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The interface of Vitamin C and Covid-19

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Abstract

Coronavirus (COVID-19) is a global public health problem The coronavirus disease (COVID-19) pandemic is now sweeping the globe, caused by the SARS-CoV-2 virus, which has changed to allow human-to-human transmission. Fever, dry cough, tiredness, severe pneumonia, respiratory distress syndrome, and mortality are all symptoms of infection. COVID-19 causes a systemic inflammatory reaction, also known as cytokine release syndrome, which damages the immune system. COVID-19 patients have a high level of pro-inflammatory cytokines and chemokines in their bodies. There are presently no anti-SARS-CoV-2 virus medicines or vaccinations available. COVID-19 affects the aged disproportionately, both directly and indirectly a multitude of age-related comorbidities. Nutrition is undeniably important in maintaining excellent health. Vitamin C is an antiviral agent because it boosts immunity. Vitamin C treatment improved the survival rate of COVID-19 patients by reducing the immune response's excessive activation. Vitamin C stimulates the production of antiviral cytokines and free radicals, lowering viral output. Excessive inflammatory responses and immune cell hyperactivation are also reduced. The importance and role of vitamin C in the management of covid-19 have been covered in this article.

Introduction: An overview

caused by the novel coronavirus SARS-CoV-2 and has been a major threat worldwide. It was first diagnosed in a group of patients with pneumonia symptoms in the city of Wuhan, China, in late 2019. Originally, it was named 2019 nCoV but later renamed COVID-19 by the World Health Organization. It is considered to be

similar to the Middle Eastern respiratory disease (MERS) and acute acute respiratory syndrome (SARS). The virus can be transmitted from person to person through respiratory drops, contact and worms. SARS-CoV-2 has two main types: 'type L' (70%) and 'S' (30%), and type L is the most aggressive and contagious [1,2]. Symptoms of COVID-19 vary having mild to severe manifestations and often include fever, dry cough, pneumonia, nausea, and severe respiratory illness [3].

Immune system protects the host from harmful natural agents especially pathogenic organisms, which can be in the form of bacteria, viruses, fungi or parasites. To deal with such a threat, the immune system has improved and it includes thousands of cell types, interconnected molecules and active responses. The immune system is always active, carrying without surveillance, but its function is enhanced if the person is infected. The enhanced activity of the immune system requires the availability of energy sources and nutrients. These sources of energy, substrates and ultimately regulating molecules are found in food, so food serves as a provision of a wide range of nutrients that is essential to support the immune system to function properly [4]. Activating the immune response triggers production of lipid-derived mediators such as prostaglandin and leukotrienes and many different types proteins include immunoglobulins, chemokines, cytokines, cytokine receptors, adhesion molecules and acute phase proteins. This requires the availability of a substrate fats and amino acids, respectively. Immune system the answer involves a large increase in cells, therefore to increase the number of immune cells available immune: this requires DNA, RNA, protein and complex lipid synthesis and readiness of substrates to support this. Metabolic machinery is involved energy production and biosynthesis requires a lot various vitamins and minerals such as cofactors. Amino acids (e.g., arginine) is a precursor to the production of polyamines, which play a role in regulating DNA replication and cell division. Other nutrients, such as vitamins A and D, and their metabolites are directly regulated of genetic expression in immune cells and play an important role on maturity, division and response of body cells. Construction of a pro-oxidant environment through the production of harmful oxygen species it is one part of the body's natural defenses; The host needs to be protected from this by old antioxidant vitamins (vitamins C and E) and antioxidant enzymes (superoxide dismutase, catalase and glutathione peroxidase); the latter require manganese, copper, zinc, iron and selenium. In fact, a healthy diet creates an environment in which the immune system responds to challenge in the right way, no matter what kind of challenge. On the other hand, malnutrition creates an environment in which the immune system is unable to respond well.

There are currently no approved treatments for COVID-19, but prevention strategies such as social distancing, public cleanliness, and wearing facial masks are the most effective current treatments. Nutritional supplements may help COVID-19 sufferers, according to new research. Higher-than-recommended daily doses of nutrients such vitamins D, C, E, Zinc, and omega-3 fatty acids may have a favourable effect, potentially lowering SARS-CoV-2 virus load and length of stay in the hospital [5]. The antioxidant and immunomodulatory activities of these nutrients are well-known. Immune dysfunction and increased preponderance to pathological infection can occur from deficiencies in certain nutrients. In fact, dietary vitamin and mineral deficiency has been documented in high-risk COVID-19 patients, such as the elderly, increasing morbidity and mortality risk [6]. It is generally established that the elderly are more likely to be nutrient deficient and have reduced immunity increasing their risk of poor COVID-19 related complication, hence emphasising the importance of appropriate nutrition in such subjects. The importance of Vitamin C in immunity, as well as their status in SARS-CoV-2 patients and their possible therapeutic function has been discussed.

The effect of Vitamin C

Acute respiratory distress syndrome, subsequent infection, and sepsis can all result from COVID-19. Sepsis and septic shock can be helped with an intravenous therapy of high-dose vitamin C. In patients with sepsis and acute respiratory distress syndrome, an intravenous infusion of vitamin C (50 mg/kg body weight) every 6 hours for 96 hours significantly reduced mortality and improved the number of ICU-free days compared to the control group. In another study, intravenous vitamin C, hydrocortisone, and thiamine for seven months dramatically reduced hospital mortality in septic patients when compared to the control group. Furthermore, there was no sepsis-related progressive organ failure, including acute kidney injury, in the therapy group. Treatment with vitamin C has shown promising antiviral effects. High doses of vitamin C have been found in clinical trials to be effective in fighting the common cold [7, 8]. When compared to the control group, a high-dose vitamin C treatment reduced flu and cold symptoms in patients. A meta-analysis found that giving high doses of vitamin C at the start of a cold reduced the length of the illness and alleviated symptoms like chest pain, fever, and chills. Vitamin C treatment improves viral infection resistance in animals, according to a study [7]. In vitro, the production of influenza virus type A was reduced by vitamin C and dehydroascorbic acid in Madin–Darby canine kidney (MDCK) cells generated from canine kidney cells [9, 10]. The antiviral impact of vitamin C may be mediated via free radical production or binding to the virus or components involved in viral replication, according

to the study. Vitamin C's antiviral impact could be linked to the generation of antiviral cytokines (IFN-α/β), the synthesis of free radicals, or direct binding to the virus.

Vitamin C may help patients with COVID-19 who have an overactive immune system. Infection with COVID-19 causes pulmonary and systemic inflammatory reactions [11]. The microbial infection leads macrophages to become too activated, resulting in the generation of inflammatory mediators and nitric oxide (NO), which are exacerbated by oxidative stress and NO [12]. When compared to healthy people, COVID-19 patients showed considerably greater amounts of inflammation-related chemicals in their blood, such as NO2, NO3, C-reactive protein, and lactate dehydrogenase. In four out of five patients, blood levels of NO3, methemoglobin, C-reactive protein, and lactate dehydrogenase were significantly reduced after oral or intravenous treatment of vitamin C with methylene blue and a recognised antioxidant N-acetyl cysteine [12]. In another trial, 17 individuals infected with COVID-19 received intravenous vitamin C at a dose of 1 g every 8 hours for 3 days. The patients had lower inflammatory indicators like ferritin and D-dimer after vitamin C treatment, as well as a quarter of their previous inspired oxygen requirements [13]. These findings imply that giving vitamin C to COVID-19 patients can help them live longer by reducing immune responses that are overly activated.

Vitamin C inhibits glyceraldehyde 3-phosphate dehydrogenase, which may prevent immune cells from becoming hyperactive (GAPDH) [14]. In activated myeloid and lymphoid cells, the glycolytic enzyme GAPDH can control the rate of glycolysis. Dehydroascorbate, the inactive form of vitamin C, can be metabolised both intracellularly and extracellularly. Dehydroascorbate is converted to ascorbate inside cells, whereas reduced glutathione (GSH) is oxidised. The nicotinamide adenine dinucleotide phosphate can reduce oxidised glutathione (glutathione disulfide) to GSH (NADPH). Vitamin C has antioxidant properties; nevertheless, large doses of vitamin C can have a pro-oxidant effect by reducing the activity of ROS scavenging mechanisms such as GSH and NADPH [15, 16]. Increased ROS can cause DNA damage, which is followed by poly(ADP-ribose) polymerase activation (PARP). NAD+ is used by PARP to make poly(ADP-ribose) for DNA repair. Because NAD+ is required for GAPDH activity, its depletion reduces GAPDH's enzymatic activity. As a result, inhibiting GAPDH with a high dose of vitamin C may limit immune cell activation by lowering adenosine triphosphate (ATP) generation in the cells. Vitamin C's effect on COVID-19 infection needs to be studied in clinical trials. From 14 February 2020 to 30 September 2020, a clinical trial was undertaken at Wuhan University's Zhongnan Hospital [17]. Patients were given 12 g of vitamin C in 50 mL of sterile water for 4 hours, then 12 g of vitamin C

in 50 mL of sterile water for another 12 hours; the total quantity of vitamin C given to each patient was 24 g/d. One of the earliest clinical trials to use intravenous vitamin C to treat COVID-19 was this one. The goal of the trial is to see if intravenous vitamin C can lower the risk of COVID-19-induced cytokine storms, enhance pulmonary function, and minimise the risk of acute respiratory distress syndrome.

Immunomodulatory role of Vitamin C

Vitamin C, often known as ascorbic acid, is a water-soluble nutrient that humans cannot produce. Vitamin C is an anti-oxidant that protects biomolecules including proteins, lipids, and nucleotides from oxidative damage and malfunction by scavenging reactive oxygen species (ROS). Vitamin C concentrations in leukocytes are 50 to 100 times higher than those in plasma. Vitamin C, which is found in leukocytes, is quickly depleted during infection. Multiple signalling pathways involving proinflammatory transcription factors, such as nuclear factor κB (NF-κB), can be disrupted when the equilibrium between antioxidant defences and oxidant production is disrupted. Increased oxidant levels activate NF-κB, which sets off a signalling cascade that result in increased synthesis of oxidative species and inflammatory mediators. NF-κB plays a role in inflammatory reactions, disease development, and viral infection. Inhibition of NF-κB may be used as a treatment option. Vitamin C is widely known for its ability to protect against infectious disease. Supplementation has been shown to strengthen respiratory defence mechanisms, reduce the length and severity of viral infections, and have anti-histamine characteristics that can help with flu-like symptoms. Vitamin C therapy lowers the severity and duration of pneumonia in older people [18]. Patients with acute respiratory infections such as pneumonia or tuberculosis have lower plasma vitamin C concentrations. COVID-19 is interested in this crucial preventive action against respiratory infections.

Immune responses of Vitamin C in Covid-19

Vitamin C has been suggested as a counter to the cytokine storm that occurs after COVID-19 infection as the disease progresses. For example, after infection, the pro-inflammatory cytokines IL-1 and TNF- rise immediately, and the acute reaction elicited by this drives additional secretion of IL-6 and IL-8, resulting in a proinflammatory state that persists. TNF- is being studied to see whether it can help SARS-CoV-2 enter host cells more easily [19]. TNF-α and other pro-inflammatory cytokines are known to be reduced by vitamin C, whereas anti-inflammatory cytokines are increased (IL-10). Clinical trials have been conducted. Vitamin C intake of 1

gram per day was shown to boost IL-10 levels. secretion by mononuclear cells in the peripheral blood IL-10 is a protein that acts as a signalling molecule. Inflammation is controlled by a negative feedback loop including IL-6. COVID-19 is particularly dangerous for the elderly, as they are more prone to infection. due to immunosenescence and poor immune cell function [20]. COVID-19 patients had an increased risk of pneumonia, according to research. Following intravenous treatment of vitamin C, improvements in inflammatory biomarkers and several respiratory measures were observed in another small trial. A case study of a female treated with high-dose vitamin C after developing Acute Respiratory Disease Syndrome was able to be taken off of ventilator after just 5 days, which was considered exceptionally early, but it should be emphasised that she was also given anti-viral drugs [21, 22]. Vitamin C has also been linked to sepsis subsequent to pneumonia, as demonstrated by COVID-19. Unpublished data suggests that high-dose vitamin C administration had therapeutic effects in 50 Chinese patients with severe symptoms, albeit this needs to be confirmed [23]. As a result, vitamin C supplementation can help prevent and sustain immunological responses in people who are low in micronutrients and are at risk of COVID-19 infection. To that purpose, Vitamin C supplementation in COVID-19 patients is being studied in a number of clinical trials.

Conclusion

Nutritional therapy should be included in patient care to help patients survive this life-threatening condition (COVID-19) and recover faster. Most notably, preventing malnutrition and providing adequate nutritional supplementation are essential for the immune system's normal functioning in the human body. Malnourished patients are more likely to come from lower socioeconomic groups; as a result, nutrition supplementation is critical for those at risk, as well as elderly persons with a weakened immune system. The role of vitamin C and its interaction in immune augmentation during Covid-19 infection was the subject of this review. Its immunomodulatory capabilities have also been examined, as well as the implications. Some clinical trials have been registered and are now being carried out to test the efficacy of specific nutrients in COVID-19 patients. The findings of these trials could hopefully shed light on the utilisation of micronutrients during SARS-CoV-2 infection. Overall, considering the low risk profile of supervised nutritional supplementation compared to the known and potential benefits, it looks important to guarantee adequate, if not increased, intake of these critical vitamins and minerals in those at risk of COVID-19 and those who are already suffering from it.

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Conflict of Interest

The author has no conflict of interest.

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