"Post-Marketing Evidence Of Neurological Side Effects In COVID - 19 Vaccinated Populations"

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Abstract

Effective vaccinations have been developed quickly as a result of substantial, coordinated multinational research following the COVID-19 virus outbreak. vaccinations are today thought to be the most effective means of achieving public safety and reducing mortality, but because of the dire circumstances, these vaccinations have been granted emergency use licenses, and some of their possible adverse effects have gone unnoticed. Simultaneously, numerous complaints of side consequences of receiving the COVID-19 vaccine. These reports suggest that vaccinations may cause side effects, particularly to the neurological system. Cerebrovascular conditions, such as cerebral venous sinus thrombosis, transient ischemic attack, intracerebral hemorrhage, and ischemic stroke, and demyelinating conditions, such as transverse myelitis, early-stage multiple sclerosis, and neuromyelitis optic, are the most significant and frequent side effects.
These side effects are frequently severe and temporary, but in rare instances, they can be lethal. Here, we present a thorough analysis of publications from 2020 to 2022 in worldwide databases that describe neurological adverse reactions of COVID-19 vaccinations and talked about neurological conditions that could be brought on by immunization.

Keywords: Thrombosis, Myelitis, Vaccine, SARS, COVID-19, and neurological adverse effects

Background

The world was first exposed to the SARS Covid-2 virus in December 2019. A virus that spread quickly over the world and was far more contagious than
SARS Covid-1. In the wake of the circumstance in 2020, the World Health Organization was forced to issue a worldwide health crisis. Hypoxia and extensive lung infections are known to be caused by this virus. According to WHO statistics, as of November 2022, there were 6.58 million COVID-19-related fatalities and 630.3 million new COVID-19 diagnoses worldwide. To halt the pandemic, the first vaccines were released in early 2021. Additionally, roughly 68.2% of the global
The entire population has received vaccinations against this illness. There are four main methods for creating COVID-19 vaccines: live inactivated (or attenuated) virus, viral vector (replication–non-replication), protein (spike protein or its subunits), and nucleic acid-based vaccination (DNA–mRNA). In vaccines based on nucleic acids and adenoviruses, pieces of the virus's genome or mRNA infiltrate human cells and cause the creation of viral proteins. Eventually, these viral proteins are recognized as antigens, which trigger the creation of antibodies. Virus particles and proteins act as antigens in vaccines that contain dormant or protein viruses, activating the immune system. As of November 2021, the World Health Organization had authorized 11 COVID-19 candidate vaccines for widespread use following their exit from phase 3 clinical trials. However, phase 4 clinical studies must be conducted to demonstrate the vaccine's efficacy in terms of effectiveness and adverse effects. Since the phase 4 studies' findings meet the appropriate standards for the real-world effectiveness of the vaccine.

Although vaccines have long been recognized as the safest and most effective medications, a number of adverse effects have been linked to them. For instance, a connection has been found between the swine flu liver infection, and HPV vaccines and demyelinating syndromes, and the injection of the influenza vaccine is one factor contributing to the prevalence of insomnia in young people. The negative effects of each COVID-19 vaccine should be carefully watched because they are urgently approved and do not undergo the required clinical studies. It is important to note that the incidence of vaccine side effects is higher in mass vaccinations because of differences in race, disease history, age, lifestyle, and other relevant factors.

The CDC, VAERS, and EMA databases show that the COVID-19 vaccine has a positive short-term outcome, but in the medium and long run, particularly concerning adverse effects have been observed with several immunizations. The most serious condition that needs to be identified and treated right now is VST. As a result, medical professionals and staff at facilities that treat these patients ought to be aware of these issues and take prompt action.

Search method

Google was searched and examined for research, review, and case report publications about the negative effects of the COVID-19 vaccine between 2020 and February 2022. NCBI, Scholar, and PubMed databases. Because there was insufficient evidence to support a connection between the problem and immunization, several Case Report publications were disregarded. Pfizer, AstraZeneca, Johnson & Johnson, Moderns, Sinovac Sinopharm, Sputnik, Coaxing, vascular thrombosis, thrombocytopenia, myelitis, demyelination, COVID-19, SARS-CoV-2, vaccination, side effects, complications, and all types of mRNA vaccines were among the keywords used in this search. The primary types of COVID-19 vaccine adverse effects are displayed in Fig. for convenience.

Neurological side effects after receiving the COVID-19 vaccine

COVID-19 vaccinations produce a number of local and systemic neurological side effects, ranging from minor to serious, depending on the individual's age, sex, past medical history, and level of immunity, according to reports in the VAERS database. Acute, temporary, and self-limiting complications often manifest one day to one month following injection; nevertheless, in extreme circumstances, hospitalization and critical care may be required. However, because they trigger a more robust immune response to foreign antigens, which can result in the targeting of antigens from themselves and autoimmune illnesses, women are more likely to experience neurological problems. There are more reports of adverse effects following the second dosage of the vaccination than following the first. Weakness, numbness, headache, dizziness, imbalance, exhaustion, muscular spasms, joint discomfort, and restless legs syndrome are among the mild neurological side effects of the COVID-19 vaccine, whereas tremors, tinnitus, and zoster herpes are less prevalent. However, serious neurological side effects included anaphylaxis, Bell's palsy, stroke, Guillain-Barre syndrome (GBS), seizures, and demyelinating disorders such acute encephalomyelitis and transverse myelitis. The most hazardous neurological consequence among them

In women of childbearing age, brain venous sinus thrombosis is brought on by COVID-19 vaccinations, particularly those based on adenoviruses. The WHO states that the site of injection reactions, fatigue, fever, headaches, and allergic dermatitis are the most frequent local and systemic adverse reactions that occur with inactivated virus-based vaccines, particularly Sinopharm. These side effects are self-limiting, and the patient does not require hospitalization.

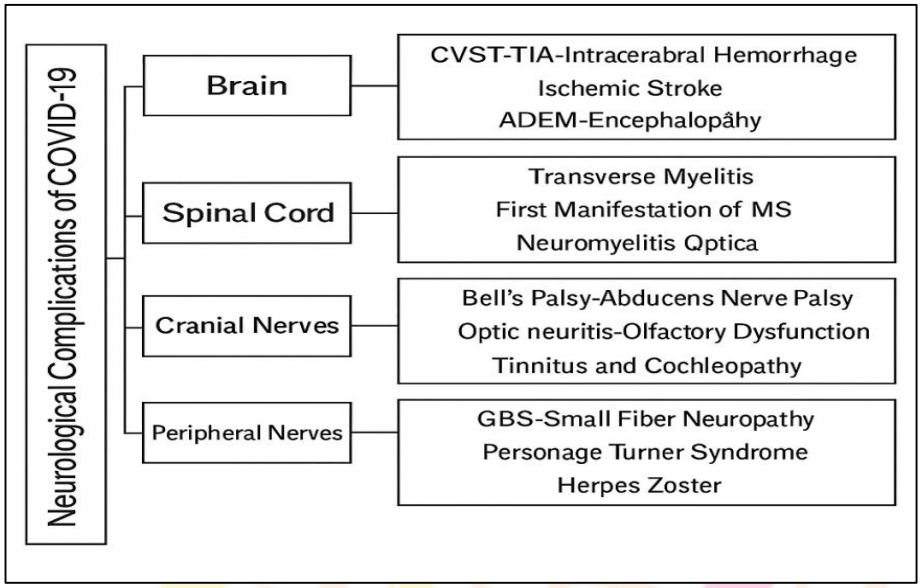

Fig 1: Classification of neurological complications observed after COVID-19 vaccination

the highest incidence of neurological complications because they induce a stronger immune response against foreign antigens, which can lead to the targeting of self-antigens and lead to autoimmune disorders. Adverse reactions after the second dose of the vaccine are reported more than in the first dose Mild neurological effects of the COVID-19 vaccine include weakness, numbness, headache, dizziness, imbalance, fatigue, muscle spasms, joint pain, and restless leg syndrome are more common, while tremors, tinnitus, and herpes zoster are less common. On the other hand, severe neurological complications included Bell's palsy,

Gillian–Bare syndrome (GBS), stroke, seizures, anaphylaxis, and demyelinating syndromes such as transverse myelitis and acute encephalomyelitis. Among these, the most dangerous neurological complication.caused by COVID-19 vaccines, especially adenovirus based, is cerebral venous sinus thrombosis in women of child bearing age.

According to the WHO, in the case of side effects of inactivated virus-based vaccines, especially Sinopharm, the most common local and systemic adverse reactions are injection site reactions, fatigue, fever, headache, and allergic dermatitis, which are self-limiting, and the person does not need to be hospitalized. It is noteworthy that rare and scattered reports have been published on the side effects of Sinopharm and other inactivated virus-based vaccines .Vaccine reactivity has been linked to a temporary increase in inflammatory

cytokines that act on blood vessels, muscles, and

other tissues. In other words, we will observe the flu-like syndrome for several consecutive days after vaccination. According to a recent report on the Sputnik vaccine, side effects are included headache, joint pain, fever, and flu-like symptoms. According to published information on the side effects of other adenovirus vaccines, it is essential to properly evaluate the efficacy of the Sputnik vaccine and publish relevant data to decide on its side effects. COVID-19 vaccination can sometimes have severe side effects on nervous system, including the brain, spinal cord, cranial nerves, and peripheral nerves, and has been shown to have adverse vascular, metabolic, inflammatory, and functional effects on the brain .The two main mechanisms, ectopic immune reactions, and molecular mimicry, have been proposed for the pathogenicity of vaccines and how these complications occur.

Acute neurological disorders

Some people have experienced neurological problems such as transverse myelitis, ADEM (acute disseminated encephalomyelitis), Bell's palsy, Guillain–Barre syndrome, encephalopathy, and seizures after receiving COVID-19 vaccines. Each vaccine type may affect the body differently and could play a role in triggering these rare conditions. In some cases, the spike protein made by the body after vaccination can cause strong inflammation and a rise in body temperature (fever). The fever may make glial cells (supporting cells in the brain) more active and temporarily weaken the blood–brain barrier, which normally protects the brain from harmful substances. When this barrier becomes more permeable, immune cells and proteins from the blood can enter the brain, leading to swelling and disrupting the brain's normal balance. This immune reaction can sometimes damage the myelin sheath that protects nerve fibers, resulting in nerve injury or degeneration. Researchers have also found spike protein antibodies in the cerebrospinal fluid of some patients, which might explain why certain people develop encephalopathy or seizures after vaccination. One example is transverse myelitis, an inflammation that affects part of the spinal cord. It can cause weakness, numbness, or problems with bladder and bowel control below the affected area. Scientists think this may happen because the body's immune system mistakes parts of the spinal cord for viral proteins from the vaccine — a process called molecular mimicry. This condition has been observed, though rarely, after both mRNA and adenovirus-based COVID-19 vaccines.

Headache

The first and most common systemic side effect of
COVID-19 vaccines is headache, which is mild to severe and is felt in the frontal area of the head. Post-vaccination headaches can be caused by stress, vascular spasm, and intracerebral or subarachnoid hemorrhage. Vaccines based on mRNA and adenovirus have been reported to
be most likely to cause headaches

Vaccine name:

1. Sinovac
2. Sinopharm
3. Covaxin

Vascular complications in the brain:

Following the administration of COVID-19 vaccines—especially those using adenovirus vectors—some rare immune-related issues such as thrombocytopenia, cerebral venous sinus thrombosis (CVST), ischemic stroke, and intracerebral hemorrhage have been observed. The likely cause of thrombocytopenia is the body's production of IgG antibodies that target platelet factor 4 (PF4). These antibodies can activate platelets and lead to clot formation in major veins. Adenovirus-based vaccines are more strongly linked to this effect because they carry nucleic acids that code for the viral spike (S) protein. If small amounts of this genetic material enter the bloodstream and bind to PF4, an autoimmune reaction may develop. Excessive clotting can also result in venous sinus thrombosis. The vaccine's viral antigens may stimulate platelets directly or promote clotting indirectly by triggering complement pathways and increasing thrombin levels. Cases of venous sinus thrombosis and brain hemorrhage have been reported more frequently in women aged 30–50 than in men.

Cognitive and Somatic Effects Following mRNA Vaccine Administration

Neurological symptoms occurring after COVID-19 vaccination have been documented in a subset of individuals, presenting a clinical picture that partially overlaps with post-COVID-19 syndrome. In a cohort of 50 patients, the most frequently reported symptoms included paraesthesia (56%), fatigue (46%), cognitive impairment (36%), and headache (30), alongside peripheral features such as fasciculations, myalgia, neuropathic pain, vertigo, and tinnitus. Despite these symptoms, routine neurological investigations—including

MRI, EEG, electrophysiology, blood tests, and skin biopsies—were largely unremarkable, indicating no consistent structural or physiological abnormalities. Cognitive assessment identified mild deficits in attention, memory, and executive functioning in a portion of patients. Psychometric analysis showed high levels of fatigue, increased anxiety and depressive symptoms, and a substantial risk for somatic symptom disorder, reflecting the significant impact on daily functioning and quality of life. Symptom onset typically occurred within three days after vaccination, mostly following mRNA vaccines. Although these symptoms were temporally associated with vaccination, current evidence does not establish causality, and such neurological manifestations remain rare considering the global scale of vaccination. Further research is needed to clarify underlying mechanisms and to differentiate vaccine-related responses from nocebo effects or post-infection sequelae.

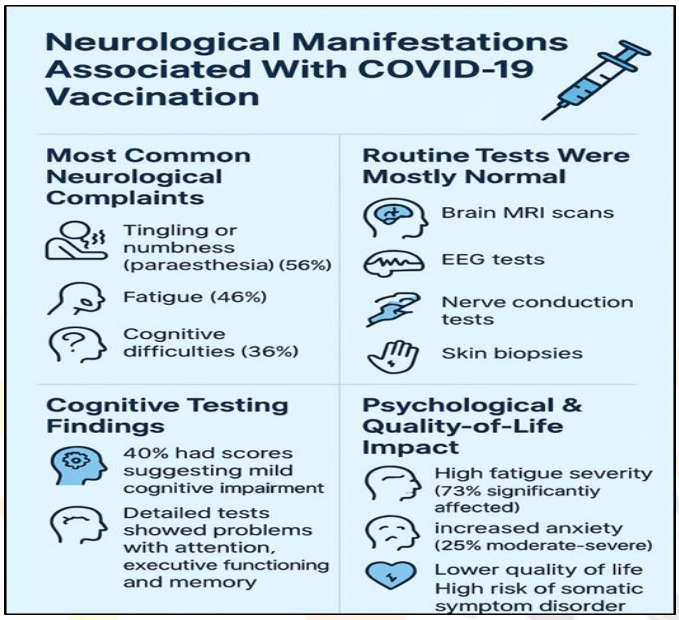

Fig 2. Cognitive and Somatic Effects Following mRNA Vaccine Administration

Conclusion:

Neurological side effects after COVID-19 vaccination have been reported in different parts of the world, and they range from mild symptoms—like headaches, numbness, and fatigue—to rare but more serious conditions such as blood-clot–related stroke, Guillain–Barré syndrome, and inflammation of the brain or spinal cord. Although these symptoms can be worrying, most people show **normal test results**, and only a very small number develop severe complications. Current evidence suggests that the body's immune response, triggered by the vaccine, may occasionally behave unpredictably in certain individuals, leading to temporary inflammation or autoimmune reactions.

Even so, the likelihood of serious neurological problems from vaccination remains **extremely low**, especially when compared with the much higher risk of long-term neurological damage caused by actual COVID-19 infection. Vaccines continue to play an essential role in preventing severe illness and reducing deaths worldwide. Going forward, continued monitoring, transparent reporting, and ongoing scientific research are important to help us better understand who might be at risk and how to manage these rare side effects while maintaining public trust in vaccination programs.

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