

SARS-CoV-2 infection (COVID-19)

SARS-CoV-2 infection (COVID-19) is a major pandemic that is worldwide and itself is causing significant mortality and morbidity. A subset of patients have presented with lingering, persistent, or prolonged symptoms for weeks or months afterwards, regardless of the severity of COVID infection [5–9]. This lingering condition has been labeled “post-acute sequelae of SARS-CoV-2 infection” syndrome or simply the “post-acute COVID-19 syndrome” or “long-COVID-19” or just “Long-COVID” or “long haulers COVID-19” or simply “long haulers” or “post-COVID syndrome”. This has extended the significant worldwide morbidity from the COVID-19 pandemic. It is estimated that 43% of patients who tested positive for SARS-CoV-2 will remain ill beyond 3 weeks, and this percentage may continue to rise. This is the subset that constitutes the Long-COVID syndrome. This does not include those who are not confirmed with acute COVID-19 that present with Long-COVID. Myocarditis is a common result of viral infection usually caused by oxidative stress due to the virus’ attack on the mitochondria in the heart muscle cell. Oxidative stress also has a significant effect on the nervous system given that all nerves contain some of the highest amounts of mitochondria of all cells in the body. Oxidative stress produced in the mitochondria and cytosol of the heart, brain, and nervous system cells contributes to dysfunction and aging of the organs. The Cytokine storm involved in COVID-19 infections is a source of oxidative stress, and there are over 1200 references (circa. 2022) relating oxidative stress to parasympathetic and sympathetic (P&S) dysfunction. Cardiac injury and primary arrhythmia may occur long-term in Long-COVID patients, but in our experience, these patients comprise a very small percentage of the Long-COVID population. The majority of Long-COVID patients with lingering cardio-neuro symptoms and disability present with P&S dysfunction(s).

This prolonged post-COVID phase, with morbidity and ongoing symptoms, creates significant burden to the patient and to the healthcare system and is not completely understood. Not just quality of life, including mental and cognitive health, but employment and productivity issues become paramount when the acute, the subacute, and the chronic phases of COVID-19 occur. The recovery from COVID-19 usually occurs at 7 to 10 days after the onset of symptoms in mild disease but could take 6 weeks or more in severe or critical cases. Laboratory abnormalities may be present and include low lymphocyte counts and elevated inflammatory markers (e.g., sedimentation rate, C-reactive protein, ferritin, interleukin 1 and 6, and tumor necrosis factor). Coagulation system abnormalities may occur. Clots may form in the acute phase as well as in the subacute phase, especially if there is a history of

thrombus formation. The symptoms of Long COVID may be traced to P&S dysfunction and oxidative stress due to viral infection, including COVID-19 and other sources.