Finding Out The Neurological Consequences Of Covid-19

Alves A.I.[1☼], Freitas C.[2], Viveiros A.[3], Ribeiro L.[4], Faria S.[5], Faria J.[6], Freitas D.[7], Faria R.[8]

1. MSc of in Food Consumption Science, MSc and Specialist in Medical-Surgical Nursing, DSc in Nursing, functions in the Intensive Care Unit of Hospital Dr. Nélio Mendonça, Funchal, Madeira, Portugal.
2. Specialist in Medical-Surgical Nursing, DSc in Nursing, Accessor of the Health Secretary of Madeira Island, functions in the Intensive Care Unit of Hospital Dr. Nélio Mendonça and in Pré-hospitalar Emergency, Funchal, Madeira, Portugal.
3. MSc DSc in Management in Nursing, Specialist in Medical-Surgical Nursing and in Intensive Care and Resuscitation, Chief of the Intensive Care Unit of Hospital Dr. Nélio Mendonça, Funchal, Madeira, Portugal.
4. Specialist in Medical-Surgical Nursing, DSc in Nursing, Nurse Coordinator of the Civil Protection Emergency Service, functions in the Intensive Care Unit of Hospital Dr. Nélio Mendonça, Funchal, Madeira, Portugal.
5. Specialist in Mental Health Nursing, DSc in Nursing, functions in Casa de Saúde S. João de Deus and in the Intensive Care Unit of Hospital Dr. Nélio Mendonça, Funchal, Madeira, Portugal.
6. Specialist in Nursing Medical-Surgical Nursing, DSc in Nursing, functions in Intensive Care Unit of Hospital Dr. Nélio Mendonça, Funchal, Madeira, Portugal.
7. Specialist in Medical-Surgical Nursing, DSc in Nursing, functions in Civil Protection Emergency Service and in the Emergency Service of Health Centre of Machico,, Madeira, Portugal.
8. Specialist in Nursing Medical-Surgical Nursing, DSc in Nursing, functions in Civil Protection Emergency Service and in the Emergency Service of Hospital Dr. Nélio Mendonça, Funchal, Madeira, Portugal.

☼**Corresponding author:** Alves AI, e-mail: anaigalves@gmail.com

DOI: 10.29322/IJSRP.11.01.2021.p10905
http://dx.doi.org/10.29322/IJSRP.11.01.2021.p10905

Abstract- Introduction: Since the first official case of COVID-19 in China in December 2019, researchers have been trying to uncover the mechanism of action of the severe acute respiratory syndrome Coronavirus 2 (Sars-CoV-2), which attacks several organs in addition to the lungs and causes circulatory changes that can lead to death not only from lung failure but also due to commitment of other organs. Objective: The aim of this study is to find out the neurological consequences of COVID-19. Material and methods: A systematic review of the literature was concretised by mobilizing the descriptors: "Sars-Cov-2", "coronavirus infections" and "Neurological Consequences". Databases were selected and seven articles were included for analysis. Results and discussion: Although the effects of Sars-CoV-2 on the lung are exemplary and frightening, the long-term effects on the nervous system may be greater and even more overwhelming, as the regeneration of nerve tissue is difficult and can lead to general disability, as the nervous system coordinates the functions of the entire body. All studies show the presence of any kind of injury (mild or severe) to Central Nervous System, but some of them highlight the need for further studies to have great certainty. Conclusion: It can be said that the studies all agree on the possibility of existing neurological sequelae and a majority agree on the need for other studies.

Keywords: "Sars-Cov-2", “Coronavirus infections” and "Neurological consequences"

I. INTRODUCTION

A new variant of coronavirus, Sars-CoV-2, which began in Wuhan, China, at the end of 2019, has since spread worldwide. The virus has caused an outbreak of viral pneumonia known as coronavirus disease (COVID-19). By February 6, 2020, more than 31000 cases and 636 deaths had been confirmed in China on January 23, 2020. The Chinese authorities imposed a lockdown of Wuhan (National Health Commission of the People's Republic of China (NHCPRC), 2020). On January 30, 2020, the World Health Organization (WHO) declared the outbreak to be Public Health Emergency of International Concern (World Health Organization (WHO), 2020) and on March 11, 2020, a pandemic (WHO, 2020).

The WHO (2020), the United States Centers for Disease Control and Prevention (United States Centers for Disease Control and Prevention (USCDC, 2019), the European Center for Disease Prevention and Control (ECDC, 2020) and Chinese researchers have issued several guides or guidelines to help control the outbreaks.
Sars-CoV-2 has elevated transmissibility and an asymptomatic incubation period during which transmission may develop (Huang et al. 2020; Rothe et al. 2020). Due to its peculiarities, more than 200 countries were affected by this disease by 19 June 2020 (Centers for Disease Control and Prevention, 2020), resulting in the most relevant pandemic in current history.
Previous publications have highlighted that coronavirus infections of severe acute respiratory syndrome and Middle East respiratory syndrome (MERS) have led to an increased prevalence of long-term neurological effects (Hong at al., 2020, Lee et al., 2020).
When the pandemic COVID-19 shot around the globe, it suddenly became clear that it was not an average respiratory disease. The disease occurs and affects a number of body systems, including the heart and brain. At the beginning of the pandemic, there were reports that many people with the disease had lost their sense of smell, a strange symptom that suggests the virus could affect the nervous system. As more people became infected, there were reports of strokes and other neurological complexes. It is not yet clear how common neurological side effects are in hospitalized patients, let alone in people with less severe respiratory symptoms who do not spend time in hospital (Weir, 2020). Despite all efforts in this direction, there is certainly still much to discover in this context.

II. MATERIALS AND METHODS

A systematic review of the literature is one of the research methods used in the practice of evidence-based research, and its purpose is to collect and summarize research findings on a particular topic in a systematic and orderly manner, thereby contributing to knowledge about the topic (Mendes et al., 2008; Benefield, 2003). The method used was based on the strategy PICO (acronym for patient, intervention, comparison and "outcomes"). In this way it maximizes the inclusion of relevant information in different databases, focusing on the research object and avoiding unnecessary searches (Santos, Pimenta e Nobre, 2007).
In strict compliance with all the steps required for the application of this method, a protocol was developed between September and November 2020 to identify studies of interest for this work, consisting of a search in the search engines: Ebsco and B-ONline and in the following databases: CINAHL Plus, PubMed/ MEDLINE, LILACS, Scielo, Web of Science, ScienceDirect and Repository of Scientific Open Access of Portugal.
A search strategy using the following descriptors was used to identify relevant studies: "Sars-Cov-2" and "Coronavirus infections" and "Neurological Consequences". After all these protocol requirements were met, some articles that did not meet the requirements were discarded and a reductive procedure was developed methodically.

III. RESULTS

Seven articles have been selected for the study, which follow in Table 1.
Table 1: Description of selected studies and main results of the investigations

Study (S)	Author(s)/ Year	Main Results
S1: Neurological consequences of COVID-19: what have we learned and where do we go from here?	Abbas Jarrahi, Meenakshi Ahluwalia, Hesam Khodadadi, Evila da Silva Lopes Salles, Ravindra Kolhe, David C. Hess, Fernando Vale, Manish Kumar, Babak Baban, Kumar Vaibhav, Krishnan M. Dhandapani, 2020	-COVID-19, caused by the recent Sars-CoV-2 virus, is associated with a broad pathophysiology that has led to global mortality and morbidity. -Although Sars-CoV-2 is primarily considered a respiratory virus, it causes far-reaching and sometimes unpredictable neurological symptoms ranging from anosmia to encephalitis and an increased risk of stroke. -Improved advances, validation and implementation of rapid imaging techniques, such as magnetic resonance imaging (MRI), can contribute to early diagnosis and proactive intervention to limit the long-term neurological consequences. -Study proposes a future analysis defining whether Sars-CoV-2 exhibits neurotropism and/or initiates peripheral immune activation and hypercoagulation to impair brain function, which will be of paramount importance for the development of effective therapies to mitigate the deleterious neurological consequences of COVID -19, including potential benefits in the treatment of acute respiratory failure.

S2: The emerging spectrum of COVID-19 neurology: clinical, radiological and laboratory findings	Ross W Paterson, Rachel L Brown, Laura Benjamin, Ross Nortley, Sarah Wiethoff, Tehmina Bharucha, Dipa L Jayaseelan, Guru Kumar, Rhian E Raftopoulos, Laura Zambreanu, Vinojini Vivekanandam, Anthony Khoo, Ruth Geraldes, Krishna Chinthapalli, Elena Boyd, Hatice Tuzlali, Gary Price, et al., 2020	-COVID-19 infection is associated with a wide range of neurological syndromes that affect the entire neuraxis, including the cerebral vessels and in some cases the response to immunotherapy. -The high incidence of acute disseminated encephalomyelitis, particularly with haemorrhagic changes, is striking. This complication was not related to the severity of the respiratory disease COVID -19. Early detection, examination and treatment of the neurological disease associated with COVID -19 is a challenge. -They suggest that further clinical, neuroradiological, biomarker-based and neuropathological studies are essential to determine the underlying pathobiological mechanisms that will guide treatment. To determine the long-term neurological and neuropsychological consequences of this pandemic, longitudinal follow-up studies are needed.
S3: Effects of COVID-19 on the Nervous System	Costantino Iadecola, Josef Anrather, Hooman Kamel, 2020	-It cloud concluded that the neurological manifestations of COVID -19 pose a major public health challenge, not only because of the acute effects on the brain, but also because of the long-term damage to brain health that may result. -These delayed manifestations are expected to be significant, as they are likely to affect patients who did not show neurological symptoms in the acute phase. -Therefore, clinical and laboratory efforts to elucidate the mechanisms of the acute effects of Sars-CoV-2 on the brain must be coupled with studies of the deleterious delayed neuropsychiatric consequences of the infection.
S4: COVID-19 Neurological Manifestations and Underlying Mechanisms: A Scoping Review	Angela Wenting, Angélique Gruters, Yindee van O, Sonja Verstraeten, Susanne Valentijn, Rudolf Ponds and Marjolein de Vugt, 2020	-Was concluded that neurological manifestations of COVID -19 vary from mild, such as headaches and dizziness, to severe, such as ischemic stroke and encephalitis. It is believed that the underlying mechanisms of CNS involvement are both direct (neurotropic) and indirect (as a result of thrombotic complications, inflammatory consequences, hypoxia, blood pressure dysregulation). No literature was found on the cognitive consequences of COVID -19. -Therefore cross-sectional and longitudinal studies are necessary. A neuropsychological assessment could be used to monitor the course of cognitive functions after recovery from COVID -19. -This should be conducted not only in inpatients COVID -19 but also include community-based studies in adults and children recovered from COVID -19.
S5: Neurological Implications of COVID-19 Infections	Edward J. Needham, Sherry H.-Y. Chou, Alasdair J. Coles, and David K. Menon, 2020	-Study indicates that although corona viruses are not a common cause of neurological disease, they are reported to cause direct CNS infection and suspected parainfectious disorders. More than one million cases of confirmed COVID -19 have been reported worldwide, and although there is little definitive evidence, new publications and preprints justify a careful review of the neurological links with infection from COVID -19. -The symptoms described (dizziness, headache and loss of consciousness) are common in many serious infections and are more likely to be disorders of neurological function than a neurological disorder per se. Anosmia and ageusia have received much attention, but are omnipresent in other common upper respiratory tract infections. -Risk for cerebrovascular disease was replicated in another preprint, the incidence was similar to critical illness in a broader sense. Another case report documented necrotising encephalopathy in conjunction with COVID -19, but without evidence of viral isolation from cerebrospinal fluid (CSF). -A greater concern than direct viral invasion of the CNS may be para-infectious neurological diseases such as Guillain-Barré syndrome, transverse myelitis or acute disseminated encephalomyelitis may be a greater problem than direct viral invasion of the CNS. -Patients with neurological complications may require lengthy intensive care stays and may place an additional burden on already overburdened facilities.
S6: Neurological manifestations and implications of COVID-19 pandemic	Georgios Tsivgoulis, Lina Palaiodimou, Aristeidis H. Katsanos, Valeria Caso, Martin Köhrmann, Carlos Molina, Charlotte Cordonnier, Urs Fischer,	-Research results from the current pandemic are accumulating and reporting COVID -19 patients who presented with dizziness, headache, myalgia, hypogesia and hyposmia, but also with more serious manifestations such as polyneuropathy, myositis, cerebrovascular disease, encephalitis and encephalopathy. -However, it is often difficult to differentiate between causality and accidental comorbidity.

	Peter Kelly, Vijay K. Sharma, Amanda C. Chan, Ramin Zand, Amrou Sarraj, Peter D. Schellinger, Konstantinos I. Voumvourakis, Nikolaos Grigoriadis, Andrei V. Alexandrov, and Sotirios Tsiodras, 2020	-Severity COVID -19 shares common risk factors with cerebrovascular disease, and it is currently unclear whether infection in itself is an independent stroke risk factor. -Irrespective of any direct or indirect neurological manifestations, pandemic COVID -19 has a huge impact on the management of neurological patients, whether infected or not.
S7: Neurological associations of COVID-19	Mark A Ellul, Laura Benjamin, Bhagteshwar Singh, Suzannah Lant, Benedict Daniel Michael, Ava Easton, et al., 2020	-The study reveals that, given the existing knowledge about other coronavirus and respiratory viruses, the broad spectrum of CNS associations with COVID -19 is not surprising, and this is the focus of most recent reports. -Case-control studies will be required to determine whether Sars-CoV-2 occurs causally or randomly in such patients. Hypercoagulable states and cerebrovascular disease, rarely observed in some acute viral infections, are an important neurological complication of COVID -19. -Neurological complications, particularly encephalitis and stroke, can lead to lifelong disability, with the associated need for care and potentially high health, social and economic costs. Health planners and decision-makers in the health care sector need to be aware of the growing burden. -Careful clinical, diagnostic and epidemiological studies are needed to define the neurological disease manifestations and burdens.

IV. DISCUSSION

Recent publications in the New England Journal of Medicine and Brain document neurological symptoms in patients with COVID-19. They range from simple cognitive difficulties to mental confusion, as well as headache, loss of smell, but also encephalitis, bleeding, thrombosis, ischaemic stroke and Guillain-Barre Syndrome (a disorder in which the immune system attacks the nerves of the body), neurological conditions that are not always correlated with the severity of respiratory symptoms (Comoli, Fukugava, Matos, 2020). This information is confirmed by all studies, in particular S1, S2, S4, S5, S7. However, none of these studies detected a virus in CSF, as in the S2 and S5 studies, where the results were negative for the presence of CSF.

Where a number of neurological manifestations were reported, in a review of case reports from 901 COVID -19 patients, including loss of sense of smell and taste, confusion, encephalitis and Guillain-Barré syndrome. A case report of 58 patients from France retained neurological findings in 67% of patients (Helms, et al., 2020). The symptoms are manifold, including headache, dizziness, weakness, confusion, eye movement disorders, seizures and paralysis. This fact is confirmed by all studies. The two most common neurological problems appear to be stroke and delirium (Fotuhi, 2020). This is particularly true for studies S1, S2, S4, S5 and S7.

People who need intensive care are more likely to have long-term cognitive problems and an increased risk of anxiety and depression. A study conducted before COVID-19 found that 20-40% of patients in intensive care units suffered from delirium, with rates rising to 60-80% in patients on ventilators (Pandharipande et al., 2017). It is assumed that such complications are related to both a serious illness and intensive care treatment. Some of the people with COVID -19 severe illness are likely to suffer from delirium and other neurological side effects from their stay in intensive care alone (Stevens, 2020). As stated in S5 and S7.

There are some reports of the virus appearing in the CSF, which increases the potential for Sars-CoV-2, the virus that causes COVID -19, to be able to directly infect brain cells. These facts speak against the S2 and S5 studies. But evidence that the virus can find its way into brain cells is still uncertain (Fotuhi, 2020; Stevens, 2020). As all the studies have concluded, further studies are needed.

Today, as we are still experiencing the pandemic and its effects, it is too early to describe the full clinical picture. However, it is believed that the published evidence has already proven to be an indisputable case for medicine to identify the growing number of ex-patients with post-COVID Neurological Syndrome and the need for continuous neurological and cognitive/effective monitoring of all cases (regardless of severity from asymptomatic, mild to severe) (Wijerate, Sales,

Crewther et al., 2020). As emphasised in all studies, the S3 study in particular emphasises the importance of continuous monitoring of 19 patients after delivery, including patients who have not been admitted to a health care unit.
Recent publications highlight new evidence of a new syndrome, Post-COVID-19 Neurological Syndrome (PCNS), specifying patients with long-term muscle weakness and other forms of myopathy among survivors of Sars-CoV-2 in Hong Kong (Chang et al., 2003). It is also worth noting that the more delayed effects of Sars-CoV-2 infection affect the nervous system and its combined effect on mental status.
A further study of 714 COVID -19 patients in China found that almost 97% of patients exhibited symptoms of severe posttraumatic stress disorder (Bo et al., 2020). As the S7 study found, the experience can be disabling and restrictive for the rest of the patients' lives.
The prevalence of neurological problems remains an open question, but it is certain that neurological injuries are not uncommon in OVC-19 patients (Fotuhi, 2020). This is undoubtedly the sentence that answers the aim of this review and contradicts all the manuscripts analysed.

V. CONCLUSION

Regarding the results of the studies analysed, it can be stated that all studies agree on the possibility of existing neurological consequences and on the need for other studies. Possible neurological lesions vary in the studies and may be mild or severe. The pandemic COVID-19 is a serious global public health challenge. Since the first appearance of a novel coronavirus in late 2019, Sars-CoV-2 has spread recklessly and affected almost every aspect of society worldwide, with a broad pathophysiology that has led to global mortality and morbidity. Although Sars-CoV-2 is primarily considered to be a respiratory virus, it produces far-reaching and often unpredictable neurological symptoms ranging from anosmia to encephalitis to an increased risk of stroke, making clinical treatment difficult. Improved development, validation and implementation of rapid imaging techniques, such as MRI, can help with early diagnosis and proactive intervention, including long-term neurological consequences.
New studies based on biological variables such as gender, age, comorbidities (e.g. hypertension, diabetes), pre-existing neurological disorders and other yet undefined genetic polymorphisms determine the clinical course of Sars-CoV-2 infection. This unbiased, population-wide research will provide valuable information that will guide practice in dealing with COVID-19 and help in managing future pandemics.

REFERENCES

1. Benefield, L. (2003). Implementing evidence-based practice in home care. Home Healthcare Nurse, 21, 804-811.
2. Bo H., Li W., Yang Y., Wang Y., Zhang Q., Cheung T., et al. (2020). Post-traumatic stress symptoms and attitude toward crisis mental health services among clinically stable patients with COVID-19 in China. Psychol. Med. 1-2.
3. Centers for Disease Control and Prevention (CDC). (2020). World Map. https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/world-map.html.
4. Chan K., Zheng J., Mok Y., Li Y., Liu Y., Chu C., et al. (2003). SARS: prognosis, outcome and sequelae. Respirology. 8: 36-40.
5. Comoli, E., Fukugava E., Lucilius C. (2020). Sequelas em pacientes recuperados de Covid-19 podem persistir por longo período24. AtualidadescoronavírusLab-19
6. Ellul M., Benjamin L., Singh B., Lant S., Michael B., Easton A., et al. (2020). Neurological associations of COVID-19. Lancet Neurol, doi: 10.1016/S1474-4422(20)30221-0.
7. European Centre for Disease Prevention and Control (ECDC). (2020). Contact tracing: Public health management of persons, including healthcare workers, having had contact with COVID-19 cases in the European Union. Stockholm: ECDC. https://www.ecdc.europa.eu/en/publications-data/public-health-management-persons-having-had-contact-novel-coronavirus-cases
8. European Centre for Disease Prevention and Control (ECDC). (2020). Infection prevention and control for the care of patients with 2019-nCoV in healthcare settings. Stockholm: ECDC. https://www.ecdc.europa.eu/en/publications-data/infection-prevention-and-control-care-patients-2019-ncov-healthcare-settings
9. Fotuhi, Majid et al. (2020). Neurobiology of COVID-19, Journal of Alzheimer's Disease. 76 (1)3-19.
10. Helms J. , Kremer S., Merdji H., Clere-Jehl R., Schenck M., Kummerlen C., et al. (2020). Neurologic features in severe SARS-CoV-2 infection. N Engl J Med; 382: 2268–70.

11. Hong K., Lee K., Chung J., Shin K., Choi E., Jin H., et al. (2020). Clinical features and outcomes of 98 patients hospitalized with SARS-CoV-2 infection in Daegu, South Korea: a brief descriptive study.Yonsei Med. J. 61:431-437.
12. Huang, L., Zhang, X., Zhang, X., Wei, Z., Zhang, L., Xu, J., et al. (2020). Rapid asymptomatic transmission of COVID-19 during the incubation period demonstrating strong infectivity in a cluster of youngsters aged 16-23 years outside Wuhan and characteristics of young patients with COVID-19: a prospective contact-tracing study. Journal of Infection, 80(6)1–13.
13. Iadecola C., Anrather J., Kamel H., (2020). Effects of COVID-19 on the Nervous System. Science Direct. 183(1)16-27. https://doi.org/10.1016/j.cell.2020.08.028
14. Jarrahi A., Ahluwalia M., Khodadadi H., Salles E., Kolhe R., Hess D., Vale F., Kumar M., Baban B., Vaibhav K., Dhandapani K. (2020). Neurological consequences of COVID-19: what have we learned and where do we go from here? Journal of Neuroinflammation. 17, 286.
15. Lee S., Kang W., Cho A., Kim T., Park J. (2018). Psychological impact of the 2015 MERS outbreak on hospital workers and quarantined hemodialysis patients. Compr. Psychiatry. 87:123-127.
16. Mendes, A., Fracolli, L. (2008). Revisão sistemática de literatura e metassíntese qualitativa: considerações sobre sua aplicação na pesquisa em enfermagem. Texto Contexto Enfermagem, 17(4), 771-778.
17. National Health Commission of the People's Republic of China (NHC PRC) (2020). Timeline of China's fight against the novel coronavirus. Beijing: NHC PRC. http://en.nhc.gov.cn/2020-03/20/c_78021.htm
18. Needham E., Chou S., Coles A., Menon D. (2020). Neurological Implications of COVID-19 Infections. Neurocrit Care. 32(3):667-671. doi: 10.1007/s12028-020-00978-4.
19. National Health Commission of the People's Republic of China (NHC PRC) (2020). Daily briefing on novel coronavirus cases in China. Beijing: NHC PRC. http://en.nhc.gov.cn/2020-02/07/c_76323.htm
20. Paterson R., Brown R., Benjamin L., Nortley R.,, Wiethoff S., Bharucha T., Jayaseelan D., Kumar G., Rhian et al. (2020). Show more Author Notes The emerging spectrum of COVID-19 neurology: clinical, radiological and laboratory findings Brain. 143(10)3104–3120. https://doi.org/10.1093/brain/awaa240
21. Pandharipande P., Ely W., Arora R., Balas M., Boustani M., La Calle G., Cunningham C., Devlin J., Elefante J., Han J., MacLullich A., Maldonado J., et al. (2017). The intensive care delirium research agenda: a multinational, interprofessional perspective, Intensive Care Med. 43(9):1329-1339. doi: 10.1007/s00134-017-4860-7.
22. Rothe, C., Schunk, M., Sothmann, P., Bretzel, G., Froeschl, G., Wallrauch, C., et al. (2020). Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. New England Journal of Medicine, 382(10), 970–971.
23. Santos, C., Pimenta e Nobre, C. (2007). A estratégia pico para a construção da pergunta de pesquisa e busca de evidências. Revista Latino-Americana Enfermagem, 15(3), 508-511.
24. Stevens R. (2020). How Does Coronavirus Affect the Brain? Johns Hopkins Medicine Home. https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/how-does-coronavirus-affect-the-brain
25. Tsivgoulis G., Palaiodimou L., Katsanos A., Caso V., Köhrmann M., Molina C., Cordonnier C., Fischer U., Kelly P., Sharma V., Chan A., et al. (2020). Neurological manifestations and implications of COVID-19 pandemic. Ther Adv Neurol Disord. doi: 10.1177/1756286420932036
26. United States Centers for Disease Control and Prevention (US CDC). (2019). Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed 2019 Coronavirus Disease 2019 (COVID-19) in Healthcare Settings. Atlanta: US CDC. https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html
27. United States Centers for Disease Control and Prevention (US CDC). (2019). Interim Guidance for Implementing Home Care of People Not Requiring Hospitalization for Coronavirus Disease 2019 (COVID-19). Atlanta: US CDC. https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-home-care.html
28. Wijeratne T., Sales C., Karimi L., Crewther S. (2020). Acute ischemic stroke in COVID-19: a case-based systematic review.Front. Neurol. 11 (1031).
29. Wijeratne T.,Sales C.,Crewther S.G. et al. (2020). First Australian case of good recovery of a COVID-19 patient with severe neurological symptoms post prolonged hospitalization. Cureus; 10(12):10366-10377https://doi.org/10.7759/cureus.10366
30. Weir, K. (2020). How COVID-19 attacks the brain, Researchers are scrambling to understand just how COVID-19 impacts the brain and what scientists can do to prevent long-term damage. 51,8.

31. Wenting A., Gruters A., Van O Y., Verstraeten S., Valentijn S., Ponds R., de Vugt M. (2020). COVID-19 Neurological Manifestations and Underlying Mechanisms: A Scoping Review. Review Article. Front. Psychiatry. https://doi.org/10.3389/fpsyt.2020.00860
32. World Health Organization (WHO). Coronavirus disease (COVID-19) outbreak situation. (2019) Geneva: WHO. https://www.who.int/emergencies/diseases/novel-coronavirus-2019
33. World Health Organization (WHO). (2020). WHO Director-General's opening remarks at the media briefing on COVID-19. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020.
34. World Health Organization (WHO). (2020). Infection prevention and control during health care when novel coronavirus ((nCoVinfection is suspected. Interim guidance. Genev a: WHO. https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125
35. World Health Organization (WHO). (2020). Home care for patients with suspected novel coronavirus ((nCoV infection presenting with mild symptoms and management of contacts. Interim guidance. Version 1. Geneva: WHO. Available from: https://reliefweb.int/sites/reliefweb.int/files/resources/20200120-ncov-home-care-infected-patients.pdf
36. World Health Organization (WHO). (2020). Risk communication and community engagement (RCCE) readiness and initial response for novel coronaviruses (nCoV): Interim guidance. Geneva https://apps.who.int/iris/handle/10665/330377
37. World Health Organization (WHO). (2019). Laboratory testing of 2019 novel coronavirus (2019-nCoV)in suspected human cases. Interim guidance. Geneva: WHO. https://www.healthynewbornnetwork.org/hnn-content/uploads/Interim-laboratory-eng.pdf