Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Review Article

Sleep medicine and COVID-19. Has a new era begun?

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ABSTRACT

Since late December 2019, COVID-19, the disease caused by the novel coronavirus, SARS-CoV-2, has spread rapidly around the world, causing unprecedented changes in provided health care services. Patients diagnosed with sleep-disordered breathing (SDB) are subject to a higher risk of worse outcomes from COVID-19, due to the high prevalence of coexistent comorbidities. Additionally, treatment with positive airway treatment devices (PAP) can be challenging because of PAP-induced droplets and aerosol. In this context, sleep medicine practices are entering a new era and need to adapt rapidly to these circumstances, so as to provide the best care for patients with SDB. Novel approaches, such as telemedicine, may play an important role in the management of patients with SDB during the COVID-19 pandemic.

1. Introduction

Coronaviruses are common human pathogens linked to respiratory and intestinal disease [1]. In most cases, infection with the following human coronaviruses: HCoV-NL63, HCoV-229E, HCoV-OC43 and HKU1, causes mild symptoms, however it can also account for severe respiratory tract infections, such as pneumonia, as previously observed in SARS-CoV and MERS epidemics [1]. In late December 2019, a novel coronavirus, designated later as severe acute respiratory syndrome coronavirus 2, or simply SARS-CoV-2, was identified in Wuhan, a city in Hubei Province, China, resulting in a series of highly contagious respiratory infections, which rapidly spread around the world [2]. On March 11, 2020, the global outspread of COVID-19 (the disease caused by SARS-CoV-2) forced the World Health Organization (WHO) to declare it a pandemic [3].

Thereafter, and due to the fact that transmission of SARS-CoV-2 is through airborne droplets, aerosols and close contact, health authorities worldwide have advised postponement of non-emergent procedures, especially those requiring respiratory tract manipulations. Along the same lines, diagnostic and laboratory assessments of chronic conditions should be postponed and rescheduled when appropriate at a future safer setting [4]. The goal was to avoid unnecessary exposure and potential contamination of hospitals and to protect both health care workers (HCWs) and patients. Based on these reports, sleep laboratories were urged to cancel or defer all scheduled in-laboratory or home sleep studies, as well as follow-up examinations of patients who have been previously receiving any form of sleep treatment [5].

This is especially important for the treatment of patients with sleep disordered breathing (SDB) since the application of positive airway pressure (PAP) can induce aerosolization and can increase substantially the risk of infection [6]. Taking into consideration this fact and the lack of robust evidence for decision making regarding the operation of sleep laboratories during this pandemic, efforts have been made to provide medical care in sleep medicine with minimum contact and reconsider management of such patients with telemedicine (TM).

2. General considerations in sleep medicine during COVID-19 pandemic

As of July 1, 2020 a total of 10,357,662 confirmed cases and 508,055 deaths from SARS-CoV-2 have been reported worldwide [7]. Sleep is an integral part of proper human function and during the COVID-19 pandemic many people have reported inability to fall early asleep or to maintain adequate sleep amount [8]. It is noteworthy that sleep disturbances are prevalent especially in individuals who are forced to medical isolation

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due to infection or exposure to SARS-CoV-2, demonstrating features of difficulty to fall asleep and early wake-up [9]. Similarly, frontline medical workers (FMW) in Hubei Province, China, during the COVID-19 outbreak reported poorer sleep quality and more often insomnia, compared with non-FMW [10]. Of note, there is high correlation between impaired sleep and mood disturbances, eg anxiety, depression, conditions that are exacerbated during public health problems, as in the COVID-19 pandemic [11].

Along those lines, the European Sleep Research Society (ESRS) has published a document providing information upon sleep loss due to unprecedented changes in people's daily routine and home confinement and suggestions regarding effective insomnia treatment during the COVID-19 pandemic [8]. In addition to sleep loss, there are people who experience other sleep disturbances, of which SDB is one of the most frequently encountered, and poses a significant burden not only for the affected patients but also for the patient's close contacts. SDB encompasses a relatively broad spectrum of disorders and obstructive sleep apnea (OSA) is by far the most prevalent among them, estimated at 1 billion adults aged 30–69 years around the world [12].

In addition, OSA is more frequently observed among-middle aged and older patients with coexistent cardiometabolic diseases, arterial hypertension, and obesity [13], conditions that are considered to be also risk factors for worse outcomes in patients diagnosed with COVID-19 [14]. Thus, patients with OSA can be considered as high-risk patients when afflicted by COVID-19 and clinicians should bear this in mind, so as to ensure adequate management of OSA [15]. PAP devices, namely continuous positive airway pressure (CPAP), bilevel PAP (BPAP) or others more complex such as adaptive servoventilation (ASV), are often prescribed for home or hospital mechanical ventilatory support of patients with SDB [16]. Among them, CPAP is currently the standard of care for the treatment of patients with moderate to severe OSA [17]. As previously noted, all these PAP devices can increase the risk of transmission through aerosolization and expose sleep laboratory personnel as well as the patients' family to an unnecessary danger to SARS-CoV-2 exposure [18].

3. Recommendations from sleep societies concerning the management of patients with SDB

A series of recommendations from sleep societies have been published regarding the function of sleep laboratories and the management of SDB patients during the pandemic from COVID-19 [5,19–23]. Nevertheless, these recommendations are based on a limited body of evidence and are subject to changes and updates when further information for COVID-19 is obtained. In fact, in face of the speed of the events that occurred during the pandemic, sleep medicine practices had to rely on clinical judgment and expert opinions in order to serve patients' demands and adapt ultimately to the current state with alternative solutions, such as remote communication with video or phone calls, and prioritize urgent over non-emergent cases. Available recommendations in the English language, published from major sleep societies as documents, abstracts, articles, or scientific brochures, are summarized in Tables 1 and 2.

A group of experts in SDB from the Chinese Thoracic Society provided feedback on the management of patients with OSA and suggested that sleep studies and initiation of PAP application should be continued only in regions with low incidence of COVID-19, preferably with the use of home sleep apnea test (HSAT) [19]. In any other circumstances as the in-hospital studies should be carefully considered when ruling out thoroughly the possibility of SARS-CoV-2 infection.

Similarly, the American Academy of Sleep Medicine (AASM) advised clinicians to continue postponing non-urgent sleep studies when local transmission is substantially high and when urgently needed, a molecular testing for COVID-19 should be preceded in a reasonable timeframe [5]. In addition, PAP administration should be performed in an isolation room with negative pressure, or else when not available, PAP-therapeutic trials should be cancelled and rescheduled [5]. Notably, application of PAP in the ward is also strongly discouraged [5].

The SDB group of the Canadian Thoracic Society has also provided feedback regarding the management of patients with SDB [23]. Specifically, members of the group reported that in lab sleep studies, HSAT and PAP studies should not be performed during this time point. When the demands for such studies are high, as in unstable cardiopulmonary disease where the contribution of SDB is significant and after weighing up the risks, then HSAT with disposable equipment should be offered instead of in-laboratory sleep study. Empiric treatment with auto-titrating PAP devices at home is always an alternative approach in order to avoid hospital PAP studies, minimize the risks of exposure and provide at the same time immediate solution to the affected patient. Clarifications are also reported in this document concerning management of previously PAP-treated SDB patients, highlighting that when COVID-19 is confirmed, continuation of PAP treatment with isolation guidance is top priority and only in those patients who will likely benefit from the treatment of their disease, eg severe SDB related to obesity hypoventilation syndrome.

In the same spirit are the recommendations of the British Sleep Society [20] and the Australasian Sleep Society [21], which underline the importance of ensuring patients, and medical staff's safety acknowledging the benefits of limited sleep studies if possible for the former in order to reduce to the risk of unnecessary exposure and with adequate prescreening tests for COVID-19 of the patients for the latter. Of note, the Australasian Sleep Society has updated its previous recommendations [21] and supports the recommencement of both PSG studies and PAP trials at this time point after appropriate patients' screening for COVID-19 [21]. Moreover, the Irish Sleep Society advices on operating HSAT over in lab sleep studies and supports only PAP studies in the home setting where this is feasible, with equipment that is disposed and offered only by the responsible sleep laboratory [24]. Finally, feedback and recommendations have been provided from two other major societies, namely the German Sleep and the Spanish Sleep Societies, but they are available only in their national languages [25,26]. Overall, sleep societies have underlined the importance of complying with general health measures in health care settings [27].

European investigators from the European Sleep Apnoea Database (ESADA) network have also shared their experience regarding sleep laboratories practices during the COVID-19 outbreak [22]. As they mention, the majority of them have avoided in-laboratory sleep studies (80%), TM practices were in fact reduced from 30% to 27.5%, while in-hospital PAP trials continued to exist in less than one of the fifth participating centers. Of note, telemedicine PAP titration has not received a great interest, with only four centers starting this approach during the pandemic. Finally, follow-up of patients already on treatment was conducted majorly by phone and video calls [22].

4. Transmission and viability of SARS-CoV-2

Knowledge of transmission and stability of SARS-CoV-2 in aerosol and on various surfaces is important for implementing public health policies, so as to ensure safety and normal continuation of medical practices, including those of sleep medicine. SARS-CoV-2 has a diameter of approximately 60–140 nm [2], and its primary means of transmission are (a) by droplet (>5 μm) spread,

Table 1
Recommendations for sleep medicine practices in the COVID-19 era.

Sleep societies	PSG and other in lab sleep studies	HSAT	PAP-studies	Suggestions and follow-up of patients with known sleep-disordered breathing
SDB group of the Chinese Thoracic Society	Continue to perform only after excluding the possibility of COVID-19 infection and only for cases with significant cardiopulmonary diseases or hypoventilation syndromes	Recommended and preferred over in lab studies for OSA diagnosis	1. Auto-PAP studies at home 2. In lab PAP studies for patients with comorbid diseases as with PSG	1. Sleep studies could be continued in areas with sporadic cases or in low-epidemic areas 2. Remote control and implementation of telemedicine practices when feasible for patients with SDB
American Academy of Sleep Medicine	AASM has provided recommendations according to the local transmission of SARS-CoV2 1. In case of none to minimal community transmission resume in lab studies 2. In any other case as of: a) substantial local transmission: consider postpone or resume only for emergencies and after screening for symptoms and testing for COVID-19, and b) minimal to moderate local transmission: resume only in those who are not at higher risk for severe illness according to CDC	1. Resume HSAT services only in cases with no or minimal community transmission 2. In any other case, as of substantial and of minimal to moderate community transmission, restrict HSAT services and comply with CDC disinfection standards	1. Continue in lab PAP studies for cases of no or minimal community transmission 2. Postpone in lab PAP studies in any other case, or as an exception, administration of PAP can be offered to isolation room and not in the ward.	1. Consider minimize contact visits and maintain access between sleep center and patients with telemedicine options whenever feasible 2. Consider testing for COVID-19 before in lab procedures when there is a high community transmission. Take also all the necessary precautions such as PPE in these circumstances. 3. Restrict also visitors
SDB group of the Canadian Thoracic Society	Continue to perform only for extremely urgent cases based on clinical judgment	1. Strongly discouraged as for PSG 2. Nevertheless, HSAT is preferred over in lab study when urgently needed	1. Avoid in lab PAP study and delay whenever possible 2. Avoid disposal of rental devices; instead offer new devices only to those who are in urgent need	1. PAP continuation: a) suspected/confirmed cases: balance risk/benefit and only in isolation rooms b) all others should continue their PAP treatment as they previously did 2. PAP configurations can be applied (eg dual closed circuit system and filter) 3. Consider empiric at home therapeutic trial with auto-PAP devices 4. In hospital treatment with PAP of known or newly diagnosed SDB and confirmed COVID-19 patients: balance risk/benefits (withhold in mild OSA for example), or else specific precautions should be performed according to hospital infection control policies
British Sleep Society	1. Under specific precautions including assessing the patient, protecting the sleep personnel, ensuring and cleaning the sleep environment and sleep equipment 2. However, there are no suggestions to support over/against HSAT	Limited sleep studies, where applicable to support SDB diagnosis, are continued to be offered	1. In lab PAP studies are highlighted as high risk AGP, and these should be performed under full PPE and with appropriate cleaning of the environment and sufficient air changes PAP 2. An alternative option is the in home PAP study 3. Consider also to educate patients on how to wear on their own PAP masks so as to avoid risks from AGPs 4. Use of non-vented masks along with a filter	1. Consider to review sleep results and provide consultations remotely whenever possible 2. Provide follow up of previously PAP treated patients using telemedicine options
Australasian Sleep Society	Recommence of in lab sleep studies	Continue whenever possible	1. In hospital PAP trials may recommence after patients' screening and compliance with the current	1. Sleep studies should be followed by appropriate patient's clinical evaluation (epidemiological risk factors, symptoms, and body temperature check) and comply

Table 1 (*continued*)

Sleep societies	PSG and other in lab sleep studies	HSAT	PAP-studies	Suggestions and follow-up of patients with known sleep-disordered breathing
			government guidelines like the diagnostic sleep studies 2. Standard (vented) masks can be given if these will be used by the patient for home use only; alternatively use of a non-vented mask	with the latest government and hospital infection control guidelines 2. Prioritize patients starting with the most urgent cases 3. No mention regarding follow-up of previously diagnosed patients with SDB
Irish Thoracic Society	Inpatient studies should be performed in single rooms when these are available and considering using disposable parts of equipment	Use of sleep laboratory equipment (disposable parts) is preferred over this offered by a third party for home use	1. Initiation of PAP should be offered to the home setting rather than in hospital. 2. Avoid performing PAP studies in the clinic settings	1. Screening for symptoms consistent with COVID-19 prior to sleep studies is recommended, whereas COVID-19 testing should be performed when PAP studies are initiated in the hospital 2. Guidance, such as application of PPE, a) for those caring for SDB patients and b) when cleaning/disinfecting the PAP device 3. Avoid humidification of PAP and suspend routine maintenance of previously used PAP devices 4. Quarantine for 14 days of PAP device when service/repair is needed 5. Ensure that all patients will receive sleep consultation even by remote communication when clinic visits are postponed 6. Patients should continue using their PAP devices at home, and when they feel unwell, they should seek for medical assistance
General recommendations provided from sleep societies	1. Screening/testing for COVID-19 prior to sleep study 2. Use of disposable equipment and cleaning disinfecting of non-disposable parts of sleep equipment 3. PPE for staff 4. Personal hygiene measurements/social distancing 4. Prioritization of telemedicine practices for sleep consultation whenever possible instead of close contact and sleep visits 5. Follow local instructions regarding COVID-19 general medical practices 6. Stay up-to-date with the local epidemics of SARS-CoV2 and reconsider medical practices accordingly			

Abbreviations: AGP: aerosol generating procedure, AASM: American academy of sleep medicine, CDC: Centers for disease control and prevention, COVID-19: coronavirus disease, HSAT: home sleep apnea test, Lab: laboratory, OSA: obstructive sleep apnea, PAP: positive airway pressure, PPE: personal protective equipment, PSG: polysomnography, SARS-CoV2: severe acute respiratory distress syndrome coronavirus 2, SBD: sleep-disordered breathing.

namely when an infected person coughs, sneezes, or talks to a close contact (approximately 1 m), and (b) by hand contamination via direct contact with contaminated objects and surfaces followed by contact of an individual's mucosa [28]. Aerosols ($\leq$5 μm) which are dispersed in air, can additionally account for extended time airborne transmission, contributing also to a non-neglectable way of SARS-CoV-2 spread in the environment, as recently shown [29].

Table 2
A synopsis of sleep societies' recommendations regarding the clinical care of patients with sleep-disordered breathing and COVID-19.

1. Reschedule and refer for clinical care while awaiting negative results for COVID-19 testing
2. Advice on patients to bring their own PAP devices in hospital
3. Use of a non-vented mask that is well fitted with a filtered exhalation port
4. Use of a double limb circuit so as to avoid leakages from air dispersion
5. Avoid using humidifier
6. Isolation at a negative pressure room
7. Keep safe distances (at least one meter)
8. Use of N95 mask
9. Gloves, hair covers, eye and face shields

Abbreviations: COVID-19: coronavirus disease, PAP: positive airway pressure.

A study [30] explored the viability of SARS-CoV-2, grown in tissue culture, on surfaces and in the air and compared it with that of SARS-CoV-1. At an experimental setting, SARS-CoV-2 was found to be able to remain present in generated aerosol for at least 3 h; however, on plastic surfaces maximum survival time was 72 h. No viability of SARS-CoV-2 could be detected after 4, 24, and 48 h on copper, on cardboard, on stainless steel, respectively [30]. Moreover, the authors observed similarities regarding the stabilities of SARS-CoV-2 and SARS-CoV-1 in their experimental study design [30]. In addition, other studies have identified RNA of SARS-CoV-2 on ventilation systems and in rooms of COVID-19 hospitalized patients [30–32]. Nevertheless, culture virus isolation was missing and thus clinical relevance of the latter findings should be interpreted with caution [30–32]. Finally, a systematic review has attempted to summarize all the available evidence regarding the stability and persistence times of coronaviruses, and of SARS-CoV-2, on surfaces and in air [33]. In order to adapt this data to sleep medicine practices, appropriate time must be provided to disinfect non-disposable parts of sleep devices (of at least 72 h, although this is not always practical). The evidence, however, is still limited and new studies should focus on this field in order to promote

prevention and control of the unprecedented COVID-19 transmission to the community.

5. COVID-19 pandemic in sleep medicine. What should be taken care?

5.1. Operation of sleep laboratories

Taking into consideration the current scientific background, all recommendations aim to propose protective strategies in sleep medicine services so as to resume their previous practices. From a practical point of view, there are two aspects that preventive measures and precautions should be addressed to: (a) the sleep clinic environment and sleep equipment, (b) the aerosol generating procedures (AGPs).

5.1.1. Sleep environment and sleep equipment

The steps that should be followed regarding infection prevention and control are provided by the WHO [34], and they were reported after adjustment to the sleep services from various sleep societies [5,19–23]. Briefly, patients' screening for COVID-19 should be initiated with telephone calls remotely the day before arrival to the sleep clinic so as to confirm absence of COVID-19 related symptoms. In case where this approach is inconclusive or there is high local community spread of the virus, testing for SARS-CoV-2 using oropharyngeal swabs has to be performed. Thereafter, the day of sleep examination clinical assessment should be offered prior to and upon entry into the sleep facilities, while hand hygiene upon arrival and wearing a facemask before entrance are of major importance for both HCWs and patients. Additionally, HCWs should wear gloves and gowns as minimum precaution measures. Keeping also distances of at least 1 m and providing clinical care at least in a single room should be routinely implemented. However, when COVID-19 status is unknown, testing availability is low, and in case of AGPs, there should be additive preventing measures to offer in HCWs such as wearing a N95 (or FFP2) mask, eye and face shield, and patient's isolation at an airborne infection room when caring for these individuals. Furthermore, cleaning and disinfection of the health care facility and adequate air changes every after patient's visit is also recommended [35,36]. As of sleep equipment, whenever possible, use of disposable parts, such as nasal cannula and electrodes, would be preferable. In any other case, reuse of non-disposable parts should be done after their proper disinfection and normally after 72 h, as there are parts containing plastic. It is noteworthy that, AASM mitigation strategies have provided useful guidance regarding the normal operation of sleep centers in terms of COVID-19 screening, infection prevention and control and resume or not of previous scheduled sleep studies according to the level of transmission of SARS-CoV-2 in the local community [5].

5.1.2. Aerosol generating procedures: administration of positive airway pressure therapy

AGPs are characterized by high inspiratory and expiratory flows that can generate an increased spread of small particles in the nearby environment and disseminate on this way a substantial virus load [37]. Use of CPAP or other various modes of non-invasive ventilation (NIV), including BPAP and more complex ventilators such as ASV for the management of SDB, is considered as an aerosol generating procedure/treatment [38], posing a threat of SARS-CoV-2 transmission by aerosolization of upper airway secretions [39]. Whether the risk of exposure to the novel coronavirus from PAP administration outweighs the benefits from its use, is a matter of concern and it is subject at the clinician's judgment; which aims to avoid the harms of intubation, or to continue PAP therapy for SDB when needed (eg, OHS, neuromuscular disorders with hypecapnia, etc.), and provided that appropriate PPE is always worn. In a systematic review with limited evidence related to SARS-CoV-2 and a high risk of bias of the included studies [40], it was found that NIV may reduce mortality in patients with COVID-19 or need for mechanical ventilation. Of note, the risk of transmission was higher among HCWs who cared for patients in need for NIV, and this risk could be decreased when helmets and PPE were used and administered [40]. It is interesting to note, that the various forms of PAP devices can result in different exhaled air dispersion distances, depending on the air leakage from the tube circuit and the proper adjustment of face masks, as summarized in a recent excellent review [41].

In a previous study [6] enrolling three groups: (a) patients with infective acute exacerbation of chronic lung disease, (b) patients with coryzal symptoms, and (c) normal controls; use of vented NIV with full face mask in form of BPAP was associated with increased spread of large droplets (>10 μm), and not of aerosols at distances lesser than 1 m for the chronic patients' group and of at least 1 m for the coryzal group compared with the baseline droplets dispersed by the non-intervention control group. Of note, modification of standard NIV, that contained a non-vented mask and antiviral/antibacterial filtered exhalate, minimized large droplet transmission at non-significant levels [6]. Notably, in another study air dispersed at greater distances in parallel with higher inspiratory positive airway pressures (IPAP: from 10 to 28 cmH2O), as delivered by two different full face masks [42]. Similar findings were reported by the same study group, which showed that treatment with NIV with a single circuit and exhalation port delivered by a total facemask, led in air jet at a distance of 0.92 m [43]. An option, which might also be proven efficacious in prevention and infection control when applying NIV by reducing air leakage and thus air dispersion, is to adjust a helmet with a good seal at the neck interface via a double circuit [43]. These results provide evidence to support that large droplet transmission, and not aerosol dissemination (smaller particles), might occur during the application of NIV treatment and acknowledge the fundamental role of proper mask fitting and appropriate personal protective equipment.

Little evidence exists on whether CPAP can also induce aerosolization as does NIV. A study assessing exhaled air dispersion during CPAP therapy with different masks [44], showed that CPAP when using a well-fitted oronasal mask, resulted in a negligible dispersion of aerosol at pressures from 5 to even up to 20 cmH20, whereas using the nasal pillows resulted in increased aerosolization in line with higher CPAP pressures, indicating that protection with oronasal mask, due to its lesser leakage, is a safe option.

Overall, and considering that respiratory maneuvers (for instance CPAP/NIV administration) are representing high risk aerosolized procedures [37], two important notes should be highlighted when managing patients with SDB: (a) AGPs should take place ideally in an airborne infection isolation room, or alternatively in a room that contains at least a portable High Efficiency Particulate Air (HEPA) filter unit that recirculates air [45], and (b) PPE and environmental precautions should be top priority during the pandemic period.

5.2. The role of telemedicine

It is significant that the use of sleep TM can be prioritized in the era of COVID-19 outbreak. There are innumerable applications of sleep TM regarding the effective and yet unexplored management of patients with SDB, as previously highlighted [46]. First and foremost, diagnostics, as well as therapeutic PAP-trials, can be performed after appropriate selection of afflicted patients. For instance, clinicians can think of shifting, on routine basis from now

on, the diagnosis of an uncomplicated suspected SDB from attended in-lab sleep study to a remote HSAT and provide specific guidance on how to put on and adjust the sleep device. Afterwards, details should be given with video and phone calls or even emails on whether patients should undergo a therapeutic study at hospital or in the home environment or simply receive sleep recommendations and lifestyle modifications. To this point, triage of a high number of patients, who were previously sought for hospital referral, can result in avoiding unnecessary contact and reducing at minimum any potential transmission of SARS-CoV-2.

What is always a matter of debate in the management of OSA is the adherence to the use of PAP devices. Good adherence to PAP treatment is a key element in the effective management of OSA. Among others, patients' perception regarding the severity and risks of their disease is an important parameter that affects adherence to PAP [47]. Currently, there is increased awareness among PAP-treated patients about the potential risk of high aerosol spread from the use of their PAP devices [15,48]. AASM, as well as other sleep societies, have advised patients under treatment with PAP to self-isolate when they have symptoms that are compatible with COVID-19; this advice however is not always feasible to apply during the stressful pandemic period [49]. In addition, treatment of hospitalized patients with COVID-19 infection and a preexisting SDB diagnosis, entails that these particular patients should be on a negative pressure room, so as to minimize any unnecessary transmission of SARS-CoV-2 when PAP is an integral part of their management (eg, OHS, comorbid CVD) [5]. Therefore, it is possible to assume on the one hand poor patient adherence due to the fear of PAP-induced aerosol transmission, and on the other hand improved patient's compliance with their PAP treatment, in an effort to prevent any OSA-related complications and worse outcomes after COVID-19 infection. In this notion, a recent study in France [50], which retrieved data by telemonitoring from 7485 CPAP users with a diagnosis of OSA from 15th January 2019 to 15th April 2020, has shown that OSA patients significantly increased PAP adherence during the lockdown period, in comparison to the pre-COVID-19 period (3.9%, $p < 0.001$). Moreover, during the first month of the lockdown (from 15th March to 15th April) a better adherence to PAP treatment (4.48%, $p < 0.001$) was noted, and the proportion of patients with very low adherence dropped substantially as compared with the same period in 2019 (18.5%, $p < 0.001$). These data provide important information that OSA patients are motivated to have good control of their disease during the outbreak of COVID-19 [50].

In patients under follow-up and in need of chronic monitoring of their OSA status, sleep TM can have an essential role on providing explanations concerning treatment options and controlling good adherence with the PAP treatment, if it will be prescribed. Interestingly, the AASM has dedicated a unique platform for sleep TM resources so as to implement it into clinical practice and guide physicians for appropriate facilitation of this useful tool across sleep laboratories practices [51].

5.3. Perspective for normal transition of sleep laboratories operation to the immediate post-COVID-19 era: a call for action

Changes should be made in sleep medicine practice following the COVID-19 pandemic. Patients at high risk for OSA should be given the opportunity for HSAT with disposable equipment (eg masks, transducers etc.) when feasible, and in case of definite OSA diagnosis, the initiation of PAP treatment should be offered under a safe environment, preferably under remote control. In case where in-laboratory sleep studies are necessary, especially for PAP titration or insurance demands, these could be performed only after patients' negative screening for COVID-19, according to local recommendations and hospital guidelines, with the personnel using all necessary personal protective equipment (PPE) and keeping safe distances, as previously mentioned and according to WHO infection prevention and control guidance [34]. The minimum number of personnel should work in each shift and those who are present should not forget to keep safe distancing. Sleep laboratories should work only with scheduled appointments for all patients' visits, ensuring sufficient time distance between them, in order to have adequate time for proper disinfection. A structured approach for sleep medicine practices following the COVID-19 outbreak, which is based on community transmission levels of SARS-CoV-2, is available online from the AASM. This includes advice for clinicians on their actions in cases of high, moderate and low-to- minimal exposure to the novel coronavirus [5].

In addition, it is also imperative to establish national recommendations for the normal transition of sleep medicine facilities and practices after the lockdown due to COVID-19 pandemic based on the different reopening phases worldwide. Furthermore, health authorities should also take into consideration the differences in incidence status of SARS-CoV-2 in the community, as it varies significantly even between regions of the same country, as well as availability of COVID-19 testing, both factors might affect the formulation of these recommendations and their future revisions. A proposed plan of recommendations should include specific details for the screening of the patients who seek for sleep consultation, for the diagnosis and treatment of SDB discriminating between HSAT and in-laboratory management, for the proper use of non-invasive ventilatory support in the hospital environment taking into account COVID-19 status and availability for isolation rooms. Finally, frequent review of the recent updates for epidemiological indices locally should be on the daily agenda, as well as guidance from the relevant authorities regarding medical practices, so as to adjust and revise previously published recommendations.

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Conflict of interest

None declared.

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