ISSN 2079-0570, Advances in Gerontology, 2022, Vol. 12, No. 4, pp. 357–369. © Pleiades Publishing, Ltd., 2022.
Russian Text © The Author(s), 2022, published in Uspekhi Gerontologii, 2022, Vol. 35, No. 2, pp. 191–205.

On the Role of Geriatric Services in the Diagnosis and Monitoring of Outcomes of Post-Covid Syndrome (Review)

E. S. Lapteva[a], A. L. Ariev[a, *], G. T. Arieva[a], M. R. Tsutsunawa[a], and D. C. Diachkova-Gerceva[a]

[a] *Mechnikov North-Western State Medical University, St. Petersburg, 193015 Russia*

**e-mail: alex.l.ariev@gmail.com*

Received December 29, 2021; revised March 4, 2022; accepted March 7, 2022

Abstract—In addition to the rapid spread of the pandemic in waves across the globe today, there is a growing problem called "long-COVID-19," a term that describes the long-term effects of the novel coronavirus infection COVID-19. How the disease proceeds after "recovery," including long-term physical and psychological health consequences, and the future of COVID-19 survivors remains largely unclear. This is especially true for older age groups. This article summarizes the experience of foreign studies aimed at determining the duration and clarifying the nature of multi-organ complications after suffering from COVID-19, as well as ways of the long-term rehabilitation of patients in older age groups with post-COVID syndrome.

Keywords: long-COVID-19, post-COVID syndrome, elderly and senile age, geriatrics, geriatric service, rehabilitation

DOI: 10.1134/S2079057022040105

INTRODUCTION

Despite the fact that much has now become known about the clinical picture and management of patients with acute COVID-19, the problem of the long-term consequences of this disease (timing of onset, clinical manifestations, risk factors, tactics of management and rehabilitation) remains unresolved. And although today the long-term symptoms and manifestations of other coronavirus infections are already known, including such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) [58], knowledge about the consequences of SARS-CoV-2 remains incomplete and requires immediate resolution [27].

The largest number of scientific publications is devoted either to the acute period of the disease or to statistical data on patients who died or "recovered" from SARS-CoV-2 infection, and there are very few publications that focus on the long-term symptoms after suffering from COVID-19. According to M. Mendelson et al., "it must be remembered that the term "recovered" from COVID-19 can be erroneous and mislead the public, politicians and clinicians" [37].

HOW DOES THE DISEASE PROCEED AFTER "RECOVERY"?

Most research on long-term COVID has been carried out for small cohorts with a short follow-up period. In one of the few publications published in the most authoritative journal *Lancet*, L. Huang et al. [30] report the largest 12-month longitudinal cohort study to date involving adult post-COVID-19 patients (mean age of 59 years) discharged from Jin Yin-tang Hospital in Wuhan, China. The study confirms that COVID-19 survivors still had great mobility problems one year later, complained of pain or discomfort, and also felt anxiety or depression, in contrast to the control group (comparable adults living in communities without SARS-CoV-2 infection). Fatigue or muscle weakness was the most common symptom at both 6 and 12 months. Almost half of the patients reported that they had at least one symptom after 12 months. The most common complaints were sleeping difficulty, either heart palpitations, or joint pain or chest pain. The study showed that for many patients, full recovery from COVID-19 can extend to more than 1 year. This work raises important questions for both medical services and future research [29].

The second important aspect that was announced in the editorial of the journal is the vocational rehabilitation programs for patients with long-term COVID. Only 0.4% of patients with long-term COVID-19 reportedly stated that they had participated in a vocational rehabilitation program. The reason for this low utilization of rehabilitation services is not clear. One reason may be a lack of understanding or recognition of the "long COVID" syndrome and clear management of these patients. And this is a real and widespread problem all over the world. Second, the impact of long-term COVID on mental health requires further study and long-term research [65].

The symptoms of "prolonged covid" include fatigue, cough, shortness of breath, loss of taste and smell, muscle weakness, muscle and joint pain, headache, confusion, conjunctivitis, chest pain, decreased mobility, and falls [36, 45].

Patients after a severe form of COVID-19 who have been hospitalized, as well as those observed on an outpatient basis with mild clinical forms of the disease, often report fatigue, shortness of breath, pain of various intensity and localization, cough, and other respiratory and extrapulmonary symptoms that persist for weeks and months. After discharge, less than 13% of patients feel healthy, while the majority continue to experience up to three or more symptoms of the disease, which usually do not include only fever [1]. In an Italian study assessing the persistence of COVID-19 symptoms in 143 patients discharged from hospital, only 18 (12.6%) were completely free of any symptoms associated with COVID-19 on average 60 days after the onset of the first symptoms [10]. The number of people ≥50 years old with long-term health problems increased to 47%. In addition, regardless of age, it has been found that the greater the number of pre-existing chronic conditions, the more likely it is that the resolution of symptoms will be delayed [60].

How long the disease lasts after "recovery," including long-term physical and psychological health consequences, as well as the future of survivors of COVID-19, remains largely unclear [53].

TERMINOLOGY OF THE POST-COVID-19 PATHOLOGICAL CONDITION

The 2019 coronavirus disease (COVID-19) pandemic has led to an increase in the population of people with a wide range of persistent symptoms after acute SARS-CoV-2 infection [59]. Because this coronavirus is a new virus, there is very little information available about the long-term effects of the disease it causes. There is not even a real consensus on what to call the long-term condition associated with COVID-19.

Several terms have been used to describe persistent symptoms after COVID-19 illness, such as "post-COVID conditions," "long-COVID," "post-acute consequences of SARS-CoV-2 (PASC) infection," "post-acute COVID-19," "chronic COVID-19" and "post-COVID syndrome."

The term "long COVID" has been introduced by patients and has taken hold in traditional media and social media. Elisa Perego from Lombardy was the first to use the term LongCovid on Twitter to describe her long-term illness, summarizing her own symptoms. In June, the term moved from social media to print describing how Dr. Jake Suett joined a patient support group [8].

The National Institute for Health and Care Excellence (NICE) in agreement with the Scottish Intercollegiate Guidelines Network and The Royal College of General Practitioners in their recommendations from 30 October 2020 first described the following forms of COVID-19:

(1) acute COVID-19—complaints and symptoms of COVID-19 lasting up to 4 weeks;

(2) ongoing symptomatic COVID-19—complaints and symptoms of COVID-19 lasting 4–12 weeks;

(3) post-COVID-19 syndrome—complaints and symptoms that develop during or after COVID-19, last >12 weeks and are not the result of another diagnosis [13].

T. Greenhalgh et al. proposed the following division [22]:

(1) extended COVID-19—for cases where symptoms persist >3–4 weeks from the moment of infection manifestation;

(2) chronic COVID-19—if symptoms persist >12 weeks after the onset of the first symptoms.

At the end of February 2021, to separate the concepts of "long-term COVID-19" and "post-covid syndrome," E. Fauci (United States) proposed the use of a new acronym instead of "long COVID-19"—PASC (post-acute sequelae of SARS-CoV-2 infection/COVID-19) [17].

While the WHO reports that 80% of COVID cases are "mild or asymptomatic" and most patients recover in 1–2 weeks, thousands of people now say they manage severe symptoms in 1–3 months or longer. In online support groups, these people call themselves "long-haulers." There is still no verbatim analogue of this word in Russian-language scientific publications. However, the term "long-haulers" refers to a patient with long-term symptoms of coronavirus infection, or a patient with a long course of the disease, or patients with a long recovery from COVID-19. The term "long-haulers" has now migrated to scientific medical publications. Post-COVID syndrome, or long-covid, has already been included in the ICD-10 with the wording "Post COVID-19 condition," and scientists from around the world are still collecting data on its manifestations and duration. At the initiative of Russian therapists, a separate code appeared in the ICD-10 to describe the post-COVID syndrome—U09.9 post COVID-19 condition.

The WHO indicates that recovery from a mild course of COVID-19 takes about 2 weeks, while a severe one can be prolonged up to 3–6 weeks. However, since COVID-19 is a new, little-studied infectious disease, it is not possible to reliably speak about the long-term consequences of the disease, i.e., more than 6 months or more. It is also not clear whether the persisting pattern of symptoms after an illness represents a new syndrome unique to COVID-19, or whether there is an overlap with recovery from similar illnesses.

Table 1. Variants of concern or under investigation (data up to November 24, 2021)

Strain (WHO name)	Other names by which this strain may be known (first sighting)	PANGO classification	Total number of confirmed (sequencing) and probable (genotyping) cases, thousand people
Alpha	VOC-20DEC-01	B.1.1.7	277585
Beta	VOC-20DEC-02	B.1.351	1106
Gamma	VOC-21JAN-02	P.1	291
Delta	VOC-21APR-02	B.1.617.2 AY.1 AY.2	1370519
VUI-21OCT-01	VUI-21OCT-01	A.Y 4.2	53630
Zeta	VUI-21JAN-01	P.2	57
Eta	VUI-21FEB-03	B.1.525 (previously designated UK1188)	514
VUI-21FEB-04	VUI-21FEB-04	B.1.1.318	367
Theta	VUI-21MAR-02	P.3	10
Kappa	VUI-21APR-01	B.1.617.1	520
VUI-21APR-03	VUI-21APR-03	B.1.617.3	18
VUI-21MAY-01	VUI-21MAY-01	AV.1	185
VUI-21MAY-02	VUI-21MAY-02	C.36.3	158
Lambda	VUI-21JUN-01	C.37	8
Mu	VUI-21JUL-01	B.1.621	57
Omicron	VUI-21NOV-01	B.1.1.529	>100

The PANGO (Phylogenetic assignment of Named Global OLINeages) classification, a dynamic nomenclature, is a system for identifying SARS-CoV-2 genetic lines of epidemiological significance [63].

LONG-TERM CONSEQUENCES FOR DIFFERENT VARIANTS OF COVID-19

The long-term consequences for different strains of COVID-19 are still unknown [12]. Since the beginning of the pandemic, several variants of COVID-19 have emerged that are more transmissible and can lead to more severe acute illness. In the UK, one of the first strains of concern to emerge was the so-called "Kent variant" from lineage B.1.1.7, now called the Alpha variant. This variant is approximately 50% more transmissible [14] and likely increases the severity of acute disease [62]. As of June 30, 2021, the Alpha variant had been confirmed in over 275000 cases in the UK and had spread to at least 136 countries worldwide [64].

In the UK, in addition to the Alpha strain, studies are underway on other identified strains of COVID-19 [65]. The US Centers for Disease Control and Prevention (CDC) and the UK government website [28] report the emergence of strains of scientific interest in both the US and the UK (Table 1).

New strains of COVID-19 such as the Eta and Delta variants will continue to emerge and spread as the pandemic evolves, with over 161000 cases of the rapidly spreading Delta strain confirmed in the UK as of June 30, 2021. Lambda and Omicron have recently emerged which will require close monitoring. The ability of these viral strains to cause long-term complications needs to be fully explored. It can be assumed that one variant causes more devastating long-term consequences than the others, and therefore patients infected with that variant who subsequently develop long-term COVID symptoms may need additional support, as well as faster and more intensive treatment strategies to combat long-term symptoms.

According to H. Crook et al. [12], at present, the understanding of what "long-term COVID" is remains a mystery, and since the question of the impact of new variants of COVID-19 on the frequency and severity of long-term COVID is still open, it is important that research continues. It is necessary to understand what the syndrome is after suffering COVID-19. A deeper understanding of the pathogenesis, risk factors, symptoms, and treatments for long-term COVID is primarily required to reduce the burden on the healthcare system [12].

LONG-TERM CONSEQUENCES: ARE THERE ANY CORRELATIONS OF COVID-19 WITH PREVIOUS CORONAVIRUSES?

Some authors, in search of answers to questions about the possible long-term effects of COVID, have turned to previous similar coronaviruses (i.e., SARS-CoV-1 and Middle-East Respiratory Syndrome Coronavirus [MERS-CoV]), in combination with the known health effects of SARS-CoV-2 infection on the

prediction of potential long-term consequences of COVID-19, including pulmonary, cardiovascular, hematopoietic, renal, central nervous system (CNS), gastrointestinal, and psychosocial manifestations, in addition to well-known post-intensive care syndrome [27, 57].

Also well known is the concept of a viral disease that leads to the development of a post-viral syndrome, usually accompanied by chronic fatigue [26]. Thus, in a study in which patients were observed after one of three viral diseases [Epstein-Barr virus, Burnet's coxiella (the causative agent of Q fever), or Ross River fever virus], 12% were found to have a specific syndrome for 6 months or more. Acute relapses of the disease were observed in the first 3 months, and chronic fluctuating symptoms included fatigue, cognitive impairment, dysphoria, anxiety, and muscle pain. This syndrome has also been called myalgic encephalomyelitis [61].

In analyzing the epidemiological data of the SARS pandemic 2002–2004, myalgia, muscle dysfunction, osteoporosis and osteonecrosis were identified as frequent consequences in patients with moderate and severe forms of this disease. Early studies have shown that some patients with COVID-19 also have significant musculoskeletal dysfunction, although long-term follow-up studies have not yet been conducted [15].

In this respect, the question remains: do the lessons of SARS apply to COVID-19? Other concerns arise: does acute COVID-19 cause diabetes [27]? Or other metabolic disorders? Will patients develop interstitial lung disease? The careful recording of symptoms and examination of the patient should allow an understanding as to how much of the consequences are common to all severe infections, which symptoms can be explained by anxiety caused by the new disease and isolation, and which symptoms are secondary to the complicated disease. If COVID-19 does cause long-term effects, then are the mechanisms underlying long-term effects immune mechanisms? Or are they caused by new or recurrent inflammation, ongoing infection, or side effects of immunomodulatory treatments? Such data may indicate candidate management strategies that will be tested during trials [66].

In general, survivors of viral pneumonia are at risk of psychological and physical complications of the disease itself, as well as treatment-related damage to the lungs and other organs. Although most survivors can return to work and normal life, a significant number of them will be found to have impaired breathing and diffusion of gases in the blood [53]. After recovery, patients remain at risk for lung disease, heart disease, weakness, and mental disorders. There may also be long-term effects of adverse events that develop during COVID-19 and its treatment [32].

SYMPTOMS OF POST-COVID SYNDROME

COVID-19 can affect virtually any organ in the body as it enters cells through angiotensin-converting enzyme (ACE) 2 receptors [5]. The possible lesions of various organs and systems of the body and associated complaints of patients are shown in Fig. 1.

It was shown in a retrospective cohort study by M. Taquet et al. [58] that the incidence of "any" signs or symptoms of long-term COVID varied from 46.42% in the age group 10–21 years to 61.05% over the age of 65 years, with 63.64% of patients initially hospitalized, and 73.22% of those hospitalized were placed in the intensive-care unit. In the post-COVID period, women were significantly more likely to suffer from headache, abdominal symptoms, and anxiety/depression, while men were significantly more likely to experience breathing difficulties and cognitive symptoms. A list of the main symptoms and their increasing relationships 1–180 days after the diagnosis of COVID-19 is presented in Fig. 2 [58].

According to C. Huang et al., the most common symptoms after acute COVID-19 are fatigue and shortness of breath. The work of these authors showed that 6 months after acute infection, COVID-19 survivors mostly suffered from fatigue or muscle weakness, as well as sleep problems, anxiety, or depression. Patients who were severely ill during their hospital stay had more severe impairments in lung diffusion capacity and abnormal chest-imaging findings. These patients are the main target population for long-term recovery [29]. Other common symptoms include joint pain and chest pain [10]. In addition to these general symptoms, dysfunction of specific organs has been reported, primarily the heart, lungs, kidneys, and brain [48].

CARDIOVASCULAR SYSTEM

Myocardial injury, defined by elevated troponin levels, has been described in patients with severe acute COVID-19, along with thromboembolic disease. Myocardial inflammation and myocarditis, as well as cardiac arrhythmias, have been described following SARS-CoV-2 infection. In a German study of 100 patients recently recovered from COVID-19, cardiac MRI (performed on average 71 days after COVID-19 diagnosis) revealed cardiac involvement in 78% and ongoing myocardial inflammation in 60% [50].

The presence of chronic comorbidities, duration and severity of acute COVID-19 illness, and time since initial diagnosis did not correlate with these data. However, the sample was not random and probably biased towards patients with heart disease. However, of 26 competitive college athletes who were diagnosed with COVID-19, none of whom required hospitalization and most reported no symptoms, 12 (46%) had evidence of myocarditis or prior cardiac injury. The increased incidence of heart failure as a major conse-

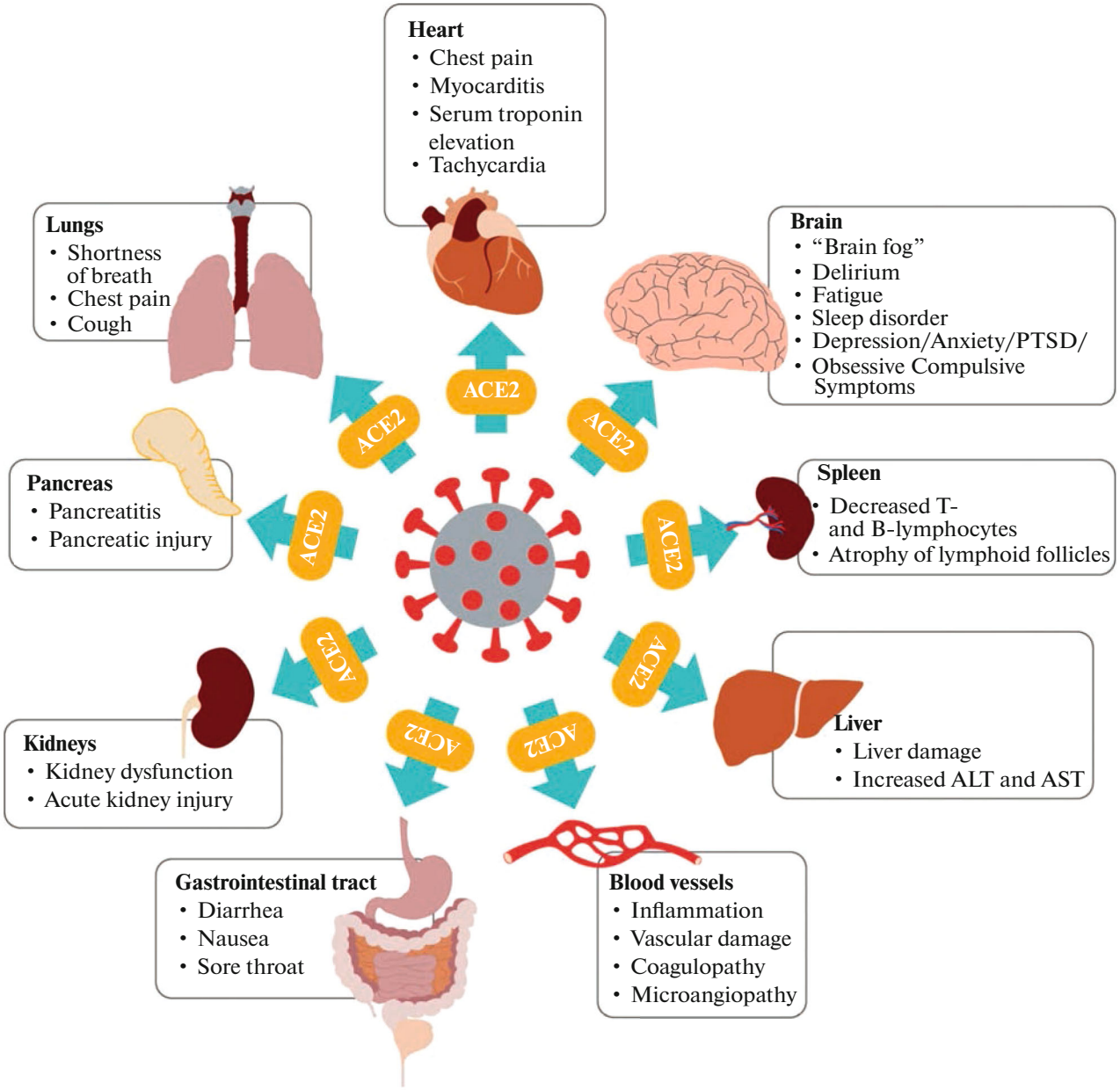

Fig. 1. Multi-organ complications of COVID-19 and long-term COVID via angiotensin-converting enzyme 2 (ACE2) receptors [12] (PTSD ia post-traumatic stress disorder).

quence of COVID-19 raises concerns about significant potential consequences for the elderly population with multimorbidity, as well as for younger, previously healthy patients, including athletes.

LUNGS

The long-term impact of COVID-19 on parenchyma and lung function remains unresolved. Although it is still too early to give a definitive answer to this question, limited observations demonstrate significant lung effects of the disease in some survivors.

In a study of 55 patients with COVID-19 3 months after discharge, 35 (64%) had persistent symptoms and 39 (71%) had radiological abnormalities consistent with pulmonary dysfunction, such as thickening of the interstitial tissue and signs of fibrosis [67]. 3 months after discharge, the ability to diffuse carbon monoxide decreased in 25% of patients. In another study in 57 patients, lung function test results obtained 30 days after discharge, including decreased carbon-monoxide diffusivity and decreased respiratory-muscle strength, were normal and occurred in 30 (53%) and 28 (49%), respectively. [28]. If comorbid cardio-

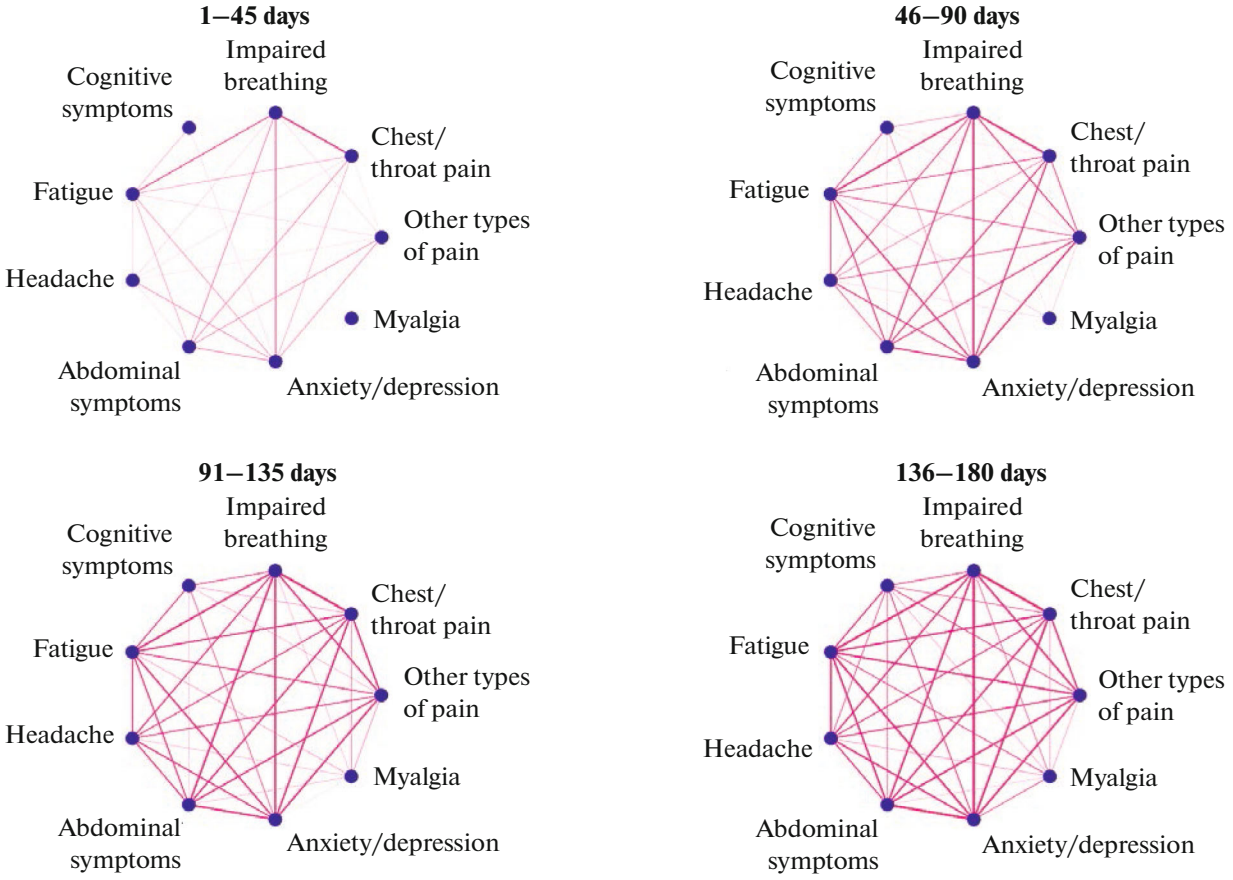

Fig. 2. Frequency, relationships, and evolution of long-term COVID symptoms: a 6-month retrospective cohort study of 273618 COVID-19 survivors [58].

vascular disease, either pre-existing or as a result of COVID-19, is exacerbated, a persistent decline in lung function can have serious adverse effects on the cardiopulmonary system.

It is important to understand that patients with severe COVID-19 pneumonia may take 6 months or more to return to normal breathing and that this is associated with decreased mobility. An elevated level of *D*-dimer is a prognostic sign of lung dysfunction after 3 months [67].

CENTRAL NERVOUS SYSTEM

SARS-CoV-2 can enter brain tissue by viremia, as well as direct penetration into the olfactory nerve, resulting in anosmia. To date, the most common long-term neurological symptoms following COVID-19 are headache, dizziness, and chemosensory dysfunction (e.g., anosmia and ageusia).

Although stroke is a serious, albeit rare, consequence of acute COVID-19, encephalitis, seizures, and other conditions such as mood swings and brain fog have been reported within 2–3 months of onset [68]. However, due to the increased incidence of coagulopathy, people with long-term covid are at stroke risk [55]. These patients require neurorehabilitation to the same extent as other individuals with vascular lesions of the brain [56].

Past pandemics caused by viral pathogens (such as SARS-CoV-1, Middle East Respiratory Syndrome [MERS] coronavirus, and influenza) have had neuropsychiatric consequences that sometimes persist for months in "recovered" patients, which could seriously threaten overall cognitive health. A decrease in cognitive functions in the post-COVID period may be due to assisted ventilation of the lungs performed for patients in the acute period of severe COVID-19, as well as a high level of pro-inflammatory cytokines and acute respiratory dysfunction [25].

As suggested by O. Sinanović et al., in COVID-19 survivors in the coming years and decades, the inflammatory systemic process and/or inflammatory process in the brain can trigger long-term mechanisms that usually lead to an increase in neurological and neurodegenerative disorders [56].

Recently, more and more publications on the development of cognitive impairment against the background and in the long-term period of COVID-19

have appeared. In a review by T.M. Ostroumova et al. this problem is analyzed in detail and it is emphasized that risk factors for severe COVID-19 and cognitive impairment are largely combined and include older age, obesity and the presence of comorbid diseases such as arterial hypertension and type-2 diabetes mellitus. Such patients are potentially at high risk of developing cognitive impairment [3]. This review also mentions the work of C. Sasannejad et al. [53], which showed that cognitive impairment in some patients with acute respiratory distress syndrome (ARDS) persisted for 5 years after the illness. This study can be extrapolated to COVID-19. Moreover, the authors suggest using a battery of tests to detect cognitive impairment in this group of patients both in the acute period of the disease and in the long-term period.

The thesis about the need to use index indicators to differentiate different types and time scales of cognitive impairment should be recognized as important in the cited work. C. Sasannejad et al. [53] suggest that establishing the true cognitive impact of ARDS requires a distinction between patients with cognitive impairment before ARDS and those who develop new cognitive symptoms after ARDS. The Mini-Mental State Examination (MMSE) measures general memory impairment at that moment, but there are two limitations to its use in intensive-care units: the severity of patients and the inability to distinguish between delirium and dementia or their simultaneous presence. These limitations have led to the development of tools that are more sensitive to differentiating different types and timescales of cognitive impairment:

— a method for assessing confusion in the intensive-care unit (CAM-ICU, Confusion Assessment Method-Intensive Care Unit), which is an algorithm for diagnosing delirium; the method demonstrates high sensitivity and specificity in detecting delirium in patients with mechanical ventilation, including questions regarding the onset of changes in mental status, inattention, disorganized thinking, and changes in the patient's level of consciousness [11];

— Modified Blessed Dementia Rating Scale (mBDRS);

— Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE);

— Mini-Mental State Examination (MMSE) for the screening of post-COVID patients.

ENDOCRINE SYSTEM

There may be long-term effects on the endocrine system in the months following COVID-19. This hypothesis was put forward based on what is known about the severe-acute-respiratory-syndrome coronavirus (SARS-CoV), which caused SARS in 2003. Patients infected with COVID-19 may be susceptible to viral damage to the pancreas, which leads to the development of diabetes. If this condition occurs, long-term follow-up is needed to understand whether the diabetes will be permanent or if SARS-CoV-2 caused a transient period of hyperglycemia that will disappear with recovery from the infection [39].

GASTROINTESTINAL TRACT AND THE HUMAN MICROBIOME

Gastrointestinal involvement in COVID-19 is also associated with ACE2 receptors. The receptors are present in the glandular cells of the intestine, and viral capsid proteins have been found in the epithelium of the stomach, duodenum, and rectum, as well as in glandular enterocytes [33, 66]. Virus-induced alteration of the gut microbiome may contribute to the development of gastrointestinal symptoms [2, 34].

The incidence of complications of COVID-19 in the gastrointestinal tract ranges from 12–61% [49]. Gastrointestinal symptoms are associated only with a longer course of the disease, but not with mortality [9, 35, 47]. According to a recent meta-analysis of 29 studies (most of which were conducted in China), infection-induced gastrointestinal disturbances include anorexia (21–35%), nausea and/or vomiting (7–26%), diarrhea (9–33%), and pain in the stomach (3% or more).

Thus, the COVID-19 pandemic may affect the human microbiome in infected individuals, with significant long-term health impacts. While much remains uncertain or unknown about the virus and its consequences, the introduction of pandemic control practices could significantly impact the microbiome [18].

CONSEQUENCES OF HYPODYNAMIA

Elderly and senile people have been subjected to prolonged isolation due to the COVID-19 pandemic and, naturally, have significantly reduced their physical activity, which has led to the development of sarcopenia to varying degrees. As noted by T.O. Flatharta et al., unfortunately, during this period, medical professionals and public-health professionals have not been able to raise public awareness and find ways to reduce the development of sarcopenia and weakness [19].

In addition, the marked increase in inflammatory cytokines in COVID-19 leads to accelerated muscle breakdown and cachexia [41]. Loss of muscle mass can be further aggravated by immobilization during hospitalization while patients are in intensive-care units for mechanical ventilation. All people who have had COVID-19 should be tested for vitamin-D deficiency, as during prolonged isolation, lack of sunlight could significantly reduce its content [16].

In addition to muscle loss with prolonged covid, prolonged bed rest can lead to postural hypotension [11].

Moreover, vasculitis during COVID-19 can lead to damage to baroreceptors leading to autonomic dysregulation [6]. Elevated levels of cytokines can damage

the autonomic nervous system. Postural orthostatic tachycardia has also been observed with prolonged COVID.

All of these factors can lead to an increase in the incidence of falls syndrome. People who fall frequently or are unstable are also likely to develop a "fear of falling" [39].

EMOTIONAL HEALTH AND WELL-BEING, AND SOCIAL CONSEQUENCES

The long-term psychological consequences associated with both the viral infection itself and the restrictive policies adopted to counter remain uncertain [31]. However, there are increasing reports of high levels of psychological stress and symptoms of post-traumatic stress disorder, both in the acute and in the long-term period of COVID-19.

The COVID-19 outbreak in China resulted in an almost instantaneous increase in negative emotions (such as anxiety, depression, and resentment) in tandem with a decrease in positive emotions and life satisfaction in the general population. In addition, psychological stress under lockdown was found to be negatively associated with recommended health behaviors (e.g., residential ventilation, social distancing) to reduce the risk of infection and positively associated with nonrecommended behaviors (i.e., vitamin pills or economic measures that contravene national guidelines for return to normal activities after the risk of a pandemic is reduced) [43]. Psychological intervention appears to be necessary to counteract the short-term and long-term psychopathological effects caused by the COVID-19 pandemic [20].

The psychosocial and mental-health consequences are also significant for the general population, and especially for health workers of all profiles [42, 56]. Media warn of drastic changes in the process of sleep, physical activity and nutrition, the use of psychoactive substances, which can subsequently affect mental health [4]. An increase in mental disorders is expected due to a possible decrease in vitamin-D levels, as well as an established connection with the economic crisis. Mental health should be a key issue in the fight against the pandemic [51].

The effect on eating and exercise behavior is currently unknown. An Australian study in the general population reported an increase in restrictive behavior and overeating; however, respondents reported a decrease in physical activity compared to the pre-pandemic period [47].

COVID-19 diagnosis and subsequent need for physical distancing has been associated with feelings of isolation and loneliness [21]. There are increasing reports of prolonged malaise and exhaustion, similar to chronic-fatigue syndrome, which can lead to physical weakness and emotional distress. In addition to the pandemic's psychological impact on the population, people recovering from COVID-19 may be at even greater risk of depression, anxiety, post-traumatic stress disorder, and substance-use disorder. These combined effects could lead to a global health crisis given the huge number of COVID-19 cases worldwide.

In the early stages of the COVID-19 pandemic, the focus was on containing the SARS-CoV-2 infection and identifying treatment strategies. While controlling this infectious disease is of paramount importance, the long-term impact on people with noncommunicable diseases is significant. Although some noncommunicable diseases appear to exacerbate the course of COVID-19 and increase the risk of death, SARS-CoV-2 infection in survivors with noncommunicable diseases may also influence the progression of their pre-existing clinical conditions. Many countries have made changes to the routine management of patients with noncommunicable diseases, such as abolishing non-urgent outpatient visits, which will have important implications for the management and diagnosis of new noncommunicable diseases, treatment adherence, and their progression [46].

PROPOSED TOOLS FOR MONITORING ELDERLY AND SENILE PATIENTS IN THE LONG-TERM PERIOD AFTER COVID-19

In addition to mandatory general clinical examination, patients in the long-term period after recovering from COVID-19 require specialized geriatric tests [38].

J.E. Morley [41], referring to already available scientific works, suggests that upon discharge from hospital, 3 months after discharge, and in the future, according to indications, all patients who have suffered from COVID-19 undergo an examination using the following tests for:

— "fragility"—the FRAIL scale for the detection of senile asthenia in wide clinical practice;

— sarcopenia—SARC-F questionnaire (Sluggishness, Assistance in walking, Rise from a Chair, climb stairs, Falls – strength, help when walking, getting up from a chair, climbing up the stairs and falling);

— anorexia—SNAQ (Simplified Nutritional Assessment Questionnaire) to determine nutritional status and diagnose malnutrition syndrome;

— cognitive insufficiency—Rapid Cognitive Screen (RCS).

All these tests are combined into a RAPID Geriatric Assessment, which is an analogue of the comprehensive geriatric assessment used in the Russian Federation. This survey allows the refined routing of patients to dedicated specialists [40].

WAYS OF LONG-TERM REHABILITATION OF PATIENTS OF OLDER AGE GROUPS WITH POST-COVID SYNDROME

Geriatric rehabilitation is a multidimensional approach of diagnostic and therapeutic interventions aimed at optimizing (preserving, maintaining, restoring) functional capabilities, preserving the functional reserve and social participation of elderly and old people in order to achieve their independence, and improve their quality of life and emotional well-being [23].

Medical care, including rehabilitation after COVID-19 for patients, especially the elderly and senile, is an extremely relevant aspect in many countries [44].

Members of the Special Interest Group for Geriatric Rehabilitation of the European Geriatric Medical Society (EUGMS) are currently conducting a study to gain insight into the functional and medical recovery of older people affected by SARS-CoV-2 receiving geriatric rehabilitation throughout Europe [24].

However, unified approaches to the monitoring and rehabilitation of patients of older age groups who have recovered from COVID-19 have not been developed so far.

In Bulletin of the Pasteur Institute from July 2021, it was figuratively stated that COVID-19 is a new disease with a unique constellation of symptoms affecting several body systems [52]. We do not know what the course of recovery will be for patients or what treatment approaches will bring the best results. We know from early experience in Italy that the rehabilitation process is complex and the course is capricious [7, 37].

Nevertheless, already now the Russian Geriatric School, relying on the existing developments of foreign partners in the management of post-COVID patients of older age groups, should present its "road map" for the monitoring, curation and rehabilitation of this contingent.

Such work is already underway. According to the press service of the St. Petersburg Health Committee, since the beginning of the pandemic, more than 12000 patients have undergone post-COVID rehabilitation, of which more than 4000 have been inpatients. Rehabilitation is carried out on an inpatient and outpatient basis, as well as in day hospitals. For the organization of medical rehabilitation, a routing of patients who have suffered from the novel coronavirus infection COVID-19 and need medical rehabilitation has been created. To determine the indications for medical rehabilitation and the conditions for its implementation, the Rehabilitation Routing Scale (RRS) is used.

In accordance with the routing, patients who have completed treatment, received medical care for rehabilitation at the first or second stage and have a RRS score of 4–5 points, are sent to the second stage of medical rehabilitation in medical organizations of the second and third groups. Patients in need of medical rehabilitation, who received assistance at the first or second stage of medical rehabilitation with a RRS score of 2–3 points, are sent to the third stage of medical rehabilitation in medical organizations of the first and second groups.

"Routing also provides for the direction of patients engaged in labor activities for aftercare in sanatorium-and-spa organizations. For this purpose, terms of reference have been developed and state contracts have been concluded for the aftercare of such patients in a sanatorium immediately after the completion of inpatient treatment. Patients with diseases that occur in parallel with coronavirus infection are sent for aftercare in a sanatorium for a priority disease (for example, myocardial infarction, cerebrovascular accident, diabetes mellitus, and others)," the department notes. *Unfortunately, there is no separate group of elderly and senile patients*. In the interim guidelines "Prevention, diagnosis and treatment of a novel coronavirus infection (COVID-19)" (the latest version no. 11 was approved by the Ministry of Health of the Russian Federation on May 7, 2021) in the section "Routing Novel Coronavirus Infection (COVID-19) Patients to Medical Rehabilitation" clearly states that it is recommended to make adjustments to the regional systems for organizing rehabilitation care to adapt to the emergence of the flow of patients who have recovered from COVID, in order to *ensure that all patients have access* to medical care at medical rehabilitation and a *personalized route* to stages depending on the severity of the condition at the time of discharge from the primary emergency department. *However, adjustments to regional systems for organizing rehabilitation care for elderly and senile patients have not yet been made*.

Nevertheless, it should be considered a great achievement that the Ministry of Health has amended the clinical recommendations for the treatment and rehabilitation after COVID and the section "Elderly age" has appeared. However, this section concerns only the first and second stages of rehabilitation, that is, at the hospital stage in the acute and subacute periods of the disease.

On the Internet, advertising offers for commercial medical clinics and boarding houses for rehabilitation for the elderly began to appear in large numbers. However, firstly, it costs money, and secondly, there is no comprehensive, multidisciplinary approach. All this should be done at the state level. A comprehensive rehabilitation program for elderly and senile patients should be carried out under the supervision of professionals, that is, specialized geriatric institutions.

K. Sathanandan, a member of the British Society of Geriatrics, categorically expressed his point of view on this topic: "Given that older people are more likely to have a delayed recovery after suffering COVID-19, involving geriatricians in influencing the design of rehabilitation programs is vital"; "During this pandemic, geriatricians have repeatedly been forced to

move forward advocating for equitable access to care and resources for their vulnerable patient groups" [54]. Unfortunately, in the Russian Federation, the role of a geriatrician in solving the problems of monitoring, curation and rehabilitation of patients of older age groups who have suffered from COVID-19 has not yet been determined.

Based on the data presented in the review, it seems to us necessary to carry out the following sequential measures to create a personalized route and individual programs for the management and rehabilitation of elderly and senile patients who have recovered from COVID-19:

— development of a long-term rehabilitation program for elderly and senile patients who have had COVID-19;

— creation of a register of elderly and senile patients who recovered from COVID-19 and with long COVID;

— conducting a comprehensive geriatric assessment and assessment of comorbid status by geriatricians in the polyclinic at the place of residence and in geriatric centers for patients who have recovered from COVID-19;

— monitoring the results of a comprehensive geriatric assessment and comorbid status 3 months, 6 months and 1 year after COVID-19 (further according to indications);

— implementation of rehabilitation measures in hospitals and on an outpatient basis, as well as in day hospitals personally for elderly and senile patients under the supervision of a geriatrician;

— expansion in bed capacity of geriatric centers;

— allocation of additional beds in geriatric centers for the correction of somatic pathology therapy and full rehabilitation measures, including both medical and psychological aspects;

— remote monitoring of the health status of patients through telephone and IT technologies;

— connection of patients to the "alarm button" of the geriatric center according to indications.

CONCLUSIONS

Summarizing the above, it can be argued that many questions remain unresolved. There is no definitive clear terminology, especially for the long-term consequences after suffering from COVID-19. There is no understanding whether remote multi-organ symptoms (especially in older age groups) are a manifestation of the viral pathology itself or if it is an independent pathology. The following questions follow from this: how to rubrify this pathology? How to deal with the long-term consequences after suffering from COVID-19, especially in patients of older age groups? The problem of the management, rehabilitation of elderly and senile patients is still open.

The coronavirus disease 2019 (COVID-19) pandemic is a global health threat with a particular risk of severe illness and death in elderly and senile people, especially in the presence of comorbid pathology (with age-related metabolic and cardiovascular diseases, etc.).

Effective public-health- and socioeconomic responses to the pandemic must be based on a scientific understanding of COVID-19.

The greatest emphasis of scientific research today should be placed on the delayed consequences of COVID-19, especially in patients of older age groups.

Post-acute COVID-19 (long-term COVID) appears to be a multi-system disease, occurring even after a relatively mild illness.

It is imperative that management of the most vulnerable group, i.e., elderly and senile patients, be based on an interdisciplinary approach with a well-integrated program of clinical, laboratory and instrumental examinations in order to avoid the fragmentation of medical care and ensure a comprehensive study of the long-term effects of COVID-19 on all body systems. Moreover, this approach will enable the effective and systematic implementation of the necessary therapeutic interventions to mitigate or reverse the adverse physical and mental-health outcomes of the hundreds of thousands, if not millions, of people "recovering" from COVID-19.

COMPLIANCE WITH ETHICAL STANDARDS

We declare that we have no conflict of interest. This article does not contain any studies involving animals or human participants performed by any of the authors.

REFERENCES

1. Belotserkovskaya, Yu.G., Romanovskikh, A.G., Smirnov, I.P., et al., Long COVID-19, *Consilium medicum,* 2021, no. 3, pp. 261–268. URL: https://cyberleninka.ru/article/n/dolgiy-covid-19 (accessed on November 1, 2021).
2. Belyakov, N.A., Rassokhin, V.V., and Yastrebova, E.B., Coronavirus infection COVID-19. Nature of the virus, pathogenesis, clinical manifestations. Report 1, *VICh-infektsiya i immunosupressii,* 2020, vol. 12, no. 1, pp. 7–21. https://doi.org/10.22328/2077-9828-2020-12-1-7-21
3. Ostroumova, T.M., Chernousov, P.A., and Kuznetsov, I.V., Cognitive disorders in patients after COVID-19, *Nevrologiya, neiropsikhiatriya, psikhosomatika,* 2021, vol. 13, no. 1, pp. 126–130. https://doi.org/10.14412/2074-2711-2021-1-126-130
4. Arora, T. and Grey, I., Health behaviour changes during COVID-19 and the potential consequences: a mini-review, *J. Hlth. Psychol.*, 2020, vol. 25, no. 9, pp. 1155–1163. https://pubmed.ncbi.nlm.nih.gov/32551944/ (accessed on November 11, 2021).
5. Bahat, G., Covid-19 and the renin angiotensin system: implications for the older adults, *J. Nutr. Hlth. Aging,* 2020, vol. 24, pp. 699–704. https://pubmed.nc-

bi.nlm.nih.gov/32744564/ (accessed on November 11, 2021).

6. Becker, R.C., Anticipating the long-term cardiovascular effects of COVID-19, *J. Thromb. Thrombolys.*, 2020, vol. 50, no. 3, pp. 512–524. https://doi.org/10.1007/s11239-020-02266-6
7. Brugliera, L., Spina, A., Castellazzi, P., et al., Rehabilitation of COVID-19 patients, *J. Rehab. Med.*, 2020, vol. 52, no. 4, p. 15. jrm00046. https://doi.org/10.2340/16501977-2678
8. Callard, F. and Perego, E., How and why patients made Long Covid, *Soc. Sci. Med.*, 2021, vol. 268, p. 113426. https://doi.org/10.1016/j.socscimed.2020.113426
9. Cao, B., Wang, Y., Wen, D., et al., A trial of lopinavir–ritonavir in adults hospitalized with severe Covid-19, *N. Engl. J. Med.*, 2020, vol. 382, no. 19, pp. 1787–1799. https://doi.org/10.1056/NEJMoa2001282
10. Carfì, A., Bernabei, R., and Landi, F., Gemelli against COVID-19 Post-Acute Care Study Group, Persistent symptoms in patients after acute COVID-19, *J.A.M.A.*, 2020, vol. 324, no. 6, pp. 603–605. https://doi.org/10.1001/jama.2020.12603
11. Chen, T., Hanna, J., Walsh, E.E., et al., Syncope, near syncope, or nonmechanical falls as a presenting feature of COVID-19, *Ann. Emerg. Med.*, 2020, vol. 76, pp. 115–117. https://doi.org/10.1016/j.annemergmed.2020.04.037
12. Crook, H., Raza, S., Nowell, J., et al., Long covid-mechanisms, risk factors, and management, *Brit. Med. J.*, 2021, vol. 374, p. n1648. https://doi.org/10.1136/bmj.n1648
13. Datta, S.D., Talwar, A., and Lee, J.T., A proposed framework and timeline of the spectrum of disease due to SARS-COV-2 infection: illness beyond acute infection and public health implications, *J.A.M.A.*, 2020, vol. 324, no. 22, pp. 2251–2252. https://doi.org/10.1001/jama.2020.22717
14. Davies, N.G., Abbott, S., Barnard, R.C., et al., Estimated transmissibility and impact of SARS-CoV-2 lineage B.1.1.7 in England, *Science,* 2021, vol. 372, p. eabg3055. https://doi.org/10.1126/science.abg3055
15. Disser, N.P., De Micheli, A.J., Schonk, M.M., et al., Musculoskeletal consequences of COVID-19, *J. Bone Joint Surg. Amer.*, 2020, vol. 102, no. 14, pp. 1197–1204. https://doi.org/10.2106/JBJS.20.00847
16. Dos Santos, R.N., Maeda, S.S., Jardim, J.R., and Lazaretti-Castro, M., Reasons to avoid vitamin D deficiency during COVID-19 pandemic, *Arch. Endocr. Metab.*, 2021, vol. 64, no. 5, pp. 498–506. https://doi.org/10.20945/2359-3997000000291
17. Fauci Introduces New Acronym for Long COVID at White House Briefing, *Medscape,* 2021 [Electronic resource], www.medscape. com/viewarticle/946419 (accessed on August 10, 2021).
18. Finlay, B.B., Amato, K.R., Azad, M., et al., The hygiene hypothesis, the COVID pandemic, and consequences for the human microbiome, *Proc. Nat. Acad. Sci. U.S.A.*, 2021, vol. 118, no. 6, p. e2010217118. https://doi.org/10.1073/pnas.2010217118
19. Flatharta, T.O. and Mulkrrin, E.C., Back to basics: giant challenges to addressing Isaac's "Geriatric Giants" post COVID-19 crisis, *J. Nutr. Hlth. Aging,* 2020, vol. 24, pp. 705–707.
20. Forte, G., Favieri, F., Tambelli, R., and Casagrande, M., COVID-19 pandemic in the Italian population: validation of a post-traumatic stress disorder questionnaire and prevalence of PTSD symptomatology, *Int. J. Environm. Res. Publ. Hlth,* 2020, vol. 17, no. 11, p. 4151. https://doi.org/10.3390/ijerph17114151
21. Galea, S., Merchant, R.M., and Lurie, N., The mental health consequences of COVID-19 and physical distancing: the need for prevention and early intervention, *J.A.M.A. Intern. Med.*, 2020, vol. 180, no. 6, pp. 817–818. https://doi.org/10.1001/jamainternmed.2020.1562
22. Greenhalgh, T., Knight, M., A'Court, C., et al., Management of post-acute covid-19 in primary care, *Brit. Med. J.*, 2020, vol. 370, p. m3026. https://doi.org/10.1136/bmj.m3026
23. Grund, S., Gordon, A.L., Van Balen, R., et al., European consensus on core principles and future priorities for geriatric rehabilitation: consensus statement, *Europ. Geriatr. Med.*, 2020, vol. 11, no. 2, pp. 233–238. https://doi.org/10.1007/s41999-019-00274-1
24. Grund, S., Caljouw, M.A.A., Haaksma, M.L., et al., Pan-European study on functional and medical recovery and geriatric rehabilitation services of post-COVID-19 patients: protocol of the EU-COGER study, *J. Nutr. Hlth Aging,* 2021, vol. 25, no. 5, pp. 668–674. https://doi.org/10.1007/s12603-021-1607-5
25. Heneka, M.T., Golenbock, D., Latz, E., et al., Immediate and long-term consequences of COVID-19 infections for the development of neurological disease, *Alzheimers Res. Ther.*, 2020, vol. 12, no. 1, p. 69. https://doi.org/10.1186/s13195-020-00640-3
26. Hickie, I., Davenport, T., Wakefield, D., et al., Post-infective and chronic fatigue syndromes precipitated by viral and non-viral pathogens: prospective cohort study, *Brit. Med. J.*, 2006, vol. 333, p. 575. https://doi.org/10.1136/bmj38933.585764.AW
27. Higgins, V., Sohaei, D., Diamandis, E.P., and Prassas, I., COVID-19: from an acute to chronic disease? Potential long-term health consequences, *Crit. Rev. Clin. Lab. Sci.*, 2021, vol. 58, no. 5, pp. 297–310. https://doi.org/10.1080/10408363.2020.1860895
28. Huang, Y., Tan, C., Wu, J., et al., Impact of coronavirus disease 2019 on pulmonary function in early convalescence phase, *Respir. Res.*, 2020, vol. 21, no. 1, p. 163. https://doi.org/10.1186/s12931-020-01429-6
29. Huang, C., Huang, L., Wang, Y., et al., 6-Month consequences of COVID-19 in patients discharged from hospital: a cohort study, *Lancet,* 2021, vol. 397, no. 10270, pp. 220–232. https://doi.org/10.1016/S0140-6736(20)32656-8
30. Huang, L., Yao, Q., Gu, X., et al., 1-Year outcomes in hospital survivors with COVID-19: a longitudinal cohort study, *Lancet,* 2021, vol. 398, no. 10302, pp. 747–758. https://doi.org/10.1016/S0140-6736(21)01755-4
31. Jiang, D.H. and McCoy, R.G., Planning for the post-COVID syndrome: how payers can mitigate long-term complications of the pandemic, *J. Gen. Intern. Med.*,

2020, vol. 35, no. 10, pp. 3036–3039. https://doi.org/10.1007/s11606-020-06042-3

32. Lamers, M.M., Beumer, J., Van der Vaart, J., et al., SARS-CoV-2 productively infects human gut enterocytes, *Science,* 2020, vol. 369, no. 6499, pp. 50–54. https://doi.org/10.1126/science.abc1669
33. Lui, R.N., Wong, S.H., Sánchez-Luna, S.A., et al., Overview of guidance for endoscopy during the coronavirus disease 2019 pandemic, *J. Gastroenterol. Hepatol.*, 2020, vol. 35, no. 5, pp. 749–759.
34. Mao, R., Qiu, Y., He, J.S., et al., Manifestations and prognosis of gastrointestinal and liver involvement in patients with COVID19: a systematic review and meta-analysis, *Lancet Gastroenterol. Hepatol.,* 2020, vol. 5, pp. 667–678. https://doi.org/10.1016/S2468-1253(20)30126-6
35. Marshall, M., The lasting misery of coronavirus long-haulers. Nature (News feature), *Nature,* 2020, vol. 585, no. 7825, pp. 339–341. https://doi.org/10.1038/d41586-020-02598-6
36. Masiero, S., Zampieri, D., and Del Felice, A., The place of early rehabilitation in intensive care unit for COVID19, *Amer. J. Phys. Med. Rehab.*, 2020, vol. 99, no. 8, pp. 677–678. https://doi.org/10.1097/PHM.0000000000001478
37. Mendelson, M., Nel, J., Blumberg, L., et al., Long-COVID: an evolving problem with an extensive impact, *S. Afr. Med. J.*, 2021, vol. 111, no. 1, pp. 10–12. https://doi.org/10.7196/SAMJ.2020.v111i11.15433
38. Merchant, R.A., Chen, M.Z., Wong, B.L.L., et al., Relationship between fear of falling, fear-related activity restriction, frailty, and sarcopenia, *J. Amer. Geriatr. Soc.*, 2020, vol. 68, no. 11, pp. 2602–2608. https://doi.org/10.1111/jgs.16719
39. Mongioì, L.M., Barbagallo, F., Condorelli, R.A., et al., Possible long-term endocrine-metabolic complications in COVID-19: lesson from the SARS model, *Endocrine,* 2020, vol. 68, no. 3, pp. 467–470. https://doi.org/10.1007/s12020-020-02349-7
40. Morley, J.E., Kalantar-Zadeh, K., and Anker, S.D., COVID-19: a major cause of cachexia and sarcopenia?, *J. Cachexia Sarcopenia Muscle,* 2020, vol. 4, no. 11, pp. 863–865. https://doi.org/10.1002/jcsm.12589
41. Morley, J.E., COVID-19— the long road to recovery, *J. Nutr. Hlth Aging,* 2020, vol. 24, no. 9, pp. 917–919. https://doi.org/10.1007/s12603-020-1473-6
42. Mukaetova-Ladinska, E.B. and Kronenberg, G., Psychological and neuropsychiatric implications of COVID-19, *Europ. Arch. Psychiat. Clin. Neurosci.*, 2021, vol. 271, no. 2, pp. 235–248. https://doi.org/10.1007/s00406-020-01210-2
43. Negrini, S., Ferriero, G., Kiekens, C., and Boldrini, P., Facing in real time the challenges of the COVID-19 epidemic for rehabilitation, *Europ. J. Phys. Rehab. Med.*, 2020, vol. 56, no. 3, pp. 313–315. https://doi.org/10.23736/S1973-9087.20.06286-3
44. Paice, J.A., Dahlin, C., Wholihan, D., et al., Palliative care for people with COVID-19-related symptoms, *J. Hosp. Palliat. Nurs.*, 2020, vol. 22, no. 6, pp. 421–427. https://doi.org/10.1097/NJH.0000000000000692
45. Palmer, K., Monaco, A., Kivipelto, M., et al., The potential long-term impact of the COVID-19 outbreak on patients with non-communicable diseases in Europe: consequences for healthy ageing, *Aging Clin. Exp. Res.*, 2020, vol. 32, no. 7, pp. 1189–1194. https://doi.org/10.1007/s40520-020-01601-4
46. Pan, L., Mu, M., Yang, P., et al., Clinical characteristics of COVID-19 patients with digestive symptoms in Hubei, China: a descriptive, cross-sectional, multicenter study, *Amer. J. Gastroenterol.*, 2020, vol. 115, no. 5, pp. 766–773. https://doi.org/10.14309/ajg.0000000000000620
47. Phillipou, A., Meyer, D., Neill, E., et al., Eating and exercise behaviors in eating disorders and the general population during the COVID-19 pandemic in Australia: initial results from the collate project, *Int. J. Eat. Disord.*, 2020, vol. 53, no. 7, pp. 1158–1165. https://doi.org/10.1002/eat.23317
48. Puelles, V.G., Lütgehetmann, M., Lindenmeyer, M.T., et al., Multiorgan and renal tropism of SARS-CoV-2, *N. Engl. J. Med.*, 2020, vol. 383, no. 6, pp. 590–592. https://doi.org/10.1056/NEJMc2011400
49. Puntmann, V.O., Carerj, M.L., Wieters, I., et al., Outcomes of cardiovascular magnetic resonance imaging in patients recently recovered from coronavirus disease 2019 (COVID-19), *J.A.M.A. Cardiol.*, 2020, vol. 5, no. 11, pp. 1265–1273. https://doi.org/10.1001/jamacardio.2020.3557
50. Riedel-Heller, S. and Richter, D., COVID-19-Pandemie trifft auf Psyche der Bevölkerung: Gibt es einen Tsunami psychischer Störungen? [COVID-19 pandemic and mental health of the general public: is there a tsunami of mental disorders?], *Psychiatr. Prax.*, 2020, vol. 47, no. 8, pp. 452–456. https://doi.org/10.1055/a-1290-3469
51. RKI—Coronavirus SARS-CoV-2—SARS-CoV-2 Steckbrief zur Coronavirus-Krankheit-2019 (COVID19), Epidemiologischer Steckbrief zu SARS-CoV-2 und COVID-19. Stand: 14.7.2021. Robert Koch Institut: [site]. URL: https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Steckbrief.html (accessed in 2021).
52. Salehi, S., Reddy, S., and Gholamrezanezhad, A., Long-term pulmonary consequences of coronavirus disease 2019 (COVID-19): what we know and what to expect, *J. Thorac. Imaging,* 2020, vol. 35, no. 4, pp. W87–W89. https://doi.org/10.1097/RTI.0000000000000534
53. Sasannejad, C., Ely, E.W., and Lahiri, S., Long-term cognitive impairment after acute respiratory distress syndrome: a review of clinical impact and pathophysiological mechanisms, *Crit. Care,* 2019, vol. 23, no. 1, p. 352. https://doi.org/10.1186/s13054-019-2626-z
54. Sathanandan, K., Long Covid: an age-old concept? BGS: [site]. URL: https://www.bgs.org.uk/blog/long-covid-an-age-old-concept (accessed in 2021).
55. Siepmann, T., Sedghi, A., Simon, E., et al., Increased risk of acute stroke among patient with severe COVID-19: a multicenter study and meta-analysis, *Europ. J. Neurol.*, 2021, vol. 28, no. 1, pp. 238–247. https://doi.org/10.1111/ene.14535

56. Sinanović, O., Muftić, M., and Sinanović, S., COVID-19 pandemia: neuropsychiatric comorbidity and consequences, *Psychiat. Danub.*, 2020, vol. 32, no. 2, pp. 236–244. https://doi.org/10.24869/psyd.2020.236

57. Sullivan, O.O., Long-term sequelae following previous coronavirus epidemics, *Clin. Med. (Northfield. Il.)*, 2021, vol. 21, pp. 68–70. https://doi.org/10.7861/clinmed.2020

58. Taquet, M., Dercon, Q., Luciano, S., Geddes, J.R., et al., Incidence, co-occurrence, and evolution of long-COVID features: a 6-month retrospective cohort study of 273,618 survivors of COVID-19, *PLoS Med.*, 2021, vol. 18, no. 9, p. e1003773. https://doi.org/10.1371/journal.pmed.100377

59. Tenforde, M.W., Kim, S.S., Lindsell, C.J., 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,* 2020, vol. 69, no. 30, pp. 993–998. https://doi.org/10.15585/mmwr.mm6930e1

60. Twisk, F., Myalgic encephalomyelitis (ME) or what? An operational definition, *Diagnostics* (Basel), 2018, vol. 8, no. 3, p. 64. https://doi.org/10.3390/diagnostics8030064

61. UK Government. NERVTAG: update note on B.1.1.7 severity, 11 February 2021: [site]. URL: https://www.gov. uk/government/publications/nervtag-update-note-on-b117-severity-11-february-2021 (accessed in 2021).

62. UK Government. Variants: distribution of cases data. 2021 [site]. URL: https://www.gov.uk/government/publications/covid-19-variants-genomically-confirmed-case-numbers/variants-distribution-of-cases-data (accessed in 2021).

63. UK Health Security Agency [site]. URL: https://www.gov.uk/government/publications/covid-19-variants-genomically-confirmed-case-numbers/variants-distribution-of-case-data-26-november-2021

64. Understanding long COVID: a modern medical challenge, *Lancet,* 2021, vol. 398, no. 10302, p. 725. https://doi.org/10.1016/S0140-6736(21)01900-0

65. Yelin, D., Wirtheim, E., Vetter, P., et al., Long-term consequences of COVID-19: research needs, *Lancet Infect. Dis.*, 2020, vol. 20, no. 10, pp. 1115–1117. https://doi.org/10.1016/S1473-3099(20)30701-5

66. Zhang, H., Kang, Z., Gong, H., et al., Digestive system is a potential route of COVID-19: an analysis of single-cell coexpression pattern of key proteins in viral entry process, *Gut,* 2020, vol. 69, pp. 1010–1018. https://gut.bmj.com/content/69/6/1010 (accessed in 2021).

67. Zhao, Y.-M., Shang, Y.-M., Song, W.-B., et al., Follow-up study of the pulmonary function and related physiological characteristics of COVID-19 survivors three months after recovery, *EClinical Med.*, 2020, vol. 25, p. 100463. https://doi.org/10.1016/j.eclinm.2020.100463

68. Zubair, A.S., McAlpine, L.S., Gardin, T., et al., Neuropathogenesis and neurologic manifestations of the coronaviruses in the age of coronavirus disease 2019: a review, *J.A.M.A. Neurol.*, 2020, vol. 77, no. 8, pp. 1018–1027. https://doi.org/10.1001/jamaneurol.2020.2065

Translated by P. Kuchina