Lyubov A. Shpagina[1], Olga S. Kotova[1], Kristina V. Likhenko-Logvinenko[1], Sergey V. Astrakov[2], Aleksander V. Kalinichenko[1], Oksana N. Gerasimenko[1], Svetlana A. Karmanovskaya[1], Dmitry V. Chebykin[1], Lyudmila P. Kuzmina[3], Igor V. Bukhtiyarov[3]

Working conditions of medical workers during the COVID-19 pandemic in 2020–2021 in Novosibirsk

[1]Novosibirsk State Medical University of Ministry of Healthcare of Russia, 52, Krasnyj Ave., Novosibirsk, 630091;
[2]Novosibirsk State University, 1, Pirogova St., Novosibirsk, 630090;
[3]Izmerov Research Institute of Occupational Health, 31, Budyonnogo Ave., Moscow, 105275

Introduction. The high risk of infection of healthcare workers dictates the need to study their working conditions during the COVID-19 pandemic.

The study aims to research the working conditions of medical workers during the COVID–19 pandemic in multidisciplinary medical and preventive organizations.

Materials and methods. Analysis of working conditions of medical workers of medical and preventive organizations. The study design is a closed population (four medical institutions were randomly selected), a target group (doctors and nurses). The authors analyzed the staffing table and 16 reports on a special assessment of working conditions at 1,251 workplaces (1,845 medical workers, of which 787 doctors, 1,058 nurses). Statistical analysis included: standard methods of descriptive statistics, determination of relationships by logistic regression (odds ratios (OR) and 95% confidence intervals (OR CI)). $p<0.05$ was taken as the critical level of significance.

Results. The largest number of ill medical workers provided assistance to patients without signs of COVID-19 both in hospitals (86.06% of doctors, 85.85% of nurses) and in outpatient polyclinic treatment and prevention organizations (90.31% of doctors, 92.05% of nurses). The probability of getting sick COVID-19 was maximum in an infectious diseases hospital (compared with emergency departments OR 2.049; 95% OR CI 1.194–4.608 and diagnostic and treatment units of medical institutions OR 3,057; 95% OR CI 1,876–4,98). The workplaces of medical workers who have undergone COVID-19 in infectious diseases hospitals and specialized teams are classified as harmful class 1–3 degrees, and workers are classified as high occupational risk groups according to SARS-CoV-2. The probability of getting sick with COVID-19 is significantly higher when in contact with pathogens of infectious diseases (class of working conditions 3.3 compared to 3.1 or 3.2).

Conclusion. *The workplaces of medical workers who have undergone COVID-19 in infectious diseases hospitals and specialized brigades are classified as harmful class of the first to third degree, and workers are classified as high occupational risk groups for COVID–19.*

Ethics. Scientists have conducted the study in compliance with the Ethical principles set out in the Helsinki Declaration of 1975 with amendments of 1983 and obtaining the informed consent of patients.

Keywords: *workplaces; working conditions; medical workers; COVID-19*

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For correspondence: *Lyubov A. Shpagina,* the Head of the Department at the Hospital Therapy and Medical Rehabilitation of Federal State Budgetary Educational Institution, Ministry of Health, Russian Federation, Dr. of Sci. (Med.), Professor. E-mail: lashpagina@gmail.com

Information about the authors:

Shpagina L.A.	https://orcid.org/0000-0003-0871-7551
Kotova O.S.	https://orcid.org/0000-0003-0724-1539
Likhenko-Logvinenko K.V.	https://orcid.org/0000-0002-6058-0807
Astrakov S.V.	https://orcid.org/0000-0001-5251-5362
Gerasimenko O.N.	https://orcid.org/0000-0002-9742-0479
Karmanovskaya S.A.	https://orcid.org/0000-0003-3446-8018
Kuzmina L.P.	https://orcid.org/0000-0003-3186-8024
Bukhtiyarov I.V.	https://orcid.org/0000-0002-8317-2718

Contribution:

Shpagina L.A.	— research concept and design, writing the text;
Kotova O.S.	— writing the text;
Likhenko-Logvinenko K.V.	— data collection and processing, writing the text;
Astrakov S.V.	— data collection and processing;
Kalinichenko A.V.	— data collection and processing;
Gerasimenko O.N.	— data collection and processing;
Karmanovskaya S.A.	— data collection and processing;
Chebykin D.V.	— data collection and processing;
Kuzmina L.P.	— writing the text;
Bukhtiyarov I.V.	— writing the text.
All the authors	— have made a significant contribution to the search and analytical work and the preparation of the article.

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Introduction. As of January1, 2022, according to the American Johns Hopkins University, the number of COVID-19 cases in the world reached 288,201,551 in 223 countries and territories of the world, 5,436,634 people died after COVID-19 infection [1]. As the number of cases and the need for medical care increased, medical workers were recognized as a high-risk group for contracting this infection [2]. In China, after informing the World Health Organization office about cases of pneumonia of unknown etiology detected in Wuhan, Hubei Province (February 11, 2020), 1,716 medical workers were infected, 6 of whom died [3].

According to a systematic review published in the international journal Clinical Practice in October 2020, the infection rate of medical personnel is about 3.5–20% [4]. In Hubei Province (China) from 01.01–28.01.2020 29% of those hospitalized were medical workers: 77.5% worked in general wards, 17.5% in the emergency department and 5% in the intensive care unit [5]. In Italy from March 1 to March 23, 2020 4826 healthcare workers were infected with SARS-CoV-2, 18 of them died [6], the mortality rate of medical workers from a new coronavirus infection ranges from 1.4% to 3.83% [4]. COVID-19 is the first new occupational disease described in this decade [2, 6, 7–9.]. At the same time, only a few works have information about the working conditions of medical personnel working during the COVID-19 pandemic [10-13].

At the end of 2020, there were 105 hospital organizations and 286 outpatient organizations (independent and part of hospital organizations) in the Novosibirsk Region, in which 15,604 doctors and 27,807 nurses worked [14]. Insurance payments for COVID-19 infection in the Novosibirsk Region in 2020 were received by 3,727 medical workers (twelve died), in nine months of 2021 — 5,734 people (eleven died) [15]. The high risk of infection of healthcare workers dictates the need to study their working conditions during the COVID-19 pandemic.

The study aims to research the working conditions of medical workers during the COVID–19 pandemic in multidisciplinary medical preventive organizations (MPO).

Materials and methods. The scientists have been conducting the study since 2021 within the framework of the state task ST Reg. No. AAAAA-A17-117071340024 in accordance with the National Standards of the Russian Federation GOST-R 52379-2005 "Good Clinical Practice" (ICH E6 GCP), with mandatory compliance with the ethical principles set out in the Helsinki Declaration of 1975 with additions of 1983 [16] and obtaining informed consent of patients. The local Committee on Biomedical Ethics at the Federal State Budgetary Educational Institution of the Russian Ministry of Health have approved the study and its program.

The study design is a closed population (four medical institutions were randomly selected), a target group (doctors and average medical workers). The authors have calculated sample size using the formula $n=[A+B]2\times2\times SD^2/DIFF^2$ [17].

The object of the study is the working conditions of medical workers.

The subject of the study is the safety of working conditions of medical workers during the COVID-19 pandemic. The diagnosis of COVID-2019 was considered verified in the presence of a positive result of laboratory testing for SARS-CoV-2 RNA (using nucleic acid amplification methods) or SARS-CoV-2 antigen (using immunochromatographic analysis) regardless of clinical manifestations [18] and/or antibodies of the IgA, IgM and/or IgG class in patients with clinically confirmed COVID-19 infection [19].

Inclusion criteria: 1. Signing an informed consent to participate in the study. 2. Medical workers who performed their professional duties during the COVID-19 pandemic (2020–2021), with higher or secondary education over 18 years of age — COVID-19 convalescents and were not ill. 3. The ability to understand and comply with the requirements of the research protocol. 4. There are no contraindications to the diagnostic procedures provided for in the study protocol.

Non-inclusion criteria: 1. Refusal to sign an informed consent to participate in the study. 2. Age under 18 years. 3. Inability to understand and comply with the requirements of the research protocol. 4. The presence of contraindications to diagnostic procedures provided for in the protocol of the study.

The main group included 128 medical workers who underwent COVID-19 and provide medical care to patients with COVID-19 (at the inpatient stage — group one (58 people), at the outpatient stage — group two (70 people)). Comparison group one — 491 people involved in providing care to patients who did not have signs of a new coronavirus infection upon admission (at the inpatient stage — group three (74 people), at the outpatient stage — group four (417 people)). Comparison group two — group five — 28 medical workers providing emergency care at the inpatient stage (at the same time, COVID-19 was diagnosed in some patients who were in emergency departments in the first 72 hours after admission). We compared the groups in demographic characteristics: the age of the main cohort was 45.27 (26–73) years, 89.80% of women, in the comparison groups — the age of 49.73 (22–70) years, 86.05% of women. The work experience in the profession of medical personnel was 15 (5–21) years.

At the first stage, the researchers used an analytical method to study the staffing table and 16 reports of a special assessment of working conditions at 1,251 workplaces (1,845 medical workers, of which 787 doctors, 1,058 nurses) of four medical organizations, two of which are large multidisciplinary institutions of the city of Almaty. Novosibirsk: The State Budgetary Healthcare Institution of the Novosibirsk region "City Clinical Hospital No. 2" and the State Budgetary Healthcare Institution of the Novosibirsk region "City Clinical Hospital No. 2". 25" and two organizations — representatives of the outpatient polyclinic link: the State Budgetary Healthcare Institution of the Novosibirsk region "War Veterans Hospital No. 3" and the State Budgetary Healthcare Institution of the Novosibirsk Region "Clinical Consultative and Diagnostic Polyclinic No. 27", for 2020–2021.

The LLC "Scientific and Practical Center for Occupational Safety and Certification" conducted a special assessment of working conditions in accordance with Federal Law of the Russian Federation No. 426-FZ of 28.12.13 "On special assessment of working conditions" and Order of the Ministry of Labor and Social Protection of the Russian Federation No. 250n of 24.04.2015 "On approval of the features of special assessment of working conditions at the workplaces of certain categories of medical workers and the list of medical equipment (devices, devices, accessories), the normal functioning of which may be affected by measuring instruments used during a special assessment of working conditions" (as amended by the Order of the Ministry of Labor of Russia dated 30.06.2017 No. 544 n).

Specialists evaluated during a special assessment of working conditions: microclimate (using the Meteoscope-M microclimate parameter meter), the severity of the labor process (using a metal UM5M tape measure, DIN-1-U electronic dynamometer, SOPpr-2a-3-000 mechanical stopwatch)), the intensity of the labor process (with a SOPpr mechanical stopwatch-2a-3-000), noise, general vibration and local vibration (with the noise and vibration analyzer "ASSISTANT" of the configuration "total"), chemical factor (with the gas analyzer Comet-5), ionizing radiation (using the dosimeter-radiometer DKS-96).

We have established classes of working conditions under the action of a biological factor on an employee's body according to P 2.2.2006-05 of the Manual on the hygienic assessment of factors of the working environment and the labor process [20]: permissible (Class 2), harmful (classes 3.1, 3.2, 3.3) and dangerous (class 4).

The scientists have carried out statistical data processing using the software package SPSS 24 version. The Kolmogorov–Smirnov criterion was used to assess the nature of the distributions of the analyzed features. Statistical analysis included: standard methods of descriptive statistics, determination of relationships by logistic regression (odds ratios (OR) and 95% confidence intervals (CI)). The researchers took $p<0.05$ as the critical level of significance when testing statistical hypotheses.

Results. An analysis of the staffing table of medical institutions indicates the allocation, starting in 2020, of special units in their structures providing medical care to patients with COVID-19 ***(table 1)***.

In the structural units engaged in providing care to patients who did not have signs of a new coronavirus infection COVID-19 at the initial treatment, the largest number of medical workers were employed both in hospitals (86.06% of doctors, 85.85% of nurses) and in outpatient clinics (90.31% of doctors, 92.05% of nurses).

When calculating the odds ratio of their confidence intervals, OR and 95% OR CI, the experts used the presence or absence of a transferred COVID-19 as outcomes, and used personnel groups, structural units, forms of outpatient departments (OPD) as factors. We calculated certain factors within various subsamples ***(table 1a)***.

All medical workers (doctors and nurses) had the highest probability of contracting COVID-19 when working in emergency departments — higher than in workers of infectious disease hospitals (OR 2049; 95% OR CI 1194–4608) and at least 1.88 times more than in diagnostic and medical units (OR 3.057; 95% OR DI 1.876–4.984). This may be due to the fact that in the first hours of admission to the emergency department, it is not always known about the presence of patients with COVID-19. In the main group of hospital medical workers, the probability of getting COVID-19 is significantly, at least, 4.16 times higher than in those who work in diagnostic and treatment departments of a medical institution (OR 6,261; 95% OR CI 4,160–9,425). Medical workers providing outpatient care are significantly

Table 1

Specific gravity of medical workers. who have undergone COVID-19

Form of institution		Hospital (H)			Outpatient polyclinic service (OPS)	
Divisions		IDH	DTU-h	ED	ST	DTU-os
Doctors	(number)	55	288	52	38	354
	who have undergone COVID-19	22	19	15	23	139
Nurses	(number)	91	489	63	71	736
	who have undergone COVID-19	36	55	13	47	278
OR doctors/nurses		1.019	0.557	1.559	0.575	1.130
95% OR CI		0.514–2.018	0.324–0.960*	0.663–3.669	0.210–1.571	0.839–1.523

Note: IDH — infectious diseases hospitals; DTU-h — diagnostic and treatment units of the hospital; ED — emergency departments; ST — specialized teams; DTU-os — diagnostic and treatment units of outpatient services; * — $p<0.05$.

Table 1a

Comparative table (OR) of groups of medical workers by hospital departments and outpatient polyclinic service (OPS)

Divisions	Doctors		Nurses		Doctors + nurses	
	OR	95% OR CI	OR	95% OR CI	OR	95% OR CI
IDH/DTU (h+OPS)	9.439	4.629–19.244*	5.165	3.116–8.560*	6.261	4.160–9.425*
H/DTU (h+OPS)	2.372	1.196–4.703*	4.662	2.107–10.313*	3.226	1.930–5.393*
OPS/Hospital	4.264	3.014–6.032*	3.352	2.514–4.471*	3.700	2.971–4.608*
ED/IDH	0.608	0.271–1.363	0.397	1/0.189–1/0.833*	0.489	1/0.285–1/0.838*
ED/DTU (h+OPS)	5.740	2.686–12.263*	2.052	1.048–4.016*	3.057	1.876–4.984*

Note: IDH — infectious diseases hospitals; OPS — outpatient service; DTU-h — diagnostic and treatment units of the hospital; ED — emergency departments; ST — specialized teams; DTU-os — diagnostic and treatment units of outpatient services; * — $p<0.05$

more likely to get sick with a new coronavirus infection than those working in hospitals (OR 3,700; 95% OR CI 2,971–4,608). This may be due to the fact that patients are admitted to the hospital in the direction of doctors from polyclinics who do not always know about the patient's diagnosis during his initial treatment, and when visiting at home they may have contact with carriers and patients with a new coronavirus infection living together with the examined patients.

The researchers have obtained similar significant results both from doctors and nurses.

A higher risk of infection of medical workers with COVID-19 was also reported by: J.F. Ha [4], L.A. Shpagina and co-authors [7], S.A. Gómez-Ochoa et al. [21], J. Wong et al. [22], W.J. Guan et al. [23].

The revealed patterns necessitated the study of working conditions in the observed groups of medical workers ***(table 2)***.

The probability of infection with COVID-19 is significantly higher in all medical workers (doctors and nurses) who come into contact with pathogens of infectious diseases (second degree of the third class of working conditions compared to the first degree of the third class by biological factor: OR 15.92; 95% OR CI 12.34–20.55).

The workplaces of doctors and nurses who have undergone COVID-19 and provide medical care to patients on the basis of infectious diseases hospitals and as part of specialized teams, according to working conditions (biological, chemical factor, final class of working conditions), belong to the harmful class of the first–third degree. These medical workers should belong to groups of high occupational risk for occupational diseases, including the new coronavirus infection.

It is also confirmed that the probability of infection with COVID-19 is significantly higher in all medical workers who come into contact with pathogens of infectious diseases (third degree of the third class of working conditions compared to the first and second degree of the third class).

We have obtained the similar statistically significant results for doctors in the final class of working conditions.

It was found that at the workplaces of doctors and nurses of the first comparison group engaged in providing care to patients who had no signs of a new coronavirus infection at both outpatient and inpatient outpatient stages (subgroups 3 and 4), exposure to chemicals whose levels correspond to class 3.1 (compared with acceptable working conditions second class) significantly increases the probability of getting COVID–19 from 11% (OR 1.98; 95% OR CI 1.10–3.56; 1.10–3.56) — at least up to 2.05 times (OR 3.09; 95% CI OR CI 2.05-4.65).

The biological factor acting on medical personnel in infectious diseases hospitals and specialized teams of outpatient institutions directly assisting patients with COVID-19 is represented by pathogenic microorganisms of the second group (pathogens of highly contagious human diseases — SARS-CoV-2SARS-CoV-2), the third group (pathogens of infectious diseases isolated in independent nosological groups), the fourth group (conditionally pathogenic microorganisms, pathogens of opportunistic infections). The biological factor, also represented by pathogenic microorganisms of the II-IV groups of pathogens, affects those working in diagnostic and treatment units of a similar form of medical and preventive institutions that do not provide assistance to patients with a new coronavirus infection.

The data obtained are similar to the results of studying the working conditions of medical workers of visiting teams of the city ambulance station [10], which also indicate the degree of association of infection of employees with professional activity, which allowed the authors to conclude that there is a proven high (intolerable) occupational risk.

Table 2

Working conditions of medical workers who have undergone COVID-19 and provide medical care to patients in OPS

Group		Main				Comparison group 1				Comparison group 2	
Harmful factor	Class working conditions	Doctors		Nurses		Doctors		Nurses		Doctors	Nurses
		1(n=22)	2(n=23)	1(n=36)	2(n=47)	3(n=19)	4(n=139)	3(n=55)	4(n=278)	5(n=15)	5(n=13)
Chemical	3.1	0	0	0	0	2	18	13	70	0	0
	2	22	23	36	47	17	121	42	208	15	13
Biological	3.3	22	23	36	47	0	0	0	0	12	10
	3.2	0	0	0	0	0	0	52	261	3	3
	3.1	0	0	0	0	18	132	0	0	0	0
	2	0	0	0	0	1	7	3	17	0	0
Physical	2	22	23	36	47	19	139	55	278	15	13
The severity of labor	2	2	2	2	2	19	139	55	278	15	13
The intensity of the labor process	2	0	0	0	0	0	0	55	278	0	0
	3.1	0	0	36	47	19	139	0	0	0	13
	3.2	22	23	0	0	0	0	0	0	15	0
Final grade	3.3	22	23	36	47	0	0	0	0	12	10
	3.2	0	0	0	0	0	0	52	261	3	3
	3.1	0	0	0	0	18	132	0	0	0	0
	2	0	0	0	0	1	7	3	17	0	0

Table 2a

The probability of COVID-19 depending on the working conditions of medical workers

Group	Subsampling	Factor	Class of working conditions	OR	95% OR CI
comparison group 1	Doctors outpatient stage	chemical	3.1/2	5.18	2.00–13.41*
comparison group 1	doctors (inpatient+ outpatient stage)	chemical	3.1/2	1.98	1.10–3.56*
group 1	nurses (outpatient stage)	chemical	3.1/2	3.09	2.05–4.65*
comparison group 1	nurses (inpatient+ outpatient stage)	chemical	3.1/2	1.60	1.18–2.17*
comparison group 1	врачи+медицинские сестры	chemical	3.1/2	1.69	1.30–2.21*
comparison group 1	врачи+nurses	biological	3.2/3.1	15.92	12.34–20.55*
all groups	doctors	biological	3.3/3.2	17.02	4.97–58.34*
all groups	dortors	biological	3.3/3.1	3.78	2.47–5.79*
all groups	dortors	final	3.3/3.2	17.02	4.97–58.34*
all groups	doctors	final	3.3/3.1	3.78	2.47–5.79*
all groups	doctors+nurses	biological	3.3/3.1	9.61	7.19–12.86*
all groups	dortors+nurses	biological	3.2/3.1	10.51	8.29–13.33*
all groups	dortors+nurses	final	3.3/3.1	9.61	7.19–12.86*

Note: * — p<0,05

The intensity of labor, being one of the psychophysiological factors of professional selection, is characterized by an emotional load on the body during work, requiring intensive brain work to receive and process information. 100% of doctors working in infectious diseases hospitals, specialized teams, emergency departments have the highest intensity of the labor process (class 3.2). According to the indicators of the intensity of the labor process, only in the comparison group of secondary medical personnel, it was assessed as acceptable in 100% of cases.

Conclusion. *This study shows that the workplaces of doctors and nurses who have undergone COVID-19 and provide medical care to patients on the basis of infectious diseases hospitals and as part of specialized teams, according to working conditions (biological, chemical factor, final class of working conditions) belong to the harmful class of the first-third degrees. These workers should be classified as high-risk groups. occupational risk for occupational diseases, including new coronavirus infection.*

All medical workers (doctors and nurses) have the highest probability of getting COVID-19 while working in emergency departments, compared with employees of infectious diseases hospitals and diagnostic and treatment departments of medical institutions.

Medical workers providing outpatient care are significantly more likely to become infected with a new coronavirus infection than those who work in hospitals.

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