



The Clinician's Handbook for

# Dental Sleep Medicine

SECOND EDITION

Steve Carstensen, DDS

Ken Berley, DDS, JD



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*Second Edition*





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# Dedications

*The impact of dentistry in health care is growing rapidly. I am dedicated to supporting the health care professionals who choose to push beyond their basic education to learn more about the impact they can have on community health. Those brave enough to say “yes” to opportunities can make a true difference in the lives of those who trust them. This approach would not be possible without the mentors who provided me with opportunities to grow—Dr L.D. Pankey, Dr Keith Thornton, Midge Carstensen, RDH, and countless others who have participated in reducing barriers to health at all stages of life. I hope every reader of this book is as fortunate as I am to have such strong support.*

—Steve Carstensen, DDS

*I would like to dedicate this book to my father, James A. Berley, who had undiagnosed OSA and died as a result of a stroke in the middle of the night. His death led directly to this book and changed my life. Also, I would like to dedicate this book to my wife, Patty Berley, RDA, who has stood by me through thick and thin, even when I was unworthy of her love.*

—Ken Berley, DDS, JD



# Contents

*Preface* **viii**

*Acknowledgments* **x**

*Contributors* **xi**

- 1 Clinical Guide for the Practice of Dental Sleep Medicine **1**
- 2 An Overview of Sleep and Sleep Disorders **29**
- 3 Dental Sleep Medicine Protocols and Practice **47**
- 4 Integrating Dental Sleep Medicine into Your Practice **67**
- 5 Treatment Decisions and Appliance Selection **91**
- 6 Delivery of a Custom MAD **125**
- 7 Complications of Oral Appliance Therapy **145**

8 Evaluating Therapy and Ongoing Care **163**

9 The New Reality **179**

10 Legal Issues Related to the Practice of Dental  
Sleep Medicine **187**

11 Medical Insurance and Medicare **199**

12 Pediatric Airway Problems **231**

13 Myofunctional Therapy **239**

14 A Multidimensional Approach to Addressing  
Breathing and Sleep Disorders **249**

15 Physical Therapy **285**

16 Rhinomanometry **319**

*Recommended Materials* **332**

*Sleep Medicine Terminology* **333**

*Index* **341**





# Preface

Life is short. Before you know it, you will be looking at your professional life in the rear-view mirror trying to figure out how you spent the time you were given. How did it go so fast? As Benjamin Franklin said, "You may delay, but time will not." Now, in the sunset of my professional career, the thing that I am most proud of is that I committed to the screening and treatment of sleep-disordered breathing (SDB) early in my professional career. I sincerely derive comfort from the fact that my professional efforts have resulted in an improved quality of life for thousands of my patients. As I have said in many of my lectures, on a good day as a dentist I may be able to save a tooth or improve a smile. On a good day as a dental sleep medicine (DSM) practitioner, I may be able to save a patient's life. I am very proud that I have helped so many patients sleep. While the dental health of our patients is vitally important, nothing is more important than air. Without that, life doesn't exist.

With the rise of DSM, dentists are in a unique position to modify the anatomy of the upper airway and improve a patient's oxygen levels during sleep. The simple act of advancing or supporting the mandible during sleep can change the lives of millions of patients who are struggling. When we advance a patient's mandible, nocturnal arousals and sleep fragmentations are diminished because the airway is patent. The patient enjoys more restful sleep and an improved quality of life.

SDB and obstructive sleep apnea (OSA), which is a subset of SDB, are true epidemics in this country. Simply defined, SDB is difficulty maintaining a patent airway during sleep. The symptoms range from simple snoring to prolonged and complete closure of the patient's airway. The patient's tongue and soft palate are typically the culprits responsible for nocturnal airway resistance. But when we advance the mandible, the tongue and hyoid bone are placed under tension, which decreases resistance and reduces the likelihood of complete or partial airway closure.

Epidemiologists estimate that more than 200 million Americans snore nightly and at least 52 million have clinically significant OSA. That means that up to 50% of the adults and 10% of the children you see each day in your dental office likely have some degree of SDB. SDB and OSA are directly associated with hypertension, coronary artery disease, stroke, diabetes mellitus, dementia, and early death. SDB results in the activation of the sympathetic nervous system, resulting in the release of adrenaline and cortisol. When released as a result of the patient's struggle to breathe, adrenaline initiates a "fight or flight" sympathetic response. During sleep, our body is supposed to be resting and repairing, not fighting for oxygen. Opening a patient's airway with a mandibular advancement device (MAD) can change their life. Nothing that you do as a health care professional will be more impactful for your patients.



DSM was introduced approximately 40 years ago in an effort to advance the use of MADs as a treatment alternative to continuous positive airway pressure (CPAP). Now, after 40 years of growth and growing pains, oral appliance therapy (OAT) is an accepted alternative to CPAP and is the first-line treatment for SDB/OSA, with reimbursement available under most medical insurance policies and Medicare. While CPAP remains the first choice of treatment for the majority of physicians, the percentage of physicians who regularly recommend OAT for their patients with SDB/OSA is growing rapidly. This shift toward OAT as the therapy of choice has resulted in an explosion in the field of DSM. Now, over 30% of all dentists provide some level of OAT to their patients, and the number of full-time DSM practitioners is growing each year. With the acceptance of DSM as an effective treatment and the expansion of medical insurance reimbursement, the addition of DSM into a general dental practice can result in significant financial gain.

There are a number of dental professional service organizations that foster and support DSM, with the American Academy of Dental Sleep Medicine (AADSM) being the largest. All of the service organizations provide various levels of training and credentialing; however, the AADSM offers diplomate certification, which is generally recognized as the highest level of training and credentialing available. With that said, readers should be aware that no significant financial investment is needed in order to provide OAT and treat OSA. You do not have to enroll in an expensive program or purchase costly equipment to treat your patients. After reading and implementing the information and techniques discussed in this handbook, you will have the knowledge and techniques necessary to successfully practice DSM. Do not be deceived into thinking that you need to spend thousands of dollars to get your DSM practice started. That is not necessary. All you need is information and a true desire to help your patients live better lives.

You have my congratulations on your decision to treat your patients' SDB; you will not regret adding DSM to your practice. Thank you for allowing Steve and me the opportunity to instruct, assist, and inspire you in your pledge to treat your OSA patients. Please don't get discouraged as you begin. Find the CPAP failures that are currently experienced by patients in your practice and start by treating them. Learn and repeat!

Respectfully,

***Ken Berley, DDS, JD***



# Acknowledgments

We would like to thank the team at Quintessence Publishing and Kristen Clark, our editor, for their guidance and assistance in the development of this handbook. Also, a big thank you to our families and friends who have tolerated and supported us throughout this process. Your understanding has been invaluable.



# Contributors

**Patty Berley, RDA**

**Karen Parker Davidson, DHA, MSA, MEd,**

**MSN, RN**

Adjunct Professor  
Department of Public Health  
School of Health Sciences  
Liberty University  
Lynchburg, Virginia

Adjunct Professor  
Division of Health Administration  
School of Health Sciences  
Central Michigan University  
Mount Pleasant, Michigan

**Bill Esser, PT**

**Brad Gilden, DPT**

Private Practice  
Old Greenwich, Connecticut  
New York City, New York

**Patrick McKeown**

Founder  
Oxygen Advantage  
Director of Education and Training  
Buteyko Clinic International  
Galway, Ireland

**Joy L. Moeller, RDH, BS**

Private Practice  
Palisades, California

**Klaus Vogt, Prof Dr, Dr med**

Guest Professor  
Faculty of Medicine  
University of Latvia  
Riga, Latvia

MedTecResearch  
Krakow am See, Germany

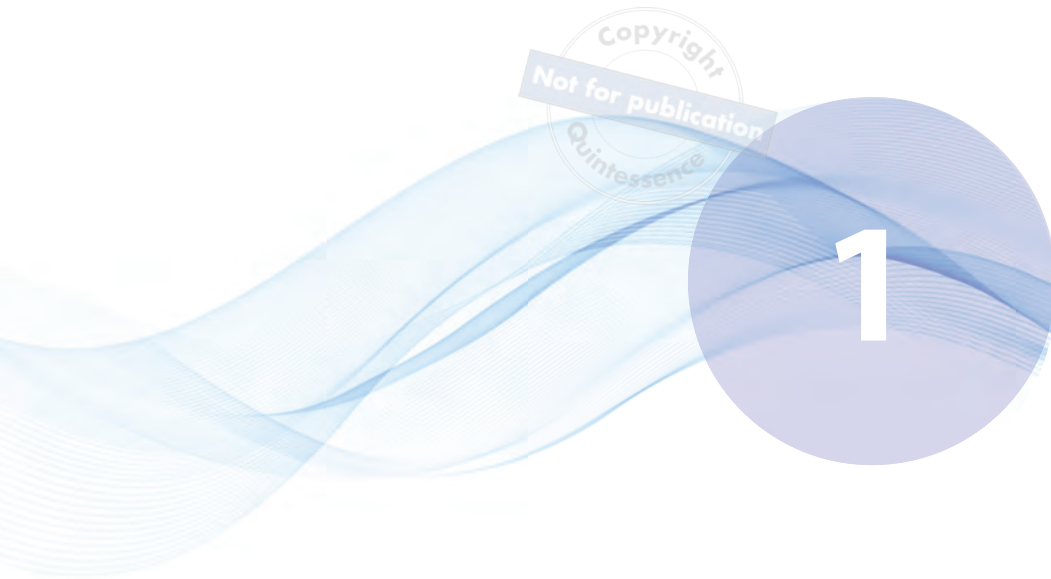
**Samantha Weaver, MS, CCC-SLP**

Director  
Academy of Orofacial Myofunctional  
Therapy  
Private Practice  
Palisades, California



Innocent sleep. Sleep that  
soothes away all our worries.  
Sleep that puts each day to rest.  
Sleep that relieves the weary  
laborer and heals hurt minds.  
Sleep, the main course in life's  
feast, and the most nourishing.

—William Shakespeare, *Macbeth*



# Clinical Guide for the Practice of Dental Sleep Medicine

## The Sleep Deprivation Epidemic

An old Irish proverb says, “A good laugh and a long sleep are the best cures in the doctor’s book.” It is easy to champion the physical, mental, and social benefits of a good night’s sleep. Sleep is mandatory for life. Humans can live approximately 4 days without water and 40 days without food but cease to function normally after missing a single night of sleep. Missing sleep for 10 days can be lethal. Even the early Greeks and Romans worshiped Hypnos and Somnus, their gods of sleep. We are all aware that every human must achieve a certain quality and quantity of sleep to function normally, but sadly, millions of individuals across the globe are unable to achieve a good night’s sleep. For these individuals, life can be a real struggle. A simple task can turn into an adventure without adequate sleep. Despite all the medical and social advances of modern society, good sleep has never been harder to achieve.

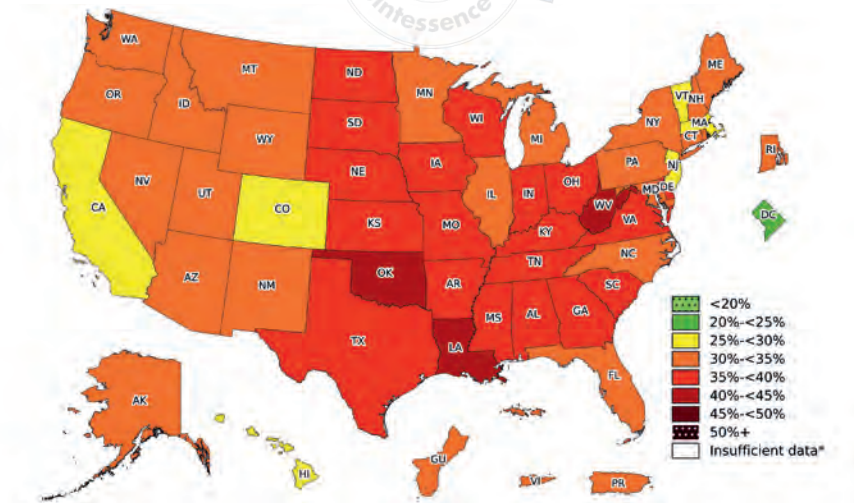
We struggle with sleep for many reasons. People face various social, environmental, and physiologic barriers when attempting to sleep. Frequently, sleep quality is sabotaged by lifestyle decisions—the self-inflicted consequences of daily choices. Attempting to sleep in a noisy, hot, or bright environment is common. Too many people live sedentary lives with insufficient exercise, and sleeping is much more difficult if we are not physically tired. A great American weekend is now defined by watching football on the couch

or binge-watching the latest Netflix release. Alcohol consumption, which significantly exacerbates sleep-disordered breathing, is also at an all-time high. We are hyperconnected with a growing array of computer-driven screens and glowing devices. The blue light emitted from many screens stimulates serotonin production and contributes to insomnia. Our technologic advances have given us the ability to work anywhere on the face of the planet at any time during the day or night, and we can stay in constant contact with anyone in the world. The health-conscious person striving for a good night's sleep must be very disciplined in light of this sensory onslaught.

In addition to the societal and entertainment choices that rob us of sleep, our ability to sleep is directly affected by certain physical characteristics and anatomical deficiencies. First and foremost, the human ability for complex vocalization and speech has created an anatomical weakness—a smaller maxillofacial complex and subsequently a decreased airway diameter. The airway from the hard palate to the top of the trachea is collapsible, with collapse typically manifested during the deeper levels of sleep. If the airway is restricted, or collapses completely, the increased respiratory effort required to breathe can lead to arousals and other physical consequences. Airflow is restricted, and blood oxygen/carbon dioxide levels become unbalanced. The repeated cycle of airway restriction/collapse and recovery to resume breathing has many names. *Sleep-related breathing disorder* (SRBD) is the general term, with *obstructive sleep apnea* (OSA) being the most consequential subset.

In addition to the anatomical component of OSA, Western civilization has adopted a fast food and microwave meal-style of living. Poor diet has resulted in rampant obesity in the United States, and OSA is closely linked to obesity and diabetes mellitus. These diseases are almost inseparable and have long-term health consequences. As patients become larger, fat deposits in the base of the tongue and the lateral walls of the airway are enlarged, reducing the cross-sectional area of the oropharyngeal lumen and making it more likely to collapse. Therefore, obesity greatly contributes to or exacerbates OSA. According to the Centers for Disease Control and Prevention (CDC), approximately 65% of Americans are overweight or obese. In many states, more than 35% of the population is obese, with the percentages rising each year (Fig 1-1). Obesity hypoventilation syndrome (OHS) is a severe disease state, and over 90% of patients diagnosed with it have OSA.<sup>2</sup>

Finally, OSA appears to have some roots in the Western practice of bottle-feeding and the use of pacifiers and sippy cups. Nonproductive suckling may result in craniofacial respiratory complex collapse (CFRC) and increased dental crowding in children, exacerbating childhood sleep disorders.<sup>3</sup>



**Fig 1-1** 2022 obesity map. (Reprinted with permission from the CDC Behavioral Risk Factor Surveillance System.)

This coalition of factors, including a smaller orofacial complex, increased BMI, an aging population, and decreased levels of exercise, has resulted in an explosion of OSA in the United States. Often, individuals with OSA are unaware that they have difficulty breathing during sleep, and it is most commonly recognized as a problem by family members or bed partners who observe the individual during obstructive episodes. Individuals who sleep alone may be unaware of the condition because no one is present to poke them in the ribs. OSA patients may seek medical care for symptoms of fatigue or daytime sleepiness, but not all patients exhibit excessive daytime sleepiness (EDS). Sadly, OSA may remain undetected for years or even decades because patients become conditioned to the daytime sleepiness and fatigue associated with significant levels of sleep disturbance.

Lack of adequate air leads to a cascade of devastating physical and emotional consequences. Restricted airway function affects our ability to sleep and can give rise to insomnia, an altered arousal threshold, asphyxia, hypoxemia, hypercapnia, and sleep fragmentation. Increased respiratory effort and airway collapse can lead to EDS and contribute to a host of comorbid diseases.



## The Rise Of Dental Sleep Medicine

This is an exciting time to be a dentist. The field of dental sleep medicine (DSM) is exploding. This is primarily because the majority of individuals with sleep disorders do not present to physicians for treatment of their sleep issues.<sup>4</sup> Instead, people typically seek medical care for comorbid diseases that are directly associated with SRBDs, in particular, hypertension, fatigue, stroke, cardiovascular disease, and diabetes mellitus. Unfortunately, most physicians do not screen for SRBDs, and the precipitating factors contributing to the patient's chief complaint frequently go undiagnosed.<sup>5</sup> However, many patients suffering from SRBDs also seek routine dental care, which provides knowledgeable dentists with a screening opportunity. Dentists who are properly trained to recognize the signs and symptoms of SRBDs can potentially provide life-saving referrals and oral appliance therapy (OAT) to sleep-deprived patients. Patients with SRBDs exhibit identifiable intraoral signs and symptoms, as well as physical and social symptoms.

DSM was founded on the principle that the mandible can be moved and supported to maintain an open airway during sleep. The tongue is attached anteriorly to the genial tubercles on the lingual aspect, and if the mandible is protruded with a mandibular advancement device (MAD), the tongue is advanced. This opens the airway and minimizes airway restriction. MADs work in the same manner as the head tilt, chin lift, jaw thrust maneuver used to open the airway in CPR. The simple act of holding the mandible in a stable or slightly protruded position during sleep may be adequate to prevent or mitigate the physiologic consequences of airway obstruction and resultant nocturnal hypoxemia. There is an ever-increasing number of MADs being cleared by the FDA to treat SRBDs, including snoring and OSA, and properly trained dentists are integral partners in the treatment of SRBDs.

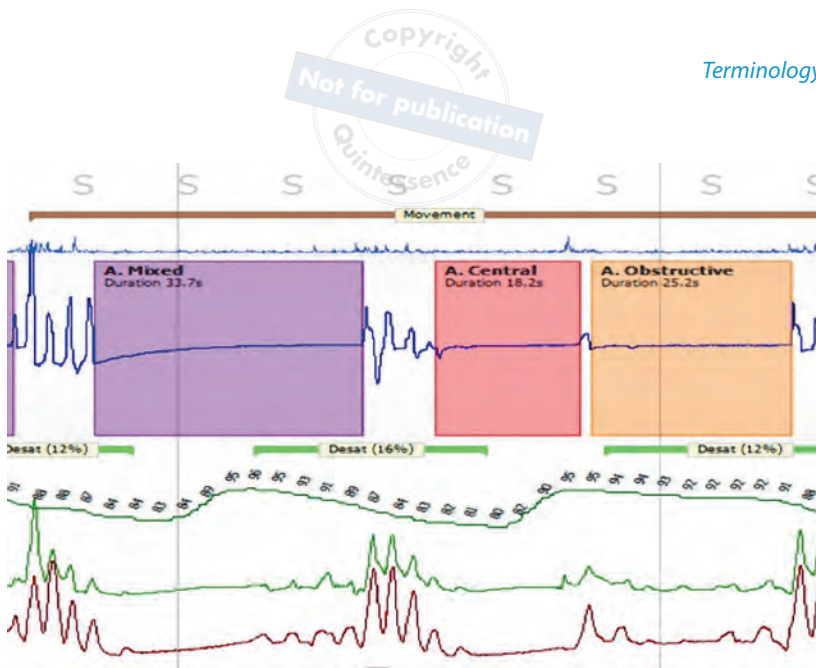
Although still in its infancy, DSM is the fastest-growing discipline in dentistry. Screening and treating patients with SRBDs can greatly improve their health and generate a significant source of income for your dental practice.

## Terminology

This section explains some useful terminology in the field of DSM.

### *Apnea*

Apnea literally means "without air." An apnea is identified during a sleep study when the patient's airflow peak signal drops by  $\geq 90\%$  compared to the pre-event baseline for at least 10 seconds as measured using an oronasal



**Fig 1-2** Screenshot of a home sleep apnea test (HSAT) indicating the different types of apneas. While the patient is in the supine position (S), the first event is scored as a mixed event because the respiratory effort belt signals are flat (no effort) for more than half of the event. Recovery breaths follow the mixed apnea, where the patient is gasping for breath. Then the next two events are scored as a central for 18.2 seconds, a small breath, then an obstructive event where the patient is trying to breathe but no air is entering the lungs. Notice that a desaturation follows each of the events.

thermal signal, positive airway pressure (PAP) device flow, or an alternative apnea sensor. There is no requirement for desaturation or arousal. Apneas can be classified as obstructive, central, or mixed, depending on the patient's respiratory effort during the event. If the patient is trying to breathe and cannot, the event is classified as obstructive. If the patient is not trying to breathe, the event is designated as central apnea. A mixed apnea is a combination of obstructive and central apnea, where the event is more central than obstructive (Fig 1-2).

### **Arousal**

An arousal is a sudden change from a deeper level of sleep to a lighter level of sleep. Patients usually do not awaken and are unaware of the arousal, but daytime sleepiness and fatigue are common symptoms of frequent arousals.

Arousals are classified as respiratory arousals and environmental arousals. Respiratory arousals are caused by any respiratory event and are directly related to the patient's effort to breathe. As oxygen levels decrease and carbon dioxide levels rise during an apnea or hypopnea event, chemosensors in the brain arouse motor pathways to restore airway function and normal

respiration. Treatment of respiratory arousals can improve daytime symptoms. Environmental arousals occur as a result of non-respiratory stimuli. Many things can cause a patient to arouse during sleep. Anything from noise from a TV left on at night to the temperature in the bedroom or air quality and light control can be associated with a disruptive sleep environment.

### ***Home sleep apnea tests***

Frequently, home sleep apnea tests (HSATs) are used to diagnose OSA. However, HSATs typically cannot fully measure the quality and quantity of sleep. HSATs measure different bodily metrics, such as respiratory activity and breathing patterns. Common metrics measured during an HSAT include the following:

- Respiratory activity, breathing patterns, and chest motion
- Heart rate and blood oxygen level
- Actigraphy, or nocturnal movement and motor activity
- Sleep position and position changes
- Snoring events and intensity

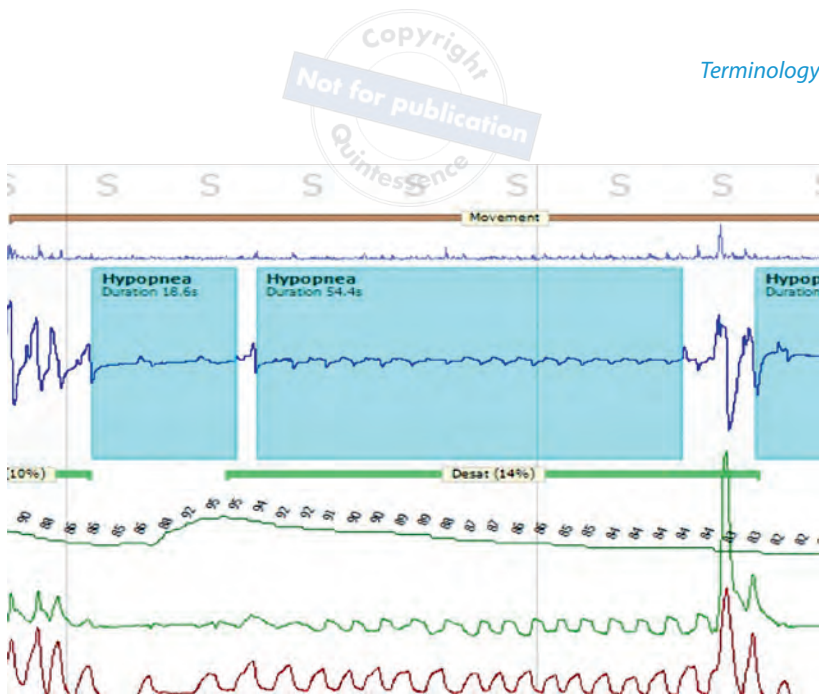
### ***Hypopnea***

Hypopnea is a drop in peak signal excursion of at least 30% compared to the pre-event baseline for at least 10 seconds measured using nasal pressure (recommended sensor), PAP device flow, or an alternative hypopnea sensor. Additionally, to qualify as a hypopnea, the event must involve at least 3% oxygen desaturation from the pre-event baseline OR the event must be associated with a cortical electroencephalogram (EEG) arousal<sup>6</sup> (Fig 1-3).

Alternatively, Centers for Medicaid and Medicare Services (CMS) defines a hypopnea as a drop in peak signal excursion by at least 30% compared to the pre-event baseline for at least 10 seconds measured using nasal pressure (recommended sensor), PAP device flow, or an alternative hypopnea sensor AND oxygen desaturation of at least 4% from the pre-event baseline. Scoring hypopnea using a 4% desaturation is a Medicare requirement. When treating a Medicare patient, make sure that the appropriate scoring parameters were used by the sleep lab or the patient will not qualify for benefits under Medicare.

### ***Polysomnography***

A polysomnogram (PSG), also called an in-lab sleep study, is a continuous recording of specific physiologic markers and variables over a full night of



**Fig 1-3** Screenshot of HSAT indicating hypopneas. Notice that the patient's airflow is not a flat line. Air is entering the lungs, but the volume is reduced to the point that the patient's blood  $\text{SaO}_2$  is not maintained. The decreased airflow results in a 14% desaturation. At all times during the event, the patient is attempting to breathe but is unable to adequately maintain oxygen levels.

sleep that helps to identify and diagnose various sleep disorders (Fig 1-4). Typically, a PSG records the following parameters:

- Brainwaves (via EEG)
- Blood oxygen levels
- Eye movements (via electrooculogram [EOG])
- Muscle tone (via electromyogram [EMG])
- Respiratory activity, breathing patterns, and chest motion (via nasal flow sensor and effort belts around the chest)
- Heart rate (via electrocardiogram [ECG])
- Leg movements (via EMG)
- Snoring
- Sleep position

### **Respiratory disturbance index**

The respiratory disturbance index (RDI) is calculated as the number of respiratory events (apneas, hypopneas, and respiratory effort–related arousals [RERAs]) divided by the number of hours of sleep documented during a PSG study.



**Fig 1-4** Patient during a PSG.

### ***Respiratory effort–related arousal***

Respiratory effort–related arousal (RERA) is not always scored during a sleep test. It is defined as a sequence of breaths lasting at least 10 seconds and characterized by increasing respiratory effort or by flattening of the inspiratory portion of the flow signal, leading to an arousal from sleep. The sequence of breaths does not include apneas or hypopneas. Because the definition of a hypopnea has never been consistent and is more frequently revised than other sleep breathing parameters, RERA is not typically used to describe SRBDs but may be useful for informing clinicians about sleep fragmentation.

### ***Snoring***

Snoring is traditionally defined as breathing during sleep with a rough, hoarse noise due to vibration of the soft palate and tongue. It is helpful to separate patients who simply make a snoring noise from patients whose snoring results in a RERA. For the purposes of this text, the authors refer to snoring as any respiratory-related noise made during sleep that does not result in an arousal. Respiratory noises and events that result in an arousal, but do not qualify as an apnea or hypopnea, are referred to as a RERA. It should be noted that loud snoring is the most common symptom of a patient with OSA.

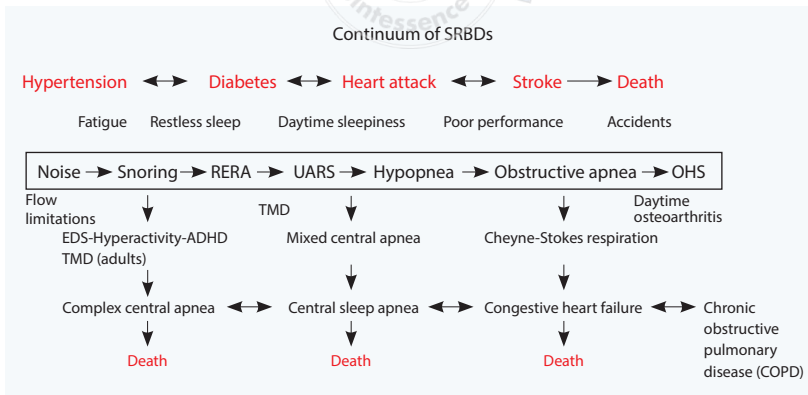
## Overview of Sleep-Related Breathing Disorders

SRBD, also known as *sleep-disordered breathing* (SDB), is a collection of conditions or disorders where patients suffer from the consequences of restricted breathing and/or reduced oxygenation during sleep. Although OSA is generally referred to as SRBD, SRBD is a much broader term that includes a spectrum of breathing anomalies, ranging from chronic or habitual snoring (resulting in airflow limitations) to upper airway resistance syndrome (UARS), OSA, central and complex apnea, and in some cases, Cheyne-Stokes respiration and obesity hypoventilation syndrome. Although OHS is not a true sleep disorder, patients with very severe OSA who are morbidly obese frequently suffer from daytime hypoventilation, which can be mitigated with the use of a single-arch temporomandibular joint (TMJ) splint that encourages the patient to function with their mandible protruded during the daytime. The amount of protrusion built into the daytime splint varies with the severity of the patient's condition. Patients with severe OHS use continuous positive airway pressure (CPAP) and a MAD during sleep.

SRBD symptoms routinely become more severe and complex with age, and the consequences of the resultant sleep fragmentation and oxygen desaturation can be deadly. SRBDs make maintaining oxygenation during sleep difficult as a result of repeated upper airway restriction and resistance during sleep that causes recurrent nocturnal asphyxia, fragmented sleep, fatigue, daytime sleepiness, major fluctuations in blood pressure, and increased sympathetic nervous system activity.<sup>7</sup> An aging population and skyrocketing obesity further contribute to SRBDs. As we age, the airway often becomes smaller, due to increased fat deposits, and more collapsible, secondary to hormonal changes. A patient who has been diagnosed with OSA is at increased risk for hypertension, stroke, diabetes mellitus, and heart attack, as well as early mortality. The physiologic changes associated with SRBDs can be devastating to a patient's ability to stay oxygenated during sleep. This is particularly impactful when a patient has a compromised immune system.

The various airway conditions associated with SRBDs include, but are not limited to, respiratory noise, snoring, flow limitations, RERAs, UARS, hypopneas, OSA, OSA syndrome (OSAS), mixed sleep apnea, and central sleep apnea. The risk factors and underlying pathophysiologic mechanisms of these disorders have both overlapping and unique features.

Figure 1-5 shows the continuum of sleep disorders, progressing from a baby making a "cute noise" when sleeping all the way to apneas, where the airway is totally obstructed. Each level represents a higher degree of collapse with increasingly serious consequences. Although SRBDs cannot be accurately represented as a true progression (snoring does not inevitably result in OSA), it is important to see that every diagnosis lies within a larger scope of poor airway function.



**Fig 1-5** Continuum of sleep disorders and related conditions.

Once a patient starts experiencing hypopneas and apneas, medical insurance may provide benefits. The last stage of SRBDs is when patients have difficulty maintaining an open airway during the daytime. OHS is common in morbidly obese patients with BMIs greater than 45. Therapies for OHS may include a TMJ mandibular advancement (Gelb) splint, portable oxygen, and weight loss therapy. A daytime advancement splint is simply one of the many tools which can help these patients stay adequately oxygenated during the day. The ultimate goal is weight loss, which will likely include bariatric surgery. OHS involves autonomic nervous system dysfunction and is not well managed in the dental office. Patients with OHS are commonly treated with multiple therapies by collaborating health care providers.


### **Obstructive sleep apnea**

Common symptoms of OSA include the following<sup>8</sup>:

- Unexplained daytime sleepiness
- Loud snoring with periods of silence followed by gasps as breathing resumes
- Attention deficit and/or hyperactivity in children
- Trouble concentrating; mood changes such as irritability, anxiety, treatment-resistant depression, and forgetfulness
- Temporomandibular disorder symptoms, sleep bruxism
- Decreased sex drive, sexual dysfunction, and heavy night sweats
- Restless leg syndrome/periodic limb movements
- Restless or fragmented sleep and lack of dreams

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# Index

Page numbers followed by “f” denote figures, those followed by “t” denote tables, and those followed by “b” denote boxes.

## A

- AASM. *See* American Academy of Sleep Medicine.
- ABDSM. *See* American Board of Dental Sleep Medicine.
- ABN. *See* Advanced beneficiary notice.
- Acetylcholine, 39–40, 254
- Acoustic rhinometry, 327
- ACPT. *See* Airway-centric physical therapist.
- Adenoidectomy, 270
- Adenosine, 40
- Adenotonsillectomy, 235
- ADHD. *See* Attention deficit hyperactivity disorder.
- Adhesive strips, 138
- Adolescents. *See also* Children; Teenagers.  
dysfunctional breathing assessment in, 265–273  
sleep requirements for, 31t
- Advanced beneficiary notice, 226–227
- Advertising, 78–79
- Affordable Care Act, 206
- AHI. *See* Apnea-hypopnea index.
- Air hunger, 259, 280
- Airway. *See also* Upper airway.  
aging effects on, 9  
anatomy of, 41  
collapse of, 2, 141  
compromised, 234  
health of, 88  
Mallampati scoring of, 84, 84f, 94  
nasal, 41, 136–139  
obesity effects on, 2, 11  
patent, 143  
pediatric, 231–236  
screening of, for airway-centric physical therapist referral, 315  
underdevelopment of, 233–236
- Airway insufficiency, 232–233
- Airway Metrics system, 109f, 109–110
- Airway resistance, 286
- Airway therapy, in obstructive sleep apnea, 40
- Airway-centric physical therapist  
definition of, 286  
evaluation by  
behavioral assessment, 297  
breathing assessment, 299–300  
breathing assessment in, 296  
cranial cervical mandibular complex. *See*  
Cranial cervical mandibular complex  
evaluation.  
cranial nerve screening, 301  
overview of, 296–297  
postural assessment, 298–299, 299f  
respiratory function assessment, 299–300  
sleep hygiene, 307–309, 308f–309f  
home exercises used by, 310  
intervention by, 310  
locating of, 311  
manual therapy by, 310  
role of, 285  
therapeutic exercises used by, 310
- Airway-centric physical therapist referral  
qualifying questions for, 287, 288b  
screening for  
airway, 315  
cervical range of motion, 292, 315  
craniofacial airway referral form, 314  
facial muscles, 292, 294–296, 295f  
form used in, 312–313  
frontal plane assessment, 288f, 289  
intraoral inspection, 290–291  
soft tissue inspection, 290–291  
static postural assessment, 288–290, 288f–290f  
temporomandibular joint charting, 292–294,  
293f–294f  
tongue position and mobility, 291–292  
trigger points in facial muscles, 294–296, 295f  
symptoms that indicate, 296b
- Alcohol consumption, 2
- Allergic rhinitis, 41
- Allergies, 194
- Allodynia, 156
- Allostatic challenges, 145–146, 155
- Alpha waves, 35, 38
- AM Aligner, 129f, 129–130, 151, 155
- AMA. *See* American Medical Association.
- American Academy of Dental Sleep Medicine

- credentials for diagnostic services from, 49  
 DSM Standards for Screening, Treating, and Managing Adults with Sleep-Related Breathing Disorders, 190, 197  
 home sleep apnea test prescribing policy statement of, 17, 56, 133  
 oral appliance therapy protocol, 52  
 oxygen desaturation index guidelines, 16  
 policy statements of, 17  
 practice parameters of, 50–51, 51b  
 qualified dentist according to, 52, 200  
 scope of practice issues, 187  
 sleep medicine governance by, 58  
 treatment protocol of, 54–57
- American Academy of Sleep Medicine  
 policy statements of, 190  
 practice parameters of, 50–51, 51b
- American Board of Dental Sleep Medicine, 164
- American Dental Association  
 Current Dental Terminology codes from, 200–201  
 home sleep apnea testing policy statement, 133, 190  
 scope of practice issues, 187  
 sleep-related breathing disorder policy statement  
 American Academy of Dental Sleep Medicine treatment protocol versus, 54–57  
 authors' support for, 56  
 dental codes, 17  
 description of, 12–13, 50, 53–54, 187, 189, 233  
 screening, 191
- American Medical Association  
 Current Procedural Terminology codes, 210, 210t, 211–212  
 policy statements of, 187, 189, 191
- American Rhinologic Society, 254
- Amygdala, 275
- Amyloid beta, 256
- Anatomy, 146
- Angle classification, 97
- Ankyloglossia, 83, 241–242
- ANS. *See* Autonomic nervous system.
- Anterior teeth movement, mandibular advancement device-related, 157
- Antidepressants, 92
- Anti-Kickback Statute, 195–196, 206
- Anxiety, 250, 253f
- Apnea  
 central sleep, 5f, 43, 98  
 complex sleep, 43, 101  
 definition of, 4–5, 13, 42  
 diagnostic criteria for, 4–5  
 home sleep apnea test findings, 5f  
 mixed, 5, 5f  
 obstructive sleep. *See* Obstructive sleep apnea.
- Apnea events, 16
- Apnea Guard, 103, 103f
- Apnea-hypopnea index  
 calculation of, 15  
 continuous positive airway pressure effects on, 60  
 elements of, 98  
 myofunctional therapy effects on, 245  
 night-to-night variability of, 15  
 oral appliance therapy and, 60, 163, 169, 170t  
 post-treatment changes in, 193
- Appliances. *See* Oral appliance therapy, appliances; Temporary appliances.
- Aqualizer splint, 148, 149f
- Arousal(s)  
 definition of, 5  
 environmental, 5–6  
 respiratory, 5–6, 13  
 respiratory effort-related, 8, 13
- Arousal burden, 16
- Arrhythmias, 19
- Artificial intelligence, 168
- Assessment  
 behavioral, 297  
 description of, 86  
 dysfunctional breathing. *See* Dysfunctional breathing, assessment of.  
 frontal plane, 288f, 289  
 posture, 298–299, 299f  
 respiratory function, 299–300  
 temporomandibular joint range of motion, 292–294, 293f
- Asthma, 271–272, 279
- Astrocytes, 256
- Atlanto-occipital joint, 302
- At-risk patients, 78
- Attention deficit hyperactivity disorder, 22, 328
- Autonomic nervous system, 30, 253–254, 258
- Avant appliances, 115, 115f
- B**
- BEARS, 234
- Behavioral assessment, 297
- Berlin Sleep Questionnaire, 50
- Beta waves, 35
- Billing services, 205
- BIPAP titration software, 172
- Bite registration  
 Airway Metrics system, 109f, 109–110  
 George Gauge bite fork for, 105–107, 106b  
 pharyngometry for, 105  
 Pro Gauge for, 107f, 107–108
- Bite repositioner, 154, 155f
- Blood pressure, 72
- Blood vessel dilation in lungs, 276
- Blue Cross Blue Shield, 62, 201
- BOLT Score, 300
- Brainwaves, 32



- Breastfeeding, 242
- Breath hold exercises, 268, 300
- Breathe Light exercise, 251–252, 258–259, 265
- Breathe Slow exercise, 260
- Breathing
- anxiety effects on, 250
  - assessments of
    - by airway-centric physical therapist, 296, 299–300
    - Control Pause for, 257–258
  - chest, 252
  - Control Pause for assessing, 255, 257–258
  - diaphragmatic, 254
  - dysfunctional. *See* Dysfunctional breathing.
  - emotions and, 253
  - functional. *See* Functional breathing.
  - low, 252
  - mouth, 235, 255, 257, 263, 266
  - nasal. *See* Nasal breathing.
  - nose's effects on, 276–278
  - open-mouth, 257, 272
  - over-breathing, 250–251, 255
  - reduced volume, 251
  - sleep affected by, 253
  - sleep-disordered. *See* Sleep-disordered breathing.
  - slow, 253–254
  - Steps exercise for assessment of, in children, 267–268, 272–273
  - tonsillectomy effects on, 270
- Breathing exercises
- Breathe Light, 251–252, 259–260, 265
  - Breathe Slow, 260
  - in children, 267, 273
  - description of, 252, 257
  - for insomnia, 261
  - Nose, Slow, and Low, 260–261
  - for obstructive sleep apnea, 262–263
  - for snoring, 261–262
- Breathing muscles, 252, 276
- Breathing patterns, 257–258
- Bronchoconstriction, exercise-induced, 279
- Bruxism, sleep
- definition of, 40
  - mandibular advancement device for, 44
- Buteyko Breathing Clinics, 264
- C**
- Caffeine, 40
- Capnometry, 300
- Capsulitis, 148–149
- Carbon dioxide, 250–251, 268, 280
- Carbon dioxide tolerance, 300
- Cardiac arrhythmias, 19
- Carotid bodies, 18
- Casts, for mandibular advancement device
- fabrication, 110
  - CBCT, 73, 85–86, 141, 150
- CBT-I. *See* Cognitive behavioral therapy for insomnia.
- CCMC evaluation. *See* Cranial cervical mandibular complex evaluation.
- Ceka Bond, 194
- Centers for Disease Control and Prevention, 2
- Centers for Medicare and Medicaid Services. *See also* Medicare.
- CMS-460 form, 222
  - CMS 1500 form, 216–217, 217f, 218t–219t
  - CMS-8551 form, 222
  - description of, 207
  - hypopnea definition by, 6
- Central obesity, 11
- Central sleep apnea, 5, 43, 98
- Cervical range of motion, 292, 315
- Chart notes, 62, 126
- Check-in, at medical encounter, 80
- Chemoreceptors, 18
- Chemosensors, 5
- Chest breathing, 252
- Chief complaint, 82–83
- Children. *See also* Teenagers.
- airway problems in, 231–236
  - asthma in, 271–272
  - breathing exercises in, 267, 273
  - breathing habits in, 273
  - dental crowding in, 2
  - dysfunctional breathing assessment in, 265–273
  - fatigue in, 22
  - mouth breathing in, 255
  - mouth taping in, 272–273
  - nasal breathing in, 266
  - nonproductive suckling in, 2
  - sleep-disordered breathing in, 269–272
  - sleep-related breathing disorders in, 22
  - Steps exercise for breathing assessments in, 267–268, 272–273
  - upper airway resistance in, 329
- Chin position from midline, 288
- Circadian rhythms, 32
- Claustrophobia, 83
- CMS. *See* Centers for Medicare and Medicaid Services.
- CO<sub>2</sub>. *See* Carbon dioxide.
- Codes/coding, medical insurance
- CPT, 210, 210t, 211–212
  - description of, 205
  - doctor time, 213b
  - documentation to support, 215
  - E/M, 212–215, 213b
  - HCPCS, 62, 210–211
  - ICD-10, 209–210
  - 99211, 214–215
- Cognitive behavioral therapy for insomnia, 43

- Cognitive function, nose and, 274  
 COMISA. *See* Comorbid insomnia and sleep apnea.  
 Commercial insurance companies, 206  
 Comorbid disease  
   medical history of, 97  
   with obstructive sleep apnea, 62  
 Comorbid insomnia and sleep apnea, 43  
 Complex sleep apnea, 43, 101  
 Complications, 110  
   capsulitis, 148–149  
   dental-related, 156–158  
   excessive salivation, 152  
   inflammatory responses, 147–149  
   informed consent discussions about, 193  
   pressure spots, 152  
   temporomandibular disorders, 150–152  
 Condyles  
   posterior posturing of, 150, 151f  
   repositioning of, using Lucia jig, 153, 154f  
 Cone beam computed tomography, 126  
 Congestive heart failure, 19  
 Consent, informed. *See* Informed consent.  
 Consumer sleep technology, 168  
 Continuous positive airway pressure. *See also* Positive airway pressure.  
   benefits of, 55  
   claustrophobia as reason for not using, 83  
   compliance with, 24, 78  
   effectiveness of, 164t  
   insurance company requirement for, 98  
   mandibular advancement device and, 25f, 55, 58–59, 98  
   mechanism of action, 24, 58  
   Medicare compliance statistics for, 24  
   noncompliance with, 59  
   obstructive sleep apnea treated with, 24–25, 151  
   oral appliance therapy and, 59, 164, 164t, 188, 223  
   sleep-related breathing disorders treated with, 24–25, 25f  
   success in use of, 59  
   trial of, 203  
 Control Pause, 255, 257–258, 263, 300  
 Convergence, 288f, 288–289, 306  
 Copays, 80  
 COVID-19, 12, 55, 74  
 CPAP. *See* Continuous positive airway pressure.  
 CPT codes. *See* Current Procedural Terminology codes.  
 Cranial cervical mandibular complex evaluation  
   in frontal plane, 306–307  
   head position on, 302, 303f–305f  
   neurology of, 302–303  
   overview of, 301–302  
   in sagittal plane, 303, 306  
 Cranial nerve screening, 301  
 Craniofacial airway referral form, 314  
 Craniofacial dystrophy, 12  
 Craniofacial respiratory complex  
   collapse of, 2  
   definition of, 231, 234  
   health of, 245  
 Craniovertebral angle, 289, 289f, 306  
 Critical closing pressure, 42  
 Cross-training, 77  
 CST. *See* Consumer sleep technology.  
 Current Dental Terminology codes, 200–201  
 Current Procedural Terminology codes, 210t, 210–212, 214  
 CVA. *See* Craniovertebral angle.
- D**  
 DAFNE software, 324–325, 325f  
 Decision-making, medical, 86  
 Deep sleep, 30, 34, 278  
 Delta waves, 35  
 Dementia, 92  
 Dental health, 63–64  
 Dental sleep medicine  
   dentist training in, 17, 58  
   limited examination protocol used in, 69–70  
   obstacles for, 58–64  
   principles of, 4  
   resources on, 45  
   terminology associated with, 4–8  
 Dental sleep medicine practice  
   advertising outside of, 78–79  
   development of, 47–50  
   documentation, 68–70  
   equipment, 72–74  
   fax machine used in, 72  
   goal setting for, 184  
   imaging used in, 73  
   keys to  
     knowing your patient, 181–182  
     knowing yourself, 180  
     knowing your work, 181–183  
     overview of, 179, 179f  
   limited examination protocol, 69–70  
   marketing outside of, 78–79  
   medical-dental collaboration, 74–76  
   office systems, 182  
   recall systems, 183  
   referrals to, 47  
   scanners used in, 72  
   software, 70–71, 208  
   staffing of, 182  
   team training, 76–78  
   vital signs-related equipment, 72–73  
 Dental team training, 76–78  
 Dentist

- in dental sleep medicine, 17, 58
  - final sleep study facilitated by, 174
  - introductory letters by, 49
  - letter of medical necessity given to, 58
  - obstructive sleep apnea monitoring by, 174–176, 175f
  - oral appliance titration by, 165–168
  - qualified, 52, 200
  - referral development by, 48
  - self-knowledge, 180
  - sleep physician and, 17, 48, 55–57
  - sleep-related breathing disorder and, 12–13, 17, 53–54
  - Dentrix, 208
  - Detailed work order, 202–203, 220–221
  - Diabetes mellitus
    - breathing-holding exercises in children with, 268
    - chronic stress and, 254
    - obstructive sleep apnea and, 2, 9, 12
  - Diaphragm, 269, 276
  - Diaphragmatic breathing, 254
  - Diastolic blood pressure, 18
  - Diphenhydramine, 40
  - DME. *See* Durable medical equipment.
  - Documentation
    - for examination codes, 215
    - medical insurance requests for, 202–205
    - SOAP notes, 68, 68b
    - treatment-related, 62–63
    - written consent for, 194
  - Dorsal fin appliance, 117f, 117–118, 194
  - Down syndrome, 121, 231
  - Dreaming, during REM sleep, 31
  - dreamTAP appliance, 115–117
  - Drowsiness
    - EEG waves in, 37f
  - “Drug spindles,” 36
  - Drug-resistant hypertension, 18
  - DS3, 208
  - DSM. *See* Dental sleep medicine.
  - Durable medical equipment
    - dentist as providers of, 221
    - mandibular advancement device classification as, 58, 220
    - oral appliance therapy classification as, 58, 204, 220
    - Reasonable Useful Lifetime for, 223, 226
    - replacement coverage for, 223
    - Stark Law prohibitions on self-referrals, 195
  - DynaFlex Herbst appliance, 160f
  - Dysfunctional breathing
    - assessment of
      - in adults, 257–265
      - in children, 265–273
      - in teenagers, 265–273
    - Control Pause for assessing, 255, 257–258
    - description of, 249
    - exercises for
      - Breathe Light, 251–252, 258–259, 265
      - Breathe Slow, 260
    - description of, 258
      - Nose, Slow, and Low, 260–261
      - Nose Unblocking, 259, 264
    - physiologic effects of, 255
    - stress and, 253, 253f
- E**
- E0486, 204–205, 209, 222
  - Eaglesoft, 208
  - EDS. *See* Excessive daytime sleepiness.
  - Elastic mandibular advancement appliance. *See* EMA appliance.
  - Electroencephalogram
    - brainwaves, 32
    - history of, 32
    - hypopnea findings on, 6, 7f
    - wave frequencies of, 35f–36f, 35–36
  - Electronic health record, 71
  - Electrooculogram, 33–34
  - Elevate appliances, 119, 119f
  - E&M. *See* Evaluation and Management.
  - E/M codes, 212–215, 213b
  - EMA appliance, 114f, 114–115
  - Emotions, breathing and, 253
  - Environmental arousals, 5–6
  - EOG. *See* Electrooculogram.
  - Epiglottis, 41–42
  - Epochs, 36
  - Epworth Sleepiness Scale, 23, 50–51, 81, 167, 195, 319
  - Eustachian tube dysfunction, 243
  - Evaluation and Management
    - codes. *See* E/M codes.
    - medical visits as, 68
  - Evidence-based treatment, 232
  - Examination
    - chief complaint, 82–83
    - nasal, 85
    - physical, 83–85, 93–97
  - Excessive daytime sleepiness, 3, 20, 23, 195
  - Exercise-induced bronchoconstriction, 279
  - Explanation of benefits, 87b
- F**
- Face-to-face examination, 190–191
  - Facial development, 280
  - Facial muscles
    - assessment of, 292
    - trigger points, 294–296, 295f
  - False Claims Act, 195
  - Family history, 81
  - Fatigue, 22
  - Fight-or-flight response/reaction, 18, 253–254

- Financial considerations, 87b  
 Flexion rotation test, 289  
 flexTAP appliances, 117, 117f  
 4% rule, 203  
 Frenulum, 233, 290  
 Frontal plane assessment, 288f, 289  
 Functional breathing  
   biochemical dimension/perspective of, 250–252  
   biomechanical dimension/perspective of, 250, 252–253  
   dimensions of, 250f  
   nasal breathing as, 254–256  
   overview of, 249  
   psychophysiologic dimension/perspective of, 250
- G**
- GABA. *See* Gamma-aminobutyric acid.  
 Gag reflex, 128  
 Galanin, 39  
 Gamma-aminobutyric acid, 40  
 George Gauge bite fork, 105–107, 106b  
 Ghrelin, 19  
 Glycine, 39  
 Glymphatic system, 256  
 Growth hormones, 22, 34, 39
- H**
- Health insurance. *See* Medical insurance.  
 Height measurements, 72  
 Herbst appliance, 112f, 112–113, 159f, 169, 194  
 High-resolution pulse oximetry, 93, 133, 191  
 Hippocampus, 275  
 History of present illness, 81–82  
 Home sleep apnea tests/testing  
   American Academy of Dental Sleep Medicine  
     policy statement on, 17, 133  
   American Dental Association policy statement  
     on, 54–55, 133  
   apnea findings on, 5f  
   authors' position on, 56  
   board of dental examiners' position on, 56  
   board-certified sleep medicine specialist's review  
     of, 203  
   definition of, 6  
   dentist-facilitated, 17, 56, 169, 170f  
   mandibular advancement device titration uses  
     of, 190  
   medical billing issues for, 57  
   metrics measured on, 6  
   obstructive sleep apnea on, 55–56  
   polysomnography versus, 14  
   screening uses of, 188, 191  
   state regulations on, 56  
 Homeostasis, 142, 145, 182  
 HPI. *See* History of present illness.  
 HRPO. *See* High-resolution pulse oximetry.  
 HSATs. *See* Home sleep apnea tests/testing.
- Humidification of air, 277  
 Hypertension, 18–19  
 Hypertrophic lymphoid tissues, 241  
 Hyperventilation, 257  
 Hypnic jerks, 33  
 Hypnogram, 38, 39f, 42f  
 Hypoglossal nerve stimulation device, 143  
 Hypopnea. *See also* Apnea-hypopnea index.  
   definition of, 6, 13, 42  
   electroencephalogram findings, 6, 7f  
   treatment of, 14  
 Hypoxia, 18  
 Hypoxic burden, 16
- I**
- ICD-10, 209–210  
 Imaging, 73, 85–86  
 Impressions, for mandibular advancement device  
   fabrication, 104, 104f  
 Infants, 31t. *See also* Children.  
 Inflammatory responses, 147–149  
 Information overload, 87  
 Informed consent  
   description of, 96, 98, 139  
   elements of  
     alternatives, 193  
     complications, 193  
     overview of, 192  
     procedure description, 192–193  
     questions, 193  
     risks, 193  
   malpractice risk reductions with, 197  
   need for, 192  
   for temporary appliances, 152  
   written consent, 194  
 Inhaled pathogens, 277  
 In-network, 202, 209, 227  
 Insomnia  
   breathing exercises for, 261  
   cognitive behavioral therapy for, 43  
   description of, 3, 23  
   sleep apnea and, 43  
   stress caused by, 260  
 Insurance. *See* Medical insurance; Medicare.  
 Intake, at medical encounter, 80–82  
 Interleukin 1 $\beta$ , 39–40  
 International Classification of Diseases, 10th version.  
   *See* ICD-10.  
 International Classification of Sleep Disorders, 40  
 Intra-abdominal pressure, 252  
 Intraoral inspection, 290–291  
 Introductory letters, 49
- J**
- Jaw positioning  
   after mandibular advancement device use, 153  
   allodynia caused by, 156

Jaw repositioning, 110

## K

K-complex, 36, 36f, 38

## L

Laboratory

- mandibular advancement device fabrication, 158–160
- product liability issues, 194

Laboratory technologist, titration by, 171–172

Latex allergies, 194

Leaf gauge, 154, 154f

Legal issues

- Anti-Kickback Statute, 195–196, 206
- face-to-face clinical examination, 190–191
- informed consent. *See* Informed consent.
- litigation, 196–197
- overview of, 187
- policy statements, 189–190
- product liability, 194
- pulse oximetry, 191
- screenings, 191
- standard of care, 197
- Stark Law, 195–196, 206
- third-party liability, 195

Leptin, 19

Letter of medical necessity, 56, 58, 63

Liability

- Anti-Kickback Statute, 195–196, 206
- product, 194
- Stark Law, 195–196, 206
- third-party, 195

Life expectancy, sleep duration and, 32

Limited examination protocol, 69–70

Lingual frenectomy, 242

Lingual tonsils, 85

Lip incompetence, 240

Lip taping, 138, 272

Litigation, 196–197

Local coverage determinant, 190, 199

Lucia jig, 153, 154f

Lungs

- blood redistribution in, 276
- blood vessel dilation in, 276
- elasticity of, 277

Lysozyme, 277

## M

MAD. *See* Mandibular advancement device.

Mallampati score, 84, 84f, 94

Malocclusion, 286–287

Malpractice, 196–197

Mandible. *See also* Jaw positioning.

- condyles of. *See* Condyles.
- gravity effects on, 42

Mandibular advancement device. *See also* Oral appliance therapy.

- acknowledgment of, 131
- adaptation to, 145
- adjustment of, 132
- apps used with, 132
- bite repositioner with, 154, 155f
- cleaning of, 130
- “comfort zones” affected by, 145
- compliance with, 59, 131
- composition of, 125
- continuous positive airway pressure and, 25f, 55, 58–59, 98
- delivery of
  - AM Aligner, 129f, 129–130, 151, 155
  - follow-up after, 131–133
  - intake and try-in, 126–128
  - lip closure evaluations, 127
  - patient considerations, 131
- dental problems caused by, 156–158
- durable medical equipment classification of, 58
- fabrication of
  - bite registration, 105–110. *See also* Bite registration.
  - casts used in, 110
  - dentist’s role in, 40
  - impressions, 104, 104f
  - laboratory considerations for, 158–160
  - photographs used in, 110
  - scanning, 104
- FDA-approved, 99, 99b
- financial considerations for, 87b
- HCPCS code for, 211
- home sleep apnea testing during titration of, 56
- homeowner’s insurance policy coverage for, 100b
- imaging for, 73
- improvement after using, 169
- ineffectiveness of, responses to
  - accept results as maximum medical improvement, 134
  - adjust the jaw position further forward, 135–136
  - overview of, 134
  - positive airway pressure, 134
- inflammatory response to, 147–149
- informed consent for, 192–193
- inspection of, 126
- jaw repositioning after first use of, 153
- laboratory considerations for, 158–160
- lifespan of, 158
- materials used to fabricate, 158, 194
- mechanism of action, 43
- mouth taping with, 263
- obstructive sleep apnea treated with, 61
- patient education about, 128, 192–193





- positional therapy and, 136
- positive airway pressure and, 139–140, 140f, 224–225
- posterior open bite caused by, 157f
- prescription for, 63
- principles of, 4
- quality inspection of, 126
- range of motion exercises, 146–147, 147f
- removal of, 128, 130
- selection of, 99
- sleep bruxism treated with, 44
- temporary, 152
- titration of, 56, 190
  - dentist-facilitated, 165–168, 172–173
  - in-lab, 171–173
  - by laboratory technologist, 171–172
  - by patient, 173
  - pulse oximetry for, 169, 170b, 170f
- tongue advancement by, 4
- tooth movement caused by, 157
- Mandibular anterior teeth movement, mandibular advancement device-related, 157
- Mandibular shift, 288, 288f
- Mandibular teeth, 290f, 290–291
- Maxilla, collapsed, 241
- Maxillary anterior teeth movement, mandibular advancement device-related, 157
- Maxillary expansion, 235
- Maxillary teeth, 290f, 290–291
- Maximum intercuspal position, 108, 129, 130, 148, 153, 155
- Maximum medical improvement, 165, 165b, 169
- McGregor's plane, 306
- Mean disease alleviation, 59–60, 60f, 164
- Medicaid, 207
- Medical decision-making, 86, 183
- Medical encounter
  - assessment, 86
  - check-in, 80
  - checkout, 87
  - examination in. *See* Examination.
  - imaging, 85–86
  - information gathering at, 81–82
  - intake, 80–82
  - parts of, 79
  - recording of, 79–87
  - sign-off, 87
- Medical encounter notes, 69
- Medical history, 92, 97–98
- Medical insurance. *See also* Medicare.
  - Affordable Care Act, 206
  - claim review by
    - documentation requests, 202–205
    - in-network issues, 202
    - overview of, 201–202
  - preauthorization, 202–203
  - codes/coding
    - CDT, 200–201
    - CPT, 210, 210t, 211–212
    - documentation to support, 215
    - E/M, 212–215, 213b
    - HCPCS, 62, 210–211
    - ICD-10, 209–210
    - for oral appliance therapy, 17
  - commercial companies, 206
  - continuous positive airway pressure trial request by, 203
  - copays, 80
  - documentation requests by, 202–205
  - event count criteria, 16
  - filing of
    - CMS 1500 form, 216–217, 217f, 218t–219t
    - codes for, 216b
    - description of, 61–62, 205
    - documents needed for, 215–216
    - requirements for, 215–217
    - software for, 208
  - gap exception, 209
  - in-network, 209, 227
  - mandibular advancement device restrictions, 111
  - national provider identifier, 207
  - out-of-network, 209
  - preappointment confirmation of, 61
- Medical insurance card, 80
- Medical records, electronic, 76
- Medical tape, 138
- Medical-dental collaboration, 74–76
- Medical-oriented computer programs, 71
- Medicare. *See also* Medical insurance.
  - advanced beneficiary notice, 226–227
  - Anti-Kickback Statute applicability to, 195–196, 206
  - continuous positive airway pressure
    - compliance criteria for, 24
    - “same or similar” denials for, 224
  - definition of, 206
  - dentist provider classification with, 221–222
  - durable medical equipment
    - dentist as providers of, 221
    - history of, 220
    - “non-participating” provider, 61
    - oral appliance therapy classification as, 220
    - physician's prescription for, 220
    - Reasonable Useful Lifetime for, 223, 226
    - replacement coverage for, 223
  - event count criteria, 16
  - hypopnea scoring with, 6
  - local coverage determination, 190, 220
  - mandibular advancement device restrictions, 111, 111b, 131



- “non-participating” provider, 61, 222–223
  - office staff proficiency in, 61
  - oral appliance therapy
    - criteria for coverage, 220–221
    - detailed work order, 220–221
    - as durable medical equipment, 220
    - ineffectiveness of, 227–228
    - local coverage determination criteria, 220–221
    - “same or similar” denials for, 224
  - Part B provider, 222
  - participating provider, 222–223
  - replacement policies, 207
  - “same or similar” denials by
    - appeal of, 225–226
    - continuous positive airway pressure failure
      - before certification, 225
    - overview of, 224
    - positive airway pressure failure after 91 days of use, 224–225
    - redetermination request for, 225–226
  - Stark Law applicability to, 195–196
  - supplement insurance, 206
  - Medicare Advantage Plan, 207
  - Melatonin, 31, 39
  - Menopause, 11
  - Metabolic syndrome, 19
  - Methylprednisolone, 149, 156
  - Mixed apnea, 5, 5f
  - MMI. *See* Maximum medical improvement.
  - Monoblock appliance, 120f, 120–121
  - Moses appliance, 120f, 120–121
  - Mouth breathing, 235, 255, 257, 263, 266
  - Mouth puffing, 264
  - Mouth snoring, 261–262
  - Mouth taping
    - in adults, 263–265
    - in children, 272–273
  - Multiple Sleep Latency Test, 23
  - Muscle tone
    - in N2 sleep, 34
    - in REM sleep, 42
  - Myalgia, 147
  - Myofunctional evaluation, 297
  - Myofunctional Research Corporation, 101, 102f
  - Myofunctional therapy
    - ankyloglossia, 241–242
    - apnea-hypopnea index lowered using, 245
    - cascading effects of, 241
    - definition of, 240
    - description of, 142, 239
    - functions of, 240
    - occlusal stability benefits of, 245
    - rhinomanometry and, 326–327
    - techniques in, 243–244
  - Myositis, 148
  - MyoTape, 264–265, 272
  - myTAP, 102, 103f
  - myTAP-PAP interface, 140, 140f
- ## N
- N1, 33, 37f, 38
  - N2, 33, 37f, 38
  - N3, 34, 37f, 38
  - Nasal airway, 41, 136–139
  - Nasal breathing
    - asthma affected by, 279
    - benefits of, 255, 266, 325
    - in children, 266
    - deep sleep promotion with, 278
    - description of, 137, 157, 235, 245, 263
    - diaphragm benefits of, 269, 276
    - during exercise
      - with mouth closed, 269
      - oxygen benefits, 280
    - exercise-induced bronchoconstriction prevented with, 279
    - facial development affected by, 280
    - importance of, 254–256
    - lungs affected by
      - blood redistribution, 276
      - blood vessel dilation, 276
      - elasticity of, 277
    - mouth taping to promote
      - in adults, 264–265
      - in children, 272–273
    - nitric oxide production during, 255, 276–277
    - obstructive sleep apnea treated with, 263, 278
    - oxygen intake in blood affected by, 276
    - oxygenation during sleep improved with, 278
    - relaxation and, 274
    - during sleep, 264–265
    - slow breathing and, 255
    - sports performance benefits of, 266
    - subjective questionnaires for evaluating, 319
    - in teenagers, 266
    - tongue positioning influenced by, 325
    - ventilation affected by, 280
    - vocal effort aided by, 275
  - Nasal cones, 138, 139f
  - Nasal congestion, 266
  - Nasal dilator, 264
  - Nasal endoscopy, 41f, 327
  - Nasal examination, 85
  - Nasal function, 73
  - Nasal function testing
    - acoustic rhinometry, 327
    - history of, 319–320, 320f
    - nasal endoscopy, 327
    - rhinomanometry. *See* Rhinomanometry.
  - Nasal Obstruction Symptom Evaluation scale, 319
  - Nasal resistance, 279, 323, 324f
  - Nasal resonance, 275–276

- Nasal snoring, 261–262
- Nasopharyngeal abnormalities, 286
- National provider identifier, 207
- National Sleep Foundation, 20
- Neurocognitive deficits, 32
- Neuroplasticity, 244
- Neurotransmitters, 39–40
- Newborns, 31 t. *See also* Children.
- Night Shift positional trainer, 136, 137f, 169
- Nightmares, 44
- 99211 code, 214–215
- Nitric oxide, 40, 235, 255, 276–277
- Nonproductive suckling, 2
- Nonsteroidal anti-inflammatory drugs, for capsulitis, 148
- Nose. *See also* specific nasal entries.
- in allergic rhinitis management, 279
  - breathing affected by, 276–278
  - cognitive function and, 274
  - decongesting of, 259, 279
  - dilation of, 279
  - dilator for, 264
  - examination of, 94–95
  - functions of, 274–280, 319
- Nose, Slow, and Low exercise, 260–261
- NOSE scale. *See* Nasal Obstruction Symptom Evaluation scale.
- Nose snoring, 261–262
- Nose Unblocking exercise, 259, 264
- NPI. *See* National provider identifier.
- NREM sleep
- description of, 30, 33
  - EEG waves in, 37f
  - N1, 33, 37f, 38
  - N2, 33, 37f, 38
  - N3, 34, 37f, 38
- O**
- OASYS device, 120, 120f
- OAT. *See* Oral appliance therapy.
- Obesity
- airway affected by, 2, 11
  - obstructive sleep apnea and, 2, 9, 11
  - prevalence of, 2, 3f
- Obesity hypoventilation syndrome, 2, 9–10
- Obstructive sleep apnea
- airway therapy in, 40
  - apnea events in, 16
  - asthma and, 271–272
  - breathing exercises for, 262–263
  - cardiac arrhythmias and, 19
  - cardiovascular effects of, 18–19
  - cerebrovascular disease and, 19
  - in children, 22
  - cognitive decline and, 92
  - comorbid conditions with, 11, 62
  - contributing factors, 3
  - COVID-19 and, 12
  - daytime hypoventilation associated with, 9
  - definition of, 42
  - dementia and, 92
  - diagnosis of
    - apnea-hypopnea index used in, 15. *See also* Apnea-hypopnea index.
    - benchmarks used in, 16–17
    - costs of not diagnosing, 17–20
    - criteria for, 13
    - by dentist, 55
    - HCPCS code for, 211
    - home sleep apnea testing, 55–56
    - overnight sleep study for, 14
    - oxygen desaturation index in, 16
    - polysomnography for, 14
    - respiratory event index in, 15
  - drowsy driving risks associated with, 20
  - economic costs of, 19
  - emotional consequences of, 3
  - ethnicity and, 12
  - excessive sleepiness caused by, 20
  - HCPCS code for, 211
  - home sleep apnea test for, 5, 5f
  - hypertension and, 18–19
  - incidence of, 20, 22
  - insomnia and, 23
  - medical disease classification of, 17
  - medications associated with, 12
  - metabolic syndrome associated with, 19
  - moderate to severe, 20
  - monitoring of, 174–176, 175f
  - nasal breathing for, 263, 278
  - neurocognitive effects of, 18
  - obesity and, 2, 9, 11
  - periodontal disease and, 64
  - physical consequences of, 3, 17–19
  - psychiatric effects of, 18
  - recall evaluations, 174–176, 175f
  - risk factors for, 11–12
  - screening for, 47
  - severity determinations for, 15
  - snoring associated with, 8
  - societal influences on, 2
  - stress caused by, 260
  - stroke and, 19
  - studies of, 20
  - sudden cardiac death secondary to, 19
  - symptoms of, 8, 10–11
  - temporomandibular disorder and, 93
  - treatment of
    - American Academy of Dental Sleep Medicine/  
American Academy of Sleep Medicine  
practice parameters, 50–51, 51b

- American Academy of Dental Sleep Medicine/  
American Academy of Sleep Medicine  
treatment protocols, 52
- in children, 22
- continuous positive airway pressure for, 24–25,  
151
- mandibular advancement device, 60. *See also*  
Mandibular advancement device.
- options for, 86
- oral appliance therapy, 221
- patient discussions regarding, 203
- protocols for, 51–57
- surgical procedures, 54
- undiagnosed, costs of, 17–20, 22
- untreated, costs of, 17–20, 22
- Obstructive sleep apnea syndrome, 21f, 22–23
- Occlusion, body positioning effects on, 307
- ODI. *See* Oxygen desaturation index.
- Odors, 274–275
- OHS. *See* Obesity hypoventilation syndrome.
- Olfactory receptors, 278
- Olfactory-induced behavioral responses, 275
- OMDs. *See* Orofacial myofunctional disorders.
- Open-ended questions, 181
- Open-mouth breathing, 257, 272
- Oral appliance therapy. *See also* Mandibular  
advancement device.
  - abandonment of, for positive airway pressure,  
134–135
  - allostatic challenges, 145–146, 155
  - alternatives to, 193
  - American Academy of Dental Sleep Medicine  
protocol for, 52
  - American Dental Association position statement  
on, 17, 53–54
  - anatomic considerations, 146
  - appliances
    - acrylic base, 159
    - with anterior attachment, 115–117, 116f
    - Avant, 115, 115f
    - comfort of, 166–167
    - dorsal fin, 117f, 117–118, 194
    - dreamTAP, 115–117, 116f
    - Elevate, 119, 119f
    - EMA, 114f, 114–115
    - flexTAP, 117, 117f
    - Herbst, 112f, 112–113, 159f, 169, 194
    - interlocking shape, 118–119, 118f–119f
    - monoblock, 120f, 120–121
    - Moses, 120f, 120–121
    - OASYS, 120, 120f
    - Panthera, 113f, 113–114
    - polymethyl methacrylate, 167
    - product liability issues, 194
    - ProSomnus[IA], 118f, 118–119
    - retrusion with, 167
    - selection of, 111
    - studying of, 181
    - substitution of parts, 159, 159f
    - TAP, 159f
    - that pull the jaw, 113–115, 114f
    - that push the jaw, 112f, 112–113
    - tongue-retaining devices, 121, 121f
    - troubleshooting of, 159
    - vertical dimension of, 135
  - candidate selection considerations for, 91
  - comfort considerations for, 166–167
  - compliance with, 86, 166–167
  - complications of, 110
    - capsulitis, 148–149
    - dental-related, 156–158
    - excessive salivation, 152
    - inflammatory responses, 147–149
    - informed consent discussions about, 193
    - pressure spots, 152
    - temporomandibular disorders, 150–152
  - continuous positive airway pressure and, 59, 164,  
164t, 188, 223
  - dental codes for, 17
  - dental insurance benefits for, 201
  - dentist's prescribing of, 17
  - durable medical equipment classification of, 58,  
204, 220
  - effectiveness of, 163, 164t, 176, 227–228
  - ineffectiveness of, 227–228
  - maximum medical improvement with, 165,  
165b, 169
  - medical history-taking for, 92
  - number of teeth needed for, 63
  - patient response to, 48
  - positive airway pressure and, 182
  - preauthorization for, 203
  - range of motion exercises before beginning,  
146–147, 147f
  - referrals for, 47–48
  - risks associated with, 193
  - sleep physicians and, 55, 163–164
  - success in use of, 163–164
  - titration of
    - dentist-facilitated, 165–168, 172–173
    - in-lab, 171–173
    - by laboratory technologist, 171–172
    - by patient, 173
    - pulse oximetry for, 169, 170b, 170f, 189
- Orbitofrontal cortex, 278
- Orofacial myofunctional disorders, 242–243, 245
- Oropharynx, 12, 42, 84, 141
- Orthotics, 310
- OSA. *See* Obstructive sleep apnea.
- OSAS. *See* Obstructive sleep apnea syndrome.



- Out-of-network, 209
- Overbite, 290f, 291
- Over-breathing, 250–251, 255
- Overjet, 290f, 291
- Overnight sleep study, 14
- Over-the-counter temporary appliances, 101
- Oximeters, 72–73, 73b. *See also* Pulse oximetry.
- Oxygen
- during exercise, 280
  - intake of, in blood, 276
- Oxygen Advantage, 264–266
- Oxygen desaturation, 6, 11
- Oxygen desaturation index, 16, 191
- Oxygenation, during sleep, 278
- P**
- PaCO<sub>2</sub>. *See* Partial pressure of carbon dioxide.
- Palatine tonsils, 85, 94f, 241
- Panthera appliances, 113f, 113–114
- PaO<sub>2</sub>. *See* Partial pressure of oxygen.
- Parasomnias, 44
- Parasympathetic nervous system, 17, 33
- Partial pressure of carbon dioxide, 18, 251, 300
- Partial pressure of oxygen, 18
- Past medical history, 81
- Pathogens, inhaled, 277
- Patients, knowing about, 181–182
- PCPs. *See* Primary care physicians.
- Pcrit. *See* Critical closing pressure.
- PDAC. *See* Pricing, Data Analysis, and Coding.
- Pediatric airway problems, 231–236
- Periodontal disease
- description of, 156
  - examination for, 95
  - obstructive sleep apnea and, 64
  - oral appliance therapy in, 62
- Periodontal status, 95
- Pharmacy, 81
- Pharyngometry, 105
- Phenotypes, 44, 242–243
- Photographs, for mandibular advancement device fabrication, 110
- Physical examination, 83–85, 93–97
- Physical therapy
- airway-centric physical therapist. *See* Airway-centric physical therapist.
  - overview of, 285–286
- Physician. *See* Primary care physicians; Sleep physicians.
- PMMA. *See* Polymethyl methacrylate.
- Policy statements
- American Academy of Dental Sleep Medicine. *See* American Academy of Dental Sleep Medicine.
  - American Academy of Sleep Medicine, 190
  - American Dental Association. *See* American Dental Association, sleep-related breathing disorder policy statement.
  - American Medical Association, 189, 191
  - on screenings, 191
- Polymethyl methacrylate, 167
- Polysomnogram/polysomnography
- board-certified sleep medicine specialist's review of, 203
  - definition of, 6–7
  - epochs on, 36
  - final titration, 173
  - 4% rule, 203
  - home sleep apnea test versus, 14
  - illustration of, 8f
  - obstructive sleep apnea diagnosed with, 14
  - parameters measured with, 7
  - sleep stages on, 42f
- Positional therapy, 136
- Positive airway pressure. *See also* Continuous positive airway pressure.
- description of, 40
  - discontinuation of, 224–225
  - failure of, after 91 days of use, 224–225
  - mandibular advancement device and, 139–140, 140f, 224–225
  - oral appliance therapy and, 134, 182
  - success in use of, 164
- Posterior condyles, 150, 151f
- Posterior open bite, 150, 157f
- Posttraumatic stress disorder, 83
- Posture
- assessment of, 298–299, 299f
  - mandibular position and, 307
  - static. *See* Static posture.
- Pressure differential principle, 322
- Pressure spots, from oral appliance therapy, 152
- Pricing, Data Analysis, and Coding, 62, 111, 216
- Primary care physicians, 48
- detailed work order signed by, 221
  - letter of medical necessity from, 56, 58, 63
  - referral from, 63
- Principles and Practices of Sleep Medicine, Seventh Edition, 45
- Pro Gauge, 107f, 107–108
- Product liability, 194
- Prone sleeping position, 309, 310f
- ProSomnus[A] appliance, 118f, 118–119
- Prostaglandin D2, 40
- Protrusion
- for airway management, 155
  - amount of, 96
  - bite registration, 105
  - Herbst appliances for achieving, 112f, 112–113
  - temporomandibular disorders and, 151

- "Pseudospindles," 36  
 PSG. *See* Polysomnogram/polysomnography.  
 PTSD. *See* Posttraumatic stress disorder.  
 Pulmonary hypertension, 19  
 Pulse, 72  
 Pulse oximetry  
   equipment used in, 72–73  
   high-resolution, 93, 133, 191  
   obstructive sleep apnea screening uses of, 93  
   sleep-related breathing disorder screening uses of, 191  
   state regulations for, 169, 191  
   titration uses of, 169, 170b, 170f, 189
- Q**  
 Qualified dentist (QD), 52, 200
- R**  
 Range of motion exercises, 146–147, 147f  
 Rapid eye jerks, 34  
 RDI. *See* Respiratory disturbance index.  
 Reasonable Useful Lifetime, 223, 226  
 Reduced volume breathing, 251  
 Referral(s)  
   airway-centric physical therapist. *See* Airway-centric physical therapist referral.  
   chart notes with, 62  
   from dentist to sleep physician, 55  
   development of, 47–48  
   documentation with, 62–63  
   promotion of, 75, 78  
   self-referral prohibition, 195  
 Referral pads, 75  
 Registered polysomnographic technologist, 14  
 REI. *See* Respiratory event index.  
 Reinforcement learning, 310  
 REM sleep  
   body paralysis in, 34  
   characteristics of, 34  
   dreaming during, 31  
   EEG waves in, 37f  
   muscle tone in, 42  
   neurologic repair during, 31  
   phasic, 38  
   sleep-related breathing disorders in, 31  
   tonic, 38  
 REM sleep behavior disorder, 44  
 Repositioner, 154, 155f, 196  
 RERA. *See* Respiratory effort-related arousal.  
 Respiration rate, 72  
 Respiratory arousals, 5–6, 13  
 Respiratory disturbance index, 7, 193  
 Respiratory effort, 13–14  
 Respiratory effort-related arousal, 8, 13  
 Respiratory event index, 15  
 Respiratory function assessment, 299–300  
 Respiratory rate, 254  
 Respiratory-related noise, 13  
 Review of systems, 82  
 Rhinoconjunctivitis Quality of Life Questionnaire, 319  
 Rhinomanometry  
   airflow through nose measured with, 41, 73  
   case studies of, 328–329  
   DAFNE software used with, 324–325, 325f  
   dental applications of, 321–322  
   diagnostic uses of, 325–326  
   flow rate with, 323–324  
   four-phase, 320–321, 321f  
   how it works, 322–325, 323f–325f  
   medical applications of, 321–322  
   myofunctional therapy and, 326–327  
   nasal resistance on, 323, 324f  
   overview of, 319–320  
   prototype machine used in, 320f  
   setup for, 322  
   treatment planning uses of, 327  
   upper airway resistance on, 328f, 329
- S**  
 Salivation, excessive, 152  
 Saw-toothed waves, 36  
 Scanners, 72  
 Scanning, for mandibular advancement device fabrication, 104  
 Scars, 290  
 Screening  
   airway-centric physical therapist. *See* Airway-centric physical therapist referral, screening for.  
   American Dental Association policy statement on, 191  
   Epworth Sleepiness Scale, 50–51, 81, 167, 195  
   high-resolution pulse oximetry used in, 191  
   home sleep apnea testing, 188, 191  
   legality issues for, 191  
   obstructive sleep apnea, 47  
   pulse oximetry used in, 191  
 SDB. *See* Sleep-disordered breathing.  
 Selective serotonin reuptake inhibitors, 92  
 Self-referrals, 195  
 Sense of smell, 274–275, 278  
 Side sleeping position, 309, 309f  
 Sleep  
   age-based requirements for, 31t, 31–32  
   alcohol effects on, 2  
   amount needed, 31t, 31–32  
   breathing effects on, 253  
   characteristics of, 29–30  
   deep, 30, 34, 278  
   definition of, 29




- electroencephalogram wave frequencies during
  - "Sleep starts," 33
  - 35f–36f, 35–36
- factors that affect, 1–2
- frequent waking up after 4 or 5 hours of
  - breathing exercises for, 261
- functions of, 30–31
- growth hormones released during, 22
- healing during, 30
- nasal breathing during, 264–265
- need for, 1
- neurotransmitters in, 39–40
- non-rapid eye movement. *See* NREM sleep.
- oxygenation during, 278
- physiologic processes affected by, 30–31
- positions for, 307–309, 308f–310f
  - in prone position, 309, 310f
  - rapid eye movement. *See* REM sleep.
  - reasons for, 29–32
  - restorative benefits of, 256
  - in side position, 309, 309f
  - slow-wave, 30
  - in supine position, 308, 308f
- Sleep apnea
  - asthma and, 271–272
  - central, 43, 98
  - complex, 43, 101
  - insomnia and, 43
  - medications that affect, 92
  - mouth breathing and, 257
  - obstructive. *See* Obstructive sleep apnea.
- Sleep assistant, 181
- Sleep bruxism
  - definition of, 40
  - mandibular advancement device for, 44
- Sleep deprivation, 1–3, 32, 256
- Sleep disorders
  - in children, 269
  - description of, 256
- Sleep hygiene, 307–309, 308f–309f
- Sleep medicine, 14
- Sleep patterns, light and dark effects on, 32
- Sleep physicians
  - collaboration with, 74–76
  - dentists and, 17, 55–57
  - face-to-face examination with, 190–191
  - obstructive sleep apnea monitoring by, 174, 176
  - oral appliance therapy and, 55, 163–164
  - primary care physicians and, 48
  - referrals, 47, 55
- Sleep quality, 1, 44, 278
- Sleep spindles, 33, 36f
- Sleep stages
  - description of, 32
  - non-REM. *See* NREM sleep.
  - REM. *See* REM sleep.
- "Sleep starts," 33
- Sleep studies
  - dentist-facilitated, 174
  - EEG wave frequencies, 35f, 35–36
  - reading of, 34–39
  - sleep stages, 36–39, 37f
- Sleep study. *See* Polysomnogram/polysomnography.
- Sleep-disordered breathing. *See also* Sleep-related breathing disorders.
  - in children, 269–272
  - definition of, 9
  - description of, 256–257
  - frenulum restriction as cause of, 241
  - medical insurance considerations, 201
  - screening for, 50
  - in teenagers, 269–272
- Sleepiness, excessive daytime, 3, 20, 23, 195
- Sleeplessness, 23
- Sleep-related breathing disorders. *See also* specific disorder.
  - aging and, 9
  - airway conditions associated with, 9
  - American Dental Association policy statement on. *See* American Dental Association.
  - characteristics of, 53
  - in children, 22
  - comorbid diseases associated with, 4
  - continuous positive airway pressure for, 24–25, 25f
  - continuum of, 9–10, 10f
  - definition of, 2
  - dentistry's role in, 4, 12–13, 17, 53–54
  - Medicare local coverage determination criteria for, 220–221
  - obstructive sleep apnea. *See* Obstructive sleep apnea.
  - overview of, 9–13
  - parasomnias, 44
  - physiologic changes associated with, 9
  - prevalence of, 20–22, 21f
  - in REM sleep, 31
  - screening for. *See* Screening.
  - signs and symptoms of, 9, 135
  - snoring. *See* Snoring.
  - standards of care for, 197
  - systemic effects of, 182
  - temporomandibular disorder and, 57
  - treatment of, 13–14, 25
  - types of, 53
  - weight loss for, 142
- Sleepwalking, 44
- Slow breathing, 253–254
- Slow-wave sleep, 30
- Snoring
  - appliances for, 60



- breathing exercises for, 261–262
  - definition of, 8
  - hypnogram of, 42f
  - mouth, 261–262
  - nose, 261–262
  - SOAP notes, 68, 68b
  - SOC. *See* Standard of care.
  - Social history, 81
  - Soft tissue inspection, 290–291
  - Software
    - for medical insurance filing, 208
    - for oxygen desaturation index calculations, 16
    - for practice, 70–71
  - SomnoSeal, 127, 127f, 139
  - Somnus, 1
  - Speedy Claims, 208
  - Standard of care, 197
  - Stark Law, 195–196, 206
  - Static posture
    - assessment of, 288–290, 288f–290f
    - visual inspection of, 298
  - Steps exercise, 267–268, 272–273
  - Stomatognathic system, 285, 296, 301
  - STOP-BANG questionnaire, 50, 81, 310
  - Stress
    - dysfunctional breathing caused by, 253f
    - health problems affected by, 254
  - Stress response system, 254
  - Stroke, 19
  - Sudden cardiac death, 19
  - Supine sleeping position, 308, 308f
  - Surgical history, 81
  - Systemic hypertension, 18
  - Systolic blood pressure, 18
- T**
- TAP appliance, 99, 159f
  - Taping
    - lip, 138, 272
    - mouth. *See* Mouth taping.
  - Teenagers. *See also* Adolescents; Children.
    - dysfunctional breathing assessment in, 265–273
    - nasal breathing in, 266
    - sleep requirements for, 31t
    - sleep-disordered breathing in, 269–272
  - Teeth
    - anterior, 157
    - examination of, 95
    - movement of. *See* Tooth movement.
    - for oral appliance therapy, 63
  - Telegnathic, 141–142
  - Telehealth, 56, 74
  - Telemedicine, 55, 57, 190
  - Temporary appliances
    - custom-made mandibular advancement device and, 100
    - failure of, 101
    - over-the-counter, 101
    - semi-custom, 102–103
    - titration of, 101
    - trial, 101
    - ZQuiet, 101, 102f
  - Temporomandibular disorders
    - anatomic considerations, 146
    - examination for, 95–96, 196
    - history of, 150–152
    - malocclusion and, 286–287
    - malpractice prevention, 196
    - obstructive sleep apnea and, 93
    - palpation for, 95–96
    - screening for, 57
    - sleep-related breathing disorder and, 57
  - Temporomandibular joint
    - anatomy of, 146
    - charting of, 292–294, 293f–294f
    - closing of, 294
    - deflections of, 293
    - deviations of, 293
    - dysfunction of, 62
    - lateral movement of, 293–294
    - opening of, 293
    - protrusion of, 294
    - range of motion
      - assessment of, 292–294, 293f
      - exercises for, 146–147, 147f
  - Thermoregulation, 277
  - Thermyl Plus, 129, 129f
  - Theta waves, 35
  - Third-party liability, 195
  - Thoracic diaphragm, 285
  - Timed physiologic sigh, 300
  - Titration
    - dentist-facilitated, 165–168, 172–173
    - in-lab, 171–173
    - by laboratory technologist, 171–172
    - by patient, 173
    - pulse oximetry for, 169, 170b, 170f, 189
  - TMDs. *See* Temporomandibular disorders.
  - Tongue
    - examination of, 94
    - functions of, 240
    - mandibular advancement device effects on, 4
    - maxillary arch development and, 233
    - range of motion assessments, 291f, 291–292
    - resting posture/position of, 240, 265, 291, 325
    - scalloping of, 290
  - Tongue-retaining devices, 121, 121f
  - Tongue-tie, 83
  - Tonsillectomy, 270
  - Tonsils
    - immune system functioning and, 270



- 
- lingual, 85  
palatine, 85, 94f, 241  
removal of, 270
- Tooth movement  
mandibular advancement device as cause of, 157  
morning repositioner to prevent, 196  
oral appliance therapy and, 110  
prevention of, 196–197
- Transference, 244
- Trigger points, in facial muscles, 294–296, 295f
- Tumor necrosis factor  $\alpha$ , 40
- U**
- Upper airway, 93–94. *See also* Airway.  
Upper airway resistance syndrome, 19  
Upper cervical examination, 297  
Upper cervical nerves, 302  
Upper chest breathing, 252
- V**
- Vagus nerve, 254  
Vasoactive intestinal peptide, 40  
Ventilation, 280  
Ventilatory burden, 17
- Visuospatial awareness, 274–275
- Vital signs  
equipment for, 72–73  
medical encounter recording of, 81
- Vocal effort, 275
- W**
- Wakefulness  
electroencephalogram wave frequencies during,  
35f–36f, 35–36  
neurotransmitters in, 39–40
- Walking, mouth closure during, 265
- Water balance, 277–278
- Weight loss, 142
- Weight measurements, 72
- Williams syndrome, 231
- Written consent, 194
- X**
- Xerostomia, 157  
Xylitol, 137
- Z**
- ZQuiet device, 101, 102f

# Contents

- 1 Clinical Guide for the Practice of Dental Sleep Medicine
- 2 An Overview of Sleep and Sleep Disorders
- 3 Dental Sleep Medicine Protocols and Practice
- 4 Integrating Dental Sleep Medicine into Your Practice
- 5 Treatment Decisions and Appliance Selection
- 6 Delivery of a Custom MAD
- 7 Complications of Oral Appliance Therapy
- 8 Evaluating Therapy and Ongoing Care
- 9 The New Reality
- 10 Legal Issues Related to the Practice of Dental Sleep Medicine
- 11 Medical Insurance and Medicare
- 12 Pediatric Airway Problems
- 13 Myofunctional Therapy
- 14 A Multidimensional Approach to Addressing Breathing and Sleep Disorders
- 15 Physical Therapy
- 16 Rhinomanometry

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