DOI: 10.20514/2226-6704-2022-12-4-302-309
EDN: ANXLZG
УДК 616.98:578.834.1-06:616-037

А.В. Мелехов*[1,2], А.И. Агаева[1], И.Г. Никитин[1,2]

[1]— Кафедра госпитальной терапии им. Г.И. Сторожакова лечебного факультета Российского национального исследовательского медицинского университета им. Н.И. Пирогова, Москва, Россия
[2]— Федеральное государственное автономное учреждение «Национальный медицинский исследовательский центр «Лечебно-реабилитационный центр» Минздрава России, Москва, Россия

СИМПТОМАТИКА В ОТДАЛЕННОМ ПЕРИОДЕ ПОСЛЕ ПЕРЕНЕСЕННОЙ КОРОНАВИРУСНОЙ ИНФЕКЦИИ: РЕЗУЛЬТАТЫ ДЛИТЕЛЬНОГО НАБЛЮДЕНИЯ

A.V. Melekhov*[1,2], A.I. Agaeva[1], I.G. Nikitin[1,2]

[1]— Deparment of Internal disease named after G.I. Storozhakov of the medical faculty of Pirogov Russian National Research Medical University named after N.I. Pirogov, Moscow, Russia
[2]— Federal State Autonomous Institution «National Medical Research Center of Treatment and Rehabilitation» of the Russian Ministry of Health, Moscow, Russia

Symptoms in the Long Period after the Coronavirus Infection: Results of Long-Term Follow-Up

Резюме

Введение: данные о виде, частоте и продолжительности остаточных симптомов после COVID-19 неоднородны, что связано с методологическими особенностями проведения исследований. **Цель:** оценка частоты и выраженности симптомов в отдаленном периоде после перенесенной новой коронавирусной инфекции. **Материалы и методы:** Проведен телефонный опрос пациентов, госпитализированных в ЛРЦ МЗ РФ в связи с COVID-19 в период 13.04.2020-10.06.2020: 195 пациентов (58,2 % выписанных) через 143 (131-154) дней после дебюта заболевания и 183 (54,6 % выписанных) через 340 (325-351) дней. **Результаты:** Субъективная оценка состояния своего здоровья по 100-балльной шкале до и после перенесенного COVID-19 на первом опросе составила 95 (80-100) и 80 (70-96) баллов (p <0,001 для сравнении оценки до и после заболевания), на втором — 90 (80-100) и 80 (60-90) баллов, (p <0,001 для сравнении оценки до и после заболевания и для сравнения оценки состояния здоровья после COVID-19 на двух этапах опроса). Разнообразные жалобы выявлены у 63 % опрошенных на первом этапе и у 75 % — на втором, количество выявленных симптомов составило 2 (0-6) и 4 (1-8) соответственно. Наиболее частыми жалобами были слабость/утомляемость (31,3 и 47,5 % опрошенных), боли в суставах (31,3 и 47,5 %) и одышка/чувство нехватки воздуха (31,3 и 43,2 %). Рост этих показателей можно связывать с изменением методики опроса. Выраженность лидирующих симптомов на втором опросе при оценке по десятибалльной шкале была низкой: утомляемость 3 (0-6) баллов, боль в суставах, слабость и одышка — 0 (0-5) баллов, чувство нехватки воздуха — 0(0-3) балла. **Заключение:** снижение самочувствия сохраняется в течение длительного времени после перенесенной коронавирусной инфекции у значительной доли пациентов, однако выраженность лидирующих симптомов к 12 месяцу наблюдения достаточно низка.

Ключевые слова: *COVID-19, последствия коронавирусной инфекции, постковид, выраженность симптомов*

Конфликт интересов

Авторы заявляют, что данная работа, её тема, предмет и содержание не затрагивают конкурирующих интересов

*Контакты: Александр Всеволодович Мелехов, e-mail: AMelekhov@med-rf.ru
*Contacts: Alexander V. Melekhov, e-mail: AMelekhov@med-rf.ru
ORCID ID: https://orcid.org/0000-0002-1637-2402

Источники финансирования

Авторы заявляют об отсутствии финансирования при проведении исследования

Статья получена 07.09.2021 г.

Принята к публикации 14.04.2022 г.

Для цитирования: Мелехов А.В., Агаева А.И., Никитин И.Г. СИМПТОМАТИКА В ОТДАЛЕННОМ ПЕРИОДЕ ПОСЛЕ ПЕРЕНЕСЕННОЙ КОРОНАВИРУСНОЙ ИНФЕКЦИИ: РЕЗУЛЬТАТЫ ДЛИТЕЛЬНОГО НАБЛЮДЕНИЯ. Архивъ внутренней медицины. 2022; 12(4): 302-309. DOI: 10.20514/2226-6704-2022-12-4-302-309. EDN: ANXLZG

Abstract

Background: assessment of type, prevalence and duration of residual symptoms after COVID-19 in recent studies is controversial because of differences in design. **Aim:** to assess the prevalence and severity of symptoms in the long-term period after COVID-19. **Materials and methods:** patients hospitalized with COVID-19 in the period 13.04.2020-10.06.2020 were interviewed by phone: 195 (58,2 %) convalescents at 143 (131-154) days after disease onset and 183 (54,6 %) of them at 340 (325-351) days. **Results:** The subjective assessment of health status with 100-point scale before and after the COVID-19 was 95 (80-100) and 80 (70-96) points, p <0,001, at first interview; 90 (80-100) and 80 (60-90) points, p <0,001, at second one. Various complaints were detected in 63 % of respondents at the first interview and in 75 % at the second, the number of identified symptoms was 2 (0-6) and 4 (1-8) respectively. The most frequent complaints were weakness/fatigue (31.3 and 47.5 % of respondents), joint pain (31.3 and 47.5 %) and dyspnoe/shortness of breath (31.3 and 43.2 %). The growth of these indicators can be associated with a change in the interview methodology. The severity of the symptoms at second interview was low: fatigue — 3 (0-6) points, shortness of breath — 0 (0-3) points; joint pain, weakness and dyspnoe — 0 (0-5) points each. **Conclusion:** a decrease of health status can sustain for a long time after COVID-19. Symptoms persist in a significant proportion of convalescents, but their severity in the end of follow-up is quite low.

Key words: *COVID-19, long covid, post-covid, severity of symptoms*

Conflict of interests

The authors declare no conflict of interests

Sources of funding

The authors declare no funding for this study

Article received on 07.09.2021

Accepted for publication on 14.04.2022

For citation: Melekhov A.V., Agaeva A.I., Nikitin I.G. Symptoms in the Long Period After the Coronavirus Infection: Results of Long-Term Follow-Up. The Russian Archives of Internal Medicine. 2022; 12(4): 302-309. DOI: 10.20514/2226-6704-2022-12-4-302-309. EDN: ANXLZG

ACTIV — Analysis of Chronic Non-infectious Diseases Dynamics After COVID-19 Infection in Adult Patients (Analysis of ComorbidiTies in survIVors), ACVE — acute cerebrovascular event, AV — artificial ventilation, BMI — body mass index, CHD — coronary heart disease, CHF — chronic heart failure, COPD — chronic obstructive pulmonary disease, COVID-19 — new coronavirus infection, ICU — intensive care unit, LMWH — low molecular weight heparin, PCR — polymerase chain reaction, RNA — ribonucleic acid, TRC — Treatment and Rehabilitation Center of the Ministry of Health of the Russian Federation, UFH — unfractionated heparin, p_{MW} — Mann-Whitney test, p_{X2} — χ^2 test, p_W — Wilcoxon test

Introduction

Analysis of the long-term consequences of COVID-19 is important for understanding the course of this disease, evaluation of individual and population-wide need for rehabilitation, predicting the impact of this disease on patients and public health.

Despite a growing number of published papers on residual post-COVID-19 symptoms, data about their types, incidence, duration, and predictors is heterogeneous due to methodological differences between studies. Foreign researchers described the prevalence and characteristics of the consequences of coronavirus infection during different follow-up periods, mainly up to six months: 2 weeks [1], 1–3 months [2–12], 3–6 months [13–18], 6–12 months [19–21]. Results of the largest study comparing the incidence of clinical and laboratory signs in 73,435 patients who recovered from COVID-19 with a cohort of those who had no such disease (n = 4,990,835) during 6 months of follow-up demonstrated high incidence of the signs of respiratory, nervous, articular disorders, as well as a wide variety of other signs of the post-COVID-19 syndrome. These signs caused a significant increase in the administration of drug products, including pain medications and antidepressants. The highest severity of the consequences was described in patients who were hospitalized in Intensive Care Units in the acute phase of COVID-19, however, the signs of post-COVID-19 syndrome are also observed in the patients who have recovered from mild coronavirus infection [22].

Russian researchers have developed the register named “Analysis of Chronic Non-infectious Diseases Dynamics After COVID-19 Infection in Adult Patients” (ACTIV) in order to study the condition of patients who have recovered from COVID-19 in the Eurasian region. It includes published data on the comorbidity over time and the detection rate of symptoms 3 and 6 months after discharge [23]. A number of differences were reported in the state of Russian patients who recovered from COVID-19 that were possibly related

to the demographic profile of the population, specific features of the organization of medical care, and media representation during the pandemic.

The objective of this study was to assess the incidence and severity of symptoms during the long-term period after new coronavirus infection.

Materials and methods

354 patients received treatment at the Federal State Autonomous Institution "Treatment and Rehabilitation Center" of the Ministry of Health of Russia (TRC) for suspected coronavirus infection or confirmed COVID-19 during the period from 13 APR 2020 to 10 JUN 2020. Data on age, sex, BMI, comorbidities, date of disease onset, results of laboratory tests and instrumental examinations, specific features and treatment duration were retrospectively obtained from medical records. The data on four patients with excluded COVID-19 based on the results of follow-up and on two patients who were hospitalized in the period of long-term effects after previous coronavirus infection were not used in further analysis. 14 patients died during hospital treatment, including one patient with excluded COVID-19.

Table 1. *Main characteristics of patients included in the study*

	Hospitalized due to COVID-19	1st interview	2nd interview
n	**348**	**195**	**183**
Interview timing, day after COVID-19 debut		143 (131-154)	340 (325-351)
Age, years	58,9 (49-70)	56,2 (44,9-64,7)*	56,2 (44,9-65,3)*
Number (%) of women	197 (57 %)	105 (53,8 %)	101 (55,2 %)
BMI, kg/m2	28,4 (24,9-32,1)	29,7 (26,0-32,8)*	29,7 (26,2-33,0)*
Day of illness at the time of hospitalization	8 (6-11)	9 (7-11)	9 (7-11)
Length of stay in hospital (bed days)	17 (14-20)	16 (13,5-19)	16 (13-19)
Number (%) of patients with a positive PCR test	246 (71 %)	138 (71,1 %)	127 (69,8 %)
Hypertonic disease	149 (42,8 %)	86 (44,1 %)	82 (44,8 %)
Diabetes	44 (12,6 %)	29 (14,9 %)	28 (15,3 %)
IHD	27 (7,8 %)	14 (7,2 %)	14 (7,7 %)
Atrial fibrillation	18 (5,2 %)	10 (5,1 %)	8 (4,4 %)
Chronic heart failure	7 (2,0 %)	3 (1,5 %)	3 (1,6 %)
cognitive decline	16 (4,6 %)	11 (5,6 %)	11 (6,0 %)
Postponed stroke	12 (3,5 %)	5 (2,6 %)	5 (2,7 %)
Hypothyroidism (medicated compensated)	22 (6,3 %)	9 (4,6 %)	9 (4,9 %)
COPD or bronchial asthma	12 (3,5 %)	7 (3,6 %)	7 (3,8 %)
Active cancer	45 (12,9 %)	20 (10,3 %)	19 (10,4 %)
Cancer in the past	9 (2,6 %)	5 (2,6 %)	5 (2,7 %)
Number (%) of patients treated in the ICU	59 (17,0 %)	29 (14,9 %)	27 (14,8 %)
Number (%) of patients receiving oxygen therapy	26 (7,5)	14 (7,2 %)	14 (7,7 %)
Number (%) of patients receiving high-flow oxygen therapy	9 (2,6 %)	5 (2,6 %)	4 (2,2 %)
Number (%) of patients receiving ALV	24 (6,7 %)	10 (5,1 %)	9 (4,9 %)
Hydroxychloroquine	260 (80 %)	144 (77,8 %)	134 (76,6 %)
Azithromycin	233 (71 %)	130 (70,3 %)	121 (69,1 %)
Antibiotics other than azithromycin	231 (80 %)	134 (83,2 %)	125 (82,8 %)
Antibiotics, including azithromycin	295 (95 %)	178 (96,2 %)	169 (96,6 %)
UFH or LMWH	267 (82 %)	149 (81,4 %)	140 (80,9 %)
Lopinavir/ritonavir	10 (3,1 %)	5 (2,7 %)	5 (2,9 %)
Glucocorticosteroids	38 (12 %)	23 (12,8 %)	21 (12,4 %)
Tocilizumab	21 (6 %)	13 (7,0 %)	10 (5,6 %)
Sarilumab	7 (2 %)	3 (1,6 %)	3 (1,7 %)
Baricitinib	13 (4 %)	10 (5,3 %)	9 (5,1 %)

Note: IHD — ischemic heart disease, ALV- artificial lung ventilation, BMI — body mass index, UFH — unfractionated heparin, LMWH — low molecular weight heparin, ICU — intensive care unit, PCR — polymerase chain reaction, COPD — chronic obstructive pulmonary disease

As a pilot study, we conducted a telephone survey of 195 (58.2 %) discharged patients 143 (131–154) days after disease onset. In addition to those who died in hospital, patients with known mental disease or dementia, patients who lived in nursing homes, and patients who refused telephone interview were also excluded.

Patients were asked to respond (yes/no) to a question about whether they had the following symptoms: dyspnea, feeling short of breath, feeling of not getting enough air, cough, sputum production, weakness, fatigue, chest pain, lack of smell, lack of taste or abnormal taste, loss of appetite, joint pain, muscle pain, nasal congestion, nasal discharge, headache, dizziness, diarrhea, eye redness, dry eyes, fever, anxiety, low mood, hair loss. For further analysis, the number of symptoms present was used.

We also asked patients to evaluate their general state of health before and after the coronavirus infection using a 100-point scale.

340 (325–351) days after the disease onset, we re-interviewed 183 (54.6 %) discharged patients (93.9 % of those interviewed at the first stage). At the second stage of this study, we detalized the answers to the questions by asking patients to assess the severity of each symptom using a 10-point scale. To compare the data obtained with the results of the previous survey, an answer was considered positive if the patient assessed symptom severity as ≥1 point. For the analysis, we used the number of symptoms present and the sum of points, as well as a 100-point assessment of general state of health before and after COVID-19.

The results obtained were processed using Excel and Jamovi software. Median and interquartile range were used to describe continuous variables. In case of incomplete data, the exact number of patients with a known value of parameter (n) is specified. Independent quantitative variables were compared using Mann-Whitney test (p_{MW}), qualitative variables — using $\chi 2$ test (p_{X2}), dependent variables — using Wilcoxon test (p_W).

Results

Basic characteristics of enrolled patients are presented in Table 1. Diagnosis of COVID-19 was confirmed by at least one positive nasopharyngeal PCR for SARS-CoV-2 RNA during the period of disease in 71 % of hospitalized patients. The presence of CHD was determined by convincing signs of past myocardial infarction, revascularization, high pretest probability, or verified coronary atherosclerosis; CHF was detected by decreased left ventricular ejection fraction of less than 40 %, or by laboratory tests that confirmed the diagnosis before coronavirus infection. High frequency of oncological comorbidity was due to the fact that 39 patients were transferred to LRC from another medical institution where they received chemotherapy and/or radiation therapy for malignant neoplasms.

There were no significant differences in the age of male and female patients during three stages of the study. The respondents were younger compared with the rest of hospitalized patients and also had high BMI; otherwise, the interviewed sample was representative in regard to the inception cohort of hospitalized patients.

Figure 1 presents the results of patients' subjective evaluation of their health state using a 100-point scale before and after COVID-19 during the first and second surveys. There was a statistically significant decrease in scores after the disease that worsened by the time of the second survey. At the same time, assessments of the baseline state of health at different stages of the survey did not differ significantly.

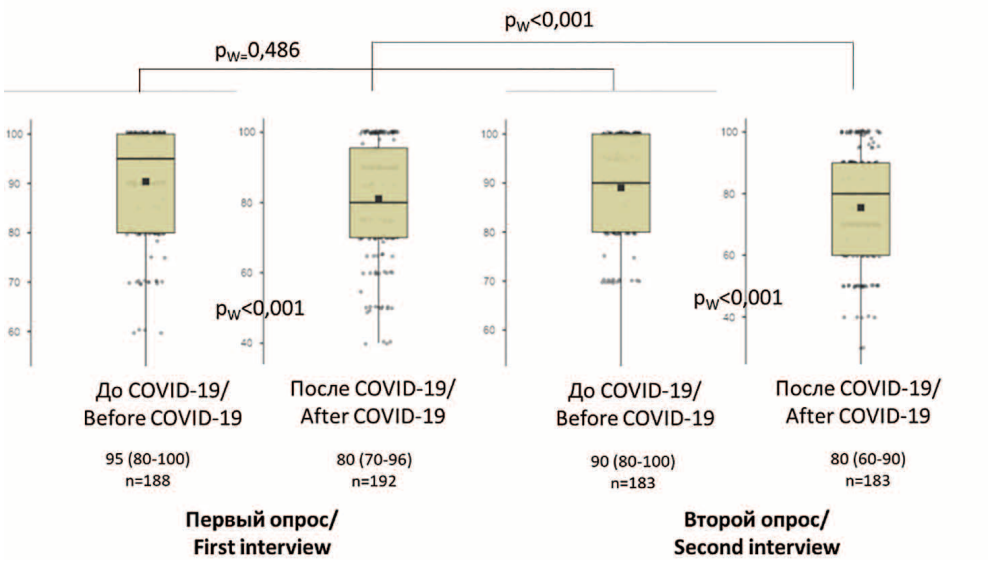

Figure 1. *The subjective assessment of health status with 100-point scale before and after the COVID-19 at first and second interview*

Note: pW- Wilcoxon method, Covid-19 — new coronavirus infection

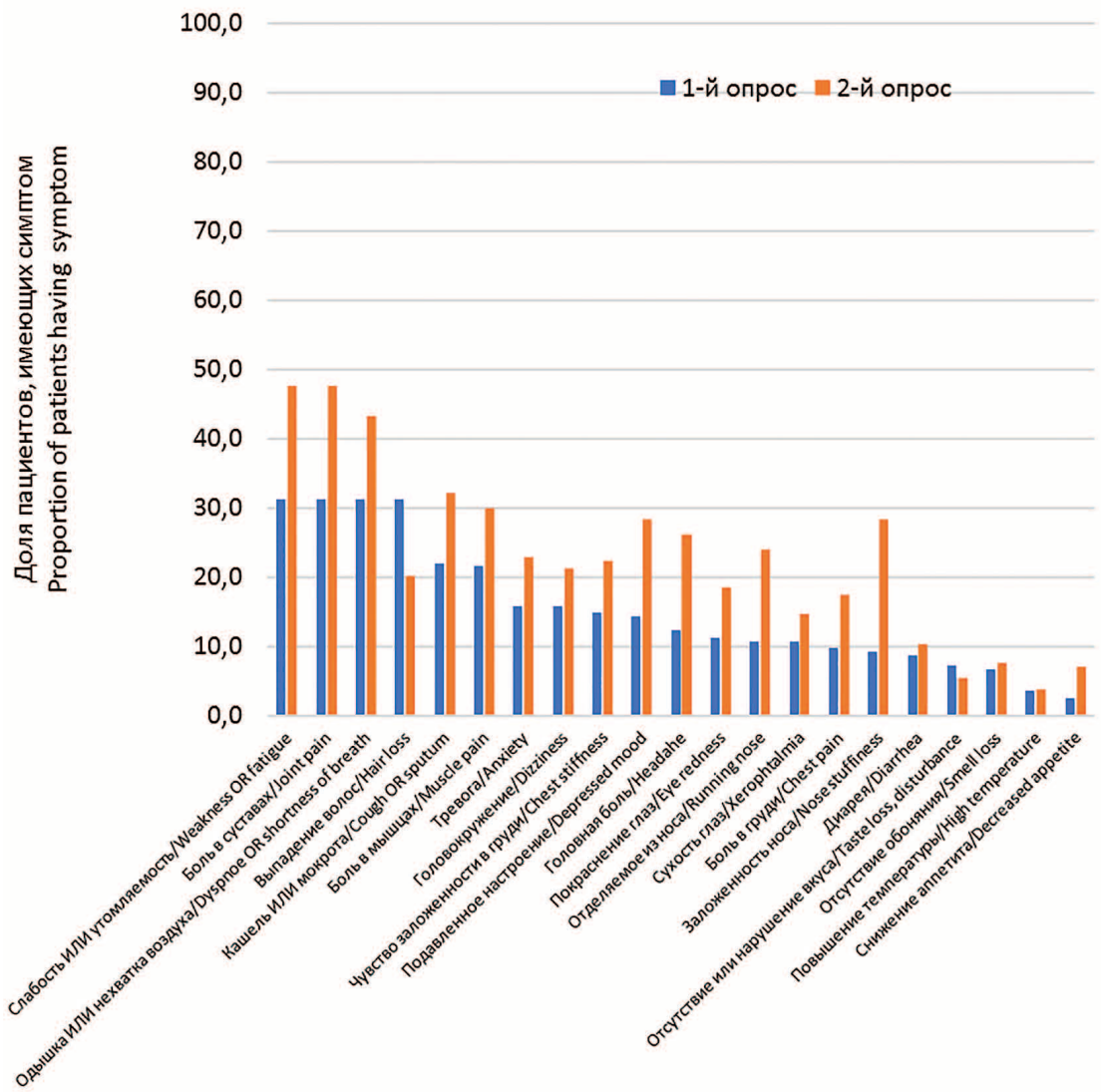

Figure 2. *Prevalence of symptoms at first and second interview*

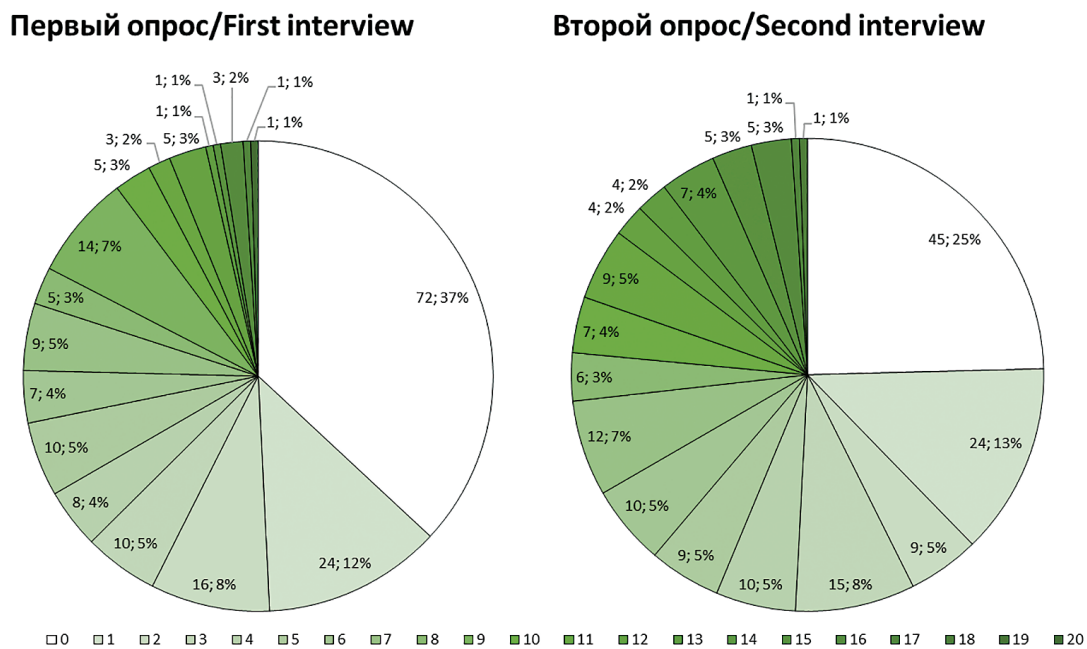

Figure 3. *Number and proportion of interviewed patients with different number of symptoms at first and second interview*

Figure 4. *The average severity of symptoms identified in the second interview (on a 10-point scale). The numbers indicate the median and interquartile range of symptom severity*

Detection rate of symptoms during two stages of the study is presented in Figure 2. Detection rate values for dyspnea/feeling of not getting enough air, weakness/fatigue, and cough/sputum production were combined for visual convenience because the symptoms are interchangeable to a high degree.

The most common complaints were weakness/fatigue (31.3 and 47.5 % of participants in two surveys, respectively), joint pain (31.3 and 47.5 %), and dyspnea/feeling of not getting enough air (31.3 and 43.2 %).

Figure 3 presents the number of patients with different number of complaints. As one can see, 37 % of patients at the first stage of the survey had no symptoms, as well as 25 % at the second stage. The number of symptoms identified in the respondents was 2 (0–6) at the first stage and 4 (1–8) at the second one.

A marked increase in the detection rate of almost all symptoms during the second survey can be explained by a change in the survey method from binary design to a more sensitive ten-point scale. In this regard, no analysis of the statistical significance of differences in the incidence of symptoms at the two stages of the study was performed.

As one can see from Figure 4, the severity of the most common symptoms (fatigue/weakness, dyspnea/feeling of not getting enough air, pain in joints and muscles) assessed by patients using a 10-point scale during the second survey, was quite low.

Discussion

A statistically significant and clinically noticeable decrease in the subjective assessment of one's health using a 100-point scale was revealed that persisted for a year after the recovery from COVID-19. The results of this assessment technique on a similar sample were quite similar: The patients who received treatment for confirmed coronavirus infection on an outpatient basis and in hospital (age 48 (37–57), 44 % female patients) assessed their health at baseline as 85 (75–90) points; at week 16 of follow-up (n = 117) — as 80 (70–90) points; at week 32 (n = 66) — as 80 (75–90) points [24].

63 % of respondents had various complaints 143 (131–154) days after the disease onset, and 75 % — 340 (325–351) days after the disease onset. The most frequent complaints were weakness/fatigue (31.3 and 47.5 %), joint pain (31.3 and 47.5 %) and dyspnea/feeling of not getting enough air (31.3 and 43.2 % of respondents); these results may indicate persistent respiratory failure and asthenia.

When comparing our results with the data of foreign observational studies and the ACTIV register [1–23], one can observe a fairly large range of the incidence of the main detected symptoms (Figure 5). This is due to significant differences in the design of these studies (number, age of patients, part of female patients, part of patients with confirmed diagnosis, part of patients

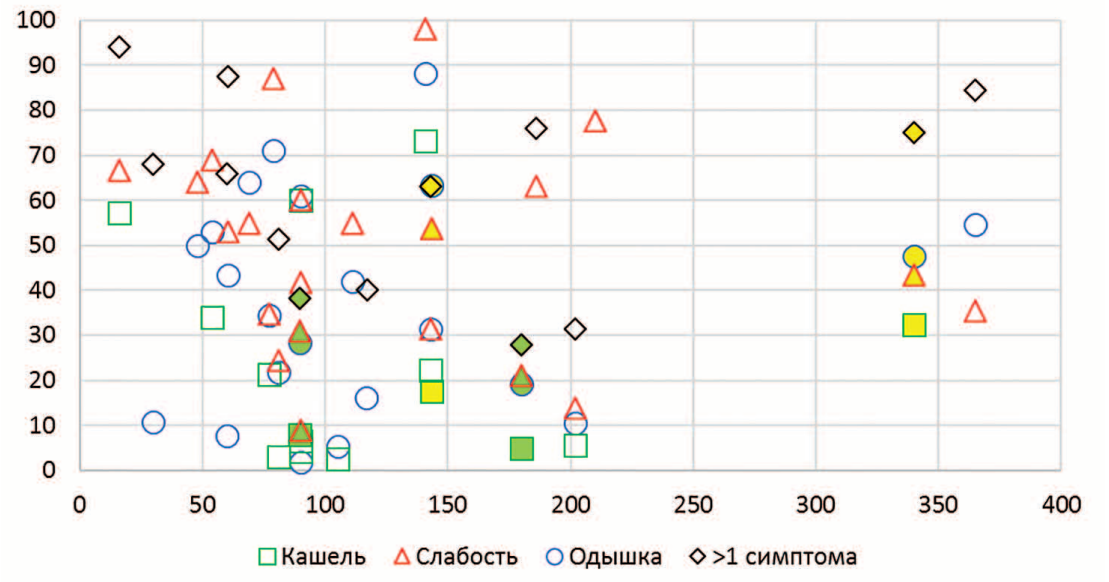

Figure 5. *Frequency of detection and duration of post-COVID symptoms. Comparison of own data (yellow markers) with the results of foreign studies and data from the AKTIV register (green markers) [1-23]*

who required hospitalization in the acute phase of COVID-19, methods for symptom detection, comorbidity of participants). However, it is clear that significant part of patients can demonstrate different of symptoms that worsen state of health for at least 12 months after coronavirus infection.

Enrolled patients received treatment during the acute phase of COVID-19 in one health care facility, and this fact may limit extrapolation of results.

Our study has several limitations associated with the telephone survey design that is characterized by the subjectivity of the self-assessment of symptom severity by patients, and possible variations in the interpretation of the names of these symptoms. In particular, the younger the respondents were, the easier was communication. However, the sample of respondents was representative of all hospitalized patients by sex, the frequency of confirmed coronavirus etiology of the disease, comorbidities and use of various groups of drugs, duration of hospitalization and stay in ICU.

An increase in the detection rate of almost all symptoms during the second survey can be explained by a change in the survey method from binary design to a more sensitive ten-point scale. Low severity of the symptoms identified during the second survey indicates a critical attitude to their clinical significance.

One can not state that the symptoms identified during the interviews are a direct consequence of a past coronavirus infection and are not associated with present comorbidities, since no comparisons were made with a sample of patients comparable in terms of sex, age and comorbidity and who had no COVID-19. In addition, it is not known whether the interviewed patients had any complaints of any severity prior to COVID-19. We were able to partially overcome this limitation in our research due to a retrospective self-assessment of the state of health of patients before coronavirus infection using a 100-point scale. These limitations can be eliminated only within a large prospective comparative study with the participation of patients comparable in terms of sex, age and comorbidity and who had no COVID-19. Under the current circumstances, no such study can be expected.

Spread of new strains, as well as mild course of the disease in vaccinated people can significantly affect the incidence, severity, and characteristics of post-COVID symptoms [25].

Conclusion

Decreased self-assessment of the state of health due to different symptoms persists for a long time after past coronavirus infection in a significant part of patients, however, the severity of the most common symptoms was quite low by month 12 of follow-up. The data obtained on the nature, prevalence, and duration of post-COVID-19 symptoms generally correspond to the results of previous studies.

Вклад авторов:

Все авторы внесли существенный вклад в подготовку работы, прочли и одобрили финальную версию статьи перед публикацией

Мелехов А.В. (ORCID: https://orcid.org/0000-0002-1637-2402): концепция и дизайн исследования, сбор и обработка материала, статистическая обработка данных, написание текста

Агаева А.И. (ORCID: https://orcid.org/0000-0001-7559-135X): сбор и обработка материала, статистическая обработка данных, написание текста

Никитин И.Г. (ORCID: https://orcid.org/0000-0003-1699-0881): концепция и дизайн исследования, написание текста

Author Contribution:

All the authors contributed significantly to the study and the article, read and approved the final version of the article before publication

Melekhov A.V. (ORCID: https://orcid.org/0000-0002-1637-2402): concept and design development, collection and data processing, statistical data processing, writing text

Agaeva A.I. (ORCID: https://orcid.org/0000-0001-7559-135X): collection and data processing, statistical data processing, writing text

Nikitin I.G. (ORCID: https://orcid.org/0000-0003-1699-0881): concept and design development, writing text

Список литературы / References:

1. Tenforde MW, Kim SS, Lindsell CJ, et al. Symptom Duration and Risk Factors for Delayed Return to Usual Health Among Outpatients with COVID-19 in a Multistate Health Care Systems Network — United States, March-June 2020. MMWR Morb Mortal Wkly Rep. 2020; 69(30): 993-998. Published 2020 Jul 31. doi:10.15585/mmwr.mm6930e1
2. Halpin SJ, McIvor C, Whyatt G et al. Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: A cross-sectional evaluation. J Med Virol. 2021 Feb; 93(2): 1013-1022. doi: 10.1002/jmv.26368.
3. Mandal S, Barnett J, Brill SE, et al. 'Long-COVID': a cross-sectional study of persisting symptoms, biomarker and imaging abnormalities following hospitalisation for COVID-19. Thorax. 2021 Apr;76(4):396-398. doi: 10.1136/thoraxjnl-2020-215818.
4. Carvalho-Schneider C, Laurent E, Lemaignen A, et al. Follow-up of adults with noncritical COVID-19 two months after symptom onset. Clin Microbiol Infect. 2021 Feb;27(2):258-263. doi: 10.1016/j.cmi.2020.09.052.
5. Carfì A, Bernabei R, Landi F. Persistent Symptoms in Patients After Acute COVID-19. JAMA. 2020;324(6):603–605. doi:10.1001/jama.2020.12603
6. Raman B, Cassar MP, Tunnicliffe EM, et al. Medium-term effects of SARS-CoV-2 infection on multiple vital organs, exercise capacity, cognition, quality of life and mental health, post-hospital discharge. EClinicalMedicine. 2021 Jan 7;31:100683. doi: 10.1016/j.eclinm.2020.100683.
7. Moreno-Pérez O, Merino E, Leon-Ramirez JM, et al. Post-acute COVID-19 syndrome. Incidence and risk factors: A Mediterranean cohort study. J Infect. 2021 Mar;82(3):378-383. doi: 10.1016/j.jinf.2021.01.004.
8. Goërtz YMJ, Van Herck M, Delbressine JM, et al. Persistent symptoms 3 months after a SARS-CoV-2 infection: the post-COVID-19 syndrome? ERJ Open Res. 2020 Oct 26;6(4):00542-2020. doi: 10.1183/23120541.00542-2020.
9. Venturelli S, Benatti SV, Casati M, et al. Surviving COVID-19 in Bergamo province: a post-acute outpatient re-evaluation. Epidemiol Infect. 2021 Jan 19;149:e32. doi: 10.1017/S0950268821000145.
10. Sathyamurthy P, Madhavan S, Pandurangan V. Prevalence, Pattern and Functional Outcome of Post COVID-19 Syndrome in Older Adults. Cureus. 2021 Aug 15;13(8):e17189. doi: 10.7759/cureus.17189
11. Liang L, Yang B, Jiang N, et al. Three-month Follow-up Study of Survivors of Coronavirus Disease 2019 after Discharge. J Korean Med Sci. 2020 Dec 7;35(47):e418. doi: 10.3346/jkms.2020.35.e418.
12. Kashif A, Chaudhry M, Fayyaz T, et al. Follow-up of COVID-19 recovered patients with mild disease. Sci Rep. 2021 Jun 28;11(1):13414. doi: 10.1038/s41598-021-92717-8.
13. Bellan M, Soddu D, Balbo PE, et al. Psychophysical Sequelae Among Patients With COVID-19 Four Months After Hospital Discharge. JAMA Netw Open. 2021 Jan 4;4(1):e2036142. doi: 10.1001/jamanetworkopen.2020.36142.
14. Garrigues E, Janvier P, Kherabi Y, et al. Post-discharge persistent symptoms and health-related quality of life after hospitalization for COVID-19. J Infect. 2020;81(6):e4-e6. doi:10.1016/j.jinf.2020.08.029
15. Stavem K, Ghanima W, Olsen MK, et al. Persistent symptoms 1.5-6 months after COVID-19 in non-hospitalised subjects: a population-based cohort study. Thorax. 2021 Apr;76(4):405-407. doi: 10.1136/thoraxjnl-2020-216377.
16. Dennis A, Wamil M, Alberts J, et al. COVERSCAN study investigators. Multiorgan impairment in low-risk individuals with post-COVID-19 syndrome: a prospective, community-based study. BMJ Open. 2021 Mar 30;11(3):e048391. doi: 10.1136/bmjopen-2020-048391.
17. Gautam N, Madathil S, Tahani N, et al. Medium-term outcome of severe to critically ill patients with SARS-CoV-2 infection. Clin Infect Dis. 2021 Apr 24:ciab341. doi: 10.1093/cid/ciab341.
18. Huang C, Huang L, Wang Y, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. Lancet. 2021 Jan 16;397(10270):220-232. doi: 10.1016/S0140-6736(20)32656-8.
19. Yomogida, K., Zhu, S., Rubino, F., et al. Post-Acute Sequelae of SARS-CoV-2 Infection Among Adults Aged ≥18 Years — Long Beach, California, April 1-December 10, 2020. MMWR. Morbidity and mortality weekly report, 70(37), 1274–1277. https://doi.org/10.15585/mmwr.mm7037a2
20. Davis HE, Assaf GS, McCorkell L, et al. Characterizing long COVID in an international cohort: 7 months of symptoms and their impact. EClinicalMedicine. 2021 Aug;38:101019. doi: 10.1016/j.eclinm.2021.101019.
21. Maestre-Muñiz MM, Arias Á, Mata-Vázquez E, et al. Long-Term Outcomes of Patients with Coronavirus Disease 2019 at One Year after Hospital Discharge. J Clin Med. 2021;10(13):2945. doi:10.3390/jcm10132945
22. Al-Aly Z, Xie Y, Bowe B. High-dimensional characterization of post-acute sequelae of COVID-19. Nature. 2021 Jun;594(7862):259-264. doi: 10.1038/s41586-021-03553-9.
23. Арутюнов Г.П., Тарловская Е.И., Арутюнов А.Г. и др. Клинические особенности постковидного периода. Результаты международного регистра «Анализ динамики коморбидных заболеваний у пациентов, перенесших инфицирование SARS-CoV-2 (АКТИВ SARSCoV-2)». Предварительные данные (6 месяцев наблюдения). Российский кардиологический журнал. 2021; 26(10):4 708. doi:10.15829/1560-4071-2021-4708.
24. Peluso MJ, Kelly JD, Lu S, et al. Rapid implementation of a cohort for the study of post-acute sequelae of SARS-CoV-2 infection/COVID-19. medRxiv [Preprint]. 2021 Mar 12:2021.03.11.21252311. doi: 10.1101/2021.03.11.21252311.
25. Bergwerk M, Gonen T, Lustig Y, et al. Covid-19 Breakthrough Infections in Vaccinated Health Care Workers. N Engl J Med. 2021 Oct 14;385(16):1474-1484. doi: 10.1056/NEJMoa2109072.