COVID-19 AND NEUROLOGICAL OUTCOMES: IMPLICATIONS FOR SPEECH-LANGUAGE PATHOLOGISTS IN REHABILITATION SETTINGS

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— ABSTRACT —

COVID-19 is caused by a novel coronavirus that has resulted in a disease condition that was initially thought to be primarily focused on the respiratory system in its most severe form. However, as the medical community has learned more about COVID-19, it has become clear that the disease is a multi-system condition with wide-ranging levels of severity from complete asymptomatic infection to death. Among those multi-system problems include the onset of neurological disorders that require specialized speech-language pathology services. Whereas there has been a primary focus on managing the respiratory ailments and infectious nature of COVID-19, there are atypical neurological aspects of the condition that will require specialized speech-language pathology services (SLP). Consequently, more must be learned about the onset of neurological disorders resulting from COVID-19 and potential future implications for the field of SLP.

Keywords: COVID-19, neurological disorders, rehabilitation

Background

In early months of 2020, a global pandemic was declared due to the health devastation caused by a novel coronavirus (COVID-19). Believed to have originated in Wuhan, China, COVID-19 is a highly infectious disease that has spread quickly around the world. By the end of June 2020, there have been approximately 10 million confirmed cases of COVID-19 worldwide and roughly 500,000 confirmed deaths resulting from the disease (World Health Organization, 2020). Similarly, in the US and as of the same date, approximately 2.5 million Americans have been diagnosed with COVID-19 and more than 120,000 have died from the disease (The COVID Tracking Project, 2020).

The first cases of COVID-19 were identified in December 2019 and were initially believed to be pneumonia of unknown origin (Guan et al., 2020). Fever was a common medical issue as 89% of all patients experienced fever before they were discharged from the hospital. Sixty-eight percent of all patients presented with a cough, 5% nausea and vomiting, and 4% diarrhea (Guan et al., 2020). The majority were characterized as non-severe and the presence of co-existing disease conditions (hypertension, diabetes, heart disease) were present in 21% with higher rates (39%) of co-existing conditions among those with severe COVID-19. The disease spread rapidly throughout China in the first two months with varying degrees of illness severity (Guan et al., 2020). The first COVID-19 death in the US is now believed to have occurred as early as February 6, 2020 in Santa Clara County, CA (Santa Clara County Public Health, 2020) and before national reports of what were thought to be initial cases in a Kirkland, WA skilled nursing facility weeks later (Arentz, et al., 2020). The original the epicenter of COVID-19 in the US, New York, has reported approximately 400,000 cases of COVID-19 and among those have been over 25,000 deaths as of the end of June 2020 (The COVID Tracking Project, 2020).

Individuals with COVID-19 frequently experience fever, cough, and devastating respiratory issues including shortness of breath (Guan et al., 2020). In its most severe form, individuals with COVID-19 require ventilator support to address their respiratory issues. To date there has been a primary focus on the devastating effects of COVID-19 on the respiratory system. However, reports are now suggesting that although the primary target of COVID-19 has been the respiratory system, the condition is multi-system.

Neurological Disorders in COVID-19

Although not widely reported, COVID-19-related neurological conditions have surfaced in multiple countries. According to Iaccarino et al., (2020), one-third of hospitalized patients with COVID-19 display neurological signs and sumptoms. Initial neurological symptoms have ranged from headache, unstable walking, loss of smell, and general malaise (Wang, Li, Yan, Sun, Han & Zhang, 2020). A range of neurological disorders/diseases have been reported including ischemic stroke, hemorrhagic stroke, encephalopathy, and Guillain-Barré syndrome (Alhahtani, Subahi & Shirah, 2020; Filatov, Sharma, Hindi & Espinosa, 2020; Li et al., 2020; Mao et al., 2020; Oxley et al., 2020; Poyiadji, Shahin, Noujaim, Stone, Patel & Griffith, 2020; Zhai, Ding & Li, 2020; Zhao, Shen, Zhou, Liu & Chen, 2020). Studies outside of the US suggests neurological conditions have been more prominent in older adults with associated cardiovascular risk factors such as hypertension and diabetes (Li et al, 2020). However, a recently published case series study by Oxley and colleagues (2020) in New York City (US) described five young adults (ages 33-49) who experienced major strokes resulting in hemiplegia, dysarthria, dysphagia, and global aphasia. Neuropathological findings from autopsies of 18 patients who died from COVID-19 showed acute hypoxic injury in the cerebrum and cerebellum in all patients, with loss of neurons in the frontal cerebral cortex, hippocampus, and cerebellum (Solomon et al., 2020). There is evidence that COVID-19 impacts both the central and peripheral nervous systems and persistence of symptoms can result in significant disability (Iaccarino et al., 2020).

To date, the exact reason for stroke and other neurological conditions in individuals with COVID-19 is unclear. It has not been determined if the observed neurological conditions are the result of the coronavirus entering the central nervous systems (CNS) or a response to the viral storm in the body resulting from the coronavirus (Talon, 2020). Some reports note that neurological disorders can result from direct viral invasion of the nervous system, viruses crossing the blood-brain barrier, or virus migration into the nervous system via sensory or motor nerve endings (Wu et al., 2020). The consequence of viral infections can be severe damage to the structure and function of the nervous system, resulting in encephalitis, toxic encephalopathy, severe acute demyelinating lesions, or cerebrovascular disease. Regardless, there is concern that the neurological consequences of the condition beyond the significant respiratory issues associated with COVID-19 may make the recovery process more difficult. More importantly, there is an urgent need to understand the neurological aspect of the condition to ensure that treatment protocols are initiated properly to reduce long-term neurologically

related disability (Baig, 2020). Further, because the neurological disorders that have been reported do not fit a specific clinical syndrome, the identification and management of symptoms are more challenging than usual (Wang et al., 2020).

The management of COVID-19 has rightly had a primary focus on the respiratory complications to prevent death while simultaneously managing the highly contagious disease. Therefore, less attention has been given to the potential rehabilitation needs of patients with COVID-19 given the unfortunate need to maintain a basic focus on preservation of life. Consequently, in the first months of the COVID-19 pandemic the emergency care, intensive care, and acute care segments of healthcare systems in the US and abroad have been overwhelmed by the need to preserve life. During that time, a key early focus of the field of speech-language pathology related to COVID-19 in healthcare settings has been the establishment of new clinical practice patterns such as guidance for in-person SLP services, return to work after exposure to COVID-19, modifications to dysphagia service, and the use of telepractice to address patient needs in the context of a highly infectious disease (American Speech Language Hearing Association, 2020a). During that same time frame there has been concern that rehabilitation of individuals with COVID-19 has been less prioritized as healthcare systems reinvent themselves to deal with the pandemic (Khan & Amatya, 2020). Among those patients are the aforementioned individuals with potentially significant neurologically based disorders of communication.

A New Management Approach for Neuro Patients with COVID-19

There is an expectation that as the US healthcare system adjusts to the pandemic and the new normalcy of healthcare provision, there will be a very high demand for rehabilitation clinicians to address the needs of survivors of COVID-19. Among those will be individuals recovering from COVID-19 with co-existing neurological disorders. Early reports have shown that common adult onset neurogenic disorders such as dysarthria, dysphagia, and aphasia are present in patients with COVID-19 (Oxley et al., 2020). Because of the hypoxic nature of the disease, some will also likely exhibit cognitive-communicative disorders (Komiyama, Katayama, Sudo, Ishida, Higaki, & Ando, 2017; Wu et al., 2020). Finally, regarding dysphagia specifically, evidence indicates that approximately 60% of patients that require oral intubation and mechanical ventilation experience dysphagia and one third of all patients with acute respiratory distress syndrome (ARDS) will have persistent dysphagia symptoms even after hospital discharge (Brodsky et al., 2017). Consequently, swallowing assessments (clinical eval and modified barium swallow) will be required by many patients with COVID-19 as assessments should be considered following prolonged intubation regardless of neurological symptoms. Some also note that the field must embrace noninvasive imaging and noninvasive diagnostic measures to address the needs of patients positive for COVID-19 (Brodsky & Gilbert, 2020). Similarly, virtual dysphagia evaluations and telemedicine approaches must be implemented in a variety of settings during the COVID-19 pandemic (Fritz et al., 2020; Soldatova, Williams, Postma, Falk, & Mirza, 2020)

The country of Italy has already moved forward to address the needs of the individuals recovering from COVID-19 and exhibiting neurological deficits. A neuro-COVID-19 unit has already been established to manage neurological syndromes (Talan, 2020). Others have also established an acute stroke management pathway for individuals COVID-positive or with COVID-suspected stroke syndromes (Baracchini et al., 2020). Similar units and processes will likely be needed in the US and other countries to meet the needs of these patients. The field of speech-language pathology and other rehabilitation disciplines have had to quickly adjust to the many challenges associated with the complicated demands of COVID-19 rehabilitative care during and after the pandemic (Khan & Amatya). Because of the complex array of neurological symptoms and post-COVID communication disorders, early evidence suggests a range of treatment approaches will be required. For some with dysphagia and aphasia syndromes, traditional approaches for dysphagia and aphasia management will be required. For others, with broader cognitive-linguistic disorders, treatment/management approaches may mirror strategies designed to improve deficits resulting from adult onset traumatic brain injury, right hemisphere syndrome, and social communication disorders. The American Speech-Language-Hearing Association (ASHA) practice portal which was designed to offer guidance related to evidence-based treatments for a range of communication and swallowing disorders will serve as an invaluable resource as speech-language pathologists (SLPs) learn more about this condition (American Speech-Language-Hearing Association, 2020b). At the same time, SLPs and other rehabilitation professions will face major challenges related to rehabilitation that center around infection control, occupational risks associated with uncomfortable personal protective equipment (PPE), and never before continuity plans for staff who become infected and require quarantine (Koh & Hoenig, 2020). Changes

will also be required in traditional approaches to rehabilitation for patients with symptoms of or history of COVID-19 to prevent infection spread (Chang & Park, 2020).

Conclusions

The emergence of neurological disorders in COVID-19 is a reminder that the field of speech-language pathology must constantly adapt to the changing needs of our constituency; individuals with disorders of communication, cognition, and swallowing. Some believe the COVID-19 pandemic will transform care of individuals with neurological disorders more than any other crisis in modern history (Bloem, Dorsey & Okun, 2020). Individuals who survive COVID-19 will require comprehensive rehabilitation to address their neurological and other multi-system needs. SLPs and other rehabilitation professionals must remain a critical part of the patient care teams for individuals with COVID-19 despite the risks. Continued refinement of current practice approaches and preparedness to address the complex nature of COVID-19 and the associated neurological disorders will be the key.

References

Algahtani, H., Subahi, A. & Shirah. B. (2020). Neurological complications of Middle East respiratory syndrome coronavirus: A report of two cases and review of the literature. *Case Reports in Neurological Medicine*, Volume 2016, Article ID 3502683, 6 pages http://dx.doi.org/10.1155/2016/3502683.

American Speech Language Hearing Association. (2020). SLP service delivery considerations in health care during coronavirus/COVID-19. https://www.asha.org/SLP/healthcare/SLP-Service-Delivery-Considerations-in-Health-Care-During-Coronavirus/.

American Speech Language Hearing Association. (2020). The Practice Portal. https://www.asha.org/practice-portal/.

Arentz, M., Yim, E., Klaff, L., Lokhandwala, S., Riedo, F.X , Chong, M. et al. (2020). Characteristics and outcomes of 21 Critically ill patients with COVID-19 in Washington State. *Journal of the American Medical Association*. 323(16):1612–1614. doi:10.1001/jama.2020.4326.

Baracchini, C., Pieroni, A., Viaro, F., Cianci, V., Cattelan, A.M., Tiberio, I., et al. (2020). Acute stroke management pathway during Coronavirus-19 pandemic. *Neurological Sciences*. doi: 10.1007/s10072-020-04375-9.

Bloem, B.R., Dorsey, E.R. & Okun, M.S. (2020). The coronavirus disease 2019 crisis as catalyst for telemedicine for chronic neurological disorders. *JAMA Neurology*. doi: 10.1001/jamaneurol.2020.1452.

Brodsky, M.B. & Gilbert, R.J. (2020). The long-term effects of COVID-19 on dysphagia evaluation and treatment. *Archives of Physical Medicine and Rehabilitation*, doi: 10.1016/j.apmr.2020.05.006.

Brodsky, M.B., Huang, M., Shanholtz, C., Mendez-Tellez, P.A., Palmer, J.B., Colantuon, E., & Needham, D.M. (2017). Recovery from dysphagia symptoms after oral endotracheal intubation in acute respiratory distress syndrome survivors. A 5-year longitudinal study. *Annals of the American Thoracic Society*, 14, 376–383. doi:10.1513/AnnalsATS.201606-455OC.

Chang, M.C. & Park, D. (2020). How should rehabilitative departments of hospitals prepare for coronavirus disease 2019? *American Journal of Physical Medicine and Rehabilitation*. Volume 99 - Issue 6 - p 475-476. doi: 10.1097/PHM.0000000000001428.

Filatov, A., Sharma, P., Hindi, F. & Espinosa, P.S. (2020). Neurological complications of coronavirus disease (COVID-19): Encephalopathy. *Cureus* 12(3): e7352. DOI 10.7759/cureus.7352.

Fritz, M.A., Howell, R.J, Brodsky, M.B., Suiter, D.M., Dhar, S.I., Rameau, A. et al. (2020). Moving forward with dysphagia care: Implementing strategies during the COVID-19 pandemic and beyond. *Dysphagia*, doi.org/10.1007/s00455-020-10144-9.

Guan, W., Ni, Z., Hu, Y., Liang, W. Ou, C. He, J. et al. (2020). Clinical characteristics of coronavirus disease 2019 in China. *The New England Journal of Medicine*, doi: 10.1056/NEJMoa2002032.

Iaccarino, M.A., Tenforde, A.S., Zafonte, R.D., Silver, J.K., Hefner, J., & Paganoni, S. (2020). Neurological manifestation of COVID-19 and the enhanced role of physiatrists. *American Journal of Physical Medicine and Rehabilitation*. doi: 10.1097/PHM.0000000000001502.

Khan, F. & Amatya, B. (2020). Medical rehabilitation in pandemics: Towards a new perspective. *Journal of Rehabilitation Medicine*, 52(4):jrm00043. doi: 10.2340/16501977-2676.

Koh, G.C. & Hoenig, H. (2020). How should the rehabilitation community prepare for 2019-nCov?

Archives of Physical Medicine and Rehabilitation. 101(6), 1068-1071. doi:https://doi.org/10.1016/j.apmr.2020.03.003.

Komiyama, T., Katayama, K., Sudo, M., Ishida, K., Higaki, Y., & Ando, S. (2017). Cognitive function during exercise under severe hypoxia. *Scientific Reports*, 7(1):10000. doi: 10.1038/s41598-017-10332-y.

Li, Y., Wang, M., Zhou, Y., Chang, J., Xian, Y. Mao, L. et al. (2020). Acute cerebrovascular disease following COVID-19: a single center, retrospective, observational study. *The Lancet*. doi: 10.2139/ssrn.3550025.

Mao, L., Jin, H., Wang, M., Chen, S., He, Q., Chang, J. et al. (2020). Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurology*. doi:10.1001/jamaneurol.2020.1127.

Oxley, T.J., Mocco, J., Majidi, S., Kellner, C.P., Shoirah, H., Singh, I.P. et al. (2020). Large-vessel stroke as a presenting feature of Covid-19 in the young. *The New England Journal of Medicine*, 82:e60. doi:10.1056/NEJMc2009787.

Poyiadji, N., Shahin, G., Noujaim, D., Stone, M., Patel, S., Griffith, B. (2020). COVID-19–associated Acute Hemorrhagic Necrotizing Encephalopathy: CT and MRI Features. *Radiology*. doi.org/10.1148/radiol.2020201187.

Santa Clara County Public Health. (2020). County of Santa Clara identifies three additional early COVID-19 deaths. Available at: https://www.sccgov.org/sites/covid19/Pages/press-release-04-21-20-early.aspx.

Soldatova, L., Williams, C., Postma, G.N., Falk, G.W., Mirza, N. (2020). Virtual dysphagia evaluation: Practical guidelines for dysphagia management in the context of COVID-19 pandemic. *Otolaryngology Head and Neck Surgery*, doi.org/10.1177/0194599820931791.

Solomon, I.H., Normandin, E., Bhattacharyya, S., Mukerji, S.S., Keller, K., Ali, A.S. et al. (2020). Neuropathological features of Covid-19. *The New England Journal of Medicine*. doi:10.1056/NEJMc2019373.

Talan, J. (2020). COVID-19: Neurologists in Italy to colleagues in US: Look for poorly-defined neurologic conditions in patients with the coronavirus. *Neurology Today*. Available at: https://journals.lww.com/neurotodayonline/blog/breakingnews/pages/post.aspx?PostID=920&fbclid=IwAR2omdLXmhl-7DEa0vLB8WVlMJp5CaI4w_gVQaJ6uPeKUNnAf-paGxy7fn3V0.

The COVID Tracking Project (2020). Available at: https://covidtracking.com/.

Wang, H., Li, X., Yan, Z., Sun, X., Han, J. & Zhang, B. (2020). Potential neurological symptoms of COVID-19. *Therapeutic Advances in Neurological Disorders*, 13, 1–2. doi.org/10.1177/1756286420917830.

World Health Organization. (2020). Coronavirus disease (COVID-19) Pandemic. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019.

Wu, Y., Xu, X., Chen, Z., Hashimoto, K., Yang, L., Liu, C. et al. (2020). Nervous system involvement after infection with COVID-19 and other coronaviruses. *Brain, Behavior, and Immunity*. doi:10.1016/j.bbi.2020.03.031.

Zhai, P., Ding, Y. & Li, Y. (2020). The impact of COVID-19 on ischemic stroke: A case report. *Research Square*. doi:10.21203/rs.3.rs-20393/v1.

Zhao, H., Shen, D., Zhou, H., Liu, J. & Chen, S. (2020). Guillain-Barré syndrome associated with SARS-CoV-2 infection: causality or coincidence? *The Lancet Neurology*, 19(5):383-384. doi: 10.1016/S1474-4422(20)30109-5.

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