Impacts of the COVID-19 pandemic on sleep center operations and sleep apnea treatment in Korea
A multicenter survey
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Abstract
The coronavirus disease-2019 (COVID-19) pandemic has not only changed the lives of people around the world but also affected all areas of the healthcare system, including sleep medicine. However, no studies in Korea have investigated the status of domestic sleep centers and their challenges during the pandemic.

An online survey was performed from December 2020 to January 2021. Hospitals that belonged to sleep-related academic societies and were considered well managed were included in this survey. The questionnaire focused on changes in sleep center operations, infection control policies, and patient treatment since the start of the COVID-19 pandemic. Telemedicine and future directions for sleep medicine services were also investigated.

Of the 20 sleep centers that responded, 80% were at university hospitals with more than 500 inpatient beds. During the third wave of the COVID-19 pandemic in Korea (November–December 2020), the routine operating schedule of the sleep study room was reduced in 30% of the sleep centers compared to November–December 2019 (before COVID-19). The number of type 1 polysomnographies performed decreased in 85% of the sleep centers. In contrast, in-lab positive airway pressure (PAP) titrations decreased in 40%, remained unchanged in 35%, and increased in 25%. With respect to prescriptions, 30% of the sleep centers increased the number of prescriptions for auto-titrating continuous PAP. However, 60% of the sleep centers reported no change in the rate of fixed continuous PAP and auto-titrating continuous PAP prescriptions. All sleep centers that participated in this survey agreed that the need for documented infection control regulations will continue after the COVID-19 pandemic. Since the beginning of the pandemic, 30% of the centers have tried telemedicine. However, respondents expressed concern about telemedicine, citing a number of practical issues.

Compared to countries where the COVID-19 pandemic was severe, Korea had less impact of COVID-19 on the sleep center operations and sleep apnea treatment. Infection and quality control in the sleep study room are important and inevitable issues, and regulation within each institution is necessary. Further research and discussion are needed regarding telemedicine and home sleep apnea test in Korea.

Abbreviations: AASM = American Academy of Sleep Medicine, APAP = auto-titrating continuous positive airway pressure, COVID-19 = coronavirus disease-2019, CPAP = continuous positive airway pressure, HSAT = home sleep apnea test, OSA = obstructive sleep apnea, PAP = positive airway pressure, PSG = polysomnography, RT-PCR = real-time reverse-transcription polymerase chain reaction, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

Keywords: coronavirus, infection, polysomnography, severe acute respiratory syndrome coronavirus 2, sleep laboratory, telemedicine
1. Introduction

Since the first report of coronavirus disease-2019 (COVID-19) cases in Wuhan, China, 111,279,860 confirmed cases and 2,466,639 deaths has been reported worldwide (figures through February 23, 2021).\[^1^\] As there are no definite treatments for COVID-19 as yet, prevention of further virus spread is the most important way to control the COVID-19 pandemic.\[^2^\] Because the transmission of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was also through airborne droplets, social distancing and quarantining are now common standards that have been implemented worldwide since the outbreak of COVID-19.\[^3^\]–\[^5^\]

The COVID-19 pandemic has not only changed the lives of people around the world but also affected all areas of the healthcare system, including sleep medicine. Given concerns about COVID-19 transmission, sleep laboratories were urged to cancel or delay scheduled in-laboratory studies.\[^6^\]–\[^7^\] Treatment with positive airway pressure (PAP) therapy was also challenged because of PAP-induced droplets and aerosols.\[^8^\] Sleep societies around the world published recommendations regarding the functions of sleep laboratories and the management of patients with sleep-disordered breathing during the COVID-19 pandemic.\[^7^\]–\[^9^\]–\[^11^\]

In Korea, the number of sleep studies has increased sharply since national health insurance coverage started in 2018. In 2018 and 2019, 16,046 and 64,970 polysomnography (PSG) tests, respectively, were performed.\[^12^\] However, in Korea before COVID-19, patients with sleep-disordered breathing were approached and treated differently by internal medicine, otolaryngology, neurology, and psychiatry. This reality made it difficult to prepare standardized medical guidelines to cope with crisis situations such as COVID-19 pandemic. In addition, no studies in Korea have investigated the status of domestic sleep centers and their difficulties since the COVID-19 pandemic began. In this study, we aimed to investigate the impacts of the COVID-19 pandemic on sleep center operations and treatments using a multicenter survey.

2. Methods

2.1. Survey

An online survey was conducted from December 2020 to January 2021. Hospitals that belonged to sleep-related academic societies and were considered well managed were included in this survey. The purpose and method of the survey were explained through e-mail. Recruitment of participating hospitals was assisted by the Korean Academy of Sleep Medicine and the sleep-disordered breathing research group in the Korean Academy of Tuberculosis and Respiratory Diseases. The anonymous questionnaire was distributed and collected through the NAVER office service (https://office.naver.com/). The survey included 32 questions comprising single- or multiple-choice items and number entries. The questionnaire focused on 5 main topics: general information about the hospital and sleep center (location, size and classification of the hospital; number of beds and workers, operating schedule of the sleep study room; and respondent’s clinical department), changes in sleep study room operations since COVID-19, infection control policies since the beginning of COVID-19, changes in treatment and teledmedicine with COVID-19, and policies and directions that will be important even after COVID-19.

By February 2021, Korea had experienced 3 waves of the COVID-19 pandemic.\[^13^\] The first wave was between February and March of 2020, and the second and third waves were from August to September of 2020 and from November 2020 to February 2021, respectively. Our survey was performed during the third wave. During this period, gatherings of more than 4 people were prohibited in the capital area. Cafes and restaurants were forced to close at 9 PM, and gatherings at clubs and karaoke bars continued to be banned. The status of sleep centers and the number of sleep studies before and during COVID-19 were based on the periods November to December 2019 and November to December 2020, respectively. Because this was an anonymous questionnaire, 3 reminders were sent to all candidates for participation. This study was approved by the Institutional Review Board of Eunpyeong St. Mary’s Hospital (PC20QISI0185).

2.2. Statistical analyses

Means and standard deviations were computed for normally distributed continuous variables, and medians and interquartile ranges (IQRs; 25th–75th percentile) were used for non-normally distributed continuous data. Categorical data are described as numbers and percentages (%). Student t test was performed for normally distributed data, and the Mann–Whitney U test for non-normally distributed data to compare the number of sleep studies before and during COVID-19. Statistical analyses were performed using the R ver. 4.0.4 program (R Development Core Team, R Foundation for Statistical Computing, Vienna, Austria). A P-value < .05 was considered indicative of statistical significance.

3. Results

3.1. Basic information about participating hospital sleep centers

A total of 20 hospitals with sleep centers participated. Figure 1 shows the distribution of hospitals participating in the survey. Of the 20 hospitals with sleep centers, 80% were university hospitals, and 15% were general hospitals (Table 1). The clinical departments affiliated with the sleep center were psychiatry, internal medicine, otolaryngology, and neurology. The numbers of sleep study beds in each hospital were 2 (55%), 3 (25%), and 4 (15%).

3.2. Changes in sleep study room operations and treatments during the COVID-19 pandemic

Among the participating hospitals, only 2 sleep centers (10%) reduced the number of sleep study beds in operation and the number of workers in the sleep study room after the start of the COVID-19 pandemic (Table 2). The average number of type 1 PSGs performed per month was 38.0 ± 22.8 during November to December 2019 (before the COVID-19 pandemic) and 30.9 ± 17.9 during November to December 2020 (during the COVID-19 pandemic). Although there was no statistically significant decrease in the number of type 1 PSGs performed per month due to COVID-19 (P = .280), we found that 1 sleep center (hospital number 12) doubled the operational sleep study beds even after the COVID-19 pandemic began (Table S1, Supplemental Digital Content, http://links.lww.com/MD2/A796). Of all sleep centers, the number of type 1 PSGs performed decreased in
85% and was unchanged in 10%. The median number of in-lab PAP titrations performed per month was 5.0 [1.0; 10.0] during November to December 2019 (before COVID-19) and 7.0 [2.0; 11.0] during November to December 2020 (during the COVID-19 pandemic). There was no statistically significant change in the number of in-lab PAP titrations performed per month due to COVID-19 ($P=.431$). Of all sleep centers, in-lab PAP titrations decreased in 40%, remained unchanged in 35%, and increased in 25% (Table S1, Supplemental Digital Content, http://links.lww.com/MD2/A796). Patients raised several questions about policies during the COVID-19 pandemic, including the following: the risk of infection and environmental management of sleep study rooms, cleaning of equipment used in sleep study rooms, telemedicine, possibility of droplet spread through the use of PAP devices, and maintaining the use of PAP devices during COVID-19 infection (Table S2, Supplemental Digital Content, http://links.lww.com/MD2/A797). With respect to prescriptions, 30% of the sleep centers increased the number of prescriptions for auto-titrating continuous PAP (APAP). However, 60% of the sleep centers reported no change in the rate of fixed continuous PAP (CPAP) and APAP prescriptions.

### 3.3. Infection control policies for sleep study rooms during the COVID-19 pandemic

Before the COVID-19 pandemic, 35% of the sleep centers had documented general infection control regulations (Table 3), and since then, more than 50% of the sleep centers have established COVID-19 screening processes. Most other sleep centers also begun COVID-19 screening during the second and third COVID-19 outbreaks. In responses to the multiple-choice question about COVID-19 screening methods, the most frequent techniques cited involved checking respiratory symptoms and asking about patient visit history at outpatient clinics or the sleep study room. Five centers required COVID-19 real-time reverse-transcription polymerase chain reaction (RT-PCR) results before the sleep study. Since the start of the COVID-19 pandemic, general infection control has been thorough at most sleep centers, with methods including the following: increased hand hygiene during the sleep test, personal protective equipment worn by technicians, strengthened process for cleaning masks and circuits, and increased use of disposable products. Fortunately, there were no cases of COVID-19 infection in the sleep laboratories at each hospital during the study period.

### 3.4. Policies and directions needed even after the COVID-19 pandemic

Infection control protocols, quality control of the sleep study room, gradual expansion of the use of disposable products, and expansion of home sleep apnea tests (HSATs) were proposed as practices that should be continued even after the COVID-19 pandemic (Table 4). All sleep centers that participated in the survey agreed with the need for documented infection control.
4. Discussion

The COVID-19 pandemic has affected all areas of the healthcare system, including sleep medicine. In this study, we aimed to investigate the impacts of the COVID-19 pandemic on sleep laboratory operations and sleep patient treatment in Korea. Similar to the situation in other countries,[7,14,15] the number of sleep studies has been reduced, and the rate of sleep study cancelation has increased. Most sleep centers in Korea established or strengthened COVID-19 screening and infection control protocols. As a result, sleep medicine has undergone many changes in terms of patient care and treatment since the start of the COVID-19 pandemic.

Data from 40 sleep centers in Europe indicated that sleep medicine services were reduced by almost 80% during the first 1 to 2 months of the COVID-19 pandemic.[7] Results from the American Academy of Sleep Medicine (AASM) COVID-19 survey conducted in July and August of 2020 showed that 66% of the sleep centers reported lower patient volume after the start of the pandemic, and 36% reported a need for financial assistance due to the COVID-19 pandemic.[16] Fortunately, Korea has passed the peak of local epidemics well within National Health System capabilities with a low fatality rate.[17] Our study revealed that the number of type 1 PSGs performed decreased in 85% of the sleep centers in Korea. However, this decrease (18.7%) was less than that in studies of other countries. The reductions in sleep laboratory facilities and staff were also less than those in other countries. In China, the number of physicians and nurses/technicians in sleep medicine services was reduced to 50% and 60%, respectively, during the pandemic compared to prepan-demic levels.[14] This result seems to have been influenced by the timing of the survey. In Korea, the largest number of confirmed COVID-19 cases occurred during the third wave of the COVID-19 pandemic, and this study was conducted during that period.

### Table 1
Basic information about participating hospital sleep centers.

| Total number of hospitals | 20 |
|---------------------------|----|
| **Classification of hospitals** |
| University hospital | 16 (80%) |
| General hospital | 3 (15%) |
| Individual clinic | 1 (5%) |
| **Number of inpatient beds** |
| ≥500 beds | 16 (80%) |
| 300–500 beds | 2 (10%) |
| 100–300 beds | 1 (5%) |
| No admission bed | 1 (5%) |
| **Clinical department affiliated with the sleep center** |
| Psychiatry | 9 (45%) |
| Internal medicine | 5 (25%) |
| Otorhinolaryngology | 4 (20%) |
| Neurology | 2 (10%) |
| **Number of sleep study beds** |
| 2 | 11 (55%) |
| 3 | 5 (25%) |
| 4 | 3 (15%) |
| 22 | 1 (5%) |
| **Median number of workers in sleep study room** | 2.0 (2.0–3.0) |
| **Number of operating days per week in sleep study room** |
| 7 days | 1 (5%) |
| 6 days | 5 (25%) |
| 5 days | 6 (30%) |
| 3–4 days | 6 (30%) |
| 1–2 days | 2 (10%) |

Categorical data are described as numbers and percentages (%). Means and the interquartile range (IQR) were used for non-normally distributed continuous data.

### Table 2
Changes in sleep study room operations and treatments during the COVID-19 pandemic.

| n |
|---|
| **Reduced the number of sleep study beds in operation** |
| Yes | 2 (10%) |
| No | 18 (90%) |
| **Reduced the number of workers operating sleep study room** |
| Yes | 2 (10%) |
| No | 18 (90%) |
| **Reduced sleep study room routine operation schedule** |
| Yes | 6 (30%) |
| No | 14 (70%) |
| **Average number of type 1 PSG per month** |
| Before the COVID-19 pandemic | 38.0 ± 22.8 |
| During the COVID-19 pandemic | 30.9 ± 17.9 |
| **Reasons for type 1 PSG decrease during the COVID-19 pandemic** |
| Patient canceled or postponed | 13 (65%) |
| Decreased patient visit | 9 (45%) |
| Infection control policy or hospital shutdown | 2 (10%) |
| No significant decrease | 4 (20%) |
| **Median number of in-lab PAP titration per month** |
| Before the COVID-19 pandemic | 5.0 (1.0–10.0) |
| During the COVID-19 pandemic | 7.0 (2.0–11.0) |
| **Median number of sleep study cancellation per month during the COVID-19 pandemic** |
| Change in treatment during the COVID-19 pandemic*
| Delayed sleep test in mild, nonemergency patients | 7 (35%) |
| Extended patient visit interval | 7 (35%) |
| Tried telemedicine with phone or video | 6 (30%) |
| **Change in prescription during the COVID-19 pandemic** |
| Increased APAP prescription | 6 (30%) |
| Increased fixed CPAP prescription | 2 (10%) |
| No difference | 12 (60%) |

Categorical data are described as numbers and percentages (%). Means and standard deviations were computed for normally distributed continuous variables, whereas medians and the interquartile range (IQR) were used for non-normally distributed continuous data.

* Multiple choice.
Traditionally, laboratory PSG has been the gold standard diagnostic procedure in sleep medicine. Since the HSAT devices typically do not include electroencephalography, electrooculography or electromyography sensors, it has limitations in measuring sleep stages and sleep duration. Due to the technical limitations, use of HSAT has been highly controversial as compared with PSG. However, considering the high cost of in-laboratory sleep tests and the increasing trend toward no contact daily life, a HSAT was suggested as an alternative. Clinical studies indicate that HSAT when used in uncomplicated patients with a high probability of moderate to severe obstructive sleep apnea (OSA) may provide similar diagnostic accuracy as PSG for moderate and severe OSA. Clinical studies indicate that HSAT when used in uncomplicated patients with a high probability of moderate to severe obstructive sleep apnea (OSA) may provide similar diagnostic accuracy as PSG for moderate and severe OSA.

During COVID-19 pandemic, HSAT is preferred over in-laboratory screening according to COVID-19 epidemiological status and availability of the test. In other countries, some sleep centers have used HSATs to continue sleep testing. However, in Korea, the HSAT is not officially used and is not covered by health insurance. As a result, the HSAT was not prescribed at sleep centers even prior to the COVID-19 pandemic. In Korea, it seems necessary to discuss appropriate indications and reimbursement for the HSAT.

Due to the COVID-19 transmission risk in sleep studies and PAP therapy, several sleep societies have offered recommendations for sleep medicine practices in the COVID-19 era. General recommendations focus largely on COVID-19 screening, infection control, and environmental management of the sleep laboratory. Several papers also suggested documented practical protocols for PSG room operations after COVID-19. Before the COVID-19 pandemic, only 35% of the sleep centers in Korea had documented infection control regulations. Since the beginning of the pandemic, all sleep centers have conducted COVID-19 screening in various ways, such as checking respiratory symptoms, taking visit histories, and requesting SARS-CoV-2 RT-PCR assay results. In addition, sleep laboratory infection control regulations have been reinforced at most centers. Strengthening the hand hygiene and mask and circuit cleaning processes, wearing personal protective equipment, and increasing the use of disposable products were representative responses in our survey. This trend was the same in other countries as well. The AASM report recommended avoiding the use of nondisposable devices for at least 72 hours after each use and proper sanitization. In Italy, some hospitals also require COVID-19 testing for all patients undergoing in-house PSG. However, the utility and necessity of SARS-CoV-2 RT-PCR before a sleep test are still debated. Cleaning and disinfection of the sleep study room and the use of disposable equipment are also recommended. Even after the COVID-19 pandemic, infection control and quality control in the sleep study room are expected to be important issues.

With respect to patient treatment since the beginning of the COVID-19 pandemic, the authors investigated whether the prescription rates of APAP and fixed CPAP have changed. From AASM clinical practice guideline, PAP therapy could be initiated due to the difficulty communicating with patients. However, no changes were observed for 60% of the centers, and 10% of the centers issued more fixed CPAP prescriptions. In addition, there was no statistically significant change in the number of in-lab PAP titrations performed per month due to COVID-19 in our study. This was because in-lab titration, which had been frequently postponed or omitted before COVID-19.
because no empty sleep study room was available, took the place of PSG. According to the Korea National Health Insurance Database, APAP accounted for 85.1% of all PAP devices prescribed before the COVID-19 pandemic in Korea.\(^{30}\) Even before the start of the COVID-19 pandemic, Korea’s APAP prescription rate was on the high side, so the change with COVID-19 may not have been very great. In other countries, prescription rate was on the high side, so the change with COVID-19 may not have been very great. In other countries, manual titration was replaced with APAP, and APAP was used even without diagnostic PSG for uncomplicated OSA patients during the pandemic.\(^{14,15}\) However, patients with heart failure, significant lung disease, patients expected to have nocturnal oxygen desaturation due to conditions other than OSA, and patients who have central sleep apnea syndromes are not candidates for APAP titration or treatment.\(^{31}\) When APAP is implemented, monitoring the clinical response and PAP usage and therapy data within the first few weeks is needed to make necessary PAP adjustments when indicated.\(^{29}\)

According to current recommendations, during the COVID-19 pandemic, sleep medicine services are advised to reduce in-house services and provide medical care remotely, such as via telemedicine.\(^{28}\) A survey done primarily in America showed a large increase in the use of telemedicine, with the majority of respondents expecting the use of telehealth to endure in the future.\(^{23}\) Similarly, the AASM pulse survey found that 62.07% of the respondents favored the continuation of telemedicine services after COVID-19 is resolved, provided they are adequately reimbursed.\(^{16}\) The AASM practice guideline, updated before the COVID-19 pandemic, also suggested telemonitoring-guided interventions during the initial period of PAP therapy in adults with OSA.\(^{29}\) Currently in Korea, telemedicine is temporarily allowed under the special circumstances of COVID-19. However, 45% of the respondents in our survey replied that they were not willing to use telemedicine even if it is officially allowed after the COVID-19 pandemic. Respondents expressed high levels of concern over many realistic issues. As we have experienced during this COVID-19 pandemic, improvised telemedicine without adequate guidance can be confusing to both patients and health professionals.\(^{32}\) Despite these concerns, patients’ satisfaction with telemedicine was significantly greater than medical staff’s satisfaction in other Korean study.\(^{33}\) In addition, the possibility, clinical effectiveness, and cost-benefit of telemedicine have already been established through various studies.\(^{32,34}\) Under these circumstances, telemedicine has the potential to become a part of medical care. In this area, practical guidelines and further research on strategies for reducing the ill effects and maximizing the positive effects seem to be needed.

Currently, the issue of infection control is the most important topic related to COVID-19. Both the medical staff and patients answered that infection and environmental management were the most important issues in sleep medicine services. Impressively, 100% of survey respondents answered that even after the COVID-19 pandemic, documented infection control regulations in sleep study rooms should be required. In addition, they preferred that the regulation of infection control be established and managed at the level of academic sleep societies or hospitals, not by governmental monitoring and regulation. In the future, infection control in sleep medicine requires both the active efforts of domestic sleep societies and the support of the government.

We are aware of the limitations of this study. First, the number of hospitals participating in this study was limited to 20. However, the participating hospitals belonged to sleep-related academic societies and were considered well managed. Except for 1 free-standing sleep clinic, all the hospitals included were university hospitals or general hospitals. Second, the survey mainly addressed large-sized hospitals, so the realities of small and medium-sized hospitals are less evident. Compared to large hospitals, small and medium-sized hospitals might have found it difficult to establish an infection control system and might have been more affected by the COVID-19 pandemic. Third, this study was answered by only 1 physician at each sleep center. It is possible that there may be some disagreement among physicians at the same center. Fourth, South Korea COVID-19 vaccination was started at the end of February 2021. Therefore, there was no vaccinated sleep laboratory staff during the study period.

Until now, this is the only report examining the situation of sleep medicine services in Korea, the perceptions of medical staff, and future directions after the COVID-19 pandemic. In conclusion, Korea had less impact of COVID-19 on the sleep center operations and sleep apnea treatment compared to countries where the COVID-19 pandemic was severe. Infection and quality control in the sleep study room are important and unavoidable issues, and documented regulation within each institution is necessary. In addition, the regulations will have to reflect the COVID-19 infection rate, vaccination rate and the updated COVID-19 situation. Further research and discussion are needed regarding telemedicine and HSATs in Korea.

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