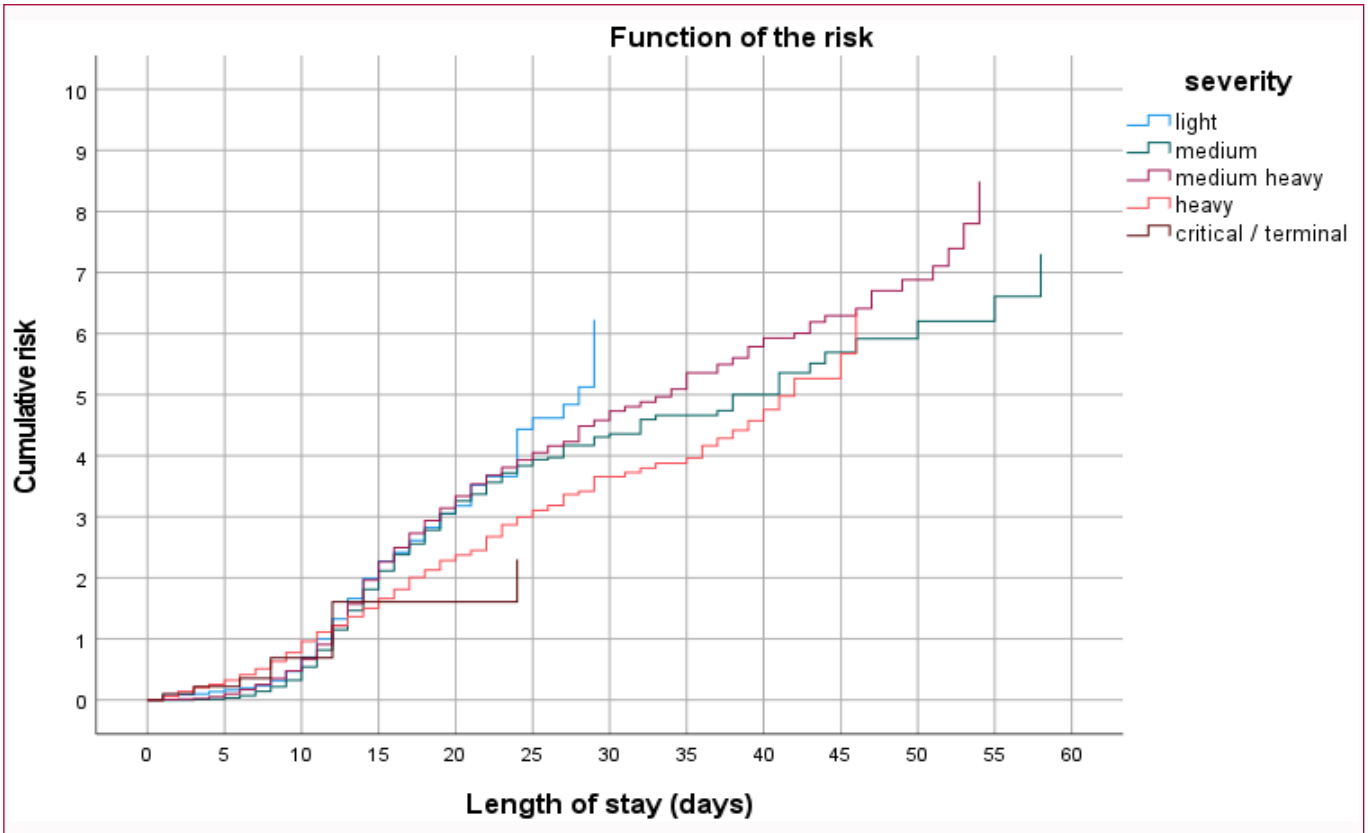

Figure 6: Function of the risk of dying during the period of hospitalization depending on the severity of the course of the disease.

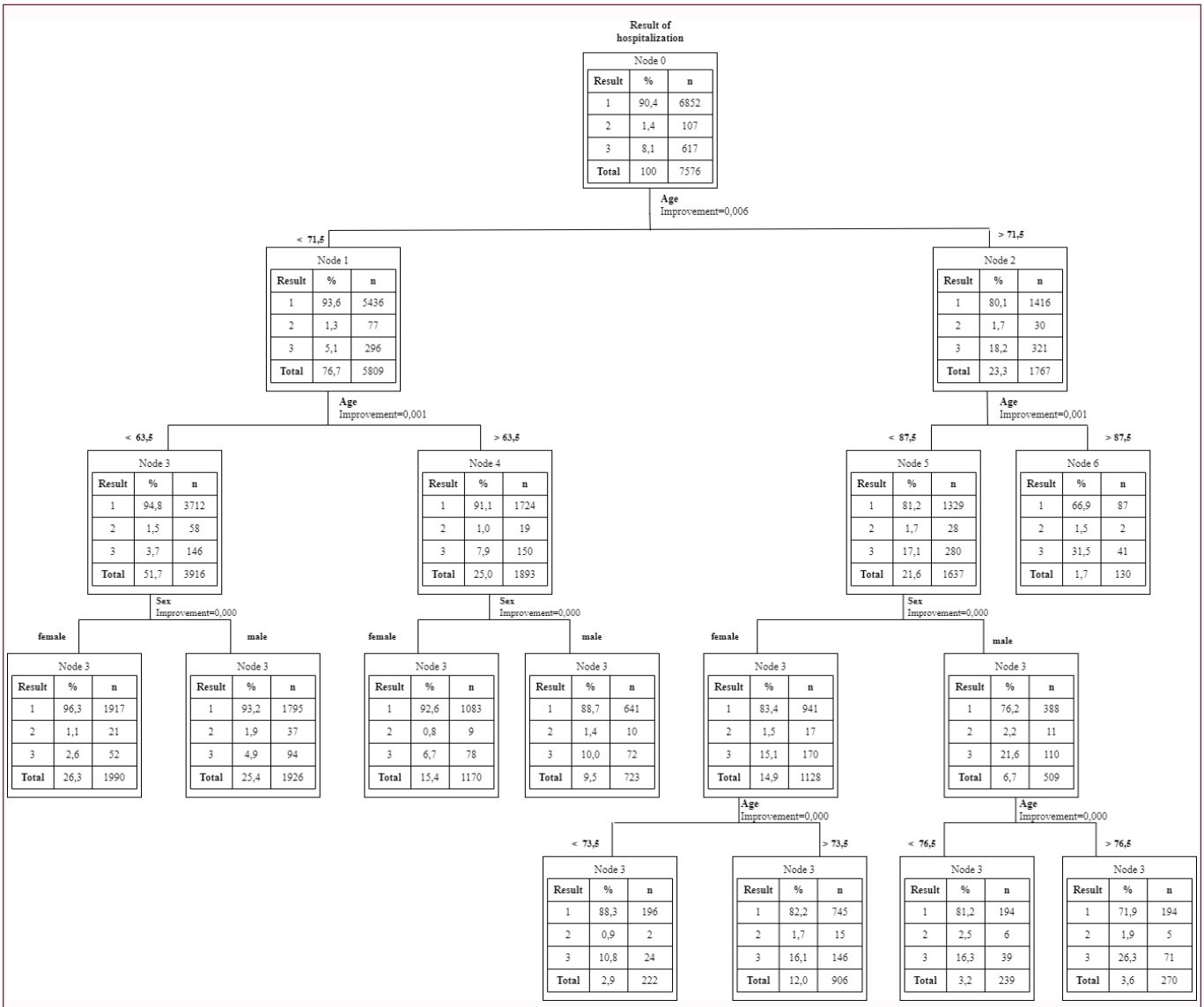

Figure 7: Distribution of patients of Noginsk Central District Hospital based on the classification tree model according to the results of hospitalization depending on age and gender.

Table 4: Interquartile ranges of length of stay in bed depending on the severity of COVID-19.

Severity	25.00%		50.00%		75.00%	
	Value	Std. Err.	Value	Std. Err.	Value	Std. Err.
	13.00	0.196	1.00	0.173	8.00	0.301
Light	13.00	0.144	11.00	0.092	9.00	0.104
Medium	13.00	0.067	11.00	0.064	8.00	0.088
Medium-heavy	14.00	0.495	9.00	0.286	5.00	0.349
Heavy	12.00	1.687	8.00	1.897	6.00	4.347
Critical/Terminal	13.00	0.057	11.00	0.050	8.00	0.073

a certain degree of disease severity. We made conclusions about the degree of risk of death depending on the duration of hospitalization.

The analysis results showed that the average number of patients per doctor per month was 28.23 ± 13.27 patients [IQR: 16.93; 41.25]. The average duration of hospital stay per physician was 10.65 ± 2.02 days [IQR: 8.77; 12.55]. The average length of stay in bed in 11 out of 15 age groups was higher in men than in women, while the difference in the indicator ranged from 0.09 days (age group 75 to 79 years, n=408) to 3.18 days (age group 18 to 24 years old, n=38). The results of the correlation analysis of the dependence of the duration of hospitalization on sex and age showed the absence of statistical significance between these indicators (r-Pearson =0.079; p<0.001; n=7573). The results of a correlation analysis of the dependence of the duration of hospitalization on the severity of the course of the disease showed no statistical significance between these indicators

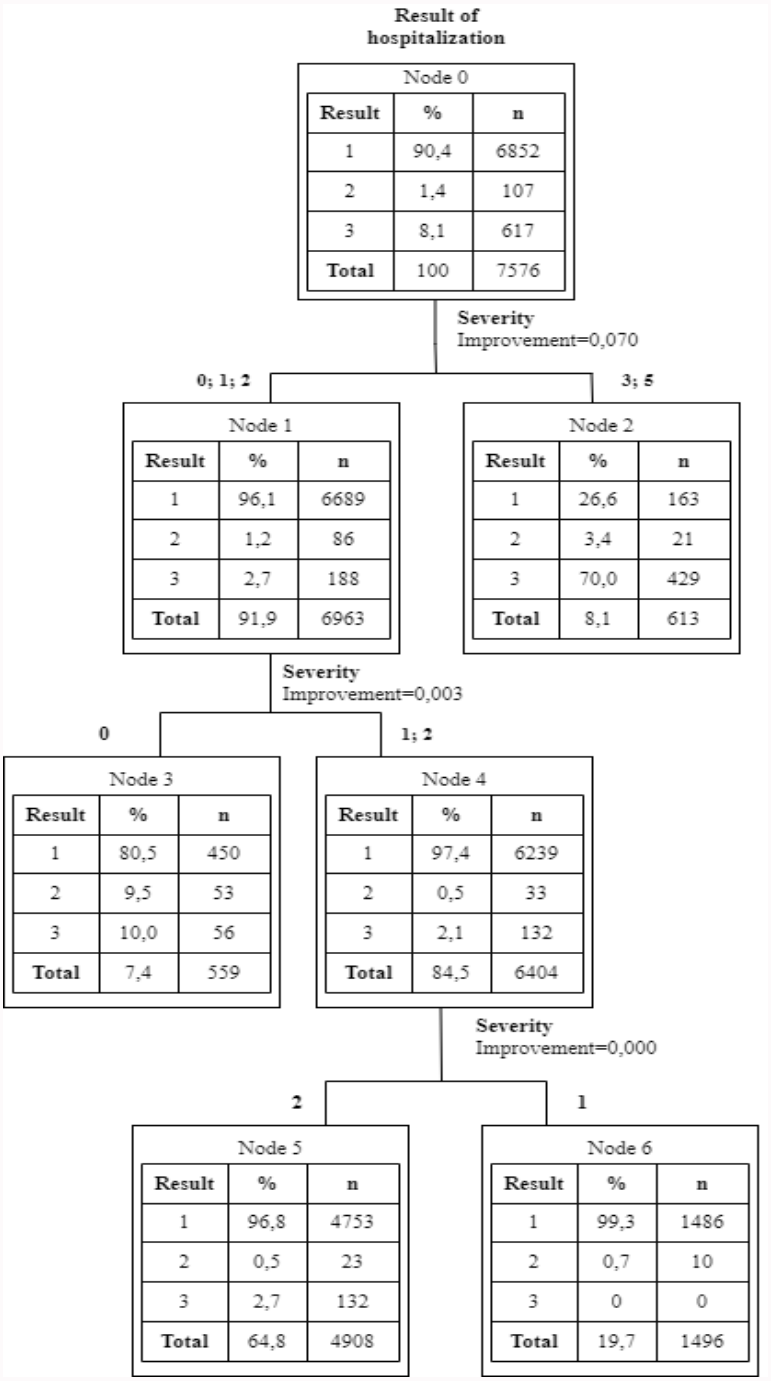

Figure 8: Distribution of patients of the Noginsk Central District Hospital based on the classification tree model according to the results of hospitalization depending on the severity of the course of the disease.

(r-Pearson =0.04; p<0.001; n=83238 (bed days)). When adjusting these indicators and excluding cases of treatment lasting 1 day and deaths within 10 days of inpatient treatment, inclusive, the correlation coefficient changed slightly (r-Pearson =0.1; p<0.001; n=81309 (bed-days)). The results of the correlation analysis showed no statistically significant dependence of the results of hospitalization on gender (r-Pearson =0.038; p<0.001; n=7573 (hospitalization cases)) and a weak direct dependence on age (r-Pearson =0.182; p<0.001; n=7573 (hospitalization cases)).

For patients with high severity, the probability of surviving on the 10th day of hospitalization was about 35%. For patients in the critical/terminal stage of the development of the disease from 10 to 12 days of hospitalization, the probability of surviving was reduced from 50% to 20%. The risk of death also increased with the length of hospitalization (e.g., with moderate disease, treatment for 30 days increased the risk of death by 4.2 times).

Conclusion

The results of our study with a detailed analysis of the level and dynamics of hospitalization in a specific medical organization, the load on the bed fund and medical workers, the average duration of hospitalization by sex and age groups, the relationship between the

average duration of hospitalization, the severity of the disease and the presence of concomitant diseases, including assessment of patient survival and the risk of adverse outcomes, allow us to establish specific standardized configurations and characteristics of patients with a new coronavirus infection (COVID-19), as well as specific parameters of organizational and managerial activities for the distribution of resources of a medical organization in the provision of medical care during an epidemic.

The obtained parameters of hospitalized persons and the prognostic characteristics determined for them in terms of the duration of hospitalization will allow, at the stage of forecasting the need for resources of a medical organization (beds and medical workers), to establish possible scenarios for their most effective use.

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