

## Main Article

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**Cite this article:** Pool C, King TS, Pradhan S, Isildak H. Sudden sensorineural hearing loss and coronavirus disease 2019. *J Laryngol Otol* 2022;1–4. <https://doi.org/10.1017/S0022215122000068>

Accepted: 6 January 2022

### Key words:

COVID-19; Coronavirus; Hearing Loss; Sudden Sensorineural Hearing Loss

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# Sudden sensorineural hearing loss and coronavirus disease 2019

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## Abstract

**Objective.** To determine if otolaryngologists and audiologists of the American Academy of Otolaryngology – Head and Neck Surgery have noticed an increase in the incidence of sudden sensorineural hearing loss during the coronavirus disease 2019 pandemic.

**Methods.** A questionnaire was developed for the purpose of providing a cross-sectional descriptive analysis of perceived association between the coronavirus disease 2019 pandemic and an increase in the incidence of sudden sensorineural hearing loss.

**Results.** Of respondents, 63.0 per cent did not notice an increase in sudden sensorineural hearing loss during the coronavirus disease 2019 pandemic. There was a weak positive correlation between patients identified with sudden sensorineural hearing loss and the percentage of coronavirus disease 2019 positive patients reported by each medical care provider (Spearman correlation = 0.20, 95 per cent confidence interval = 0.05–0.33). There was no association between geographical location and perceived increase in sudden sensorineural hearing loss ( $p = 0.38$ ).

**Conclusion.** The majority of respondents did not perceive an increase in the incidence of sudden sensorineural hearing loss during the coronavirus pandemic, regardless of geographical region.

## Introduction

The coronavirus disease 2019 (Covid-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) strain, was first reported in Wuhan, Hubei province, China, in December 2019. Since then, the virus has rapidly spread across the world, resulting in the current global pandemic. In symptomatic patients, Covid-19 can present with cough, fever, myalgia, fatigue, mucus over-production and pharyngitis. Early data suggested an association of coronavirus infection with anosmia and ageusia.<sup>1,2</sup> This is thought to result from direct damage of the virus on the olfactory neurons, as some patients present with anosmia or hyposmia without nasal obstruction or rhinitis.<sup>1,3</sup>

In addition to lung damage, the virus has been associated with an increased coagulopathic state, resulting in arterial and venous thrombosis.<sup>4,5</sup> Neurological manifestations, including seizures, encephalitis, meningitis and strokes, have also been described.<sup>6</sup> While a myriad of neurological symptoms have been described, we noticed several cases in the spring of 2020 that were suspicious for damage to auditory processing in the setting of SARS-CoV-2.<sup>7</sup>

One such case was an otherwise healthy 50-year-old female who presented with sudden sensorineural hearing loss (SNHL) of the left ear. She worked in the emergency department and had cared for several coronavirus-positive patients while wearing appropriate personal protective equipment. She denied having Covid-19 symptoms and her test result before her visit to the otology clinic was negative, but her occupation put her at high risk for exposure and there may have been subsequent resolution of her viral load prior to evaluation.

In a second case, a 57-year-old male presented after having SARS-CoV-2 pneumonia and associated hearing loss at the same time. He noticed that his hearing aid on the right side was not working as well when compared to before his hospitalisation. He was evaluated for sudden SNHL three months after his initial Covid-19 diagnosis and his hearing never recovered.

These and other observations led us to question whether there was an association between Covid-19 infection and sudden SNHL. We surveyed the American Academy of Otolaryngology – Head and Neck Surgery (AAO-HNS) to determine if other medical care providers had noticed an association between Covid-19 and sudden SNHL. This study aimed to determine whether an association exists between Covid-19 and hearing loss, in order to better inform regarding the potential clinical presentation and sequelae of the virus.

## Materials and methods

A questionnaire was developed for the purpose of providing a cross-sectional descriptive analysis of perceived association between the Covid-19 pandemic and an increase in sudden SNHL incidence. The survey was reviewed and approved by the Institutional Review

Board at the Penn State Health Milton S. Hershey Medical Center. The survey was also reviewed and approved by the Hearing Committee of the AAO-HNS before being emailed to 5168 members of the AAO-HNS in March 2021.

Study data were collected and managed using the REDCap electronic data capture tools hosted at the Penn State Health Milton S. Hershey Medical Center and Penn State College of Medicine. REDCap (Research Electronic Data Capture) software is a secure, web-based application designed to support data capture for research studies. This application provides: (1) an intuitive interface for validated data entry; (2) audit trails for tracking data manipulation and export procedures; and (3) automated export procedures for seamless data downloads to common statistical packages for importing data from external sources.<sup>8</sup>

The distributed survey included an introductory letter and the survey instrument. The survey comprised questions regarding: responder profession; geographical location; recognition of an association between symptoms suspicious for coronavirus (cough, fever, but no formal testing performed) or coronavirus-positive patients and sudden SNHL; an increase in sudden SNHL since the beginning of the pandemic; the percentage of sudden SNHL patients also found to be coronavirus-positive; suspicious symptoms in patients with sudden SNHL; additional neuropathies in patients presenting with sudden SNHL (e.g. anosmia, change in taste); and high-risk occupation status in patients presenting with sudden SNHL (dentist, emergency department worker, and so on).

Descriptive statistics were presented as frequencies and percentages for categorical responses to the survey items, and as means (standard deviations), medians and ranges for continuous responses. The bivariate associations of the categorical outcome variables and the stratification factors were displayed using two-way contingency tables and examined using chi-square tests. All analyses were performed using SAS statistical programming language, version 9.4 (SAS Institute, Cary, North Carolina, USA). All statistical tests were two-sided. Statistical significance was determined at  $p < 0.05$ .

## Results

The survey was sent to 5168 members of the AAO-HNS. The response rate was 4.6 per cent ( $n = 238$ ). Of the respondents, 98.7 per cent ( $n = 235$ ) identified as otolaryngologists (in ENT), with the remaining respondents identifying as audiologists (1.3 per cent,  $n = 3$ ). Sixty-one of the US-based respondents (25.8 per cent) were from the Northeast, 66 (28.0 per cent) were from the Southeast, 40 (16.9 per cent) were from the Midwest, 29 (12.3 per cent) were from the Southwest and 40 (16.9 per cent) were from the West (Table 1).

Of the respondents, 63.0 per cent ( $n = 150$ ) had not noticed an increase in the incidence of sudden SNHL since January 2020 (Table 1).

The majority of respondents (59.7 per cent,  $n = 142$ ) did not know the coronavirus status of patients presenting to them with sudden SNHL. Those respondents who did know patients' coronavirus status reported that 20.2 per cent of patients ( $n = 48$ ) had a negative coronavirus test result at presentation, 17.6 per cent of patients ( $n = 42$ ) had a positive coronavirus test result and 2.5 per cent of patients ( $n = 6$ ) were presumed positive as determined by a medical care provider (i.e. signs and symptoms highly suggestive of coronavirus without formal testing) (Table 1).

**Table 1.** Survey responses related to patient demographics

Survey question	Value(s)
What is your profession? ( $n$ (%))	
– Otolaryngologist (in ENT)	235 (98.7)
– Audiologist	3 (1.3)
Where are you located? ( $n$ (%))	
– Northeast	61 (25.8)
– Southeast	66 (28.0)
– Midwest	40 (16.9)
– Southwest	29 (12.3)
– West	40 (16.9)
How many patients with sudden SNHL have you identified since January 2020?*	
– Mean (SD) number of patients per responder	25.0 (89.83)
– Median number of patients per responder	10.0
– Range of patients per responder	0.0–1000.0
Have you noticed an increase in sudden SNHL incidence since January 2020? ( $n$ (%))	
– No	150 (63.0)
– Yes	88 (37.0)
Would you consider this increase outside the range of normal variance for your practice? ( $n$ (%))	
– No	167 (70.2)
– Yes	71 (29.8)
What was the Covid-19 status of your sudden SNHL patients seen since January 2020? ( $n$ (%))	
– Positive test result	42 (17.6)
– Presumed positive (as determined by medical care provider)	6 (2.5)
– Negative test result	48 (20.2)

Total number of respondents,  $n = 238$ . SNHL = sensorineural hearing loss; SD = standard deviation; Covid-19 = coronavirus disease 2019

Of respondents, 66.0 per cent ( $n = 157$ ) reported that patients presenting to them with sudden SNHL did not have symptoms of Covid-19, such as cough, fever and shortness of breath. Thirty-six respondents (15.1 per cent) reported that patients did report at least one of these symptoms, and 45 respondents (18.9 per cent) were unsure if patients had these symptoms. Of respondents, 74.8 per cent ( $n = 178$ ) reported that patients presenting with sudden SNHL did not have other neuropathies at the time of diagnosis, including anosmia, change in taste, or limb weakness. Twenty-three respondents (9.7 per cent) reported that patients presenting with sudden SNHL did have at least one of these symptoms and 15.5 per cent ( $n = 37$ ) were unsure if patients had these symptoms.

Two hundred respondents (84.0 per cent) indicated that patients presenting with sudden SNHL were not in populations at high risk for contracting coronavirus. Of the respondents, 78.6 per cent ( $n = 187$ ) did not notice an association between suspected or positive coronavirus cases and sudden SNHL.

There was no difference among geographical locations with respect to a noticed increase in the incidence of sudden SNHL during the coronavirus pandemic ( $p = 0.38$ ) (Table 2), or a noticed association between suspected or positive coronavirus

**Table 2.** Increase in sudden SNHL during the pandemic by region

Question	Have you noticed an increase in sudden SNHL incidence since January 2020?			p-value**
	No*	Yes†	Total‡	
Where are you located?				0.3838
- Northeast	37 (24.8)	24 (27.6)	61 (25.8)	
- Southeast	37 (24.8)	29 (33.3)	66 (28.0)	
- Midwest	29 (19.5)	11 (12.6)	40 (16.9)	
- Southwest	21 (14.1)	8 (9.2)	29 (12.3)	
- West	25 (16.8)	15 (17.2)	40 (16.9)	

Data represent numbers and percentages of respondents, unless indicated otherwise. \*n = 150; †n = 88; ‡n = 238. \*\*Chi-square test. SNHL = sensorineural hearing loss

patients and sudden SNHL ( $p = 0.27$ ) (Table 3). There was a weak positive correlation between the number of patients identified with sudden SNHL since January 2020 and the percentage of Covid-19 positive patients reported by each medical care provider (Spearman correlation = 0.20, 95 per cent confidence interval = 0.05–0.33).

**Discussion**

Coronavirus disease 2019 has been shown to affect nearly every organ system in the body, including the cardiovascular system, gastrointestinal system, skeletal system and neurological system. Given its ability to impact nearly every organ system, and considering those patients in our clinic who had both Covid-19 and sudden SNHL, we hypothesised an association between coronavirus infection and sudden SNHL.

Viruses have been implicated in the development of sudden SNHL via a variety of mechanisms. These include direct mechanisms like invasion and viral reactivation, as well as indirect mechanisms including immune-mediated hearing loss and stress response related hearing loss.<sup>9</sup> Direct insults have been hypothesised to begin in the olfactory system. Insults to the olfactory system are thought to be due to direct damage, as olfactory epithelium has been shown to have high levels of angiotensin-converting enzyme 2 (ACE2) proteins

**Table 3.** Association between suspected or positive Covid-19 and sudden SNHL by region

Question	Have you noticed an association between suspected or positive Covid-19 & sudden SNHL?			p-value**
	No*	Yes†	Total‡	
Where are you located?				0.2629
- Northeast	50 (26.9)	11 (22.0)	61 (25.8)	
- Southeast	49 (26.3)	17 (34.0)	66 (28.0)	
- Midwest	30 (16.1)	10 (20.0)	40 (16.9)	
- Southwest	21 (11.3)	8 (16.0)	29 (12.3)	
- West	36 (19.4)	4 (8.0)	40 (16.9)	

Data represent numbers and percentages of respondents, unless indicated otherwise. \*n = 187; †n = 51; ‡n = 238. \*\*Chi-square test. Covid-19 = coronavirus disease 2019; SNHL = sensorineural hearing loss

which the virus uses to infect cells.<sup>10</sup> The virus has been found in the cerebrospinal fluid of infected individuals. This may occur via haematogenous, lymphatic or retrograde neuronal invasion, as has been detected with SARS-CoV-2.<sup>11</sup> Cerebrospinal fluid is in direct contact with the cochlear perilymph via the cochlear aqueduct and internal auditory meatus, allowing for direct viral insult.<sup>12</sup> Other viruses have been shown to indirectly damage audiological processing via strong adaptive immune responses that cause immune-mediated hearing loss.<sup>13</sup> This increase in inflammation can lead to a cytokine storm and cause damage to hair cells, the stria vascularis and the organ of Corti.<sup>14,15</sup> Additional indirect insults include virally induced hypercoagulability leading to cochlear ischaemia and hearing loss.<sup>16</sup>

Several case reports have described sudden SNHL following Covid-19, similar to the cases presented in this manuscript.<sup>17–22</sup> However, more studies are needed to ascertain a causality between Covid-19 infection and sudden SNHL. We understand that Covid-19 infections can be asymptomatic. In those patients, it appears that Covid-19 has minimal impact on hearing. Dror *et al.* demonstrated no cochlear dysfunction in auditory brainstem responses, or transient evoked and distortion product otoacoustic emissions testing, following asymptomatic Covid-19 infection.<sup>23</sup> Kökoğlu *et al.* reiterated this finding by demonstrating that patients with mild to moderate Covid-19 disease processes did not have permanent hearing loss.<sup>24</sup>

Nevertheless, some groups have suggested an increase in sudden SNHL during the pandemic and an association with the virus.<sup>25</sup> In their clinic, Fidan *et al.* noted an increase in sudden SNHL, with case numbers rising from 41 patients to 68 patients from 2019 to 2020.<sup>25</sup> They also noted that 60.3 per cent of patients in 2020 were positive for Covid-19 when compared to 9.8 per cent of those diagnosed in 2019. In a second study, 40.5 per cent of Covid-19 positive patients were found to have SNHL.<sup>26</sup>

This survey study attempted to determine whether medical care providers in the USA have noticed an association between the current pandemic and sudden SNHL. While there was no statistically significant association determined, 37 per cent of respondents had noticed an increase in sudden SNHL during the pandemic. Interestingly, medical care providers who reported more cases of sudden SNHL during the study period also reported a higher percentage of patients who were positive for SARS-CoV-2, although this association was weak. The current literature is equivocal for an association between Covid-19 and hearing loss. More research is needed to determine the incidence of sudden SNHL during the pandemic, as well as potential treatment options.

- Coronavirus disease 2019 (Covid-19) can cause cranial nerve deficits
- There is speculation that Covid-19 infection is associated with sudden sensorineural hearing loss (SNHL)
- Medical care providers did not notice an increase in sudden SNHL during the pandemic period when compared to baseline
- Further research is needed to determine the relationship between Covid-19 infection and sudden SNHL

There are several limitations to this study that should be noted. Though questions were reviewed to minimise bias, the wording of the questions may still have unintentionally led respondents to choose a particular option. The response rate also limits the ability to make generalisations about AAO-HNS practice patterns. The survey was administered

during the Covid-19 pandemic, which may have contributed to the low response rate. As with any voluntary survey, there may be selection bias in that those responding to the survey do not represent the entire population of otolaryngologists and audiologists. Furthermore, the survey did not ask about the respondents' type of work environment (e.g. academic, private, government); such detail may have provided useful information regarding practice patterns.

## Conclusion

At the time of the survey, the majority of respondents did not notice an association between the Covid-19 pandemic and a rise in sudden SNHL. Given our current understanding of virally induced hearing loss and case reports describing a potential association, more research is needed to determine whether there is a correlation.

**Competing interests.** None declared

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