Covid-19 and the nervous system


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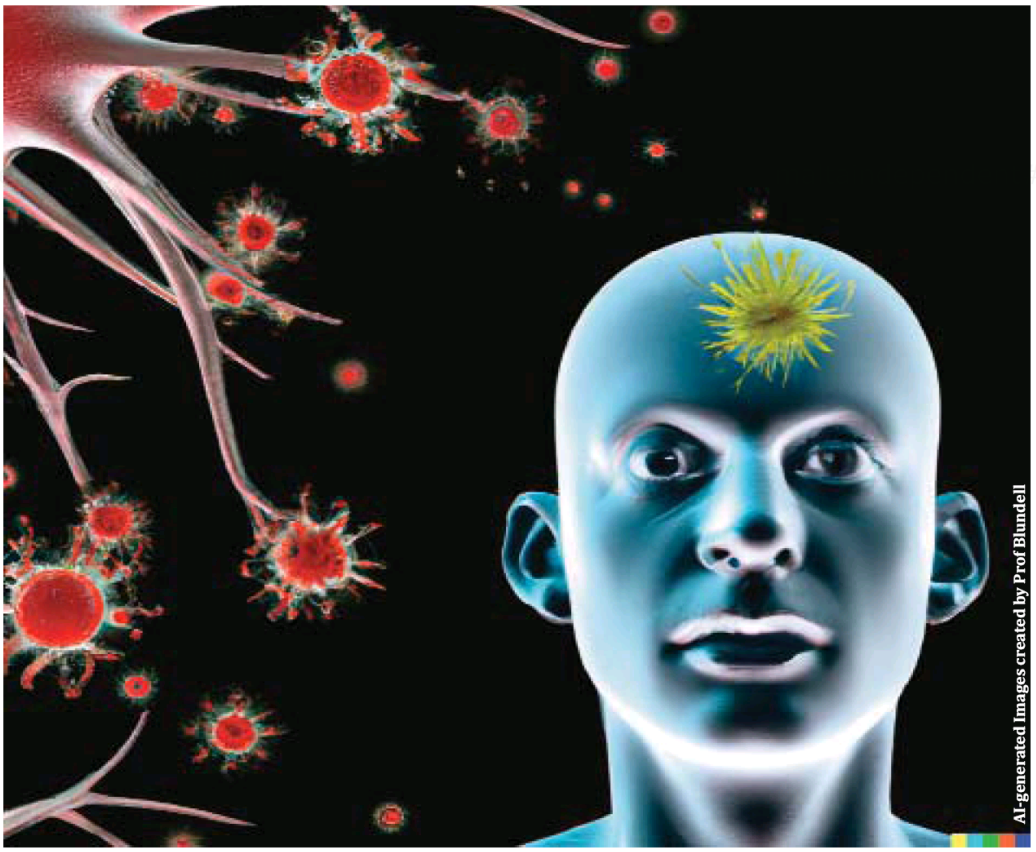
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SARS-COV-2 (the virus responsible for Covid-19) has caused global unrest by creating a global pandemic. Covid-19 is considered a respiratory virus and for good reason as the symptoms are most often focused on the lungs and respiratory tract. However, as more research is being done on the effects of the virus in humans, it is becoming more apparent that SARS-COV-2 can target multiple areas of the body including the nervous system.

To understand the effects of Covid-19 on the nervous system we must first discuss the basics of viral infection. Viruses are essentially small bits of genetic information surrounded by a protein shell. The virus itself has no way of producing more of itself on its own, thus in order to replicate it needs to infect a cell. It does this by entering a cell and hijacking the host cell's components to focus on making more viruses. In order for this process to begin the virus has to find a way to enter the cell. Viral binding to the host cell is primarily done by attaching on one of the many molecules present on the cell's outer covering. Viruses then use such surface molecules as an anchor point to enter the host cell. Once inside the host cell the virus replicates and the newly formed viruses leave the host cell to infect the surrounding cells, resulting in a rapid increase in viral growth.

It is worth noting that viruses are only able to recognise a limited number of surface molecules which is why certain viruses can only infect certain tissues in the human body. Thus, if a given cell does not express the molecular target of the virus it cannot infect the cell. In the case of SARS-COV-2 its target is known as the ACE-2 receptor. This receptor is abundantly present in the cells lining our respiratory tract, however, it is also expressed by a wide variety of cells throughout our body. In fact, Covid-19 has been detected in organs such as the kidney and the heart, however the effects Covid-19 has on these organs are still being determined.

Increasing evidence is also showing that Covid-19 can also affect the nervous system. For instance Covid-19 has often been associated with anosmia and ageusia (which refer to the loss of smell and taste respectively.) This is not surprising given that a lot of respiratory viruses can induce these symptoms by stimulating the production of mucus This mucus blocks your nose dulling your sense of smell. As for the taste, patients do not actually lose their sense of taste, but rather perceive their taste to be dulled due to the lack of smell.

However, in the case of Covid-19 anosmia has been shown to occur independently of a runny nose and ageusia has been documented without anosmia, contrary to what is normally reported with "ordinary" respiratory viruses. This can be explained by the fact that the nerve cells which are responsible for detecting smell and taste have ACE-2 receptors, suggesting SARS-COV-2 directly infects these nerve receptors, inhibiting them from carrying out their normal functions.

Infection of nerves responsible for smell and taste receptors can provide a direct pathway for the virus to migrate to the brain, since these nerves are known as cranial nerves meaning that they originate directly from the brain. This hypothesis has not yet been demonstrated in the case SARS-CoV-2, but migration of a similar virus (SARS-COV, the virus responsible for SARS) has been demonstrated clearly.

Another good example of the effects of Covid-19 on the central nervous system is the generation of seizures. Seizures can be defined simply as an aberrant over excitation of certain neurons in the brain. These can be brought about by interfering with neural stimulation, such as by high alcohol intake or even a high fever. The high levels of inflammation caused by Covid-19 are thus the likely cause as it interferes with neural stimulation to result in a seizure. However, this inflammatory damage can also result in generalised damage to the CNS namely in the form of encephalopathy. This is evident in the severe mood changes and states of confusion found in some Covid-19 patients who also present with high levels of brain damage.

ACE-2 receptors are also present in the brain blood vessels. This makes the virus able to directly damage the brain's blood vessels resulting in an increased likelihood – a block forms in the blood vessels. These blockages make the vessel more likely to burst open which is exactly what occurs in a stroke. This is likely responsible for the increased incidence of strokes detected in sufferers of Covid-19.

Zooming out into the broader nervous system where further examples of neuro-Covid interactions can be observed. For instance, inflammation in the eye referred to as optic neuritis – this can cause temporary vision loss as well as severe pain when moving the eye. This is likely due to inflammation, however interestingly this process has also been linked to the production of specific proteins by the immune system known as antibodies. This means that the immune response to Covid-19 might produce molecules that attack the nervous system.

While these are medically relevant cases of Covid-19 affecting the CNS there are some limitations to consider. For a lot of these conditions such as strokes and seizures these only occur in a small percentage of Covid-19 patients who are already badly infected. The actual biological processes that lead to these conditions are still unknown. While it is likely is some combination of direct infection/inflammation whether one plays a bigger role than the other is unknown. Furthermore, it is also possible that the exact cause of the neural injury differs across patients. Whatever the case, further research is crucial to understand and thus treat the neurological effects of Covid-19.

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