

Report to the Boards of Health

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Post-COVID Conditions

Some people have new, ongoing, or recurring symptoms or health problems a month or more after their infection with COVID-19. These post-COVID conditions have been referred to by many names, including long COVID, post-acute COVID-19, long-term effects of COVID, post-acute COVID syndrome, chronic COVID, long-haul COVID, late sequelae, and others. In the area of research, the term post-acute sequelae of SARS-COV-2 infection (PASC) is typically used.

The frequency of long-term symptoms and health issues after COVID-19 ranges widely in research from 5% to 80%. It can be difficult to tell what symptoms are being caused by post-COVID conditions rather than other reasons. For those that were severely ill, there is a separate condition, known as post-intensive care syndrome, or PICS, that affects between 30% to 80% of people who stay in the Intensive Care Unit (ICU) for any reason. This causes brain fog and weakness that can last more than a year. In addition, the social isolation from the pandemic and infection can lead to symptoms of depression, anxiety, and other mood issues. Since these post-COVID conditions still do not have a formal definition and our understanding of them is still changing as research continues, it is difficult for both patients and providers to diagnose and manage.

There are concerns that the huge numbers of infections caused by the recent Omicron surge will be followed by a second surge of people struggling with long-term disability from post-COVID conditions. The majority of post-COVID conditions appear after mild cases of COVID-19, primarily because most cases of COVID-19 are mild. People may have symptoms caused by post-COVID conditions, but it is not recognized because they had no symptoms for their initial COVID-19 infection or tested negative for COVID-19 due to inaccurate or improper testing. Many people with post-COVID conditions are too ill to work or work as they once did. However, they are unable to qualify for disability or get disability in a timely manner.

Being fully vaccinated prior to COVID-19 infection has been shown to reduce your risk of developing post-COVID conditions by 2 to 10 times. It appears that unvaccinated people who get their first dose of vaccine within 12 weeks of being diagnosed with COVID-19 are likely to have post-COVID conditions compared to those that do not get vaccinated soon after their illness.

Post-COVID conditions have been found to affect the entire body, including the cardiovascular (heart and blood vessels), pulmonary (lungs and airways), renal (kidneys), dermatologic (skin), neurological (brain and nerves) and psychiatric (thinking and mood). These affects can be very serious, leading to many repeat hospitalizations, disability, and death. We don't know how long organ systems will be affected or how much this damage will affect people in the years to come.

The most commonly-reported symptoms in people with post-COVID conditions have been:

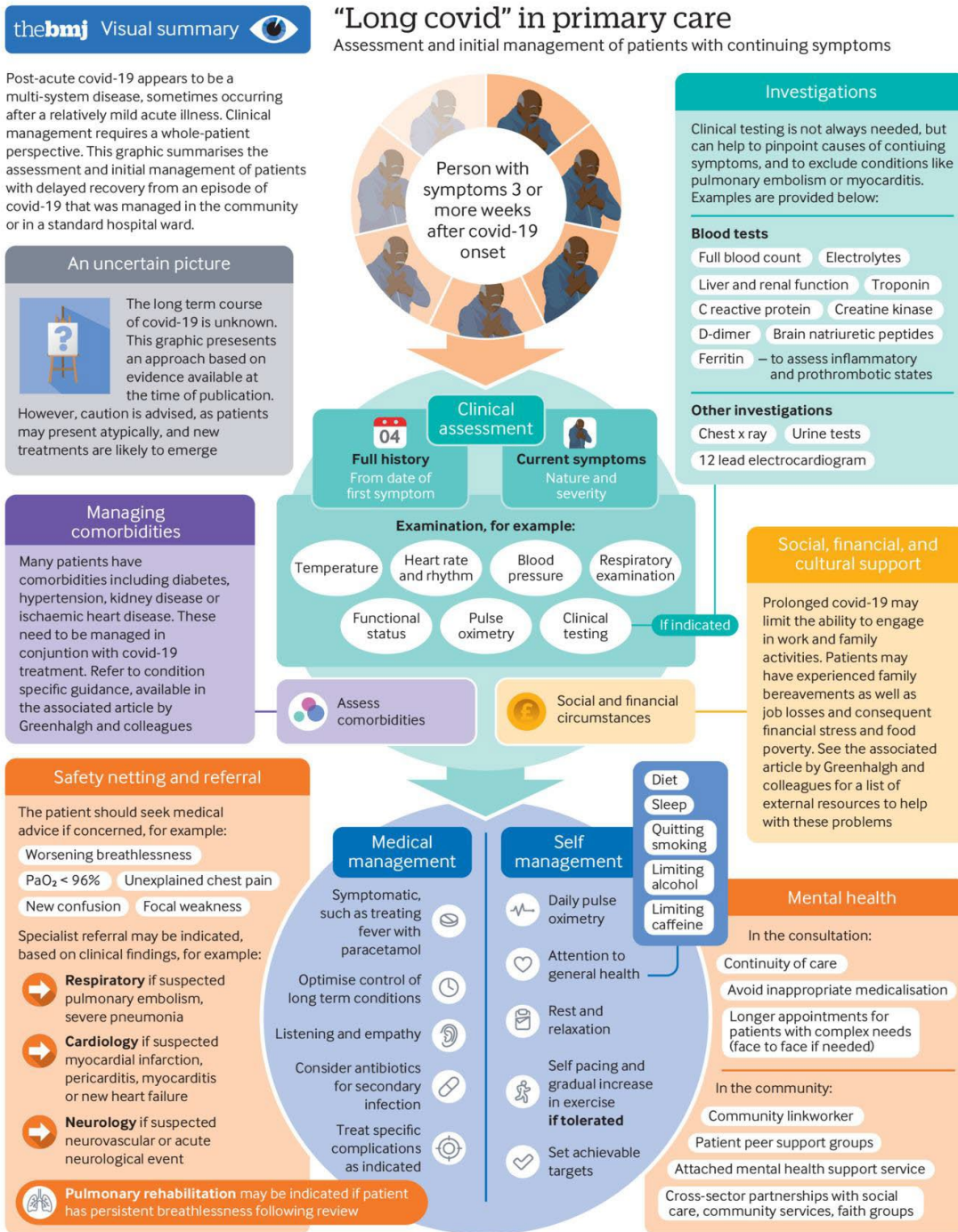
- Shortness of breath or difficulty breathing
- Fatigue

- Poor endurance or post-exertional malaise (PEM) (which is the worsening of symptoms following even minor physical or mental exertion; symptoms typically worsening 12 to 48 hours after activity and last for days or even weeks)
- “Brain fog,” or cognitive impairment
- Cough
- Chest pain
- Headache
- Palpitations and/or tachycardia
- Joint pain
- Muscle pain
- Numbness and tingling
- Abdominal pain
- Diarrhea
- Insomnia and other sleep difficulties
- Fever
- Lightheadedness
- Impaired daily function and mobility
- Pain
- Rash (e.g., urticaria)
- Mood changes
- Loss of smell or taste
- Menstrual irregularities

A summary of the organ systems that can be effected, symptoms, and the suspected mechanisms causing these symptoms is included on the following page.

Organ Systems	Clinical Manifestations	Pathological features	Potential Underlying Biology
Respiratory system	<ul style="list-style-type: none"> Chronic cough Shortness of breath (dyspnea), breathlessness Chest pain Reduced exercise capacity Acute respiratory diseases Fibrotic lung disease Bronchiectasis Pulmonary vascular disease 	<ul style="list-style-type: none"> Congestive lungs with alveolitis Ground glass opacities Pulmonary lesions Mononuclear inflammatory cell (Monocyte and macrophage) and fibrinous exudate Inflammatory edema in respiratory mucosa and alveolar wall Platelet-fibrin thrombi Necrotising bronchiolitis, diffuse alveolar damage (DAD), hyaline membrane formation 	<ul style="list-style-type: none"> Direct viral invasion <i>via</i> ACE-2 expression in the upper airway(goblet and ciliated epithelial cells), lower respiratory tract epithelium (type II alveolar), and pulmonary vasculature (arterial smooth muscle), and endothelial cells Residual virus in lungs post recovery Cytokine storm Activation of the complement system Microthrombi and macrothrombi formation
Cardiovascular system	<ul style="list-style-type: none"> Chest pain Palpitations Ventricular dysfunction Myocardial injury Myocarditis Cardiomyopathy Cardiac arrhythmias Myocardial ischemia Thromboembolism 	<ul style="list-style-type: none"> Cardiac Increased troponin levels Low-grade myocardial inflammation Hypertrophied cardiomyocytes with inflammatory infiltrates Focal edema Interstitial hyperplasia Fibrosis Degeneration, necrosis and signs of lymphocytic myocarditis Hematologic Edematous changes in alveolar capillaries Fibrin thrombi Perivascular inflammatory infiltrates 	<ul style="list-style-type: none"> Direct viral invasion <i>via</i> ACE-2 receptor in cardiac tissue (pericytes, endothelial cells, cardiomyocytes, cardiofibroblasts, and epicardial adipose cells, and vascular cells) Cytokine storm Hyperinflammation Endothelial dysfunction Leucocyte infiltration Formation of microvascular thrombosis
Nervous system	<ul style="list-style-type: none"> Fatigue Myalgia Anxiety Depression PTSD Sleep disorders Headaches Taste and smell impairment (ageusia and anosmia) Cognitive impairment (brain fog) Mood swings Seizures Ischemic or hemorrhagic stroke Encephalitis 	<ul style="list-style-type: none"> Brain lesions Hyperemia, edema and neuronal degeneration Demyelination Acute hypoxic ischemic injury 	<ul style="list-style-type: none"> Proposed SARS-COV-2 viral invasion by breaching blood-brain barrier or through olfactory nerves Hypoxia Cytokine storm Hyperinflammation Coagulation abnormalities Endothelial dysfunction
Urinary system/ Kidney	<ul style="list-style-type: none"> Acute kidney injury Albuminuria Proteinuria Hematuria 	<ul style="list-style-type: none"> Diffuse proximal tubule injury Protein exudate in balloon cavity and thrombus in capillaries Non-specific fibrosis with lymphocytic infiltrates Acute tubular necrosis 	<ul style="list-style-type: none"> Direct viral invasion <i>via</i> positive ACE-2 expression in kidney tissue (proximal tubule epithelial cells, glomerular endothelial cells, podocytes and kidney vasculature) Cytokine storm Systemic hypoxia Activation of complement components (C5b-9) Abnormal coagulation
Digestive system/ Liver	<ul style="list-style-type: none"> Acute liver injury Cholestasis Elevated serum liver biomarkers (aspartate aminotransferase (AST), alanine aminotransferase (ALT), bilirubin) 	<ul style="list-style-type: none"> Hepatic cell degeneration Multi-focal necrosis, indicative of cirrhosis Biliary plugs in the small bile duct Atypical lymphocytic infiltration in the portal tract Increased number of portal veins Activated Kupffer cells Smooth muscle fragmentation of portal vein 	<ul style="list-style-type: none"> Direct viral invasion <i>via</i> ACE-2 expression in the hepatobiliary system (cholangiocytes, hepatocytes and bile duct cells) Systemic inflammation Hypoxia Drug-induced damage Coagulation abnormalities
Digestive system/ Gastrointestinal tract	<ul style="list-style-type: none"> Diarrhea Decreased appetite Nausea/Vomiting Abdominal pain Gastrointestinal bleeding Anorexia 	<ul style="list-style-type: none"> Stenosis of small intestine Segmental dilatation Degeneration, necrosis and shedding in the gastrointestinal mucosa Inflammatory infiltrates 	<ul style="list-style-type: none"> Direct viral invasion <i>via</i> ACE-2 expression in digestive tract (small intestinal enterocytes) Alteration of intestinal microbial flora Cytokine storm
Reproductive system/ Testis	<ul style="list-style-type: none"> Orchitis Infertility Sterility 	<ul style="list-style-type: none"> Leucocyte infiltration Edematous testicular cells Destruction of the seminiferous tubules Reduced spermatogenesis 	<ul style="list-style-type: none"> Direct viral invasion <i>via</i> positive ACE-2 and TMPRSS2 expression in testicular cells Hyperinflammation
Dermatological system/ Skin	<ul style="list-style-type: none"> Hair loss Erythematous rash Dermatitis Pseudo-chilblains on fingertips and toes Urticaria Chicken pox-like vesicles* 	<ul style="list-style-type: none"> Vasculitis Dermatological lesions in trunk, hands and feet Perivascular inflammatory infiltrates in the superficial dermis with extravasation of red blood cells and intraluminal thrombi Capillary thrombosis with diffuse hemorrhage Parakeratosis, acanthosis, dyskeratotic keratinocytes, necrotic keratinocytes, acantholytic clefts along with lymphocytes satellitisms 	<ul style="list-style-type: none"> Direct viral invasion <i>via</i> positive ACE-2 expression in endothelium, stratum basale, sebaceous and eccrine cells

Most post-COVID conditions can be diagnosed clinically and managed by a primary care provider. Centers that manage post-COVID conditions also exist, mainly in large or academic centers, however they are currently overwhelmed with patients and too far from most that need them.



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Resources:

- Excellent Collection of Information: <https://www.idsociety.org/covid-19-real-time-learning-network/disease-manifestations--complications/post-covid-syndrome/#guidelines>
- Find Post-COVID Clinics: <https://www.survivorcorps.com/pccc>

Recommendations:

1. Encourage COVID-19 vaccination as a way to prevent post-COVID conditions and long-term disability.
2. Promote education of patients who have had COVID-19 of the possibility of post-COVID conditions and the need to follow up with their primary care provider should they continue to struggle with symptoms.
3. Promote continuous research and education of healthcare providers regarding post-COVID conditions.

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