Acta Med. Okayama, 2021
Vol. 75, No. 4, pp. 511-516

Acta Medica Okayama
http://escholarship.lib.okayama-u.ac.jp/amo/

Short Communication

Effects of Protective Measures against COVID-19 on Auditory Communication for People with Hearing Loss

Yuko Kataoka*, Yukihide Maeda, Akiko Sugaya, Ryotaro Omichi, and Shin Kariya

Department of Otolaryngology, Head & Neck Surgery, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama 700-8558, Japan

WHO has recommended various measures to combat the COVID-19 pandemic, including mask-wearing and physical distancing. However, these changes impair communication for individuals with hearing loss. We investigated the changes in auditory communication associated with COVID-19 measures in 269 patients (male: 45.7%, female: 54.3%, median age: 54 y.o.). Most patients with hearing loss had difficulty engaging in auditory communication with people wearing masks, especially in noisy surroundings or with physical distancing. These difficulties were noticeable in patients with severe hearing loss. Developing communication support strategies for people with hearing loss is an urgent need while COVID-19 measures are in place.

Key words: coronavirus disease 2019 (COVID-19), hearing loss, communication problem, mask, physical distance

In December 2019, an outbreak of pneumonia of unknown cause was confirmed in Wuhan City, Hubei Province, in the People's Republic of China [1]. Since then, the new coronavirus disease 2019 (COVID-19) has spread throughout the whole world in a short period of time.

The World Health Organization (WHO) recommended a variety of measures to protect oneself and others from COVID-19, such as avoiding groups of people and crowded spaces, maintaining a physical distance of at least 1 meter from other persons, wearing a mask in public settings, disinfecting surfaces, increasing ventilation and air filtration indoors, hand hygiene, covering one's mouth when coughing, and so on <World Health Organization: https://apps. who. int/iris/handle/10665/332293 (accessed in December, 2020)>.

In Japan, the government recommended a "new lifestyle" as a preventive measure against infection. The recommended basic measures to prevent infection are physical distancing (in Japan usually called "social distancing"), wearing a mask, and hand hygiene. Even as of September 2020, it was still recommended to wear a mask and ensure physical distancing in most public places, and acrylic panels had been installed between customers and staff at counters in many public spaces. In addition, web conferences and classes have been recommended as alternatives to face-to-face conversations. Although measures against COVID-19 have significantly changed communication methods, and people with hearing loss have had a great deal of difficulty when listening or communicating under these measures [2-4], only limited data have been reported on the communication problems of people with hearing loss during the pandemic. The aim of this study was to clarify how COVID-19 affects auditory communication for persons with normal hearing and for those who have hearing loss using a questionnaire.

Received December 17, 2020; accepted March 11, 2021.
*Corresponding author. Phone: +81-86-235-7307; Fax: +81-86-235-7308
E-mail: yu-kat@cc.okayama-u.ac.jp (Y. Kataoka)

Conflict of Interest Disclosures: No potential conflict of interest relevant to this article was reported.

Patients and Methods

Study Design. From July to August 2020, Okayama University Hospital Otolaryngology outpatients with ear diseases completed a questionnaire regarding changes in auditory communication associated with the measures taken against COVID-19. Patients more than 15 years old were targeted, and patients with psychogenic hearing loss were excluded.

Collection and analysis of questionnaire data. The content of the questionnaire dealt with the extent to which listening and communication had changed as a result of the measures taken against COVID-19. The specific questionnaire items were as follows:"1. Hearing the speech of a person wearing a mask (wearing mask);" "2. Hearing and communicating with a small number of people (a few people);" "3. Hearing and communicating with a large number of people (many people);" "4. Hearing in classes and meetings (class and meeting);" "5. Hearing at supermarket cash registers (supermarket);" "6. Communication with physical distancing (physical distance);" "7. Online listening and communication such as web classes and meetings (web class and meeting);" and "8. Textual information using subtitles or speech-to-text applications (textual information)." In their responses to the eight items, the respondents provided their subjective evaluations using the following seven-stage rating: −3 (very inconvenient), −2 (inconvenient), −1 (slightly inconvenient), 0 (no change), +1 (slightly improved), +2 (improved), +3 (very improved). In response to the three items, "4. class and meeting," "7. web class and meeting," and "8. textual information," another option, "no experience," was also provided.

Information regarding the sex, age, hearing test results, and hearing aid status of the patients was gathered. The results of standard pure tone audiometry were used as hearing assessments. The hearing level was a quadrant average of the hearing thresholds of 4 frequencies (500, 1,000, 2,000, and 4,000 Hz). If the threshold at a specific frequency exceeded the limit of the audiometry, the threshold was calculated by adding 10 decibel (dB) to its upper limit. The level of hearing loss was defined as mild [>25-≦40 dB hearing level (dB HL)], moderate (>40-≦70 dB HL), severe (>70-≦90 dB HL), or profound (>90 dB HL) [5]. Bilateral hearing loss was classified according to the degree of hearing loss in the better hearing ear, unilateral deafness was categorized as "unilateral," and bilateral normal hearing was categorized as "normal." The answers to the survey questions were collected and analyzed statistically, and in addition, cross analysis using background factors was performed. In calculating the average, those who answered "no experience" were excluded. The differences between the patients' answers to items 1-8 were analyzed using a nonparametric test (the Kruskal-Wallis test). The presence or absence of differences for each answer in association with the following factors was analyzed by a nonparametric test (the Kruskal-Wallis test or Mann-Whitney *U* test): (1) bilateral hearing loss, unilateral hearing loss, or bilateral normal hearing; (2) the level of hearing loss (mild, moderate, or severe to profound; and (3) with or without hearing aid in the patients with moderate hearing loss.

This research was conducted in compliance with the Declaration of Helsinki and was approved by the Bioethics Committee of Okayama University (Survey of People with Hearing Loss and Examination of the Usefulness of Intervention with Hearing Aid, Cochlear Implant or Hearing Alternative Devices, Lab 2008-002).

Results

Subjects. A total of 285 patients who visited our hospital during the period agreed to participate in the study and responded to the questionnaire. We obtained valid answers from 269 patients (94.4%, 123 male and 146 female) and included them in this study, excluding 16 patients who gave inadequate answers or did not meet the criteria. Their median age was 54 years. Table 1 shows their clinical characteristics. We classified the patients according to hearing level as follows: 36 cases of bilaterally normal hearing (13.4%), 81 cases of unilateral hearing loss (30.1%), and 152 cases of bilateral hearing loss (56.5%). In the subjects with bilateral hearing impairment, the severity was mild in 62 (40.8% of the bilateral hearing loss group), moderate in 53 (34.9%), and severe to profound in 37 cases (24.3%). Overall, 64 patients (23.8%) wore hearing aids, 13 (4.8%) used cochlear implants, and 192 patients (71.4%) did not wear either hearing aids or cochlear implants.

Auditory communication problems. Figure 1 shows the distribution of scores for each item in the survey. Tables 2 and 3 show the average score for each item. The responses given by all patients to each item showed that the communication difficulty was statisti-

cally different among the items ($p<0.01$, by Kruskal-Wallis test) in the following order, from most difficult to least difficult: "many people," "supermarket," "wearing mask," "class and meeting," "physical distance," "a few people," "web class and meeting," and "textual information" (Table 2). In answering the former 5 questions, the patients reported a great deal of difficulty.

A total of 100 patients (37.2%) responded "no experience" to the "web class and meeting" item. The median age was 47 years for those with experience and 65 years for those on this item. Sixty-two (34.6%) of the 179 patients with normal hearing to mild hearing loss and 38 (42.2%) of the 90 patients with moderate and severe to profound hearing loss gave the "no experience" response to the "web class and meeting" item. Eighty-six patients (32.0%), especially those with better hearing, had "no experience" with "textual information," and the median age was 50 years for those with experience and 64 years for those with no experience on this item. For those with moderate and severe to profound hearing loss, the score for "textual information" was higher than for the other questions; that is, they reported little inconvenience in communicating with visual information.

In a comparison among respondents with bilateral hearing loss, unilateral hearing loss, and bilateral normal hearing, the difficulty reported in response to each question was significantly different for questionnaire items 1, 2, 3, 4, 5, and 6 ($p<0.05$, by Kruskal-Wallis test) and the difficulty reported was generally in the

Table 1 Comparison of demographic factors by hearing level

	Total	Norma hearing	Unilateral hearing loss	Bilateral hearing loss		
				Mild >25-≤40 dB HL	Moderate >40-≤70 dB HL	Severe to profound >70 dB HL
Number	269	36	81	62	53	37
Male	123	20	39	26	25	13
Female	146	16	42	36	28	24
Median Age (y.o.)	54	41.5	45	58.5	69	59
HA	64	0	2	7	31	24
CI	13	0	0	0	0	13
Neither	192	36	79	55	22	0

y.o., years old; HA, hearing aid; CI, cochlear implant

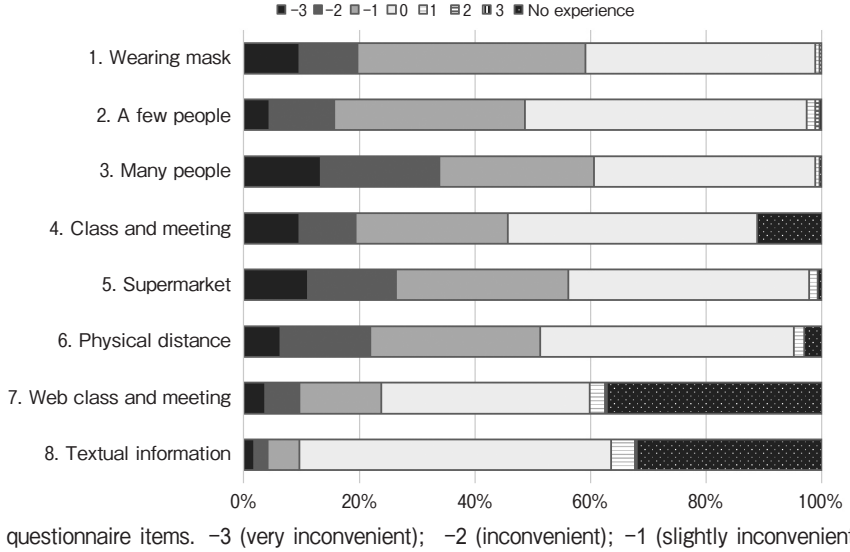

Fig. 1 Responses to questionnaire items. −3 (very inconvenient); −2 (inconvenient); −1 (slightly inconvenient); 0 (no change); +1 (slightly improved); +2 (improved); +3 (very improved). A lower score indicates greater inconvenience. About half of the total have communication difficulties in 1–6 situations.

Table 2 Comparison of average score of each question between presence or absence of hearing loss

	All	Normal hearing	Unilateral hearing loss	bilateral hearing loss
1. Wearing mask	−0.87	−0.42	−0.70	−1.07
			**	
2. A few people	−0.65	−0.44	−0.51	−0.77
			*	
3. Many people	−1.07	−0.64	−0.90	−1.27
			**	
4. Class and meeting	−0.84	−0.41	−0.61	−1.08
			**	
5. Supermarket	−0.93	−0.67	−0.77	−1.08
			*	
6. Physical distance	−0.80	−0.64	−0.62	−0.94
			*	
7. Web class and meeting	−0.53	−0.43	−0.33	−0.69
8. Textual information	−0.15	−0.17	−0.07	−0.19

** $p<0.01$ * $p<0.05$

Those are the average score of each answer. Items that had significant difference among 3 groups in the Kruskal-Wallis test are underlined, and those that had significant difference in the Mann-Whitney *U* test are shown in upper parentheses. The difficulty of each question was significantly different for the items 1 to 6 and higher in the order of bilateral hearing loss, unilateral hearing loss, and normal hearing loss.

Table 3 Comparison of average score of each question in hearing level

	Bilateral hearing loss		
	Mild hearing loss	Moderate hearing loss	Severe to profound hearing loss
1. Wearing mask	−0.73	−1.15	−1.51
		**	
2. A few people	−0.60	−0.96	−0.78
3. Many people	−1.03	−1.38	−1.51
4. Class and meeting	−0.84	−1.33	−1.17
5. Supermarket	−0.87	−1.04	−1.50
		*	
6. Physical distance	−0.71	−0.94	−1.31
		*	
7. Web class and meeting	−0.40	−0.90	−0.87
8. Textual information	−0.16	−0.24	−0.19

** $p<0.01$ * $p<0.05$

Those are the average score of each answer. Items that had significant difference among 3 hearing level (mild, moderate and severe to profound) in the Kruskal-Wallis test are underlined, and those that had significant difference in the Mann-Whitney *U* test are shown in upper parentheses. People with more severe hearing loss have more difficulty with auditory communication notably in 1, 5 and 6.

following order from highest to lowest: bilateral hearing loss, unilateral hearing loss, and normal hearing loss (Table 2). The differences among these three groups of respondents in their answers to the following items ran from largest to smallest in this order: "wearing mask," "class and meeting," "many people," "physical distance," "supermarket," and "a few people". There were significant differences by hearing level for the "wearing mask," "physical distance," and "supermarket" items ($p<0.05$, by Kruskal-Wallis test); a slight difference was also confirmed for the "many people" item. Six items with significant differences according to the Kruskal-Wallis test were analyzed using the Mann-Whitney *U* test (Table 2, upper parentheses), and there were notable significant differences between respondents with unilateral and bilateral hearing loss and between those with normal hearing and bilateral hearing loss. For the three items in which the Kruskal-Wallis test showed a significant difference among patients with bilateral hearing loss, a Mann-Whitney *U* test showed a significant difference between those with mild hearing loss and those with severe to profound hearing loss.

In patients with moderate hearing loss, there was no significant difference in responses to any item between those with and those without wearing hearing aids, ($p>0.05$, by Mann-Whitney *U*-test).

Free description. Over 10% of the patients stated their problems in the free description field, as follows. The most common problem was that "wearing a mask made it difficult not only to listen, but also to read lips or facial expressions." Other comments included: "The acrylic panel at the cash register in the store hinders listening." "Writing is not so useful, because communication speed becomes slow." "I have given up listening and stopped wearing a cochlear implant." "Hearing aids often fall off due to interference with the mask."

Some of them described measures related to communication difficulties, as follows: "transparent masks with a visible mouth should be widespread;" "from the viewpoint of infection prevention, I think it is better to use a face shield in addition to a transparent mask;" "to

speak smoothly and loudly is important;" "the use of Bluetooth with a cochlear implant makes it easier to hear the content of telephone calls and online meetings;" and "I want a badge that indicates hearing loss."

Discussion

COVID-19 is an infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. The infection route includes droplets, contact, and aerosols. The WHO recommended wearing a mask, ensuring physical distancing, and opening windows or doors for ventilation as preventive measures. However, these changes impair communication for the many people with hearing loss.

The present study focused on how masks or other measures against COVID-19 undermine auditory communication for people with hearing loss, and the following were the key findings: (1) Not only patients with bilateral hearing loss, but also those with normal hearing or unilateral hearing loss have some difficulty with auditory communication due to the measures taken against COVID-19, with wearing a mask or trying to communicate under poor conditions such as with a large number of people, at the checkout area in supermarkets, in public places, or while maintaining physical distancing. (2) A comparison among hearing levels showed that the more severe a patient's hearing loss was, the greater the hearing difficulties became for almost all items except visual information. (3) People with moderate to profound hearing loss did not find online communication to be very useful, even without masks, and they wanted to be provided with other means of communication, such as visual information contained in text.

With regard to the communication problems encountered by people with hearing loss due to COVID-19 countermeasures, some brief reports from other countries have already been published. The use of masks has not only led to a decrease in the transmission intelligibility of sound, especially in the high frequency range, but has also been a barrier to the reading of lip movements and facial expressions, and thus has significantly impaired communication [2,6-8]. Generally, people with hearing loss have difficulty hearing under poor conditions, such as in the presence of many people, in noisy environments and at a distance, even if the hearing loss is mild or moderate. However, hearing under such conditions is even more inconvenient with the wearing of masks. Research conducted in a soundproof room compared speech intelligibility with and without a simple or an N95 medical mask and found that each type of medical mask essentially attenuated the high frequencies (2,000-7,000 Hz) spoken by the wearer by 3 to 4 dB for a simple medical mask and close to 12 dB for the N95 mask [6]. A study conducted in Italy involving 59 people with mild to profound hearing loss (median age 60 years) explored the difficulties experienced in relation to their hearing impairment during an emergency visit during the COVID-19 outbreak. This study found that 13.6% of subjects reported no change, but 25.4% had mild difficulties, 37.3% moderate difficulties, and 23.7% severe difficulties. Furthermore, 44.1% pointed out that voice information was difficult to hear due to the wearing of face masks, and 55.9% of the people reported that lip reading was impossible with face masks [3]. Ertugtul *et al.* compared the proportion of hearing aid applicants among outpatients from April to June 2019 with the corresponding proportion in the same months in 2020 and found it to be significantly higher in 2020 [9]. They considered that the COVID-19 pandemic made hearing aids indispensable because the wearing of masks made speech less intelligible and lip reading difficult for people with hearing loss.

There is an urgent need to take measures against these problems, and Reed *et al.* have already proposed some possible strategies [10]. Five methods involve technological considerations: (1) handheld amplification, (2) amplified and captioned telephones, (3) in-room videoconferencing, (4) speech to text, and (5) smartphone amplification. Four measures involved environmental modifications: (1) remove background noise, (2) improve room lighting, (3) pre-printed placards, and (4) using a whiteboard or tablet. Seven communication strategies were suggested: (1) ensure attention, (2) employ face-to-face communication, (3) make the mouth visible when possible, (4) speak slowly and low, (5) do not shout, (6) give context to conversation, and (7) rephrase rather than repeat.

Face shields and see-through prototype masks are efficient ways to make it possible to read lips and facial expressions. Mendel *et al.* reported that using a transparent surgical mask improved speech perception in noisy environments for listeners with hearing loss [9]. However, these masks are difficult to obtain. It is

important to convey the need for environmental modifications and communication considerations, but they are not always understood by others. Various technological communication tools have been or are expected to be introduced soon. For example, a smartphone amplifier is a telephone application that turns a telephone into a microphone by pairing it with a Bluetooth speaker, and the volume can be raised with a simple adjustment. However, people with hearing loss, especially those with more severe hearing loss, often need captioning to be able to understand speech rather than additional auditory information. Smartphones and tablets offer real-time speech-to-text transcription, and many such applications now run with remarkable speed and accuracy. Speech-to-text captioning can also be used on various platforms, including web meetings and lectures. Communication can often be improved by speaking slowly and increasing the volume of one's voice slightly. However, in our study, web classes and meetings as well as textual information were not convenient for people with hearing loss to use. In addition, the number of users of such platforms was small, particularly among the elderly, which suggests that there are still issues to be solved before they can be fully utilized in society.

The limitations of this study are as follows: (1) The evaluation of communication difficulty is subjective, and there may be differences in how such difficulties are perceived among individuals. (2) The data may be biased due to the social background of the subjects, because there were variations in age among the subject groups. Verification of these results in more cases is needed to increase their statistical reliability.

According to a report from the Ministry of Health, Labor and Welfare at the end of December 2020, the cumulative number of COVID-19 infections in Japan had exceeded about 180,000, and the number of deaths reached over 2,700. Even if the COVID-19 pandemic is controlled, it is quite possible that individual infection prevention measures will be needed for several months or years. On the other hand, the new lifestyle adopted during the pandemic has incorporated some conveniences, such as remote work and online meetings and classes, that may continue even after the pandemic has ended. To secure means of communication for persons with hearing impairment, it is urgent that new ways of coping with these changes be developed and that social consideration and support be strengthened.

In conclusion, measures to prevent COVID-19, such as wearing masks and ensuring physical distancing, make communication difficult for people with hearing loss by decreasing their understanding of auditory communication. This is particularly noticeable for people who have a high degree of hearing loss. The widespread use of transparent masks and face shields can help such individuals function well in society, but it is also necessary that amplifiers and speech-to-text transcription be available and that people be mindful of how they speak. Building social considerations and support to promote communication for people with hearing impairment is an urgent task.

Funding and Acknowledgements. This study was supported by a grant from the Japan Agency for Medical Research and Development (Grant No. JP20dk0310107h0001). The authors would like to express our sincere appreciation to Professor Takashi Nakagawa, the principal investigator of this project supported by the grant. The authors would also like to thank all of our collaborators in this study.

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF and Tan W: China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med (2020) 382: 727–733.
2. Chodosh J, Weinstein BE and Blustein J: Face masks can be devastating for people with hearing loss. BMJ [Online] 2020; 370: m2683.
3. Trecca EMC, Gelardi M and Cassano M: COVID-19 and hearing difficulties. Am J Otolaryngol [Online] 2020; 41: 102496
4. West JS, Franck KH and Welling DB: Providing health care to patients with hearing loss during COVID-19 and physical distancing. Laryngoscope Investig Otolaryngol (2020) 5: 396–398.
5. Clark JG: Uses and abuses of hearing loss classification. Asha (1981) 23: 493–500.
6. Goldin A, Weinstein BE and Shiman N: How do medical masks degrade speech perception? Hear Rev (2020) 27: 8–9.
7. Nobrega M, Opice R, Lauletta MM and Nobrega CA: How face masks can affect school performance. Int J Pediatr Otorhinolaryngol (2020) 138: 110328.
8. Mendel LL, Baltimore WJ, Patro C, Lee S, Pousson M, Spann MJ and Atcherson SR, et al: The Effect of Conventional and Transparent Surgical Masks on Speech Understanding in Individuals with and without Hearing Loss. J Am Acad Audiol (2017) 28: 58–67.
9. Ertugrul S and Soylemez E: Explosion in hearing aid demands after Covid-19 outbreak curfew. Eur Arch Otorhinolaryngol in press.
10. Reed NS, Ferrante LE and Oh ES: Addressing Hearing Loss to Improve Communication During the COVID-19 Pandemic. J Am Geriatr Soc (2020) 17: 10.