Sleep Disorders: Diagnosis and Treatment

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Sleep medicine is evolving rapidly. This Journal Conference summarizes recent and upcoming developments in sleep-monitoring technology, our understanding of the underlying physiology of sleep disorders and the relationships of sleep disorders to other health problems, the treatment of sleep disorders, and regulatory matters in sleep medicine. Sleep medicine is a growing field, partly because of the obesity epidemic and partly because of an increasing recognition of how sleep disorders cause and/or exacerbate serious conditions such as heart disease, and how poor sleep increases societal costs (eg, decreased work/school productivity, and motor vehicle accidents from hypersomnolence). Some key questions that remain to be answered include: What are the best metrics for diagnosing the severity of sleep apnea? What outcomes are most relevant to evaluate the efficacy of therapy? What is the best type of positive airway pressure (PAP) therapy for each category of sleep disorder? What is the best approach to treatment when positive airway pressure does not work? How often should sleep studies be repeated? What are the indications for re-titration of the PAP level? What will happen to sleep laboratories, especially if reimbursement is reduced and portable unattended sleep studies gain in popularity? Could non-sleep-specialists interpret sleep studies? What is the role of increased nasal resistance in producing upper-airway obstruction? What is the influence of chronic sinusitis on adherence to PAP therapy? How do gender differences affect the incidence, morbidity, and outcomes of sleep apnea? What are the needs of special populations with sleep disorders, such as children, patients with mental impairment, psychiatric patients, and ICU patients? *Key words: sleep-disordered breathing; obstructive sleep apnea; sleep medicine*. [Respir Care 2010;55(10):1389–1396. © 2010 Daedalus Enterprises]

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> Even where sleep is concerned, too much is a bad thing.
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> —Homer

Introduction

The problem of excessive sleepiness has been recognized for many centuries. However, there was no clear-cut nomenclature for disorders associated with excessive sleepiness, and patients were generally lumped under the broad

umbrella of "Pickwickian syndrome." Leila Kheirandish-Gozal and Babak Mokhlesi made me aware of a paper from the 19th century entitled "*On some causes of backwardness and stupidity in children*."[1] Dr Hill, a surgeon at St Mary's Hospital in London, described a dramatic and often immediate improvement in the mental function of children after removal of enlarged adenoids, tonsils, and hypertrophic catarrhal conditions of the nose. He ascribed the improvement of cognitive abilities in these children to a variety of possibilities, but did not associate it with improvement in their sleep quality. He concluded that "the stupid looking lazy child who frequently suffers from headache at school, breathes through his mouth instead of his nose, snores and is restless at night, and wakes up with a dry mouth in the morning, is well worthy of the solicitous attention of the school medical officer." In modern clinical practice, we now recognize that this pattern of symptoms is typically seen in patients with sleep-disordered breathing.

Our understanding of sleep disorders has improved dramatically in the past 100 years. Several developments contributed to the growth of sleep science. First and foremost, new technology contributed immensely to advancements in this field. In the past, multi-channel recorders for recording various bio-physiological signals were so large that their use was confined mostly to research laboratories. With the development of portable monitors, physiological signals could be recorded at the bedside, and this allowed the monitoring of large numbers of patients. Computers and the internet also made immense contributions to recording and interpretation of sleep studies. Development of well-fitting mask interfaces led to the widespread adoption of noninvasive ventilation (NIV), and further progress occurred when technology was developed to employ this therapy in a domiciliary setting. Finally, the enormous success of continuous positive airway pressure (CPAP) therapy in improving clinical outcomes in patients with obstructive sleep apnea (OSA) has transformed this field. The high prevalence of sleep-disordered breathing and its links to several other disorders commonly seen in clinical practice have further solidified the position of sleep science in the mainstream of modern medicine.

Obstructive and Central Sleep Apnea

The first session of the conference got off to a good start with Vishesh Kapur's talk on OSA.[2] He reminded us that OSA is a very common illness in adults that occurs because of the repeated collapse of the upper airway during sleep. Besides airway anatomy and local muscle dilator activity, other factors that contribute to variability in the clinical presentation are lung volume, ventilatory control stability, and the stability of sleep itself. Fluid shifts from the legs to the neck in the recumbent position could also contribute to development of OSA. Patients at high risk of having OSA can be identified by the occurrence of snoring, witnessed apneas, and hypertension. Patients with higher body mass index (BMI) and neck circumference, especially males, have a greater likelihood of developing OSA. He very astutely pointed out that the metrics used as cut-offs, and other definitions employed for diagnosing and managing therapy of OSA need to be better defined. We do have several metrics, but are they the best metrics to use? He also pointed out that there's a cost of diagnosing and treating OSA but there's probably much greater cost in *not* treating it. A review of the literature and meta-analyses show that CPAP is cost-effective for treating patients with moderate to severe OSA. Whether treatment of OSA results in actual cost savings is unknown at this time.

In the discussion, Sam Kuna made the important comment that the upper airway could be likened to a box with fixed dimensions that is bounded by the mandible and the hard palate. The dimensions of the upper airway opening depend on the size of the soft tissues (tongue, palatal, and pharyngeal muscles) within that box, and this may be genetically determined. Obviously, inflammation in the upper airway narrows the dimensions of the upper airway opening. Other participants also commented on the fact that the epidemiologic studies on OSA are more than 25 years old, and the prevalence of OSA has probably increased during this period because of the increasing prevalence of obesity in the general population. Another issue that was discussed was the importance of daytime sleepiness in patients with sleep apnea. Occurrence of sleepiness in patients with sleep apnea may be associated with higher risk of cardiovascular morbidity, compared to patients with sleep apnea who do not have daytime sleepiness.

In his presentation, Atul Malhotra described the various categories of central sleep apnea, including: primary alveolar hypoventilation; sleep hypoventilation syndrome in patients with a high P_{CO_2}, which occurs commonly at sleep onset; sleep transition apneas occurring with heightened ventilatory responses to recurrent arousals in patients who have a normal P_{CO_2}; treatment-emergent apneas that occur after CPAP titration, and these may also be termed complex apneas; and periodic breathing that could occur for several months after tracheostomy.[3] He very elegantly described Cheyne-Stokes respiration as a waxing and waning respiratory problem that is commonly observed in patients with congestive heart failure and low left-ventricular ejection fraction and is associated with an increased mortality. He gave an excellent description of the mechanism underlying the instability of ventilatory control in such patients.

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Cheyne-Stokes respiration improves with optimization of medical therapy. CPAP therapy improved hemodynamic parameters but did not improve mortality in the Canadian Continuous Positive Airway Pressure for Patients with Central Sleep Apnea and Heart Failure (CanPAP) trial.[4] A follow-up trial (CanPAP2) is underway to further address this issue. Malhotra also discussed the diagnostic approach to patients with hypoventilation syndromes. He distinguished patients who "can't breathe" due to neuromuscular weakness or abnormal mechanics of the lungs and chest wall from those who "won't breathe" because of an inadequate central drive. He proposed that in addition to the history and physical examination, measurement of $P_{0.1}$ (airway-occlusion pressure 0.1 s after the start of inspiratory flow) was a good test to categorize these patients.

Diagnosis of Sleep Apnea

Polysomnography (PSG) is the currently accepted standard for the diagnosis of sleep apnea. Susheel Patil talked about what every clinician should know about PSG.[5] He described how these continuous biophysiologic signals are recorded during sleep, and provided details of the signals that are actually recorded. He pointed out that there has been a recent change in the PSG scoring system and compared the new guidelines to the previously used schema for scoring PSGs. According to currently accepted criteria, apnea is defined as a drop in peak thermistor excursion by more than 90% of baseline, which lasts more than 10 seconds, and at least 90% of the event's duration meets amplitude criteria. There doesn't seem to be much controversy about the definition of apnea. However, the definition of hypopnea remains a challenge. The conventional definition of hypopnea relies on a nasal pressure signal drop of more than 30% of baseline *with* oxygen desaturation $\geq 4\%$. An alternative definition proposes a greater decline in the pressure signal, a somewhat lesser decline in the oxygen saturation, and this event must be associated with an arousal. For both definitions of hypopnea, the event has to be at least 10 seconds in duration, and more than 90% of the events duration should meet amplitude criteria. There exists significant controversy about the best definition of hypopnea. Patil pointed out that the arousal-based definition had a stronger correlation with sleepiness symptoms than the conventional definition of hypopnea that is entirely based on the occurrence of oxygen desaturations. He also pointed out that non-obese patients are less likely to experience oxygen desaturation with hypopneas, and they may be under-diagnosed if the conventional definition of hypopnea based on oxygen desaturation is employed.

During the discussion following this presentation several participants commented on the need for better methods to characterize central hypopneas. This would require signals to recognize patient efforts, such as with esophageal pressure monitoring and air-flow limitation. Comments were made about the qualitative rather than quantitative nature of PSG recordings, and the need to share sleep study recordings across various centers was emphasized. In the future, metrics for defining abnormality should be correlated with outcomes (cardiovascular morbidity, hypertension, neurocognitive effects) rather than PSG criteria alone.

In his presentation, Sam Kuna compared the merits of portable versus laboratory testing for sleep disorders, and pointed out the problems with PSG.[6] Clinical investigations have been unable to correlate apnea-hypopnea index (AHI) scores on PSG with clinical symptoms and outcomes. Moreover, the PSG-based disease severity classification of OSA uses arbitrary levels of AHI as cut-offs. He also pointed out the lack of uniform scoring criteria for hypopneas mentioned above. Recent changes in Centers for Medicare and Medicaid Services policy allowing reimbursement for portable unattended and attended sleep studies are having a sweeping impact on the field. Performing portable studies followed by a formal PSG would not be cost-effective. Kuna suggested that the number of negative sleep studies could be minimized by performing portable sleep studies in patients with a high pre-test probability of OSA. There may be a role for performing home unattended auto-CPAP titration studies to identify optimal CPAP settings. He emphasized the need to standardize portable monitors and conduct randomized, prospective clinical trials to compare outcomes with therapy based on at home versus in-lab testing.

There was a lively discussion about interpretation of portable sleep studies, and how the field would be impacted by an increasing number of portable sleep studies, especially with regard to diagnostic and treatment strategies.

Treatment of Sleep Apnea

PAP therapy is currently the mainstay of treatment for sleep apnea. Sai Parthasarathy very elegantly summarized the various modes of PAP ventilation.[7] He pointed out that several newer modes of ventilation are being employed; however, problems with NIV, such as poor adherence, high pressure requirements, and air leak from the mask, continue to significantly impact the ability to effectively deliver PAP therapy. A programmed reduction of expiratory pressure, such as with C-flex, makes it easier to breathe during CPAP. Parthasarathy recommended that patients with OSA could be treated with CPAP or bi-level PAP, while patients with obesity hypoventilation would probably require either auto-bi-level PAP or volume-assured pressure support ventilation. Adaptive servo ventilation may be best suited for patients with central sleep apneas, Cheyne-Stokes respiration, and complex sleep apneas, whereas patients with restrictive thoracic disorders and

COPD overlap syndrome, and those with neuromuscular disorders could be treated with auto-bi-level PAP or volume-assured pressure support ventilation. The appropriate ventilatory mode to employ in a variety of sleep disorders is still evolving, and clinical practice has changed over the years with the introduction of newer technology. He pointed out that at least one trial has reported a better resolution of central sleep apnea with adaptive servo ventilation, as compared to other conventional modes of PAP therapy.[8] Sai emphasized that adherence to PAP therapy is a major factor influencing patient outcomes.

Parthasarathy's presentation was a great segue into the presentation by Suzanne Bollig on encouraging CPAP adherence.[9] She described the factors influencing patient adherence with CPAP within the framework of a 3-legged stool. Thus, *patient-related practices, clinician-related practice, and therapy-related practice* all contribute to the acceptance and use of PAP therapy by patients. So how can we encourage CPAP adherence? Technological interventions can be helpful, but behavioral interventions are probably the most important in tackling problems due to non-adherence to CPAP. Bollig emphasized that healthcare providers should utilize every interaction with patients to provide them with "layers of information." For example, in the clinic, in the sleep laboratory, over the telephone, in their home, or in support groups, clinicians must avail themselves of every opportunity to educate patients about their PAP delivery devices, their appropriate use, and the long-term benefits that would accrue from their regular use. She provided the address of the Web site for the "Clinician's Guide to PAP Adherence" (http://www.aarc.org/education/pap_adherence). Bollig reiterated the importance of ensuring continuum of care as a very important goal for patients with sleep apnea.

A great deal of discussion ensued about the best methods to enhance adherence to CPAP therapy, especially in the initial period after the therapy is initiated. The lack of discussion between physicians and patients about the results of the sleep study was highlighted. David Pierson raised an important question about the follow-up of patients to ensure that the CPAP prescription and set-up are appropriate. He also enquired if there were criteria to consider re-titration of CPAP, because it seems that this decision is currently based entirely on patient's symptoms.

Many patients who are unable to tolerate CPAP, or find it inconvenient for other reasons, employ dental appliances or undergo various surgical procedures to relieve symptoms due to sleep apnea. Tucker Woodson gave his presentation on various surgical therapies that are employed for patients with OSA over the telephone from Milwaukee, a unique event for a Journal Conference.[10] Nasal septoplasty, adenotonsillectomy, uvulopalatopharyngoplasty, bariatric surgery, and tracheostomy are the most frequently employed surgical procedures. A variety of other surgical techniques have been employed to improve the caliber of the upper airway; however, no one surgical option stands out above the rest. Uvulopalatopharyngoplasty increases the caliber of the upper airway and helps in alleviating snoring, but Woodson mentioned that patients experience extremely severe pain after the procedure, and its value in treating OSA is doubtful. Tracheostomy is useful, but it is infrequently performed for this indication, as it is often employed as a last resort. The outcomes after tracheostomy are not as well studied as those with CPAP therapy. While discussing various dental appliances, Woodson mentioned that those devices that advance the mandible are most commonly used. Individual responses may differ with these appliances that advance the mandible, and although they commonly produce short-term clinical benefit, long-term problems with the teeth and relapse or failure of therapy are frequently observed after 3 to 5 years of use of such devices.

Sleep Apnea and Cardiovascular Disorders

Stuart Quan's engaging presentation discussed the relationship of sleep-disordered breathing and cardiovascular disease.[11] He presented details of data from the Sleep Heart Health Study.[12] Hypertension is frequently associated with sleep apnea, and in the United States as many as 16 million patients may have this combination of diseases. The risk of hypertension is higher even in patients with mild sleep-disordered breathing compared with the normal population, and the incidence of hypertension increases with increasing AHI. Nocturnal hypoxemia may contribute to development of hypertension, and CPAP therapy modestly reduces the elevated blood pressure.

With regard to the relationship between sleep-disordered breathing and coronary heart disease, there is a modest age- and race-adjusted association, with incident coronary heart disease only in men with severe OSA. After adjusting for BMI, OSA is independently associated with coronary heart disease risk only in men < 70 years of age, and this association has not been seen in women. It is unclear if treatment of OSA reduces the risk of coronary heart disease. Randomized controlled trials are currently being conducted to determine the effect of OSA treatment on morbidity and mortality related to coronary artery disease.

Both OSA and central sleep apnea are highly prevalent in patients with congestive heart failure. After adjusting for BMI, OSA is independently associated with incident congestive heart failure only in men. CPAP effectively treats OSA in congestive-heart-failure patients. However, the CanPAP study[4] suggests that CPAP does *not* improve outcomes in patients with central apnea or Cheyne-Stokes respiration. Bi-level PAP ventilation may be effective in these patients with central sleep apnea or Cheyne-Stokes

respiration, but further investigations are needed to definitively establish improvement in outcomes.

Quan also presented data showing independent association between sleep-disordered breathing and all-cause mortality in general community samples. In the Sleep Heart Health Study[12] there was a dose-dependent relationship between AHI/hypoxemia and all-cause mortality in men but not in women, and the association was most evident in men < 70 years of age.

Sleep Apnea in Special Populations

Presentations on the second day of the meeting focused on sleep apnea in various patient populations. Peter Gay spoke on sleep-disordered breathing in the hospitalized patient.[13] He described various sleep disturbances in hospitalized patients, especially those in intensive care unit (ICU) patients. Importantly, these changes may not resolve for several weeks after the patient leaves the hospital. Sleep disturbances predispose patients to the development of delirium, and because the development of delirium prolongs hospital stay, the sleep disturbances could have economic consequences. Very high prevalence rates of OSA have been reported in hospitalized patients, especially in those suffering from strokes, and the recognition of OSA in these patients is extremely important for their safety. Several adverse outcomes from OSA, including death, occur in patients admitted to the hospital. He emphasized the need to identify those patients at risk, perform appropriate monitoring, and intervene accordingly. The appropriate placement of the patient (floor vs step-down unit vs ICU) is crucial to prevent adverse outcomes. Standardized protocols should be implemented to recognize OSA and improve the care of these patients during their hospital stay. Gay mentioned that there may be financial incentives in the future for implementation of such standardized protocols.

The high prevalence of OSA in hospitalized patients was emphasized by several speakers during the discussion. There does not seem to be a satisfactory approach for treating patients, especially those in the postoperative period, who are suspected to have OSA for the first time because of the occurrence of oxygen desaturation during sleep. Such patients often find it difficult to initiate CPAP therapy in this setting. Patients who are already diagnosed with OSA prior to their hospital admission should be instructed to bring their CPAP device with them to the hospital, and *use it while sleeping during the day and at night*. Identification of daytime hypoventilation during hospitalization is important, as it could be a marker of increased mortality after discharge from the hospital.

Another combination of disorders that is commonly seen in clinical practice is the occurrence of sleep apnea in patients with COPD. This topic was covered in Robert Owens's presentation on sleep-disordered breathing in patients with COPD.[14] Both insomnia and excessive sleepiness are common complaints in patients with COPD. Objective measurements during sleep in such patients have shown increased sleepiness, decreased total sleep time, and increased arousals. In patients with COPD, nocturnal oxygen desaturations occur very frequently, and they are associated with increased mortality. The occurrence of OSA with COPD in the same patient is called the overlap syndrome, and the frequent combination of the 2 disorders is probably explained by the high prevalence of both disorders in the general population. Patients with the overlap syndrome have a higher morbidity and mortality, compared to those with OSA alone, but it is unclear if the morbidity and mortality due to the overlap syndrome is higher than that due to COPD alone. A high index of suspicion is crucial to diagnose the overlap syndrome. The presence of right-heart dysfunction or hypercapnia with relatively mild COPD should prompt consideration of coexistent OSA. CPAP and oxygen supplementation are the current standard of care for these patients. The role of NIV in this patient population is not well defined as yet. Intensive noninvasive therapy may be required to impact outcomes, and it may only be possible to achieve the desired pressure settings after initial adaptation in a hospital-based environment.[15]

During the discussion of Owens's presentation the use of NIV was recommended for patients with overlap syndrome who have hypoventilation.

Babak Mokhlesi, gave an interesting talk on obesity hypoventilation syndrome.[16] This syndrome is a combination of obesity, chronic hypercapnia, and sleep-disordered breathing, with no other explanation for the hypercapnia. This combination is observed in 10–20% of patients with OSA, with a higher prevalence among the morbidly obese population. Despite being excessively sleepy during the day, such patients often remain undiagnosed until they are admitted to the hospital with acute hypercapnic respiratory failure. The treatment of this syndrome includes PAP therapy, bariatric surgery, and drug treatment with medroxyprogesterone acetate or acetazolamide. The majority of patients with OHS can be effectively treated with CPAP, but hypoxemia and hypercapnia may persist despite CPAP therapy in some patients. Importantly, hospitalized patients with OHS had a significantly higher mortality (23%) over 18 months of follow-up than patients with eucapnic morbid obesity (9%).[17]

Leila Kheirandish-Gozal spoke on the important topic of sleep-disordered breathing in infants and children.[18] She asked the very relevant question: What is OSA in children? She pointed out the lack of a precise definition of OSA in this age group and mentioned that criteria for diagnosis and treatment of OSA in children are not well defined. Should children be treated if they don't have symp-

toms or end-organ dysfunction? Kheirandish-Gozal pointed out that the presence of snoring, neurocognitive deficits, or nocturnal hypoxemia may help in making decisions about instituting treatment for OSA in children. Removal of enlarged adenoids or tonsils is the first step for treatment of children with OSA. However, in children with severe OSA or obesity, sleep problems may persist after surgery. Obviously, there are unique challenges in using long-term NIV in small children. Kheirandish-Gozal highlighted the gaps in knowledge about the diagnosis and treatment of OSA in children, and described some innovative research that is being conducted to differentiate normal from abnormal sleep patterns in children.

During the discussion, Kheirandish-Gozal mentioned some studies that showed reduction in adenoid size, snoring, and AHI with use of intranasal corticosteroids, oral montelukast, or the combination of the 2 agents. This positive result was more likely to occur in younger children. In older children, reductions in tonsil size with the medications mentioned above may be less impressive than those observed in younger children.

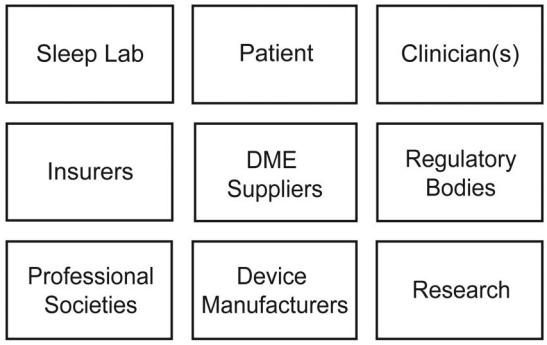

Fig. 1. Multiple stakeholders have an impact on the care of patients with sleep-disordered breathing. At the core, is the patient-physician relationship. Physicians from various specialties participate in the care of patients with sleep disorders. Other clinicians, especially RTs, also play an important role in diagnosis, education, follow-up, and monitoring of patients with sleep apnea. Similarly to other chronic diseases, the care of patients with sleep apnea is influenced by insurers, durable medical equipment suppliers, home care companies, and device manufacturers. Various professional societies, federal and state licensing boards, and private regulatory bodies control licensing, certification, and accreditation. For a unified approach to the care of these patients with sleep disorders, close collaboration and cooperation is needed between these multiple stakeholders.

Regulation, Certification, and Accreditation Aspects of Sleep Practice

With the expansion in sleep practice, issues related to regulation, certification, and accreditation have emerged and have engendered considerable controversy in recent years. Brian Carlin gave a comprehensive summary of various aspects of clinical sleep practice.[19] He helped to sort through the alphabet soup of various agencies and regulatory bodies. There's the Board of Registered PSG Technologists (BRPT) and the National Board for Respiratory Care (NBRC). The only currently Medicare-recognized certification for sleep technologists is the RPSGT provided by the BRPT. In 2010 the NBRC is starting a Sleep Disorders Specialist (SDS) certification. Eligibility criteria for technologists to qualify for SDS certification will be much more stringent than the educational and training requirements for obtaining RPSGT certification. The Commission on Accreditation of Allied Health Education Programs (CAAHEP) is also likely to provide their own certificate if a candidate has completed PSG training in a program accredited by their organization. The actions of these various boards have generated a great deal of, sometimes acrimonious, debate about the best qualifications for technologists to perform sleep studies.

Accreditation of sleep centers is currently monitored by the American Academy of Sleep Medicine (AASM) and the Joint Commission for hospital-based laboratories, although most laboratories are currently accredited by AASM. Recently, the Accreditation Commission for Health Care has also designed a program to accredit sleep centers. Carlin suggested that, instead of federal and state governments, we should be policing ourselves. Ideally, physician groups should be regulating sleep laboratories and nonphysician providers who participate in the care of patients with sleep disorders.

During the discussion, several participants stressed the need for various professional organizations and licensing boards to work together and ensure that well qualified personnel perform and score sleep studies. The patients' interests are of paramount importance and their safety should never be compromised.

Sleep Apnea as a Chronic Illness

Sleep apnea needs to be viewed within the framework of a chronic illness, with multiple stakeholders having an impact on patient care (Fig. 1). The patient-physician interaction is of paramount importance in this framework. Similarly to other chronic diseases, such as diabetes mellitus, or hypertension, the care of patients with sleep disorders may be provided by various specialists, including pulmonologists, neurologists, sleep specialists, ear-nose-and-throat surgeons, orthodontists, psychiatrists, or primary care physicians. Involvement of multiple physicians makes it difficult to adopt a unified approach to the management of patients with sleep-related illnesses. Patient preferences regarding the most acceptable forms of treatment have a significant impact on therapeutic choices. At the moment, there is heavy reliance on the sleep laboratory for establishing a diagnosis and titration of an appropriate

PAP level, but this may change in the future. Other groups that influence management of sleep apnea include health insurers, suppliers of durable medical equipment, regulatory bodies, device manufacturers, professional societies, and researchers (see Fig. 1). Comprehensive treatment programs, incorporating counseling on smoking cessation; education about adherence to PAP therapy; measures to achieve weight loss; and treatment of comorbidities such as hypertension, diabetes mellitus, coronary artery disease, and surgery, are needed. A comprehensive treatment program is especially important in treating children. Standardized protocols should be developed and adopted for management in specific clinical settings, such as in the perioperative period. Drug therapies are not very effective but they can help in certain aspects of management, especially in facilitating adherence to CPAP. Of course, the mainstay of treatment for sleep-disordered breathing is PAP therapy. The treatment has to be individualized by titrating the pressure according to each patient's need, using an appropriate interface that fits well and is acceptable to the patient, monitoring adherence to the regimen, and ensuring frequent and regular communication and follow-up. Various occupational and social factors also require individual attention. Ensuring effective utilization of various forms of PAP therapy is crucial to the future success of management of patients with sleep disorders.

Integrating Sleep Care in Pulmonary Medicine

Like many practicing pulmonologists who are not trained in sleep medicine, I have to regularly diagnose and treat patients with sleep apnea. The history is crucial for diagnosis; unfortunately, many patients are not aware of snoring or sleep disturbance. Therefore, one has to rely on the bed partner for the history. A history of sleep disturbance should be incorporated as one of the 7 cardinal symptoms of pulmonary disease (other symptoms include cough, expectoration, hemoptysis, dyspnea, wheezing, and chest pain). Whether a patient is being evaluated in the clinic or in the hospital, it should be routine to enquire about symptoms during sleep. The clues to sleep apnea on the physical examination can range from the extremely obvious to very subtle signs that may be very difficult to decipher. Patients who are excessively sleepy, are obese, and have a thick, short neck, with a narrow oropharynx have a high probability of OSA. Some common tests that are routinely performed (pulmonary function tests, echocardiograms) also provide clues to the existence of OSA. A reduced total lung capacity or reduction in functional residual capacity in an obese patient could be associated with a greater propensity for upper-airway obstruction in the supine position.[20] The presence of hypercapnia, unexplained hypoxemia, or polycythemia may be other clues to the diagnosis of OSA and hypoventilation. Occasionally, a sawtooth pattern on the expiratory flow-volume loop is observed due to oscillation of a floppy upper airway during forced expiratory efforts. Unexplained pulmonary hypertension on the echocardiogram often prompts a sleep study. Increased awareness and a high index of suspicion are needed to avoid complications due to this highly prevalent disorder.

The Key Role of Respiratory Therapists

The strategic role of respiratory therapists (RTs) in the diagnosis and management of patients with sleep disorders is often inadequately highlighted. In the sleep laboratory, many, if not most, sleep technologists have their roots in respiratory therapy. After a sleep disorder is diagnosed, RTs are at the front line in providing nocturnal oximetry studies, and in maintaining CPAP or other modes of NIV in the patient's home.

RTs have an especially important role to play for patients admitted to the hospital. They ensure that previously diagnosed patients receive their prescribed treatment. If patients bring their own equipment to the hospital, this provides RTs with the opportunity to check it out and teach proper care and cleaning. On such occasions, RTs are also able to correct any problems that may be barriers to adherence with PAP therapy.

RTs make especially crucial contributions in the care of patients with previously undiagnosed sleep disorders who are admitted to the hospital for a variety of reasons. My expert RT colleagues are often the first to recognize periodic breathing, obstructive apneas, or oxygen desaturations as possible indicators of a sleep disorder. Such information often leads to CPAP/bi-level titration in an ICU or step-down unit setting, with their active participation. Finally, RTs monitor such patients, and adjust or change masks and pressure settings for optimal comfort and resolution of observed abnormalities. These interactions provide excellent opportunities for education and training and often have a lasting impact on the patient.

Summary

One and a half days of discussion at this Journal Conference highlighted some of the important clinically relevant questions about sleep disorders. A partial list of these unanswered questions includes:

1. What is (are) the best metric(s) for diagnosing the severity of sleep apnea?
2. What outcome(s) is (are) most relevant to evaluate the efficacy of therapy? Is it PSG findings (eg, reduction in AHI), hypoxemia, sleepiness, or is it some other metric of metabolic control or inflammatory state, or mortality?
3. What is the best form of PAP therapy for each category of patients with sleep disorders?

4. What is the best approach to treatment when PAP treatment does not work?
5. How often should sleep studies be repeated? What are the indications for re-titration of the CPAP level?
6. What will become of sleep laboratories, especially if reimbursement is reduced and portable unattended studies gain in popularity?
7. Should non-sleep-specialists be able to interpret sleep studies?

In my opinion, other areas that deserve further study include:

1. The role of increased nasal resistance in producing upper-airway obstruction, and the influence of chronic sinusitis on adherence to PAP therapy.
2. Gender differences in the incidence, morbidity, and outcomes of sleep apnea.
3. The needs of special populations with sleep disorders, such as children, patients with mental impairment, psychiatric patients, and ICU patients need to be addressed in greater depth.

Finally, it is my pleasure to recognize the exceptional efforts and dedication of my co-chair, Sai Parthasarathy in planning this meeting. I am thankful to all the participants for their expertise and valuable contributions. It has been my privilege to participate in this Journal Conference, and I hope the readership will find the content interesting and informative.

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