ONLINE FEATURE | COVID-19 and Its Impact on the Auditory and Vestibular Systems

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The first published concern about the virus' risk of causing hearing loss was reported in Thailand in March, 2020. Thailand was the first country to experience the outbreak after China. There was some concern about hearing loss (n=82) but limited info was available (Sriwijitalai and Wiwanitkit, 2020).

The first report about an ear-related side effect was published in July 2020 after the Indiana School of Medicine (ISM) began following COVID-19 survivors to determine if their treatments were a complete success of if there were any lingering medical issues. These patients were described as "long-haulers" (Lambert, 2020) who continued to have medical issues for weeks and even months after the diagnosis. Since July 2020, a dozen diagnostic terms have appeared in the literature to describe these patients. (DiSogra, 2021).

The ISM study collected data on 1,550 persons and identified 50 complaints after medical intervention for the virus. Tinnitus was #43 (see Tinnitus section). Absent from the list were hearing loss, balance issues and auditory processing disorder (Lambert, 2020).

Since then, a small body of knowledge began to emerge about the virus' presence in all parts of the auditory system from the outer ear to the auditory cortex.

Case History

A case history is the first step with any patient encounter although traditional case history questions might not provide sufficient information with the COVID-19 population. It would be beneficial to develop a separate COVID-19 Survivor case history form given the current 'unknowns" about the virus.

Audiologists need to know if the auditory/vestibular complaints are new or reflect a change/deterioration of a pre-existing condition. The use of a self-assessment tool such as the Hearing Handicap Inventory for Adults (Newman et al, 1990) could be very effective to learn more about the patient before testing begins. Because of unknown cognitive impairments from COVID-19, patients should have a close family member or friend accompany them to confirm the answers to the medical history (see "Brain Fog"–Mild Cognitive Impairment section).

Outer Ear: Traces of COVID-19 in Cerumen

Two studies were published in the fall 2020 that evaluated the presence of the virus in the cerumen of COVID-19 positive patients (Islamoglu et al, 2020). Cerumen analysis revealed that the virus was not detectable (n=60) but the second study (Hanege et al, 2020) identified evidence of the virus in approximately 40 percent of the patients (n=38). Celik et al (2020) analyzed studies and speculated that the virus could contaminate cerumen via secretions in the ceruminous glands (ear canal epithelium) and not the result of an external contamination.

An online survey of audiologists (n=146) revealed that 96 percent of the respondents were disposing of cerumen in the trash/drain/toilet just as they would normally do, even from patients with a positive history of COVID-19. Only 4 percent (n=6) were taking an extra precaution by using a biohazard bag and disposing the contents accordingly (DiSogra, 2021).

COVID-19 is highly contagious which is why sterilization of cerumen management tools, disinfecting surfaces and the use of personal protective equipment is critical to your safety and the safety of your staff and patients. Cerumen management infection control protocols have already been developed and should be followed closely (Clark et al, 2003).

Middle Ear: Conductive Hearing Loss

Frazier et al. (2020) noted that the COVID-19 virus can colonize in the middle ear and mastoid region. Several case reports have been published reporting otitis media with COVID-19 patients and one case with a tympanic membrane perforation (Raad, 2021; Fiden, 2020).

No studies have been published on the effect of the virus on middle ear muscle reflexes (MEMR). However, the degree of hearing loss could result in absent MEMRs. Also, if there is brainstem involvement (see Brainstem section), this too, could explain the absence of the MEMR.

Inner Ear/Cochlea: Sensorineural Hearing Loss

Audiologists know that hearing loss can occur from viral infections (i.e., rubella, cytomegalovirus, measles), thus affecting hearing and balance (Young, 2020). It was still too soon in 2020 to predict just how this virus was going to affect the auditory/vestibular system and what effect, if any, the virus would have on both subjective and objective tests.

By the fall of 2020, studies with small sample sizes and anecdotal case reports started to appear in the literature. By the Spring of 2021 it became apparent that the auditory and vestibular systems were not immune from this virus (Freni, 2020; Mustafa, 2020) yet other researchers were not convinced (Munro, 2020). But despite Munro's speculation, the subject

sample (n=138) showed that more than one in ten adults had a change in hearing status within eight weeks after discharge (Munro, 2020). This group would be considered ‘long haulers’ (Lambert, 2020).

The profile of hearing loss from the virus included both outer and inner hair cell damage, damage to the stria vascularis and spiral ganglion (Mustafa, 2020). The degree of hearing loss has been reported to be from mild to profound, bilateral or unilateral (Saniasiaya, 2021; Maharaj, 2020) which explains why bilateral high frequency sensorineural hearing loss (SNHL) would be an expected finding with a COVID-19 survivor. But, again, the loss could be an exacerbation of a pre-existing SNHL.

Last summer/fall was likely too soon to know about hearing loss from the virus. Munro et al. (2020) and Almufarrij et al (2020) noted that it was unclear which cases of hearing loss could be directly attributed to the virus and that hearing loss, tinnitus, and vertigo were rarely reported and referred to their COVID-19 patients as having “mostly minor symptoms.”

Ciorba et al (2020) expressed concerns about the ototoxic effects of the medications used during the initial treatment of the virus and whether or not any hearing loss will be from the medications and not from the virus. Consequently, otoacoustic emission data (transient or distortion product) may be abnormal because of outer hair cell damage.

Therefore, audiologists may see bilateral high frequency SNHL although there are reports of sudden SNHL (Karimi-Galoughahi et al, 2020; Kilic et al, 2020; Chern et al, 2021). See Case History.

Word Recognition Test Scores

There is no published research on the virus’ impact on word recognition scores (WRS). However, do we assume that WRS will be consistent with the degree of high frequency hearing loss? Future research needs to explore WRS in those who had COVID-19.

Reduced Tolerance to Loud Sounds

There is no published research on the virus’ impact on reduced sound tolerance; however, reduced tolerance could occur with SNHL regardless of the etiology.

Mixed Hearing Loss

These was one published case study identifying mixed hearing loss with the COVID-19 virus (Mohan, 2020). However, reports of conductive/mixed hearing loss are less frequent than SNHL. Almufarrij and Munro (2020) speculated that conductive hearing loss could reflect normal life circumstances and would not be significant.

Mixed hearing loss is an area of COVID-19 hearing loss that needs further monitoring because it is still too soon in the pandemic's life to truly ascertain the significance of conductive hearing loss.

Vestibular System

Semicircular canals have no collateral blood supply and are largely susceptible to ischemia (Chandrasekhar et al, 2019).

The current research about COVID-19 and the vestibular system is sparse. Vertigo appears to be the least commonly reported COVID-19 symptom (Almufarrij et al, 2020). Their review of 20 studies showed that approximately 20 percent of COVID-19 survivors might experience vertigo/balance disorder. However, one year later, a follow-up review revealed that the number was lower (7.2 percent) (Almufarrij and Munro, 2021).

TABLE 1 shows the data from three large studies (subject sample >100 subjects) demonstrating that the incidence of vertigo varies greatly.

n	PERCENTAGE	AUTHORS
1420	00.04	Lechien et al, 2020
138	00.70	Munro, et al, 2020
642	60.00	Assaf, et al, 2020

TABLE 1. Incidence range of vertigo from three studies (sample n=>100).

Central Auditory Pathways: Brainstem to Auditory Cortex

In addition to cochlear hearing loss, there is evidence emerging suggesting the brainstem and the primary auditory cortex were showing traces of the virus (Yong, 2021; Sriwijitalai and Wiwanitkit, 2020). Therefore, abnormal wave morphology (including total absence of subsequent waves beyond Wave I in the auditory brain stem response test) may be an expected finding.

"Brain Fog"–Mild Cognitive Impairment

Brain fog is a non-medical term used to describe a COVID-19 survivor's inability – either temporarily or permanently – to stay focused and process information. Fatigue is another symptom. The term mild cognitive impairment has also been used. (Centers for Disease Control and Prevention, 2021; Cleveland Clinic, 2021). "Brain fog" has also been referred to as clouding of consciousness (Schildkrout, 2011).

These behaviors include (but not limited to) difficulty staying focused, difficulty concentrating, difficulty following/understanding conversations, memory impairment (including short term memory), poor listening skills and word finding problems. These behaviors have also been seen in persons with hearing loss or having an auditory processing disorder, mild cognitive impairment and/or executive function disorder (Centers for Disease Control and Prevention, 2021).

“Brain Fog” is a new area for research for audiologists however it could be an auditory processing deficit (or the beginning of hearing loss). Hopefully the term “brain fog” will be used less often if evidence emerges to support the presence of auditory processing issues.

Therefore, if patients identify themselves as having been diagnosed with “brain fog” or it is referred to in a medical report, the audiologist may consider initiating an auditory processing issue evaluation and counsel accordingly after the basic audiometric battery.

For reference, the American Academy of Audiology has already published Clinical Practice Guidelines: Diagnosis, Treatment and Management of Children and Adults with Central Auditory Processing Disorder (American Academy of Audiology, 2010).

Tinnitus

To date, the literature points to SNHL from the virus with tinnitus as a secondary diagnosis. It is common knowledge that tinnitus is associated with SNHL no matter how mild the loss may be or even if no loss has been identified on a conventional audiogram. Almufarrij and Munro (2021) reported in their review of 26 studies about the audio-vestibular symptoms of the virus, the incidence of tinnitus to be 14.8 percent. It is not fully known if the pandemic (and its associated stress on persons with the diagnosis) exacerbated any pre-existing tinnitus or the tinnitus was a direct result of the virus.

Aside from the audiological evaluation, a tinnitus self-assessment will need to be completed. Tinnitus Handicap Inventory (THI) (Newman et al, 1996) and the Tinnitus Functional Index (TFI) (Henry et al, 2014) are two popular self-assessment tools (not an endorsement by the author or the American Academy of Audiology).

Also, an exacerbation of pre-existing tinnitus could occur from any other medication the patient might be taking. Co-morbidities must be identified in the case history along with the patient’s current medications (Ciorba et al, 2020). Two websites to help identify drug side effects are www.drugs.com and www.rxlist.com (not an endorsement by the author or the American Academy of Audiology).

Tinnitus as a Vaccine Side Effect

As of this writing, three COVID-19 vaccines are available in the United States under the Food and Drug Administration's Emergency Use Authorization: Moderna, Pfizer and Johnson and Johnson/Janssen (US FDA, 2021).

The U.S. Department of Health and Human Services (HHS) has established the Voluntary Adverse Event Reporting System whereby consumers and health-care professionals can report any vaccine-related event online (2021). A database is being established for future reference. Therefore, it is critical that any adverse event from any the three vaccines should be reported to HHS. Aside from online reporting, an email can be sent to info@VAERS.org or by calling 800-822-7967.

Dietary Supplements for COVID-19 Management

There is no published research that supports the use of any dietary supplement (including cannabidiol products) as an effective management strategy for COVID-19 survivors or any ear-related disorder (DiSogra, 2020). Also, no dietary supplement has been approved by the Food and Drug Administration for hearing loss, tinnitus, or vertigo treatment. User testimonials in advertisements are not a substitute for evidence-based research. Patients should be counseled accordingly on their use (Adams et al, 2020).

As of this writing there are at least 17 dietary supplements undergoing clinical trials for COVID-19 intervention (clinicaltrails.gov, 2021).

Infants

The pandemic resulted in clinics either reducing their hours or temporarily closing. Parents of the babies who failed their newborn hearing screenings may have received a referral for follow-up testing but appointments might not have not kept for fear that the parent/caregiver could contract the virus (Cunningham and Foley, 2021). The authors strongly recommend that the audiologist improve their relationship with all pediatricians in their community and prioritize appointments for infants/children for initial diagnostic testing or hearing aid fittings.

Persons with Diabetes

With the COVID-19 virus, there is an increased risk of inflammation and internal swelling of peripheral vascular structures according to the Centers for Disease Control and Prevention (2021). Changes in any pre-existing SNHL could be expected, therefore clinicians should monitor accordingly. However, more research is needed with this population.

Adults with Down Syndrome

The concern for adult Down Syndrome (DS) patients diagnosed with COVID-19 is that there is an increase in confusion or altered conscious ("brain fog?"). Huls et al, (2021) reported on 1,046 DS patients (mean age: 29 years). They noted a much higher rate of medical complications and mortality after age 40 in their study. Although changes in hearing was not reported, it would appear that the DS population might be more susceptible to the changes in both the middle ear and the central auditory pathways. This continues to be an area that needs additional research as well as with DS children.

Individuals with Disabilities

Lebrasseur et al (2020), reported that individuals with disabilities have a higher risk of contracting COVID-19 because of their need for close contact from their caregivers.

There are no special changes needed when conducting an audiometric evaluation (subjective and objective tests) except for having a greater level of compassion towards the patient and their family.

Persons Who Are Blind or With Low Vision

A published report by the Royal National Institute of Blind People (RNIB) in England found that two-thirds of visually impaired individuals felt that they have become less independent because of the pandemic (RNIB, 2020).

Again, there are no special changes needed when conducting an audiometric evaluation (subjective and objective tests) except for having a greater level of compassion towards the patient and their family.

Persons with Post-Traumatic Stress Disorder

One report suggests that post-traumatic stress disorder (PTSD) may occur following the COVID-19 experience (i.e., respiratory complaints leading up to a hospitalization, anxiety from testing in addition to dealing with the duration of the hospital stay and then being discharged only to learn that there are still ongoing medical issues) (Janiri et al, 2021).

A team of researchers followed 381 patients up to four months after their diagnosis and recovery (Janiri et al, 2021). They diagnosed 30.2 percent (n=115) with PTSD based on DSM-5 criteria. More than half (55.7 percent) were female. The most significant co-morbidity was a history of psychiatric disorders with 17.3 percent having depressive episodes and 7 percent with a general anxiety disorder (Janiri et al, 2021).

Patient management strategies must be addressed on an individual basis with a PTSD patient. Their PTSD drug regimen and counseling history will need to be established before auditory processing, if necessary, is scheduled.

The Use of Face Masks

Patients with special needs will have a greater reduced ability to communicate when caregivers are using face masks because of a loss of speech intensity and clarity (Atcherson et al, 2020). Therefore, communication strategies with various types of face masks/shields will need to be modified on a patient-by-patient basis.

Billing and Reimbursement

The only new COVID-19 related CPT code is 99072. This code can be used for billing for personal protective equipment (PPE), supplies, for time spent pre-screening patients before the visit, time spent checking patients for symptoms onsite, PPE for the patient, clinician, and staff as well as cleaning supplies for disinfecting equipment and rooms after each encounter (American Medical Association, 2020). All other diagnostic tests can be billed in the usual manner with no special coding for a COVID-19 patient.

Conclusion

Although the COVID-19 virus has been a part our lives for over 18 months, auditory research is slowly emerging to guide our profession as to which tests to use, what findings to expect and how to better manage COVID-19 survivors—especially those with special needs—both short term and long term.

A new case history form needs to be developed for these COVID-19 patients because we are still learning about the effects of the virus on the auditory system.

A database of audiometric findings needs to be established to help add to the body of knowledge about the impact of the COVID-19 virus on the auditory and vestibular systems.

More research will emerge over the next 18 months to further our understanding of the virus on the auditory system and how our test results and management strategies can be improved upon.

Finally, the American Academy of Audiology has an excellent coronavirus resource page with excellent practice management information (2020).

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