

The Impact of COVID 19 on Neuropsychological Functions: Implications for Cognitive Neurorehabilitation

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Coronaviruses belong to a large family of viruses that usually cause upper respiratory tract illness, such as the common cold. Seven coronaviruses have been identified of which four cause only mild to moderate disease. Three of these cause more serious disease leading even to fatality. These include, MERS (Middle East Respiratory Syndrome), SARS (Severe Acute Respiratory Syndrome), and SARS-Covid-2, which is the name for the new virus causing the current pandemic. The illness caused by SARS-Covid-2 is known as Covid-19, which emerged from China in December 2019 and was officially declared a global pandemic by the World Health Organization on March 11, 2020 [1]. Like any global pandemic, the virus has rapidly spread throughout the world and has resulted in severe and devastating illness, and death, with wide-ranging public health implications [2].

COVID-19 presents mainly with high fever, shortness of breath, chills and cough, and may result in acute respiratory distress [2]. Although characterized predominantly by respiratory symptoms, there is evidence that the SARS-CoV-2 virus, like other known human coronaviruses has Central Nervous System (CNS) involvement, that directly affects the brain, either through infection or inflammation-based mechanisms, and numerous secondary neurological effects. These neurological symptoms that may be secondary to both neuroinvasive and neurovirulent mechanisms, include meningo-encephalitis encephalopathy, ischaemic stroke, and Guillain-Barre' syndrome [2]. Additionally, based on radiological studies infarcts, microhaemorrhages, and features of posterior reversible encephalopathy syndrome, or nerve root enhancement have been identified [2,3]. Besides the well-acknowledged neurological symptoms, patients recovering from COVID-19 may also present with cognitive, behavioural and emotional difficulties that may require a referral to clinical neuropsychological, behavioural neurology and/or neuropsychiatric services.

Although the number of persons affected by neurocognitive or behavioural complications due to COVID-19 is not yet known, nor the duration or possible reversibility of these problems, there are several recently reported case studies and neuropsychological reports that have provided some initial insight and several clinical trends. Specifically, Priftis, *et al.* reported on a patient who was affected by a left-hemisphere ischemic stroke [4]. The patient had a highly specific neuropsychological profile which was characterized by severe agraphia and signs of conduction aphasia without any further cognitive and sensorimotor deficits. The authors concluded that specific neuropsychological signs can be observed in patients with COVID-19. Therefore, they suggest comprehensive neuropsychological assessment should be included to adequately explore and quantify the neuropsychological consequences of COVID-19.

In another case report, Padala, *et al.* described a functionally independent and physically active older adult with Mild Cognitive Impairment, who showed worsening of depression and anxiety symptoms associated with the restrictions of COVID-19 and functional decline [5].

Recently, Riordan., *et al.* reported that cognitive dysfunction is common in acute and chronic pulmonary disease, although unique predictors and symptom trajectories appear to be associated with each [6]. They concluded that although the full breadth of neuropathophysiology associated with COVID-19 remains to be established, pulmonary insults associated with the disease are likely to produce cognitive dysfunction in a substantial percentage of patients.

In recent review by Ritchie., *et al.* the broader neuropsychological aspects of COVID-19 were reported [7]. Specifically, in their article they cite a preliminary study documenting that 70% of people with COVID-19 admitted to intensive treatment units required mechanical ventilation, and link this to the international literature on cognition in acute respiratory distress syndrome (ARDS). They conclude that 78% of patients with ARDS had cognitive impairment one-year after been discharged and approximately 50% at two years post discharge. They also self-reported everyday memory difficulties, such as forgetting medication and appointments, found to persist in patients five years after been discharged. Furthermore, they stipulate that a proportion of patients who have spent time in intensive care (a population that overlaps significantly with ARDS patients) are known to develop cognitive impairment in the long term [8].

The issue of whether recovered COVID-19 patients present with cognitive complications was also investigated recently. Specifically, Zhou., *et al.* indicated that cognitive impairment exists even in patients recovered from COVID-19 and appears to be associated with the underlying inflammatory processes [9]. In another interesting cross-sectional study on the same issue, Woo., *et al.* reported frequent neurocognitive deficits after recovery from mild COVID-19, in mostly young patients, 20 - 105 days (median, 85 days) after recovery from mild to moderate disease who visited their outpatient clinic for post-COVID-19 care [10].

In this respect, Woo., *et al.* suggest that as increasing numbers of individuals require acute rehabilitative treatment following COVID-19, and due to the neurocognitive and neurobehavioural complications that they develop, the role and practice of clinical neuropsychologists in these rehabilitation settings will expand in this direction [10]. Within such interdisciplinary rehabilitative settings, neuropsychologists routinely assess and treat cognitive, emotional, and behavioral sequelae of individuals with complex medical and psychiatric presentations associated with brain injury. With increasing evidence of adverse impacts of COVID-19 on central nervous system function, neuropsychologists are uniquely positioned to assist in holistic conceptualization and treatment planning for these patients; however, given the limited understanding of disease-related neurocognitive sequelae and long-term outcomes, a comprehensive understanding of the rehabilitation needs for patients with COVID19 is still under investigation.

Supporting the suggestions of Woo., *et al.* Rabinovitz and colleagues in their recent article [1], discuss the roles that clinical neuropsychologists can play in evaluating and treating the cognitive difficulties and psychiatric/behavioural symptoms of these patients. However, they stipulate that although the effects of COVID-19 are poorly understood, information gained from the recent literature on similar viruses and utilized interventions can help guide clinical neuropsychologists as they begin to handle patients in this population.

Although the above mentioned studies provide us with important insights regarding the neurological, neuropsychological and neurobehavioural consequences of COVID 19, further longitudinal, clinical, neuroradiological, neuropsychological, biomarker and neuropathological studies are essential to determine the underlying pathobiological mechanisms that will guide future treatment of this pandemic [11].

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