

TOPICAL ISSUE

L.K. Danilova, A.A. Evsyukov, S.Yu. Shtarik, E.V. Zorina,
D.S. Kaskaeva, O.V. Tutynina, I.I. Baron, N.Y. Shimokhina,
M.M. Petrova

ANALYSIS OF VACCINE EFFECTIVENESS AGAINST COVID-19 ON THE EXAMPLE OF RESIDENTS OF TWO CITIES OF EASTERN SIBERIA

DOI 10.25789/YMJ.2023.84.18

УДК [616.98:578.834.1]-085.371(571.5)

The analysis was conducted of 14,578 patients vaccinated against coronavirus infection in Krasnoyarsk and Zelenogorsk. As a result of the study, the effectiveness of vaccination against the SARS-Cov-2 coronavirus was proven. It was found that of all vaccinated people, 49.5% did not get sick with COVID, and the majority of vaccinated patients had a mild course of the disease. Mortality in the study group from a new coronavirus infection was 3.9% in Krasnoyarsk, 2.9% in Zelenogorsk ($p = 0.0005$). The median age of patients who died from a new coronavirus infection in Krasnoyarsk was 68.0 [61.0; 72.5] years, among women 68.5 [61.5; 77.0] and in Zelenogorsk among men 72.5 [62.0; 83.0] years, among women 78.0 [71.0; 83.0] years.

Among patients with severe and extremely severe severity, 24 patients were vaccinated, which accounted for 7.9% of all patients with severe and extremely severe severity. Among the deceased patients, 21 (7.8%) patients were vaccinated. In 18 (6.8%) patients who died, infection with a new coronavirus infection occurred within 10 days from the date of vaccination.

Keywords: coronavirus infection, SARS-Cov-2, vaccination against COVID-19, effectiveness of vaccination, mortality from coronavirus infection.

DANILOVA Lyudmila K. – PhD, Associate Professor at the Department of Outpatient Care and Family Medicine, V.F.Voino-Yasenetsky Krasnoyarsk State Medical University, Federal Siberian Scientific and Clinical Center FMBA of Russia, ORCID: 0000-0002-9854-2312, e-mail: ludmila-danilova@mail.ru; **EVSYUKOV Aleksandr A.** – PhD, Associate Professor at the Department of Outpatient Care and Family Medicine, Krasnoyarsk State Medical University named after Prof. V.F.Voino-Yasenetsky, ORCID: 0000-0003-1575-633X, e-mail: evsyukovsasha@mail.ru; **SHTARIK S.Yu.** – PhD, Professor at the Department of Outpatient Care and Family Medicine, V.F.Voino-Yasenetsky Krasnoyarsk State Medical University, ORCID: 0000-0003-3245-1132, e-mail: Shtarik@yandex.ru; **ZORINA Ekaterina V.** – Associate Professor at the Department of Outpatient Care and Family Medicine, V.F.Voino-Yasenetsky Krasnoyarsk State Medical University, ORCID: 0000-0003-1308-9115, e-mail: zorina-eka@mail.ru; **KASKAEVA Darya S.** – PhD, Associate Professor at the Department of Outpatient Care and Family Medicine, V.F.Voino-Yasenetsky Krasnoyarsk State Medical University, ORCID: 0000-0002-0794-2530, e-mail: dashakas.ru@mail.ru; **TUTYNINA Olga V.** – PhD, Associate Professor at the Department of Outpatient Care and Family Medicine, V.F.Voino-Yasenetsky Krasnoyarsk State Medical University, ORCID: 0000-0003-4129-479X, e-mail: tutynina_ljelya@mail.ru; **BARON Iri-na I.** – PhD, Associate Professor at the Department of Outpatient Care and Family Medicine, V.F.Voino-Yasenetsky Krasnoyarsk State Medical University, ORCID: 0000-0003-1185-4426, e-mail: irinabaron@mail.ru; **SHIMOKHINA Natalya Yu.** – MD, Associate Professor at the Department of Outpatient Care and Family Medicine, V.F. Voino-Yasenetsky Krasnoyarsk State Medical University, ORCID: 0000-0002-0091-5265; e-mail: doctorkardiolog99@rambler.ru, **PETROVA Marina M.** – MD, Professor, Head of the Department, ORCID - 0000-0002-8493-0058.

Introduction. Coronavirus SARS – Cov -2 has become an extraordinary shock throughout the world [1]. The pandemic has disrupted the usual way of life of society and resulted not only from an increase in morbidity and mortality of the population, but also from the destabilization of international political and economic relations, increased unemployment, and social upheaval.

Official information about an outbreak of pneumonia of unknown etiology in Wuhan City, the capital of Hubei Province of China, first appeared on December 31, 2019. According to the World Health Organization (WHO) Center in China (WHO China Country Office) from On January 3, 2020, this new disease was confirmed in 44 patients [2]. And on March 11, 2020, WHO recognized COVID-19 as a pandemic [11].

Among the most frequent symptoms with which patients with suspected COVID-19 were hospitalized, the following were noted: fever (98-98.6%), unproductive cough (76-82%), shortness of breath (43%); myalgia and fatigue (44%). Much less frequently, patients complained of headache (up to 9%), hemoptysis (5%), productive cough (28-37%), diarrhea (up to 14%), nausea (up to 14%) and vomiting (5%). These symptoms at the onset of infection were also observed in the absence of fever [1].

Analysis of the database of 5700 patients with COVID-19 (average age 63 [52; 75] years, 39.7% of women) admit-

ted to 12 New York City hospitals between March 1 and April 4, 2020 showed that the most common comorbidities were hypertension (3,026; 56.6%), obesity (1737; 41.7%) and diabetes mellitus (1808; 33.8%). Also S. Tai et al. in their study, they determined the relationship between the severe course of coronavirus infection and the patient's history of cardiovascular diseases (CVD), in the structure of which arterial hypertension took the leading position. Of 332 patients with mild COVID-19 (mean age 51 [40; 59] year, 61.2% of women) 48 (14.5%) patients had CVD. Of these, 23 (47.9%) had a severe course and required hospitalization. The level of intensive care requirement among these patients also increased compared to the group without concomitant cardiac pathology (47.92 and 12.4%, respectively, $p < 0.001$) [2;4; 6].

Mortality at COVID-2019 is proportional to the age of patients: from 0% in children under 9 years old to 14.8% in people over 80 years old. Approximately 10-15% of the lungs and 81-82% of the moderate cases from all infected go to severe. About 15-20% of severe cases become very severe. The category of high risk of mortality from COVID-2019 should include elderly patients with concomitant diseases, especially those with damage to the cardiovascular system [1].

In this regard, it became necessary to take the most effective measures that will help stop the coronavirus epidem-

ic. Despite a certain decline in infection with coronavirus infection, measures are needed to manage the epidemic, which necessarily include specific immunoprophylaxis. In January 2020, several organizations and institutions began work on the creation of a vaccine against SARS-CoV-2 based on the published genome [7]. Vaccination is the most effective measure that reduces morbidity and deaths. Back in the 18th century, the introduction of smallpox vaccination showed its exceptional effectiveness. The consequence of success was the disappearance of smallpox as an actual viral infection. [13].

To date, the following vaccines have been registered in the Russian Federation for vaccination against COVID-19: combined vector vaccines "Gam-COVID-Vac", "Gam-COVID-Vac-Lio", "Gam-COVID-Vac-M" and "Gam-COVID-Vac" (nasal drops), vaccines based on peptide antigens "EpiVacCorona" and "AURO-RA-CoV", inactivated whole-virion concentrated purified coronavirus vaccine "CoviVac", vaccine for the prevention of COVID-19 "Sputnik Light", subunit recombinant vaccine "Convaseal". Of the foreign vaccines, the most popular are: AZD1222 (ChAdOx1 nCoV-19) or Covishield - a vaccine developed by Oxford University and AstraZeneca, Pfizer/BioNTech - a vaccine produced by the German biotechnology company BioNTech in collaboration with the American Pfizer and Chinese Fosun Pharma, mRNA-1273 - COVID-19 vaccine being developed by Moderna [9; 12].

There is strong evidence that vaccines against SARS-CoV-2 infection are clinically effective in preventing infections and are also effective in reducing the likelihood of hospitalization and death [14].

Gam-COVID-Vac has proven its effectiveness not only in the Russian Federation, but also in the countries that have used this vaccine. According to some reports, the effectiveness exceeds 95%. The effectiveness of vaccines developed by BioNTech from Pfizer, Covishield from the University of Oxford and mRNA-1273 from Moderna ranged from 91% to 94%. According to a study conducted in the Krasnoyarsk Territory, the incidence of COVID-19 among vaccinated individuals is 8 times lower than among unvaccinated individuals. It has been convincingly proven that among patients with COVID-19 who fell ill after vaccination, compared with unvaccinated patients with COVID-19, hospital treatment is required 1.3 times less often, and artificial ventilation is required 2.2 and 2.0 times less often, respectively. hospitalization

in intensive care units, patients are 1.5 times less likely to be in serious and extremely serious condition. An important aspect is also that among vaccinated COVID-19 patients, deaths are 1.6 times less common compared to COVID-19 patients who were not vaccinated at the time of illness [10].

To date, 64.4% of the world's population has received at least one dose of a COVID-19 vaccine. In some countries, the proportion of vaccinated people reaches high values, for example, in the UAE - 99%, Portugal - 95%, China - 88%, Canada - 86%, Brazil - 85%, Italy - 84%, Vietnam - 81%, Japan - 81%, France - 80%, Great Britain - 77%, USA - 55%, Germany - 76%, India - 71%, and at that time in Russia this figure does not exceed 55% [5]. The population of pregnant women who have had infection and/or been vaccinated against COVID-19 deserves special attention [3]. According to published data from the US Department of Veterans Affairs health database (34 thousand fully vaccinated patients and 113 thousand unvaccinated participants who had COVID-19), among fully vaccinated patients who had COVID-19, the risk of death within the next 6 months is significant lower than in unvaccinated people (risk ratio (RR) was 0.66). According to a study in Khabarovsk, in the cohort of those effectively immunized in relation to the unvaccinated, the following was noted: a decrease in the incidence of coronavirus infection by 4.3 times; reduction in the frequency of hospitalization of patients by 57.7 times; reduction in the specific gravity of severe and critical forms by 84 times [8].

The purpose of our study was to analyze the effectiveness of vaccination against COVID-19 in Krasnoyarsk and Zelenogorsk of patients who applied to medical institutions of the Federal State Scientific and Clinical Center of the Federal Medical and Biological Agency of Russia, the structure of the incidence of coronavirus infection in the study group.

Research materials and methods.

An analysis of the database of patients in Krasnoyarsk and Zelenogorsk, who are served at the Federal Siberian Scientific and Clinical Center of the Federal Medical and Biological Agency of Russia, was carried out. Krasnoyarsk and Zelenogorsk are located at a distance of 155 km from each other. Both cities have a similar natural and climatic zone: Krasnoyarsk is a large industrial center of Eastern Siberia, Zelenogorsk has the status of a closed administrative-territorial entity. During the vaccination process, a register was compiled that included

28,762 patients who were vaccinated in medical institutions of the Federal State Scientific and Clinical Center of the Federal Medical and Biological Agency of Russia in Krasnoyarsk and Zelenogorsk for the period from 2020 to 2022. We took into account gender, age, the drug used for vaccination, the diseases for which the patients sought medical help, the severity of these diseases and the place of treatment of these patients.

Statistical analysis of the material was carried out on a personal computer using nonparametric methods of statistical analysis. The quantitative and qualitative characteristics included in the study formed a computer database. To describe quantitative characteristics, medians and interquartile ranges (Me, 25th and 75th percentiles) were calculated. Qualitative variables are presented as absolute values and as percentages. To compare independent data series based on quantitative characteristics, the Mann-Whitney test was used.

Analysis of the statistical significance of differences in qualitative characteristics was carried out using the χ^2 test. In all statistical analysis procedures, the critical significance level (p) was taken to be 0.05 or less.

Results and discussion. For immunization against the new coronavirus infection, Russian-made vaccines Gam-COVID-Vac 26,638 (92.7%), CoviVac 322 (1.1%), EpiVacCorona 638 (2.2%), Sputnik Light 1,164 (4.0) were used (%). The majority of patients completely completed the course of vaccination, which amounted to 92.8% (26,699). Of the 26,638 patients, only 2,063 (7.2%) patients received only one component of the Gam-COVID-Vac vaccine for any reason.

We analyzed 14,578 patients (50.6%) from the registry who sought medical attention for respiratory symptoms and subsequently received outpatient or inpatient treatment in medical institutions depending on the severity of the disease. The register includes residents of Krasnoyarsk (8,263 people) and Zelenogorsk (6,315 people). Of these, 4,159 (50.3%) men and 4,104 (49.7%) women were included in Krasnoyarsk, and 2,654 (42.0%) men and 3,661 (58.0%) in Zelenogorsk women. The median age of these patients was 53.0 [40.0; 65.0] years in Krasnoyarsk and 56.0 [41.0; 67.0] years in Zelenogorsk. Table 1 presents the diseases with which patients were observed in health care facilities.

When comparing the detection of SARS-Cov-2 among men and women in Krasnoyarsk and Zelenogorsk, it was re-

vealed that infection with the virus among the female population is significantly higher than in men ($p < 0.001$). The diagnosis of new coronavirus infection was established in 5880 (45.3%) men and 7104 (91.5%) women.

Depending on the severity, patients were observed on an outpatient or inpatient basis (Table 2).

When comparing the detection of SARS-CoV-2 among men and women in Krasnoyarsk and Zelenogorsk, it was found that infection with the virus among the female population is significantly higher than that of, respectively ($p < 0.001$). The diagnosis of a new coronavirus infection was established in men 5880 (45.3%) and 7104 (91.5%) women.

Depending on the severity, patients were observed in outpatient or inpatient settings (Table 3).

The study revealed that most often patients received outpatient treatment both in Krasnoyarsk and Zelenogorsk - 4,635 (56.1%) and 4,628 (73.3%), respectively. Table 4 shows the distribution of diseases depending on severity.

The course of coronavirus infection in most patients was mild, both in Krasnoyarsk (5,932 (71.8%)) and in Zelenogorsk (5,305 (84.0%)). Moderate severity of the disease was diagnosed in 1,987 (24.1%) patients in Krasnoyarsk and 910 (14.4%) patients in Zelenogorsk. Patients with severe and extremely severe severity were in the ICU in 267 (3.2%) patients in Krasnoyarsk and 37 (0.6%) in Zelenogorsk. Of these, 251 patients were on mechanical ventilation. Among patients with severe and extremely severe severity, 24 patients were vaccinated, which accounted for 7.9% of all patients with severe and extremely severe severity. The severe course of the new coronavirus infection in vaccinated patients is due to decompensation of comorbid pathology, and in patients without comorbid pathology it is due to infection with the Delta variant of SARS-CoV-2. Among the deceased patients, 21 (7.8%) patients were vaccinated. In 18 (6.8%) patients who died, infection with a new coronavirus infection occurred within 10 days from the date of vaccination.

The duration of treatment in Krasnoyarsk was 14 [10; 20] days and 13 [11; 17] days in Zelenogorsk ($p = 0.04$). Moreover, there are no significant differences in the duration of the disease between men and women.

Mortality from the new coronavirus infection was 324 (3.9%) patients in Krasnoyarsk, 180 (2.9%) in Zelenogorsk ($p = 0.0005$). It comprised equal shares among men and women in both local-

ities. The median age of patients who died from a new coronavirus infection in Krasnoyarsk was 68.0 [61.0; 72.5] years, among women 68.5 [61.5; 77.0] and in Zelenogorsk among men 72.5 [62.0; 83.0] years, among women 78.0 [71.0; 83.0].

The leading cause of death among patients included in the registry in both cities was the new coronavirus infection, in both men and women. A postmortem diagnosis of coronavirus infection was es-

tablished in 269 patients, which amounted to 83.1% of all deaths in Krasnoyarsk, of which 130 (40.2%) were men and 139 (42.9%) women. In Zelenogorsk, 86 patients died from coronavirus infection, which was 47.7%, of which 42 (23.3%) were men and 44 (24.4%) women. A large proportion of deaths from SARS-CoV-2 were registered in 2020 before the start of mass vaccination and were not vaccinated with a full course.

Table 1

Structure of acute respiratory diseases with which vaccinees were observed by residence

Diagnosis	Krasnoyarsk (n = 8263)		Zelenogorsk (n = 6315)		p
	n	%	n	%	
J12.8-J18.9	502	6.1	256	4.1	$p = 0.046$
U 07.1	7 060	85.4	5 924	93.7	$p = 0.001$
U 07.2	701	8.5	137	2.2	$p = 0.001$

Table 2

Distribution of patients diagnosed with a new coronavirus infection among men and women in Krasnoyarsk and Zelenogorsk

	men (n=5880)		women (n=7104)		
Krasnoyarsk	3 398	26.2	3 662	28.2	
Zelenogorsk	2 482	19.1	3 442	26.5	
Total	5 880	45.3	7 104	54.7	$p < 0.001$

Table 3

Place of treatment for patients with respiratory symptoms depending on gender and place of residence

Treatment	Gender	Krasnoyarsk		Zelenogorsk		
Outpatient treatment	men	2 185	26.4	1 896	30.0	
	women	2 450	29.7	2 732	43.3	
	Total	4 635	56.1	4 628	73.3	$p < 0.001$
Inpatient treatment	men	1 974	23.9	758	12.0	
	women	1 654	20.0	929	14.7	
	Total	3 628	43.9	1 687	26.7	$p < 0.001$

Table 4

Distribution of patients with coronavirus infection depending on severity in Krasnoyarsk and Zelenogorsk

Degree of severity	Krasnoyarsk		Zelenogorsk		p
	n	%	n	%	
Easy	5 932	71.8	5 305	84.0	$p < 0.001$
Average	1 987	24.1	910	14.4	$p < 0.001$
Heavy	120	1.5	61	1.0	$p = 0.0107$
Extremely heavy	224	2.7	39	0.6	$p < 0.001$

Table 5

Structure of post-mortem diagnoses among men and women in Krasnoyarsk and Zelenogorsk

Diagnosis	Krasnoyarsk				Zelenogorsk			
	men		women		men		women	
	n	%	n	%	n	%	n	%
B20 ¹	3	0.9	1	0.3	0	0	0	0
C18-C91 ²	2	0.6	2	0.6	5	2.8	2	1.1
E11 ³	0	0	1	0.3	0	0	1	0.6
G31-46 ⁴	1	0.3	0	0	1	0.6	0	0
I21-46 ⁵	6	1.8	2	0.6	32	7.7	33	18.4
I61-67 ⁶	3	0.9	4	1.2	5	2.8	6	3.3
J12-18 ⁷	16	5.0	14	4.4	4	2.2	5	2.8
U07 ⁸	130	40.2	139	42.9	42	23.3	44	24.4

Note: 1 - B20 - Disease caused by human immunodeficiency virus [HIV]; 2 - C18-C91- Malignant neoplasms; 3 - E11 - Diabetes mellitus; 4 - G31-G46 - Damage to the nervous system; 5 - I21-46 - Heart diseases (AMI, cardiac arrest); 6 - I61-I67 - Intracerebral hemorrhages; 7 - J12-18 - Community-acquired pneumonia; 8 - U07 - Coronavirus infection.

Conclusion. Thus, the main vaccine for immunization against the new coronavirus infection of the adult population is the Russian-made Gam-COVID-Vac vaccine. An analysis of the register showed that the bulk of cases occurred in 2020 before mass vaccination of the population. Of all those vaccinated, 49.5% did not get sick with coronavirus infection. The vaccinated patients had a mild course of the disease - 5932 people from Krasnoyarsk (71.8%) and 5305 patients from Zelenogorsk (84.0%). The disease was of moderate severity in 1987 (24.1%) patients in Krasnoyarsk and 910 (14.4%) patients in Zelenogorsk. In vaccinated patients, a severe and extremely severe course of the disease, which led to death, is due to decompensation of severe comorbid pathology. In 6.8% of deceased patients, infection with a new coronavirus infection occurred before 10 days from the date of vaccination. The severe course of the new coronavirus infection in vaccinated patients without comorbid pathology is caused by infection with the Delta variant of SARS-CoV-2.

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