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ORIGINAL ARTICLE

Sleep medicine practices in pediatric patients during the COVID-19 pandemic

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Received: 22 March 2022, Accepted: 30 January 2023, Published online: 31 March 2023

ABSTRACT

Objectives: The COVID-19 pandemic required precautions for infection control in sleep centers. Our aim was to assess the impact of the COVID-19 pandemic on sleep medicine practices.

Methods: Data of patients undergoing polysomnography and positive airway pressure titration studies prior to (2019) and during the pandemic (2020) were analyzed. In addition, the effect of taking appropriate precautions and performing SARS-CoV-2 polymerase chain reaction testing on the safety of sleep medicine practices was investigated.

Results: The median age of the patients who underwent sleep studies (polysomnography + positive airway pressure titration studies) in 2019 was 7 (2.5-11.5) years (164 male, 147 female), whilst it was 9 (4-12) years (127 male, 84 female) in 2020. During the outbreak, the frequency of sleep studies increased from 3% (311 tests/10068 total number of outpatient visits in 2019) to 3.7% (211 tests/5666 in 2020). In contrast, the frequency of positive airway pressure titration studies declined from 31.8% (99 positive airway pressure titration studies/311 sleep studies) to 21.8% (46 positive airway pressure titration studies/211 sleep studies) in 2020 compared to 2019. Down syndrome was found to be the most common indication both in 2019 (20.9% of all tests) and 2020 (13.7%).

Conclusions: Polysomnographies were performed at a high rate despite the pandemic. However, positive airway pressure titration studies were avoided except for urgent indications because of the potential for aerosolization. In this study, it was shown that sleep studies can be performed safely when necessary precautions are taken.

Keywords: COVID-19, children, sleep study, polysomnography.

INTRODUCTION

In late December 2019, unusual pneumonia cases caused by a new coronavirus originated in Wuhan city of China. The existence of a new epidemic was reported to the World Health Organization (WHO) and announced to the world on December 31st, 2019 [1]. On February 11th, 2020, WHO announced that the disease caused by this new coronavirus was called "COVID-19", which stands for "Coronavirus disease 2019". The epidemic that started in the People's Republic of China rapidly spread globally and was declared a pandemic on March 11th, 2020 [2].

The virus is now known as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 caused by this virus is a highly infectious disease leading to high morbidity and mortality. Transmission of SARS-CoV-2 from person to person occurs by respiratory droplets containing the virus particles, and via surfaces contaminated by respiratory droplets or other secretions from an infected person [3-5]. Another route is airborne transmission by aerosols [6]. COVID-19 is transmitted by both symptomatic patients and asymptomatic carriers [7].

The first COVID-19 case in Turkey was reported on March 11th, 2020, and it has spread rapidly in our country since this date. In order to curb the pandemic, certain measures such as restricting the use of places of social interactions, postponing various scientific and cultural meetings, prohibiting transportation between cities, cancellation of flights and installing a curfew for the elderly and children have been taken, additionally, non-urgent hospital admissions were likewise restricted. The field of sleep medicine as well as other medical practices and healthcare systems were heavily affected owing to the social distancing measures taken during the pandemic.

Polysomnography (PSG) is the gold standard for the diagnosis of several sleep disorders. It is also used to eval¬uate abnormal sleep-related movements and behaviors. PSG is generally performed in sleep laboratories and requires close and prolonged patient-technician contact [8]. Some phases of the PSG are not suitable for the patient to wear a mask and in these situations, the sleep technician who is in close contact with the patient is potentially exposed to droplets and aerosol particles. In addition to diagnostic PSG, sleep studies are also carried out on patients who require noninvasive ventilation (NIV) therapy such as continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BPAP) ventilation. In children on chronic positive airway pressure (PAP) support, follow-up PSG is performed to determine whether pressure requirements have changed [9]. NIV has been listed as a high-risk aerosol generation procedure by WHO and it is recommended that airborne precautions in combination with contact precautions are used when performing aerosol-generating procedures [8, 10]. Therefore, sleep medicine practices need to be adapted according to the current pandemic measures.

The purpose of this study was to determine how the social and medical measures taken to prevent the spread of the COVID-19 pandemic affected the sleep medicine in our tertiary center and to compare how sleep medicine procedures and indications during the pandemic have changed compared to the previous year.

METHODS

Study design

This observational descriptive study was conducted at the pediatric pulmonology department of our tertiary referral children's hospital between January 2019 and April 2021. The pre-pandemic period which included 14 months from January 2019 to February 2020 was defined as the '2019' period. Whereas the COVID-19 pandemic period included 14-months from March 2020, when the first case was detected in Turkey, to April 2021 and was defined as the '2020' period. Pediatric patients between 0-18 years with sleep disorders as well as other lung diseases are followed up at our center. Patients with a range of diagnoses such as genetic disorders, neuromuscular disorders, metabolic disorders, muscular dystrophies, musculoskeletal disorders, obesity, epilepsy and other rare diseases who underwent sleep studies were included in the study. The total number of annual outpatient department visits between 2019 and 2020 were recorded. Data of patients undergoing PSG or PAP titration studies both prior to and during the

pandemic were extracted from the medical records of the sleep laboratory. Indications of the sleep studies before and during the pandemic were compared.

All patients included in the study underwent type 1 PSG (Alice 6, Philips, USA). PSG consists of an electroencephalogram (4 channels, parietal and occipital), electrooculography (2 channels, right and left), electromyography (tibialis anterior and submandibular), electrocardiogram, oronasal airflow sensor, chest and abdominal movement sensor, body position sensor, snoring microphone, capnometer and a pulse oximeter. Simultaneous video recording was performed by a trained sleep laboratory technician. During PAP titration full PSG monitoring with flow, pressure, leak signals in addition to video and audio signals were recorded. PSG records were evaluated according to the standards of the American Academy of Sleep Medicine (AASM) for children. Pediatric scoring criteria was used for our patients who were under the age of 18 [11]. Apnea-hypopnea index (AHI) consisted of the total number of apnea or hypopneas per hour of sleep. An AHI of 1 or less was considered to be normal, while an AHI of 1-5 was defined as mildly increased, 5-10 moderately increased and >10 severely increased. All PSG studies were evaluated by two sleep medicine clinicians.

The Centers for Disease Control and Prevention (CDC) recommendations relevant for sleep practices during COVID-19 were followed at our department. AASM also advises sleep clinicians to follow the recommendations of the CDC [12]. According to the measures taken, telehealth strategies in terms of assessing the COVID-19 risk were used to evaluate and triage patients before the day they were scheduled to be seen. Triage protocols were used to determine if an appointment was necessary or if the patient could be managed from home. The goal was to avoid unnecessary exposure and to protect both the health care workers and patients.

All patients and their companions were asked to come to the hospital wearing a medical face mask and performing hand sanitization. At the entrance of the hospital children were permitted entry to our department with one parent only. Temperature checks were done at the entrance of the outpatient clinic. Decals or colored tape on the floor were placed 6 feet apart to show the patients where to stand. A questionnaire was prepared and risk factors and symptoms related to COVID-19 were questioned in another isolated room before going into the examination room. All patients and their companions were asked whether they came in close contact with any COVID-19 patient or had symptoms compatible with COVID-19. All patients underwent SARS-CoV-2 polymerase chain reaction (PCR) testing prior to sleep studies. Because of the possibility of false-negative PCR test results, sleep studies of the patients with symptoms suggestive of COVID-19 were delayed for at least one month.

Moreover, the staff was provided with all the appropriate personal protective equipment including surgical gown, gloves, medical face masks and for aerosol generating procedures N95 respirators (or the equivalent).

In our sleep laboratory, the recordings are performed with video-monitoring in order to allow the technician to examine the patient from a separate room and intervene only when strictly necessary. During the pandemic, rooms were cleaned according to the guidance for disinfection and ventilated with fresh air before admitting new patients.

Ethical approval was obtained from the ethics committee of our university (Reference number: GO 21/501).

Statistical Analyses

The SPSS V.22.0 (IBM Corp., Armonk, NY, USA) software was used for statistical analyses. All continuous variables were non-normally distributed and analyzed using Mann-Whitney U test and expressed as median (interquartile range-IQR). Categorical variables were presented as percentages (%) and analyzed using Chi-square test (with or without continuity correction) or Fisher's exact test. A value of $p<0.05$ was considered statistically significant.

RESULTS

Evaluation of the numbers of patients and diagnostic procedures

A total of 10068 patients were seen at our pediatric pulmonology department and 311 sleep studies (3%) were performed during the pre-pandemic period in 2019. The median age of the patients who

underwent sleep studies in 2019 was 7 (2.5-11.5) years (164 male, 147 female). Ninety-nine (31.8%) PAP titration studies were performed of which 46 were CPAP and 53 were BPAP. The remaining 212 (68.2%) PSGs were performed for diagnostic purposes.

A total of 5666 patients were seen at our outpatient department and 211 patients (3.7%) underwent sleep studies during the COVID-19 pandemic in 2020. The median age of the patients who underwent sleep studies in 2020 was 9 (4-12) years (127 male, 84 female). Compared to the previous year prior to the pandemic, although there was a slight decrease in the number of sleep studies (n=211 in 2020 vs. 311 in 2019), the frequency has increased from 3% to 3.7% (211 tests/5666 total number of outpatient visits in 2020 vs. 311/10068 in 2019). Of the 211 sleep studies conducted in 2020, 46 (21.8%) were PAP titration studies, including 8 CPAP and 38 BPAP. Compared to the pre-pandemic period, a decrease in the frequency of total PAP studies from 31.8% to 21.8% was observed.

By the end of 2020, with the necessary precautions taken, no increased risk of COVID-19 was detected in any of our patients undergoing sleep studies or the healthcare staff assisting the procedure. Additional to all the taken measures, every patient without exception underwent SARS-CoV-2 PCR testing prior to the sleep study and COVID-19 was not detected in any of our patients. Patients were additionally questioned for symptoms of COVID-19, around 2 weeks after their sleep study when they contacted us to learn of their results, none of the participants were found to have any complaints compatible with COVID-19. According to the evaluation in the outpatient clinic or via telephone, the sleep studies of 18 patients with symptoms such as fever, cough, dyspnea, muscle pain, sore throat, headache, chest pain that was compatible with COVID-19 were postponed and home isolation was recommended.

Evaluation of the indications of the sleep tests

Polysomnography

In 2019, of the 212 patients that underwent PSG, 24% (n=51) had Down syndrome, 7.5% (n=16) had Prader-Willi syndrome, 6.6% (n=14) had mucopolysaccharidosis, 6.1% (n=13) had obesity, 5.1% (n=11) had spinal muscular atrophy, 4.7% (n=10) had Duchenne muscular dystrophy and 2.8% (n=6) had epilepsy. The remaining 91 PSGs were done for rare conditions (e.g., ROHHAD syndrome, Bardet-Biedl syndrome, Joubert syndrome, myotonic dystrophy, etc.).

In 2020, of the 165 patients that underwent PSG 11.5% (n=19) of patients had Down syndrome, 10.9% (n=18) had spinal muscular atrophy, 7.8% (n=13) had epilepsy, 6.6% (n=11) had Prader-Willi syndrome and 3.6% (n=6) had mucopolysaccharidosis. The remaining 98 PSGs were done for other indications (e.g., Canavan disease, Pompe disease, Krabbe disease, etc.).

In 2020, compared with 2019, the number of PSGs decreased by 22.1%, from 212 to 165 (Figure 1). The largest group tested were patients with Down syndrome both before and during the pandemic.

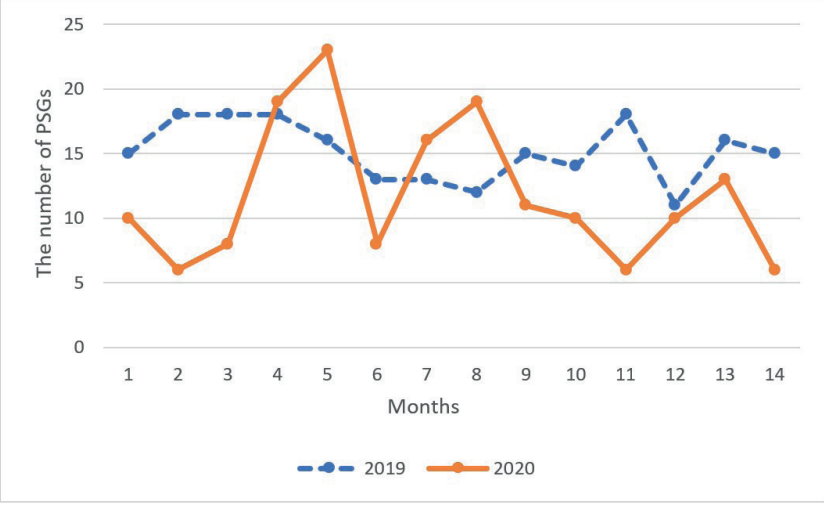

Figure 1. The number of PSGs by month

The number of PSGs by month in 2019 were more stable while serious fluctuations were seen in the number of PSGs in 2020 due to closures and reopenings.

PAP titration studies

In 2019, 99 PAP titration studies were performed. Twenty two percent (n=10) of patients with Down syndrome, 13% (n=6) with Prader-Willi syndrome and 8.6% (n=4) with obesity underwent CPAP titration studies while 19.5% (n=9) patients with Prader-Willi syndrome and 7.5% (n=4) with Down syndrome underwent BPAP titration studies. The remaining PAP titration studies were done for different indications (e.g., Jeune syndrome, Rubinstein-Taybi syndrome, Crouzon syndrome, pontine glioma, etc.).

In 2020, we performed a total of 46 PAP titration studies. Down syndrome was the most common indication and was performed on 10 patients. Fifty percent (n=4) of the patients with Down syndrome underwent CPAP titration while 15.7% (n=6) with Down syndrome and 10.5% (n=4) with spinal muscular atrophy underwent BPAP titration studies. The remaining PAP titration studies were done due to other indications (e.g., infantile neuroaxonal dystrophy, Smith-Lemli-Opitz syndrome, arthrogryposis multiplex congenita, etc.)

In 2020, compared with 2019, the number of PAP titration studies decreased by 53.5%, from 99 to 46 (Figure 2). The largest group tested were patients with Down syndrome both before and during the pandemic.

Evaluation of the PSG results

Results of 377 PSGs performed both in 2019 and 2020 were analyzed. Unavailable data from 34 patients and 12 PSG results with a sleep efficiency of 30% or less were not included in the analysis. The data presented here are from 331 PSGs, of which 191 were performed in 2019 and 140 in 2020.

Of the PSGs performed in 2019, 29.3% (n=56) was determined as mild apnea, 18.3% (n=35) as moderate apnea and 32.5% (n=62) as severe apnea. The median AHI score was found as 5 (1.7-14.7) events per hour. Sleep apnea was not detected in 38 (19.9%) patients.

Of the PSGs performed in 2020, 45.7% (n=64) was determined as mild apnea, 11.5% (n=16) as moderate apnea and 19.3% (n=27) as severe apnea. The median AHI score was 2.5 (1.1-7.7) events per hour. Thirty-three (23.5%) patients did not have sleep apnea in 2020.

The median AHI score in 2019 was higher compared to 2020 (AHI score 5 vs 2.5/hour; p=0.001, respectively).

DISCUSSION

PSG is an essential tool for the diagnosis and treatment management of several sleep disorders. The COVID-19 pandemic has had massive effects on healthcare procedures, including sleep medicine. Early in the course of the outbreak, sleep laboratories abruptly shut down in accordance with social distancing measures. As medical facilities prepared to reopen, taking into consideration the rate of infection in the community and the urgency of the sleep study, it was necessary to reschedule sleep medicine practices during the pandemic

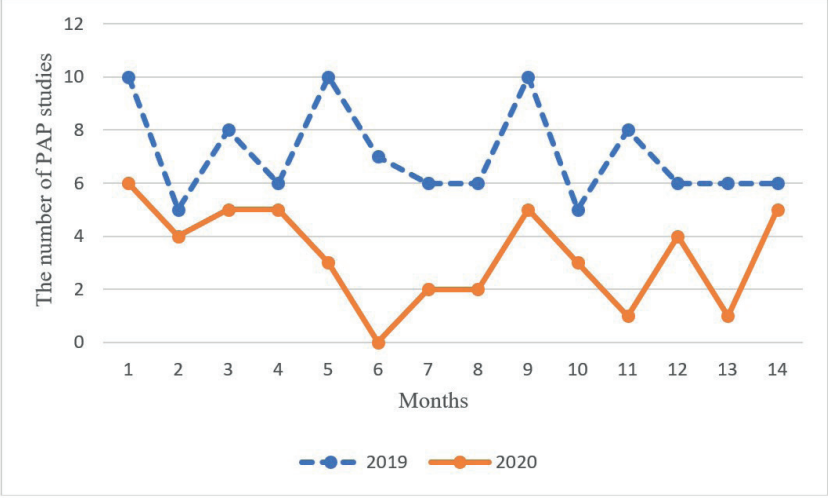

Figure 2. The number PAP studies by month

The number of PAP studies by month in 2020 was markedly declined compared to 2019.

[13]. Here we describe the effects of the COVID-19 pandemic on our sleep laboratory practices and provide our experience to conduct sleep studies safely. There are few studies about the impact of the pandemic on sleep medicine and the individual measures taken by the centers in order to prevent viral spread.

COVID-19 most commonly spreads via respiratory droplets during close contact. The transmission also occurs by airborne inhalation or through contact with contaminated surfaces. Airborne transmission of SARS-CoV-2 can occur during medical procedures that generate aerosols [14]. These procedures are more likely to generate higher concentrations of infectious respiratory aerosols than coughing, sneezing, talking, or breathing. Open suctioning of airways, sputum induction, cardiopulmonary resuscitation, endotracheal intubation and extubation, NIV (e.g., BPAP, CPAP), bronchoscopy, manual ventilation are considered aerosol-generating procedures [15]. On the other hand, we have little knowledge on whether PAP titration as a part of the sleep study emits the same amount of aerosol as NIV. In a study, CPAP therapy with different masks was evaluated and a well-fitted oronasal mask was found to be safe with a negligible dispersion of aerosol [16].

AASM recommendations concerning sleep practices during COVID-19 were updated repeatedly, most recently on January 2021 [17]. According to these recommendations, PAP titration and split night studies were postponed due to the potential for aerosolization, except in emergencies. Similarly, while some centers suggested stopping PAP titration studies, others did not agree with this interruption [18]. In accordance with the recommendations, we did not perform PAP titration studies unless there was a strict necessity and the frequency of PAP titration studies decreased in our sleep practices during the pandemic. We generally performed PAP titration studies for the first time in patients in whom we decided to start PAP therapy. However, we preferred not to do repetitive PAP titration studies if not strictly necessary for the patients who were under PAP treatment. In addition, in certain situations where we had to perform the sleep studies, all of our staff followed disinfection rules and used appropriate personal protective equipment.

While certain measures such as the restriction of socializing and non-urgent hospital admissions, closure of schools and the installation a curfew caused a decrement in hospital admissions, patients especially those with chronic diseases and their parents were also hesitant to visit hospitals [19]. In a recent study, a decline in the numbers of outpatient clinic visits and pediatric pulmonology procedures were observed due to the pandemic [20]. However, PSG and PAP titration therapy are indispensable studies for certain indications. In some cases, not performing a PAP titration, in particular, can lead to unacceptable health risks. For this reason, the continuity of these tests should be ensured by making decisions in accordance with the indications and taking the necessary precautions.

AASM also recommended that visits be conducted via telemedicine [13]. Several studies have found telehealth services to be both effective and helpful in other fields of pediatric pulmonology [21]. Our study also showed that the risk of transmission of COVID-19 to health care providers or other patients was preventable with the appropriate precautions. Although the total number of sleep studies did decrease during the pandemic compared to the previous year prior to the pandemic, the frequency did increase from 3% to 3.7%. To date, none of our healthcare staff including our sleep technicians have been infected with SARS-CoV-2.

In our study, before the pandemic the largest group of patients to undergo sleep studies were patients with Down syndrome and indications of sleep studies during the pandemic did not change. PSG helps diagnose obstructive sleep apnea (OSA) in patients with Down syndrome and since there is also a need for pressure support in most patients with OSA, PAP titration studies are commonly used to determine the pressure needed.

Multiple randomized trials have demonstrated that a home-based diagnostic and treatment strategy is as effective as a lab-based strategy for most patients [22]. The AASM guidance also advises the use of home sleep apnea testing (HSAT) in certain conditions during the ongoing pandemic. HSAT may be considered as an alternative for the diagnosis of OSA, although the current gold standard in children is in-lab PSG. HSAT is potentially more cost effective, convenient, and accessible. However, the

current evidence on the feasibility and diagnostic accuracy for pediatric OSA is limited. Furthermore, HSAT is not indicated for the diagnosis of other sleep-related breathing disorders.

Although there was a slight decrease in the number of sleep studies in 2020 compared to 2019, the increase in the frequency could be attributed to the decrease in outpatient clinic visits owing to the pandemic. During this period, there was a significant decrease in PAP titration studies, while a relative increase in the number of PSGs was observed. This result may suggest that the PSGs of the patients who needed a faster evaluation were prioritized due to the pandemic. However, when the PSG results were examined, the median AHI scores were found to be lower in 2020 compared to 2019. One of the reasons may be that the number of sleep studies performed on patients with chronic diseases (e.g., Down syndrome, neuromuscular disorders, mucopolysaccharidosis) has declined, as can be seen in patients with chronic lung diseases due to the anxiety about applying to a hospital during the pandemic [19]. Another reason could be that patients exaggerated their symptoms due to COVID-19 related anxiety or the fact that pre-evaluation to determine the indication was less optimal. The serious fluctuation in the number of monthly visits in 2020 due to closures and reopenings also strengthens this final interpretation. However, because of the descriptive design of this study, we could not establish a cause-effect relationship.

Our study has several limitations. First of all, the design of the study is not adequate to determine whether the number of hospital applications decreased only due to the COVID-19 pandemic. Secondly, we could not compare the results of our study with another one, because to date this is the first study about the effects of the COVID-19 pandemic on sleep laboratory practices. Additionally, the prognosis of patients whose PAP titration studies and PSGs were postponed is unknown. Whether the diagnostic power of sleep studies performed during the pandemic has decreased due to the implementation of measures is also unknown. Furthermore, when applying the results of this study to clinical practice, sleep centers themselves should take into account the fluctuations in the rate of infection.

In conclusion, our study showed that the pandemic has had negative effects on sleep medicine practices. However, after deciding to perform sleep studies within the risk-benefit balance, they can be done safely with the appropriate infection control measures. Due to the possibility that the pandemic may prolong, to decrease its unfavorable effects and aggrievedness on our patients it is necessary to manage sleep laboratory practices with urgency rather than postponing them.

Acknowledgements

We would like to thank all the sleep laboratory technicians for their continuous support throughout the duration of the study.

Author contribution

Study conception and design: BS, NE, UÖ; data collection: BS, BO, DAT, HNB, and IG; analysis and interpretation of results: BS and NE; draft manuscript preparation: EY, DD and NK. All authors reviewed the results and approved the final version of the manuscript.

Ethical approval

The study was approved by the Clinical Research Ethics Committee of Hacettepe University (Protocol no. GO 21/501/2021).

Funding

The authors declare that the study received no funding.

Conflict of interest

The authors declare that there is no conflict of interest.

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