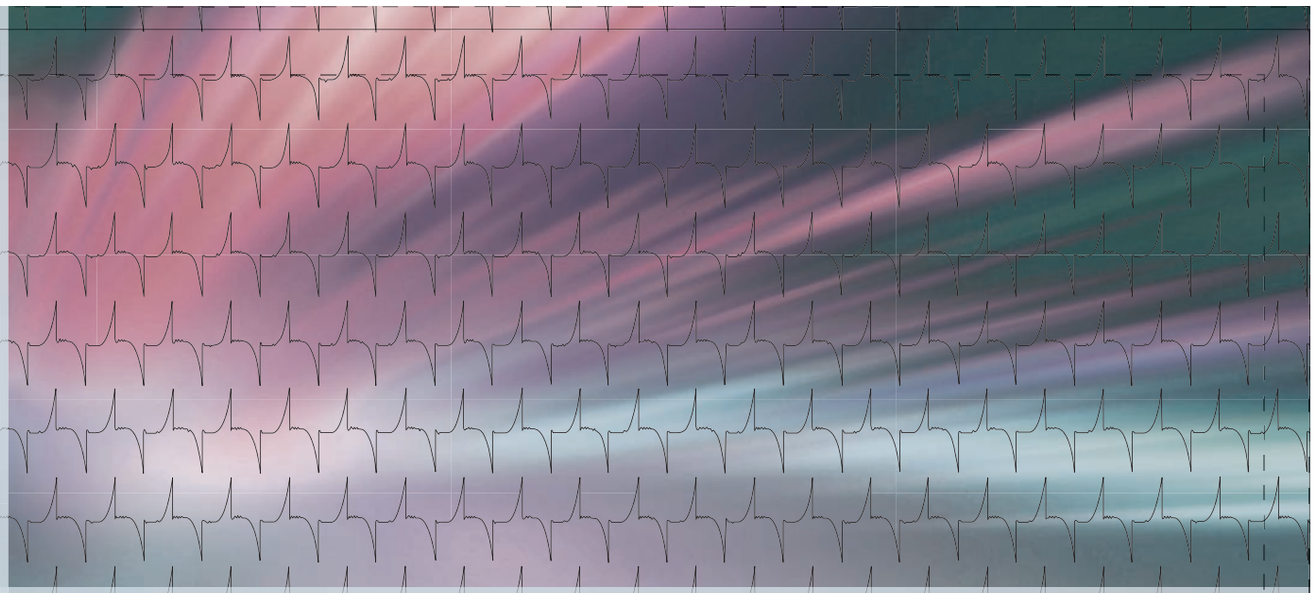
CHAPTER

2



Sleep Disorders

CHAPTER OUTLINE

LEARNING OBJECTIVES

1. Discuss a brief history of sleep disorders
2. Learn the classification of sleep disorders as outlined by the AASM
3. Describe the features and symptoms of each disorder
4. Discuss the social and personal impact of specific disorders

KEY TERMS

pickwickian syndrome
Association of Sleep Disorders Centers (ASDC)
***International Classification of Sleep Disorders* (ICSD)**
insomnia
psychophysiological insomnia
idiopathic insomnia
sleep state misperception
paradoxical insomnia
sleep diary
sleep log
sleep hygiene
limit-setting disorder
behavioral insomnia of childhood
adjustment insomnia
group therapy
light therapy
sleep restriction
self-control techniques
biofeedback
sleep-related breathing disorders
obstructive sleep apnea (OSA)
obstructive apnea
hypopnea
oxygen desaturation
EEG arousal
excessive daytime sleepiness (EDS)
Apnea Hypopnea Index (AHI)
Respiratory Disturbance Index (RDI)
respiratory effort–related arousal (RERA)
upper airway resistance syndrome (UARS)
sudden infant death syndrome (SIDS)
central sleep apnea (CSA)
central apnea
hypercapnia
Cheyne-Stokes breathing
high-altitude periodic breathing
primary sleep apnea of infancy
treatment-emergent central sleep apnea
complex sleep apnea
obesity hypoventilation syndrome
congenital central alveolar hypoventilation syndrome
late-onset central hypoventilation with hypothalamic dysfunction
alveolar hypoventilation
idiopathic central alveolar hypoventilation
primary snoring
snoring
sleep-related groaning
catathrenia
central disorders of hypersomnolence
multiple sleep latency test (MSLT)
maintenance of wakefulness test (MWT)
narcolepsy
cataplexy
sleep paralysis
hypnagogic hallucinations
narcolepsy tetrad
automatic behavior
microsleep
narcolepsy type i
hypnagogic
hypnopompic
sleep onset REM periods (SOREMPs)
narcolepsy type ii
idiopathic hypersomnia
recurrent hypersomnia
periodic hypersomnolence
kleine-levin syndrome
hypersomnia
insufficient sleep syndrome
circadian rhythm sleep–wake disorders
delayed sleep–wake phase disorder
advanced sleep–wake phase disorder
irregular sleep–wake rhythm disorder
free-running circadian rhythm
non-24-hour sleep–wake rhythm disorder
shift work disorder
jet lag disorder
parasomnia
confusional arousal
sleepwalking
sleep terror
night terror

sleep-related eating disorder
REM-related parasomnias
REM sleep behavior disorder (RBD)
isomorphism
sleep paralysis
recurrent isolated sleep paralysis
nightmare
posttraumatic stress disorder (PTSD)
exploding head syndrome
sleep-related hallucinations
nocturnal enuresis
bedwetting
sleep enuresis
sleep talking
sleep-related movement disorders
restless legs syndrome (RLS)
periodic limb movement disorder (PLMD)
periodic limb movements in sleep (PLMS)
pLM index
sleep-related leg cramps
bruxism
sleep-related bruxism
body rocking
head banging
sleep-related rhythmic movement disorder
benign sleep myoclonus of infancy
myoclonus
propriospinal myoclonus at sleep onset (PSM)
excessive fragmentary myoclonus
hypnagogic foot tremor (HFT)
alternating leg muscle activation (ALMA)
sleep starts
hypnic jerks
environmental sleep disorder

History of Sleep Disorders

Since the beginning of time, humans have been fascinated with sleep. Many early writings discuss sleep and sleep disorders in a variety of ways. In 1836, Charles Dickens published a series of papers called the "Posthumous Papers of the Pickwick Club." In these writings, he describes a boy named Joe who was overweight and very tired, and who snored heavily. A drawing of the boy shows an obese young man with a short, fat neck. From this, the term **Pickwickian syndrome** was coined; although it is not used today, it is similar to a sleep disorder called obesity hypoventilation syndrome (OHS).

Pioneering sleep researchers in the 1950s and 1960s, such as Nathaniel Kleitman, William Dement, and others, identified different stages of sleep and were able to recognize specific patterns of these stages throughout the night. This, along with the development of new technologies designed to read and record physiological activities, gave way to the development of the field of sleep disorders. In 1961, the Sleep Research Society began informally with such sleep pioneers as Doctors William Dement, Allan Rechtschaffen, Nathaniel Kleitman, Michel Jouvet, and Eugene Aserinsky. In 1968, Doctors Rechtschaffen and Anthony Kales produced *A Manual of Standardized Technology Techniques and Scoring Systems for Sleep Stages of Human Subjects*, which defined scoring techniques for sleep studies for the next 40 years.

In 1970, Dement started the first sleep disorders lab, which provided all-night evaluations of patients with sleep complaints; within five years there were four more sleep centers in business. In 1975, the **Association of Sleep Disorders Centers (ASDC)** was developed, which is now known as the American Academy of Sleep Medicine (AASM). Its sleep center accreditation went into effect two years later, in 1977. By the early 1990s, several professional sleep societies had developed, including the ASDC, Clinical Sleep Society (CSS), Association of Professional Sleep Societies (APSS), American Board of Sleep Medicine (ABSM), and National Sleep Foundation (NSF). The American Academy of Sleep Medicine was known as the Clinical Sleep Society from 1984 to 1986 and the American Sleep Disorders Association from 1987 to 1998; in 1999 it became the American Academy of Sleep Medicine.

In 1990, the AASM developed the first edition of the **International Classification of Sleep Disorders (ICSD)**, which categorized and described all known sleep disorders. A second edition of the ICSD was published in 2005, and the third edition was published in 2014. The information in this chapter is reflective of the updated definitions and classifications of sleep disorders found in the ICSD-3.

Classification of Sleep Disorders

The following pages categorize sleep disorders as outlined in the third edition of the ICSD[1]:

1. Insomnia
   a. Chronic insomnia disorder
   b. Short-term insomnia disorder
   c. Other insomnia disorder
   d. Isolated symptoms and normal variants
2. Sleep-related breathing disorders
   a. Obstructive sleep apnea disorders
      i. Obstructive sleep apnea, adult
      ii. Obstructive sleep apnea, pediatric
   b. Central sleep apnea syndrome
      i. Central sleep apnea with Cheyne-Stokes breathing
      ii. Central sleep apnea due to a medical disorder without Cheyne-Stokes breathing
      iii. Central sleep apnea due to high altitude periodic breathing
      iv. Central sleep apnea due to medication or substance
      v. Primary central sleep apnea
      vi. Primary central sleep apnea of infancy
      vii. Primary central sleep apnea of prematurity
      viii. Treatment-emergent central sleep apnea
   c. Sleep-related hypoventilation disorders
      i. Obesity hypoventilation syndrome
      ii. Congenital central alveolar hypoventilation syndrome
      iii. Late-onset central hypoventilation with hypothalamic dysfunction
      iv. Idiopathic central alveolar hypoventilation
      v. Sleep-related hypoventilation due to medication or substance
      vi. Sleep-related hypoventilation due to medical disorder

   d. Sleep-related hypoxemia disorder
   e. Isolated symptoms and normal variants
      i. Snoring
      ii. Catathrenia

3. Central disorders of hypersomnolence
   a. Narcolepsy type I
   b. Narcolepsy type II
   c. Idiopathic hypersomnia
   d. Kleine-Levin syndrome
   e. Hypersomnia due to a medical disorder
   f. Hypersomnia due to a medication or substance
   g. Hypersomnia associated with a psychiatric disorder
   h. Insufficient sleep syndrome

4. Circadian rhythm sleep–wake disorders
   a. Delayed sleep–wake phase disorder
   b. Advanced sleep–wake phase disorder
   c. Irregular sleep–wake rhythm
   d. Non-24-hour sleep–wake rhythm disorder
   e. Shift work disorder
   f. Jet lag disorder
   g. Circadian rhythm sleep–wake disorder not otherwise specified (NOS)

5. Parasomnias
   a. NREM-related parasomnias
      i. Disorders of arousal from NREM sleep
      ii. Confusional arousals
      iii. Sleepwalking
      iv. Sleep terrors
      v. Sleep-related eating disorder
   b. REM-related parasomnias
      i. REM sleep behavior disorder
      ii. Recurrent isolated sleep paralysis
      iii. Nightmare disorder
   c. Other parasomnias
      i. Exploding head syndrome
      ii. Sleep-related hallucinations
      iii. Sleep enuresis
      iv. Parasomnia due to medical disorder
      v. Parasomnia due to medication or substance
      vi. Parasomnia, unspecified
   d. Isolated symptoms and normal variants
      i. Sleep talking

6. Sleep-related movement disorders
   a. Restless legs syndrome
   b. Periodic limb movement disorder
   c. Sleep-related leg cramps
   d. Sleep-related bruxism
   e. Sleep-related rhythmic movement disorder
   f. Benign sleep myoclonus of infancy
   g. Propriospinal myoclonus at sleep onset
   h. Sleep-related movement disorder due to medical disorder
   i. Sleep-related movement disorder due to medication or substance
   j. Sleep-related movement disorder, unspecified

Insomnias

Insomnia can be defined as a complaint of a lack of sleep or of nonrestorative sleep. The ICSD-3 defines insomnia as "a repeated difficulty with sleep initiation, duration, consolidation, or quality that occurs despite adequate opportunity and circumstances for sleep, and results in some form of daytime impairment." The ICSD-2 identified several different types of insomnia. The ICSD-3 consolidates these types and groups them into the categories of chronic and short-term insomnia. Within the chronic insomnia grouping, several characteristic types of insomnia are defined.

Psychophysiological Insomnia

Psychophysiological insomnia is very prevalent. The insomnia must last at least one month to classify as psychophysiological insomnia, and is not caused by an outside stressor. Rather, psychophysiological insomnia is caused by a learned response that teaches the subject to not fall asleep when planned. The subject typically has no difficulty falling asleep when sleep is not planned, but at the normal bedtime and during planned naps, sleep onset is difficult to achieve.

Idiopathic Insomnia

Perhaps the most detrimental and debilitating form of insomnia is **idiopathic insomnia**. Idiopathic insomnia, also termed "life-long insomnia," is first identified at infancy or early childhood and persists throughout the patient's life. There appears to be no external cause for this insomnia, and no other sleep disorder exists that could be a contributing factor.

Paradoxical Insomnia

Formerly termed **sleep state misperception**, **paradoxical insomnia** consists of the subject's complaint of insomnia without any actual evidence of insomnia. Many times in the sleep lab, a patient will present poststudy complaints of being awake all night, even though the technician was able to determine by viewing the electroencephalograms (EEGs) that sleep was achieved. In some cases, the patient may have had a normal sleep efficiency, but still insists he or she did not sleep at all. This type of comment should always be included in the technician's notes, because the patient may have paradoxical insomnia. A useful tool for both the clinician and patient when facing paradoxical insomnia is a **sleep diary**. A sleep diary or **sleep log** is a self-report of sleep habits over a period of time. Sleep diaries usually last at least five days,

and sometimes as long as a month. **Figure 2–1** shows a sample sleep diary.

A sleep diary can help the patient see abnormalities in their own sleep habits, such as irregular or inconsistent bedtimes, or daytime naps that may affect the sleep schedule at night. Clinicians can use a patient's sleep diary to point out some of these inconsistencies or poor sleep habits. They can also use a patient's sleep diary during recorded sleep from a sleep study to identify the patient's misperception of sleep.

Inadequate Sleep Hygiene

The term **sleep hygiene** refers to habits that are healthy for one's sleep. Therefore, inadequate sleep hygiene is a set of habits or practices that are bad for a person's sleep, or may cause a person to sleep poorly. Sleep hygiene techniques are practices that everyone should follow to help them fall asleep easier and stay asleep longer. Often a clinician finds that a person's insomnia may be due to bad habits, in which case the use of these and other sleep hygiene techniques may be taught:

- Get up at the same time every day.
- Go to bed only when tired.
- Establish relaxing presleep rituals.
- Eat a healthy diet.
- Exercise regularly.
- Do not exercise heavily within four hours of bedtime.
- Maintain a regular schedule.
- Avoid caffeine for six hours before bedtime.
- Avoid drinking alcohol.
- Avoid smoking.
- If you must nap, do it at the same time every day.
- Use sleeping pills conservatively and with a physician's advice.
- Avoid unnecessary stress when possible.
- Use the bed for sleep rather than watching television, reading, planning, or studying.
- Make the bedroom a clean, comfortable, relaxing environment.
- Block out light and noise as much as possible from the bedroom.

Day	Date	Time in Bed	Time Out of Bed	Total Time in Bed	Time Asleep	Awake Time	Total Sleep Time	Estimated Sleep Efficiency	Notes
1									
2									
3									
4									
5									
6									
7									
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Time in Bed: The final time of day the subject got in bed to go to sleep.
Time Out of Bed: The time of day the subject got out of bed for the last time in the morning.
Total Time in Bed: The total time in minutes the subject spent in bed during the night. This equals the Time Out of Bed minus the Time in Bed.
Time Asleep: The estimated time of day the subject fell asleep for the first time.
Awake Time: The estimated time of day the subject awoke for the last time in the morning.
Total Sleep Time (TST): The estimated total amount of time the subject actually slept.
Estimated Sleep Efficiency: This is calculated by dividing the TST by the Total Time in Bed. A sleep efficiency >90% is considered normal.

FIGURE 2–1 Sleep log.

Following these habits can greatly improve one's ability to fall asleep and stay asleep.

Behavioral Insomnia of Childhood

Also called **limit-setting disorder**, **behavioral insomnia of childhood** is comparable to inadequate sleep hygiene for children or infants. In addition to the sleep hygiene practices listed in the previous section, parents should consider other sleep hygiene practices specific for children such as not putting toys or other distractions in the crib, allowing the child to fall asleep alone rather than in the parent's arms, or preventing the infant from becoming dependent on a bottle to initiate sleep. Although some of these actions may be appropriate at some points during infancy or childhood, they should not be practiced on a regular basis because the child may develop poor sleep habits. A normal, healthy bedtime routine for a child is recommended, such as reading for a short period of time.

Insomnia Due to a Mental Disorder

As its name implies, this insomnia is caused by a diagnosed mental illness, and persists for at least one month. Common mental illnesses contributing to insomnia include depression and anxiety disorders. Clinicians are faced with the challenge of determining whether the mental illness is causing the insomnia or if another type of insomnia is causing the mental illness. For example, a patient suffering from a chronic insomnia can experience depression as a result of the inability to sleep. Alternately, a person who is depressed will often experience insomnia as a symptom.

Insomnia Due to Medical Condition

A very large number of medical conditions have the potential of causing insomnia, either short-term or long-term. Some of the most common and persistent insomnia-causing medical conditions include those associated with pain or discomfort. These are more common in the elderly, but can, of course, occur at any age.

Insomnia Due to Drug or Substance

Another form of insomnia is secondary to substance abuse or withdrawal. These substances most often include alcohol, hypnotic drugs, sedatives, stimulants, and opiates. Most drugs have the ability to alter or create a disturbance in sleep, in one form or another. These disturbances can, of course, vary greatly depending on the type of drug used, and the amount, duration, and regularity of its use, as well as individual factors. Alcohol can have many effects on sleep, including a reduced sleep latency, reduced wakefulness, and reduced rapid eye movement (REM) sleep and increased slow wave sleep during the first third of the night. During the latter portions of the night, alcohol can increase the number of arousals and produce sleep fragmentation. It can also increase the likelihood of nightmares due to a REM rebound. The use of alcohol, sedatives, and pain medications can increase the likelihood of sleep disturbances due to obstructive respiratory events. These drugs relax the muscles, which can lead to the likelihood of obstructions in the upper airway.

Prescription and illegal drugs alike can cause sleep problems, including insomnia. Medications with insomnia as a side effect include, but are not limited to, the following:

- Beta blockers
- Corticosteroids
- Adrenocorticotropic hormones
- Monoamine oxidase inhibitors
- Diphenylhydantoin
- Calcium blockers
- Alpha methyldopa
- Bronchodilators
- Stimulating tricyclics
- Stimulants
- Thyroid hormones
- Oral contraceptives
- Antimetabolites
- Decongestants
- Thiazides

Short-Term Insomnia Disorder

Also called **adjustment insomnia**, short-term insomnia disorder is extremely common, especially in today's busy, high-stress culture. Almost everyone experiences difficulty initiating or maintaining sleep for a night or two at some point in their lives. This can be due to stress, excitement, anticipation, pain, illness, changes in time zones or altitude, reactions to medications, changes in sleep schedules, light, noise, or many other intrinsic or extrinsic factors. Adjustment insomnia is also known as acute insomnia, and was formerly known as transient insomnia or short-term insomnia. Adjustment insomnia is insomnia associated with a specific stressor. These stressors can be events in our everyday lives such as stress from work, financial hardship, or marital stress. They can also be atypical events such as the death of a loved one or a natural disaster. Although adjustment insomnia is extremely common, it also typically corrects itself when the stressor is corrected. If a college student experiences adjustment insomnia due to stress from upcoming final exams, for example, the insomnia will likely be corrected when finals are over.

Insomnia Treatment Options

Insomnia is often a secondary condition. In these cases, the insomnia is treated naturally as the primary condition is resolved. For example, a woman experiencing insomnia as a result of her painful arthritis will likely be able to sleep better if her pain is reduced by medications.

When insomnia is the primary condition, or the primary condition is unknown, the clinician must seek to resolve the insomnia independently. Some sleep labs include an insomnia clinic. These clinics use a variety of techniques to help patients treat their insomnia including **group therapy**, **light therapy**, sleep hygiene, **sleep restriction**, **self-control techniques**, and **biofeedback**. Group therapy is useful in that it allows the patient to explore possible underlying psychological causes for the insomnia and hear the causes of other people's insomnias. Light therapy can help adjust the circadian rhythm, to help the patient initiate sleep at the appropriate time. Biofeedback mechanisms train the patient to control certain physiological parameters such as muscle tension, skin temperature, and EEG recordings, in order to gain control over their insomnia. These techniques have been shown to be effective in patients who are especially tense or stressed. Self-control techniques are more psychological in nature than biofeedback mechanisms, but the underlying purpose is the same: to allow the patient to gain control over his or her ability to initiate and maintain sleep. These are helpful for patients who feel that their lives are out of control because of any number of reasons. Sleep restriction is another useful tool for treating chronic insomnia, especially for older patients. This is particularly useful for people who tend to stay in bed for longer and longer periods of time per night. Many people with chronic insomnia may stay in bed for 10 hours per night but only sleep 6 hours. For these patients, the clinician may decide to treat the insomnia by restricting the amount of time the patient is in bed per night. This is another case in which a sleep diary may be useful.

Sleep-Related Breathing Disorders

Sleep-related breathing disorders are divided into those of central origin and those caused by an obstruction. Central breathing disorders are characterized by a lack of respiratory effort caused by either a central nervous disorder or a cardiac dysfunction.[2] Obstructive respiratory events are caused by an obstruction, usually in the upper airway, and often are associated with obesity; large tongue, tonsils, or adenoids; or inflamed tissue in the upper airway.

Obstructive Sleep Apnea, Adult

Obstructive sleep apnea (OSA) is one of the most common sleep disorders. Although common and dangerous, it is relatively easily diagnosed and treated. OSA is characterized by the presence of repeated **obstructive apneas** and **hypopneas**. Obstructive apneas are respiratory events classified by a complete cessation (defined as a decrease in amplitude of at least 90%) of airflow for at least 10 seconds, and continued respiratory effort. A hypopnea is similar to an apnea, although the decrease in airflow is 30–90% in amplitude. Both are often associated with an **oxygen desaturation** (a decrease in the amount of hemoglobin saturated by oxygen), and are often associated with other events such as body jerks, limb movements, snores, or brief (three seconds or longer) shifts in EEG frequency called **EEG arousals**.

OSA has long been believed to be a contributor to hypertension, heart disease, stroke, depression, and many other serious complications. It often leads to **excessive daytime sleepiness (EDS)**, memory loss, lack of concentration, and morning headaches.

Obesity is believed to be the largest contributor to OSA. Patients with a large neck circumference and excess body fat, particularly males between the ages of 30 and 60, are at a higher risk for OSA. Diagnostic criteria for OSA call for an **Apnea Hypopnea Index (AHI)** of at least a total of five apneas and hypopneas per hour of sleep with complaints of daytime sleepiness as well as gasping, choking, or snoring, or a **Respiratory Disturbance Index (RDI)** of at least 15 in the absence of these complaints. AHI is calculated by dividing the total apneas and hypopneas by the total sleep time in hours. RDI is calculated by dividing the total apneas, hypopneas, and **respiratory effort–related arousals (RERAs)** by the total sleep time in hours. A RERA is an EEG arousal that is associated with a marked decrease in airflow, continued respiratory effort, and consistent oxygen saturation. **Upper airway resistance syndrome (UARS)**, which is similar to OSA, is characterized by RERAs during sleep and symptoms similar to those of OSA, but that do not meet the diagnostic criteria for OSA.

Figure 2–2 illustrates an obstructive apnea. The airflow is absent despite the persistence of respiratory effort. With the chest and abdomen expanding and contracting, and no airflow through the nose or mouth, an airway obstruction exists.

Figure 2–3 illustrates a hypopnea, also an obstructive respiratory event. Like obstructive apneas, the effort persists; however, the airflow is not completely absent, but rather decreased.

Figure 2–4 shows an obstructive apnea. The respiratory effort decreases slightly, but persists despite the cessation of airflow. At the end of the event, the patient jerks the right leg as a response.

The sample in **Figure 2–5** shows another obstructive apnea with an associated EEG arousal and limb movements.

The sample in **Figure 2–6** shows an obstructive apnea during REM sleep. Notice that the cessation of airflow is easier to detect with the pressure cannula than with the thermister. **Figure 2–7** also shows an obstructive apnea.

The epoch in **Figure 2–8** shows a subtle hypopnea. The decrease in airflow would be very difficult to see using just a thermister.

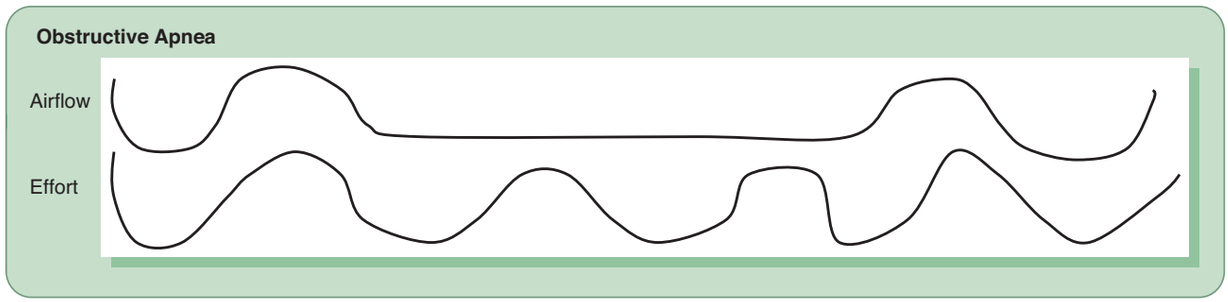

FIGURE 2–2 An obstructive apnea.

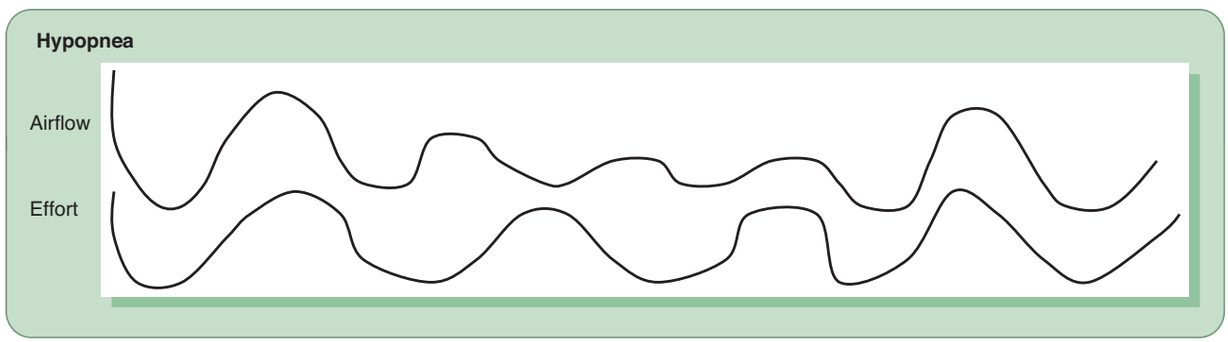

FIGURE 2–3 A hypopnea.

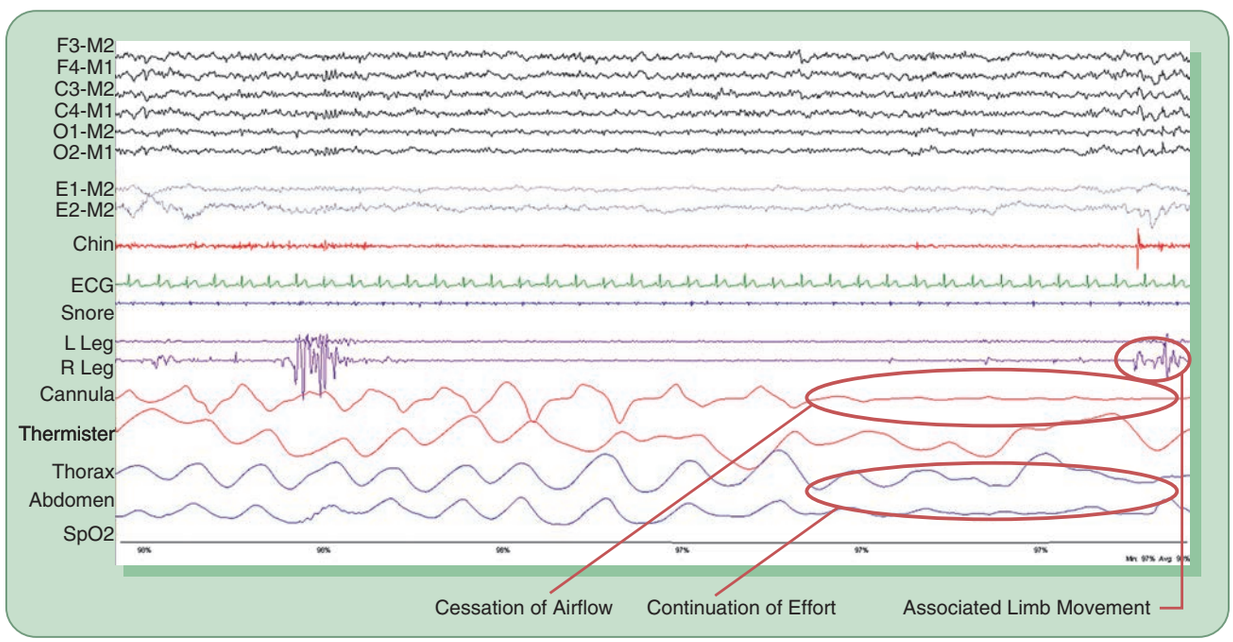

FIGURE 2–4 An obstructive apnea. At the end of the event, the patient jerks the right leg.

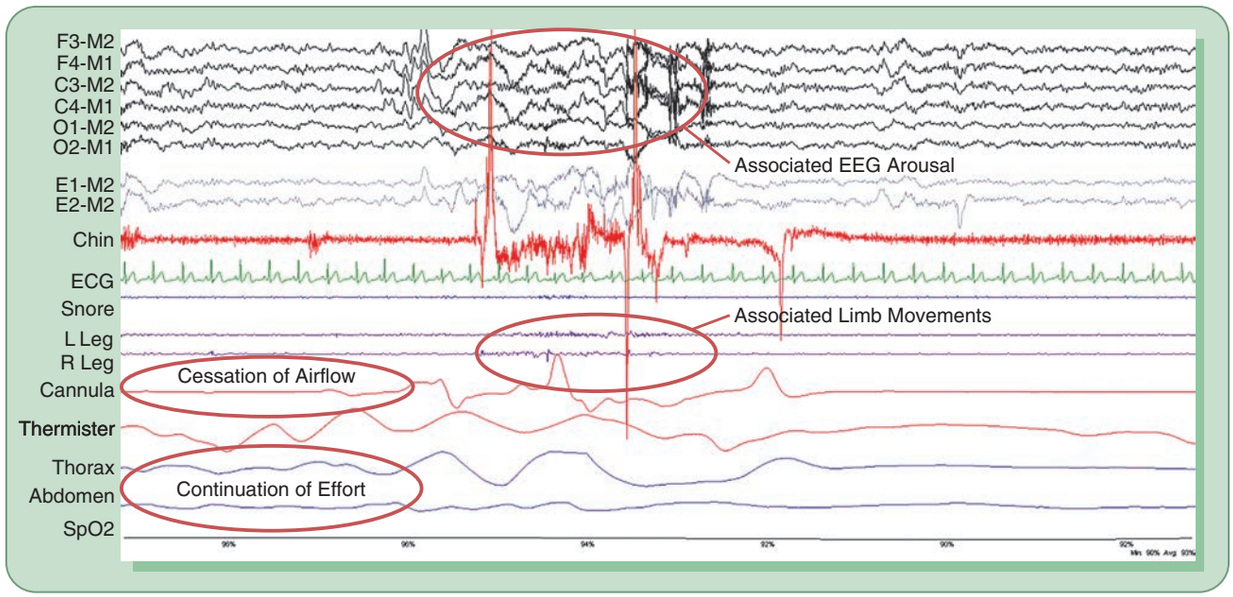

FIGURE 2–5 Another obstructive apnea with an associated EEG arousal and limb movements.

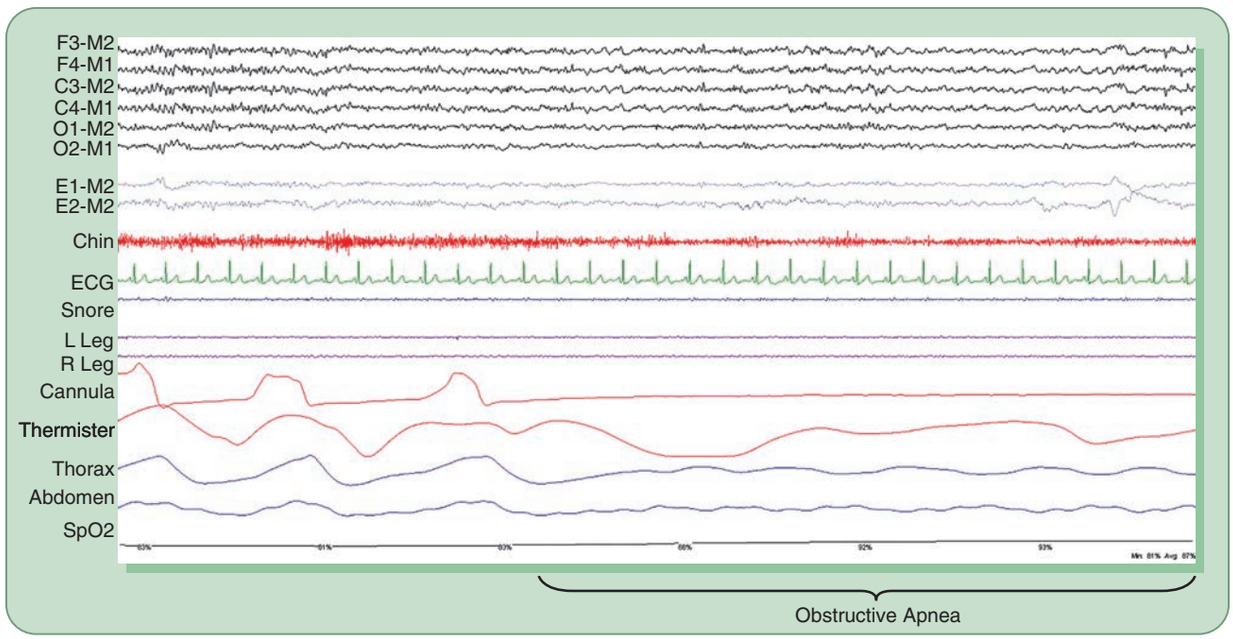

FIGURE 2–6 An obstructive apnea during REM sleep.

Obstructive Sleep Apnea, Pediatric

Like OSA in adults, pediatric OSA is characterized by obstructive apneas and hypopneas. The associated events are similar as well, and include snoring, labored breathing, morning headaches, oxygen desaturation, and hypercapnia. Paradoxical respiratory effort motion in the rib cage may be present as well.

OSA has been shown to be more prevalent in infants and children who are obese, and those with Down's syndrome. Even mild cases of pediatric OSA can have

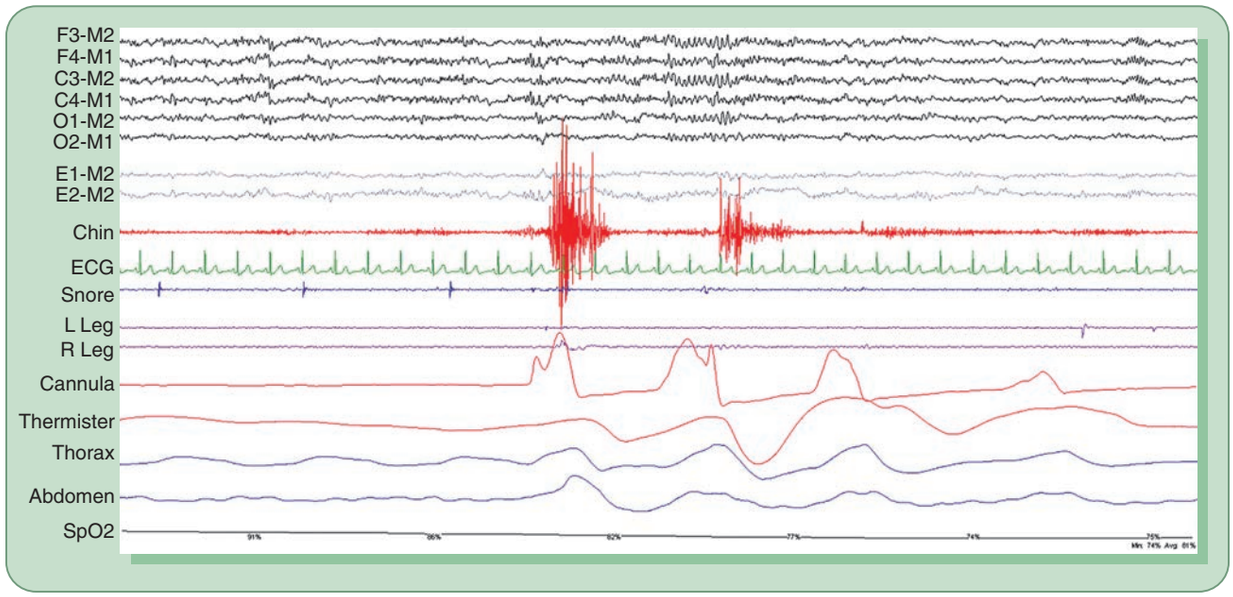

FIGURE 2–7 An obstructive apnea.

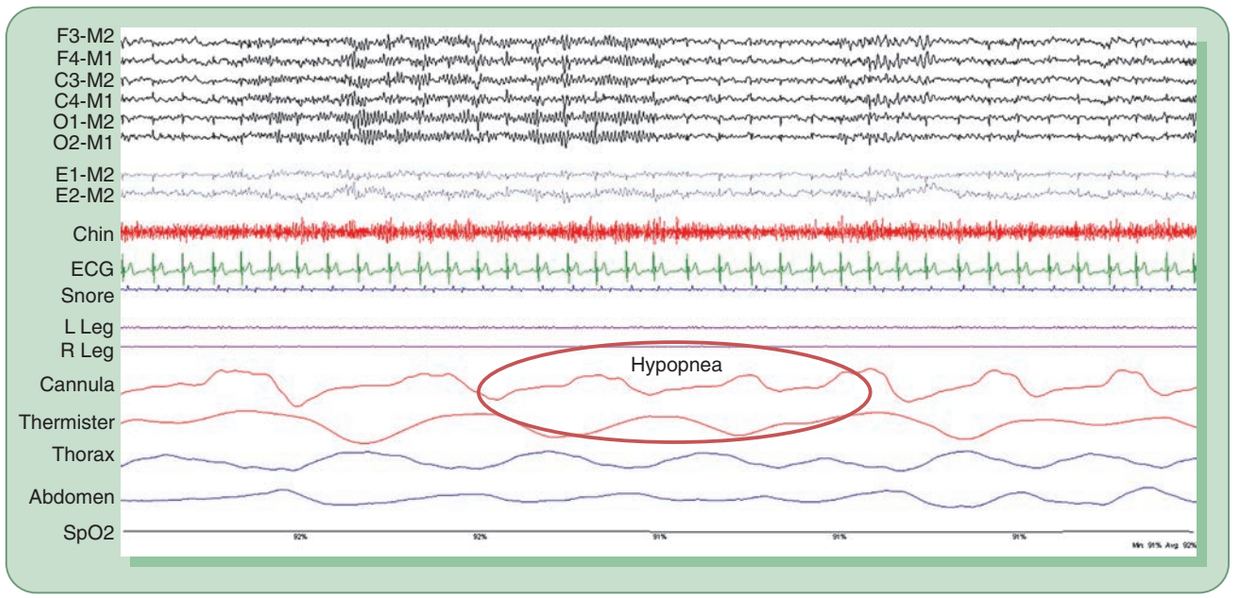

FIGURE 2–8 A subtle hypopnea.

lasting and severe effects. OSA in infants and children can inhibit both physical and mental growth, and is believed to be associated with **sudden infant death syndrome (SIDS)**, an occurrence in which an infant dies during sleep seemingly without warning. Diagnostic criteria for pediatric OSA require an average of only one obstructive apnea or hypopnea per hour of sleep. Because one of the main causes of OSA in infants and children is large tonsils or adenoids, a tonsillectomy and adenoidectomy is sometimes the most appropriate treatment. Continuous positive airway pressure (CPAP) is occasionally prescribed, but should be used with careful consideration.

Central Sleep Apnea Syndromes

Primary **central sleep apnea (CSA)** is characterized by a repeated cessation of airflow and a concurrent cessation of respiratory effort. **Central apneas** are often seen in

older patients or in patients on CPAP for the first time or with a very high CPAP pressure. This is often caused by low CO_2 levels in the blood. Normal respiratory effort comes as a result of **hypercapnia**, or the presence of a high level of CO_2. To reduce these levels, we exhale the CO_2 in our lungs. A patient with a resting $PaCO_2$ level less than 40 mm Hg is likely to have CSA. Diagnostic features of CSA include an average of at least five central apneas per hour during sleep. Occasional central apneas are also common at sleep onset. **Figure 2–9** illustrates a typical central apnea. The airflow ceases at the same time as the respiratory effort, and resumes as the effort resumes.

The sample epoch in **Figure 2–10** shows a central apnea. The airflow drops as a result of the lack of respiratory effort. When the patient attempts to breathe at the end of the apnea, he is able to do so without any difficulty because there is no obstruction present.

The sample epoch in **Figure 2–11** shows another central apnea, approximately 15 seconds long. Notice in these samples that there is very little oxygen desaturation, as is common in central events.

Figure 2–12 is another example of a central apnea, this one during REM and lasting at least 20 seconds.

Central Sleep Apnea with Cheyne-Stokes Breathing

Cheyne-Stokes breathing is similar to central sleep apnea in that the underlying cause is central. However, in Cheyne-Stokes breathing, the volume of breaths shows a distinct waning and waxing pattern. This pattern is typically seen during nonrapid eye movement (NREM) sleep and is corrected during REM. Most patients with Cheyne-Stokes breathing are males over the age of 60. The diagnostic criteria for Cheyne-Stokes breathing pattern require an average of at least 10 central apneas per hour of sleep that show a crescendo–decrescendo pattern.

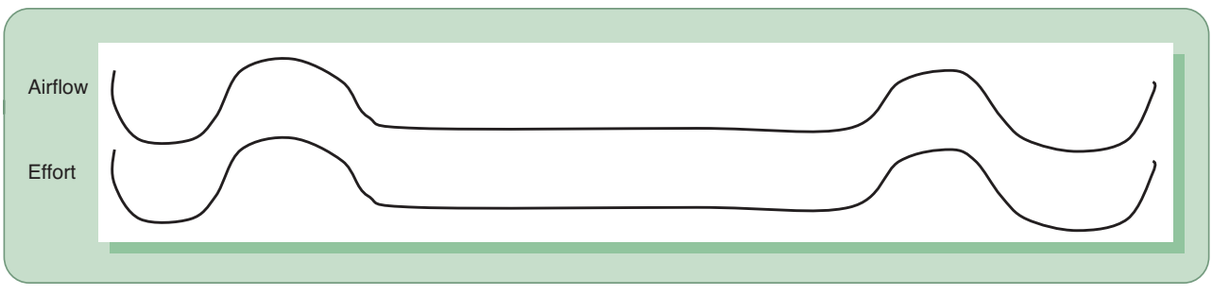

FIGURE 2–9 A typical central apnea.

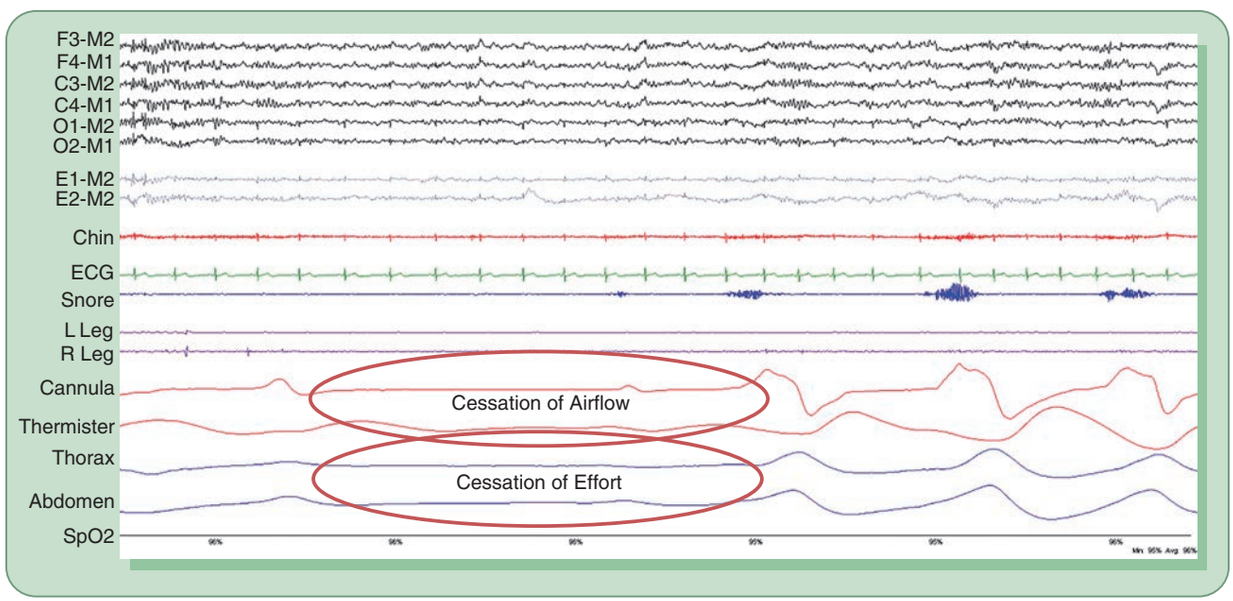

FIGURE 2–10 Another central apnea.

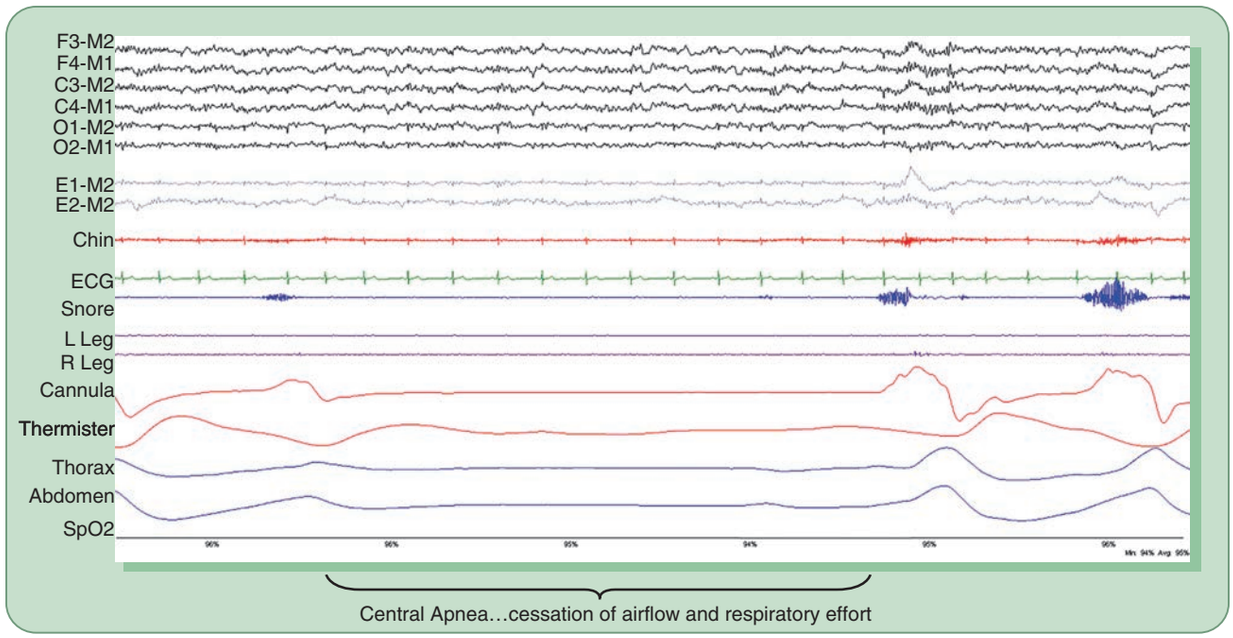

FIGURE 2–11 A 15-second-long central apnea.

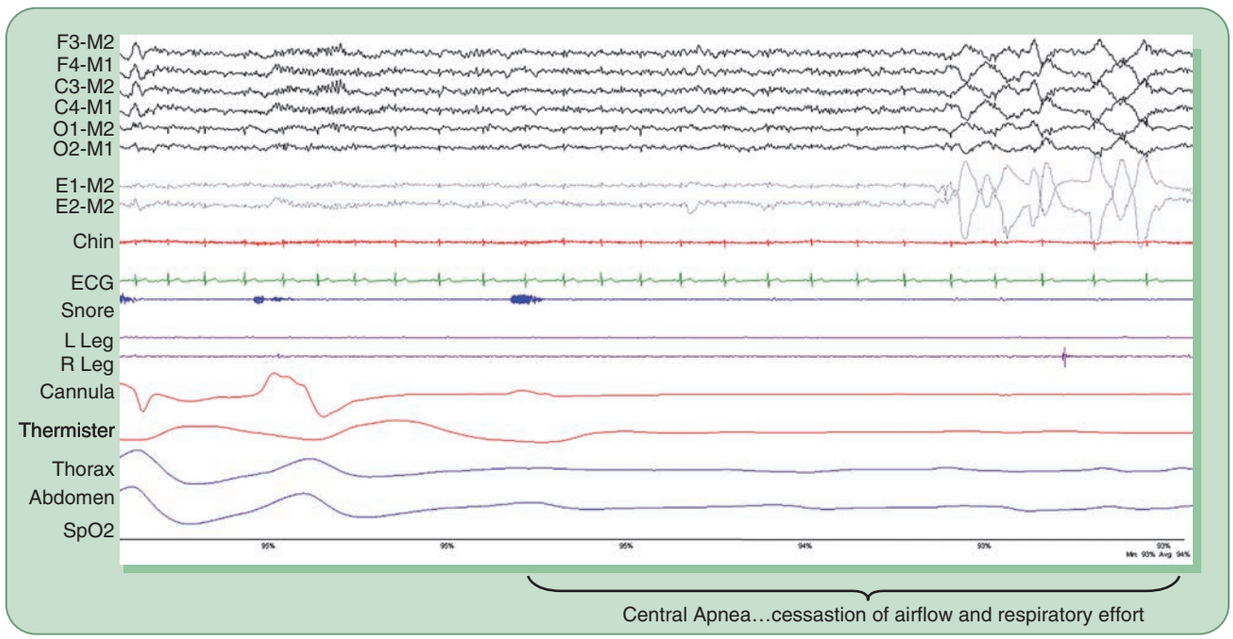

FIGURE 2–12 A central apnea during REM and lasting at least 20 seconds.

Central Sleep Apnea Due to Medical Disorder Without Cheyne-Stokes Breathing

Medical conditions such as degenerative brainstem lesions have been known to cause central respiratory events. In this case, the central respiratory events occur as a secondary disorder.

Central Sleep Apnea Due to High-Altitude Periodic Breathing

High-altitude periodic breathing disorder is characterized by central apneas and hypopneas occurring during a recent ascent to at least 4,000 meters, or approximately 12,000 feet. The events occur at least five times per hour

of sleep. The occurrence of central events during an altitude adjustment such as this is considered a normal response, and tends to correct itself when the subject returns to lower altitudes.

Central Sleep Apnea Due to Medication or Substance

Certain drugs, including methadone and hydrocodone, have been known to occasionally cause central respiratory events. In this case, the disorder is secondary in nature.

Primary Central Sleep Apnea of Infancy

This life-threatening disorder afflicting infants is characterized by long respiratory events, obstructive or central in nature, lasting at least 20 seconds. **Primary central sleep apnea of infancy** is extremely dangerous for newborns, and should be diagnosed and treated as quickly as possible.

Primary Central Sleep Apnea of Prematurity

Central sleep apnea is common in premature infants, and sometimes requires ventilator support. The diagnostic criteria for primary central sleep apnea of prematurity include a conceptional age of less than 37 weeks and either recurrent central apneas of at least 20 seconds in duration or periodic breathing for at least 5% of the duration of sleep study monitoring.

Treatment-Emergent Central Sleep Apnea

Treatment-emergent central sleep apnea, often referred to as **complex sleep apnea**, is diagnosed after the patient has been diagnosed with OSA and has had a subsequent positive airway pressure (PAP) titration. After resolution of obstructive events during the titration, central events emerge and persist with at least five central events per hour of sleep. These patients are often placed on bilevel PAP, sometimes with a backup rate to help resolve the central events. There is currently much discussion on the existence and prevalence of complex sleep apnea.

Sleep-Related Hypoventilation Disorders

Obesity Hypoventilation Syndrome

Also referred to as hypercapnic sleep apnea, **obesity hypoventilation syndrome** is characterized by hypoventilation occurring during sleep in obese individuals. This was formerly called Pickwickian syndrome, but this term is no longer preferred because it is also occasionally used to describe those who have OSA. Diagnostic criteria for this disorder include a $PaCO_2$ greater than 45 mm Hg during sleep, a body mass index (measured by kg/m2) greater than 30, and the absence of a medical disorder or medication that may cause hypoventilation.

Congenital Central Alveolar Hypoventilation Syndrome

Congenital central alveolar hypoventilation syndrome is characterized by the failure of automatic central control of breathing, and is caused by a genetic mutation in the PHOX2B gene. Subjects with this disorder experience hypoventilation during both wake and sleep, with onset usually at birth. Hypoventilation is typically worse during sleep than during wake.

Late-Onset Central Hypoventilation with Hypothalamic Dysfunction

Subjects with **late-onset central hypoventilation with hypothalamic dysfunction** are typically healthy until approximately age 2, when they develop severe obesity and central hypoventilation. Diagnostic criteria call for an absence of symptoms during the first few years of life, sleep-related hypoventilation, obesity, and a lack of mutation in the PHOX2B gene.

Idiopathic Central Alveolar Hypoventilation

Formerly called **alveolar hypoventilation** or central alveolar hypoventilation, **idiopathic central alveolar hypoventilation** is defined in the ICSD-3 as "the presence of alveolar ventilation resulting in sleep related hypercapnia and hypoxemia in individuals with presumed normal mechanical properties of the lung and respiratory pump." Diagnostic criteria for this disorder include the presence of sleep-related hypoventilation that is not primarily due to another medical disorder or medication.

Sleep-Related Hypoventilation Due to a Medication or Substance

This disorder is characterized by hypoventilation during sleep that can be traced to a medication or other substance that is known to inhibit respiration, and is not caused by a medical disorder.

Sleep-Related Hypoventilation Due to a Medical Disorder

This disorder is characterized by hypoventilation during sleep that can be traced to a medical disorder that is known to inhibit respiration, and is not primarily caused by a medication or substance.

Isolated Symptoms and Normal Variants

Snoring

Also called **primary snoring**, **snoring** is defined as audible vibrations of the upper airway during respirations in sleep. Snoring is caused by a partial obstruction of the upper airway, often including nasal obstruction, and in isolation may or may not be considered malignant. Snoring can often lead to dry mouth or irritated

tissues in the throat and can awaken the snorer or the bed partner. In some cases, snoring can be loud enough to be disruptive to sleepers in adjacent rooms. Snoring tends to increase with body mass, and may or may not be combined with obstructive apneas. Because snoring is often combined with apnea and is a common feature of OSA, it is typically investigated further with a sleep study. Snoring can often be corrected with CPAP, dental appliances, or in mild cases a multitude of other devices and methods. Many snoring treatments have been developed in the last few years, including throat lubricants, specialized pillows to further open the airway, dental devices to pull the lower jaw forward, pillar implants inserted into the soft tissues of the palate, and adhesive strips to widen the nasal cavity. The effectiveness of many of these treatments varies greatly according to the severity and other characteristics of the patient.

Catathrenia

Sleep-related groaning, or **catathrenia**, consists of repeated groaning during exhalation, mainly in REM sleep. Typically the patient is not affected by this disorder, but the bed partner's sleep is often disrupted as a result. This disorder is rare but appears to be more common in males than in females.

Central Disorders of Hypersomnolence

The ICSD-3 refers to this group of sleep disorders as those in which "the primary complaint is daytime sleepiness not caused by disturbed nocturnal sleep or misaligned circadian rhythms."[3] Sleepiness can often be classified by questionnaires such as the Epworth Sleepiness Scale or the Stanford Sleepiness Scale, or by tests such as the **multiple sleep latency test (MSLT)** or the **maintenance of wakefulness test (MWT)**.

Narcolepsy Type I

The term **narcolepsy** is derived from the Greek words *narke*, meaning numbness or stupor, and *lepsis*, meaning attack. As the name suggests, narcolepsy is a disorder characterized by sleep attacks. Narcolepsy is primarily caused by a physiological or pathological abnormality. Although the severity and symptoms of narcolepsy may vary greatly between individuals, it is characterized by a variety of symptoms, which may include excessive daytime sleepiness (EDS), **cataplexy**, and other REM-sleep phenomena such as **sleep paralysis** and **hypnagogic hallucinations**. These four characteristics constitute the **narcolepsy tetrad**. Very few narcoleptic patients suffer from all of the listed symptoms, but many suffer from more than one of these. Frequent and often irresistible napping is also a common symptom of narcolepsy. Another common symptom of narcolepsy seen in approximately 20–40% of narcoleptics is **automatic behavior**, which is characterized by the subconscious performance of activities. Often these activities appear to be performed deliberately. A common example of automatic behavior is speaking on a subject matter that is completely out of context for the situation.

EDS is the most common symptom of narcolepsy. EDS can manifest itself in many ways, such as difficulty concentrating, difficulty remaining awake during normal waking hours, decreased cognition, napping, hallucinations, memory loss, and decreased performance in work-related tasks. Memory loss and difficulty concentrating as a result of EDS often lead to poor performance in school or work (see **Figure 2–13**). Excessive daytime sleepiness can also negatively affect one's personal relationships. Individuals experiencing profound EDS are also at an increased risk for automobile accidents and work-related accidents. Nearly half of narcoleptics have reported falling asleep at the wheel.[4] Narcoleptic patients are often able to detect an oncoming sleep attack in time to fight it off; however, narcoleptics are known for falling asleep unintentionally and at inappropriate times, such as in the middle of a conversation, while laughing, or during sexual activity. Even those who fight off sleep attacks may experience periods of **microsleep**. Microsleep is a period of sleep that is so brief the individual may not be aware that he or she slept. Microsleep is often felt as a brief lack of consciousness or awareness. Brief naps may help narcoleptic patients momentarily with feelings of EDS and periods of microsleep.

One of the most well-known and disruptive symptoms of narcolepsy is cataplexy. Cataplexy comes from the Greek words *kata*, meaning down, and *plexis*, meaning stroke or seizure. Cataplexy is sometimes mistaken for seizure activity, and is characterized by a bilateral loss of muscle tone, usually provoked by strong emotion. It manifests itself as muscle weakness that can range from a mild feeling of weakness to complete limb atonia with a resulting fall. Patients suffering from cataplexy may drop items they are holding, which can cause embarrassment or can be hazardous. Periods of cataplexy usually last only a few seconds, but if prolonged they may lead to a period of REM sleep. Cataplexy is seen in approximately 70%

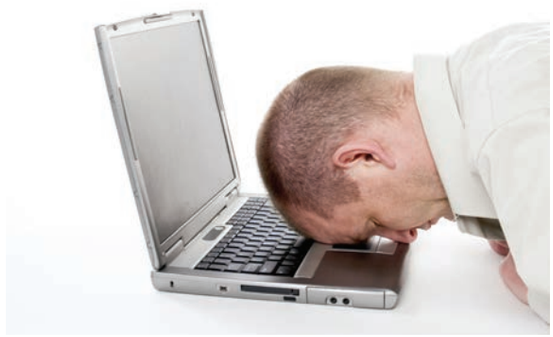

FIGURE 2–13 An individual experiencing severe excessive daytime sleepiness.

of narcoleptics, but often these individuals are able to control the symptoms by controlling emotional stimuli. **Narcolepsy type I** includes the diagnosis of narcolepsy with the complaint of cataplexy. This type was formerly called narcolepsy with cataplexy.

Sleep paralysis, another symptom of narcolepsy, is characterized by a partial or total paralysis of skeletal muscles that occurs upon awakening or at sleep onset. When occurring at sleep onset, this is called **hypnagogic**; when it occurs upon awakening it is referred to as **hypnopompic**. The average REM latency for a normal, healthy adult sleeper is 90–120 minutes; in contrast, narcoleptics with sleep paralysis may enter REM sleep immediately or almost immediately after sleep onset. Sleep paralysis occurs in about 25% of narcoleptic patients, and is also often associated with hypnagogic and/or hypnopompic hallucinations, which are seen in approximately 30% of narcoleptic sufferers. These hallucinations are characterized by vivid, dreamlike experiences occurring at sleep onset or upon awakening. They are often accompanied by intense feelings of fear. Sleep paralysis and hypnagogic and hypnopompic hallucinations may also be seen in subjects other than narcoleptics who are severely sleep deprived. Typical onset for narcolepsy is during the late teen years or early 20s, and although there is no known cure, there are treatments available that have been shown to be effective against the symptoms of narcolepsy. Although the exact cause of narcolepsy is not known, there appears to be a strong genetic component. There also appear to be certain variations in an area on the sixth chromosome called the HLA complex that tend to increase the likelihood of developing narcolepsy. Additional studies of the brains of narcoleptic patients have found increased levels of norepinephrine, dopamine, and epinephrine. In some cases, severe head injuries and brain tumors have been known to cause narcolepsy.

Narcoleptic patients often suffer from depression, possibly as a result of the inability to carry out certain normal activities, and are often underachievers. This can also lead to low self-esteem.

Because of the large number of sleep disorders with resulting symptoms similar to those of narcolepsy, diagnosing the disorder may be difficult. Physicians suspecting narcolepsy may have the patient complete certain sleepiness scales or a sleep diary. Most importantly, the physician should order an MSLT preceded by an overnight diagnostic sleep study. The overnight diagnostic sleep study is to rule out the presence of other sleep disorders such as OSA or periodic limb movement disorder, which are often the underlying causes of certain narcoleptic symptoms. The MSLT is performed the following day and consists of a series of four or five short nap opportunities. The patient is given the opportunity to fall asleep during these periods, and if asleep within 20 minutes, is monitored for the next 15 minutes. REM periods and early sleep onsets during these naps can be indicators of narcolepsy. Whereas the average sleep latency for normal sleepers usually ranges from 5 to 20 minutes, more than 80% of narcoleptic patients have an average sleep latency of less than 5 minutes. **Sleep onset REM periods (SOREMPs)** are also indicators of narcolepsy. Two or more SOREMPs during five MSLT naps and the previous night's diagnostic sleep study may be indicative of narcolepsy. The final diagnosis is based on medical history, physical examination, patient questionnaires, and sleep study results.

As mentioned earlier in this section, there is currently no known cure for narcolepsy; however, certain behavioral and medical treatments have been shown to be effective in treating the symptoms. A behavioral treatment that has been shown to be very effective in narcoleptics is taking short, regularly scheduled naps during the daytime. Narcoleptics also may find it helpful to discuss their disorder and its associated symptoms with friends, family members, and coworkers. Doing so can help relieve some of the embarrassment and stress that may occur with EDS and some of the other symptoms of narcolepsy. Perhaps the most significant behavioral treatment for narcoleptics is to practice proper sleep hygiene. Sleep hygiene techniques include practices that are beneficial to the quality of one's sleep, and have been shown to be effective in improving a patient's ability to initiate and maintain sleep and remain awake and alert during the daytime. Examples of sleep hygiene practices include retiring and awakening at consistent times from day to day; avoiding caffeine, alcohol, and sedatives; getting regular exercise but avoiding heavy exercise within four hours of retiring; avoiding reading or watching television while in bed; and avoiding greasy, fatty foods and snacks. Consistently practicing proper sleep hygiene techniques can greatly improve the quality of sleep and the quality of life for both narcoleptics and normal sleepers.

In addition to behavioral modifications, narcoleptics may use certain medications to treat the disorder and its symptoms. The most common medications used to treat narcolepsy are CNS stimulants such as Provigil, Ritalin, and Dexedrine. Amphetamine-like stimulants such as methylphenidate and methamphetamine are also commonly used to treat narcolepsy. CNS stimulants are the most commonly prescribed drugs for treating narcoleptics with excessive daytime sleepiness; REM suppressants and antidepressants are often used to treat narcoleptics with cataplexy, hypnagogic hallucinations, and sleep paralysis. In recent years, fluoxetine and monoamine oxidase inhibitors have also been shown to be useful in treating cataplexy. The diagnostic criteria for narcolepsy call for a mean sleep latency of eight minutes or less during an MSLT, at least two sleep onset REM periods during the five MSLT naps and the diagnostic study from the previous night, and the irresistible need to sleep or daytime lapses into sleep for at least three months. Diagnostic criteria for narcolepsy type I also include cataplexy.

Narcolepsy Type II

Narcolepsy type II is characterized by a diagnosis of narcolepsy as defined in the ICSD-3, but without the presence of cataplexy. An additional diagnostic criterion for narcolepsy type II requires that either cerebrospinal fluid (CSF) hypocretin-1 concentration was not measured or that it is measured at > 110 pg/mL.

Idiopathic Hypersomnia

Idiopathic hypersomnia is characterized by EDS, refreshing naps, decreased sleep latency (less than eight minutes average on an MSLT), an absence of cataplexy, and a sleep period of a normal duration (6–10 hours). Although these symptoms may be common secondary symptoms in other disorders, the diagnostic criteria for this disorder require the absence of other sleep disorders causing them.

Kleine-Levin Syndrome

Also referred to as **recurrent hypersomnia** or **periodic hypersomnolence**, **Kleine-Levin syndrome** occurs when a patient experiences repeating episodes of **hypersomnia** (excessive sleeping). Patients may sleep 16–18 hours a day during these periods, and have associated symptoms including hallucinations and confusion. These periods of hypersomnia may last as long as four weeks, and recur at least once a year. A typical episode lasts approximately 10 days, with some rare cases lasting several weeks.

Hypersomnia Due to Medical Disorder

This disorder exists when a primary medical condition is the underlying cause for hypersomnia. Patients with this diagnosis have the symptoms of hypersomnia, but the daytime sleepiness occurs as a result of a medical disorder.

Hypersomnia Due to Drug or Substance

This disorder is present when the use or abuse of a drug or medication is responsible for extended periods of sleepiness or excessive sleep. This can occur as a result of drug abuse or prescribed use of certain medications.

Hypersomnia Associated with a Psychiatric Disorder

Patients with this disorder meet the diagnostic criteria for hypersomnolence, but the daytime sleepiness is associated with a psychiatric disorder. This is most common among those with mood disorders such as depression, bipolar disorder, and seasonal affective disorder.

Insufficient Sleep Syndrome

A very common sleep disorder in today's busy world, **insufficient sleep syndrome** is characterized by not sleeping long enough to satisfy physical and psychological needs. Common alternate names include chronic sleep deprivation and sleep restriction. Diagnostic criteria for insufficient sleep syndrome include daytime lapses into sleep, a total sleep time less than expected for the patient's age for a period of at least three months, and an absence of another sleep disorder, medication, or mental or physical disorder that may cause the symptoms. Sleep patterns, durations, and times are often recorded in a sleep log or with actigraphy. Although there are many possible causes of insufficient sleep syndrome, it is common during the teenage years when the need for sleep is high but the subject's lifestyle is not conducive to adequate sleep periods.

Circadian Rhythm Sleep–Wake Disorders

Circadian rhythm sleep–wake disorders are characterized by a disturbance or disruption to the normal circadian rhythm, which causes the patient to experience excessive daytime sleepiness, insomnia, or both. When the sleep schedule is not a consistent part of the circadian rhythm, it can greatly disturb the ability to initiate or maintain sleep, or the ability to achieve restful, restorative sleep.

Delayed Sleep–Wake Phase Disorder

Delayed sleep–wake phase disorder is characterized by a later sleep time than expected or desired. A patient with this disorder is unable to fall asleep at the desired time or at a time that is considered normal, but is able to at a later time in the night. The patient then sleeps until late in the morning. This disorder is common in adolescents or young adults who develop habits of staying up late at night.

Advanced Sleep–Wake Phase Disorder

Advanced sleep–wake phase disorder is characterized by an earlier sleep time than expected or desired. A patient with this disorder has difficulty staying awake until the normal or expected bedtime, but then awakens early in the morning. This is common in older adults who develop the lifestyle of eating and sleeping at earlier times than they did at younger ages.

Irregular Sleep–Wake Rhythm Disorder

Irregular sleep–wake rhythm disorder is characterized by abnormal sleep and wake times. Although the total sleep time during the 24-hour cycle is comparable with normal sleepers, the sleep periods may come in the form of several naps as opposed to one main sleep period. The patient also experiences periods of insomnia and EDS.

Non-24-Hour Sleep–Wake Rhythm Sleep Disorder

Formerly called **free-running disorder**, **non-24-hour sleep–wake rhythm sleep disorder**

is characterized by a circadian rhythm not consistent with the 24-hour clock. The patient's circadian rhythm

is often longer than 24 hours, and does not seem to be related to the light–dark cycle. Many patients with this disorder are blind.

Shift Work Disorder

Patients with **shift work disorder** are assigned to work a shift that occurs during the late night or early morning hours, such as the graveyard shift. As a result of the disturbance of the circadian rhythm, the patient typically experiences EDS. As a result, many of these workers have poor work performance, impaired judgment, and reduced wakefulness while at work. Much research has been done on the topic of shift work and its effects on the human body, as more and more people are assigned to work during the normal sleep period.

Jet Lag Disorder

Jet lag disorder occurs when a person travels across two or more time zones, resulting in EDS or insomnia. Other symptoms such as gastrointestinal disturbances or poor performance often occur.

Circadian Rhythm Sleep Disorder Not Otherwise Specified

This disorder is characterized by a disturbance to the normal circadian rhythm that does not meet the criteria for other disorders in this class of sleep disorders. Most of these are secondary to medical conditions or medication or substance use. Examples of medical conditions associated with this condition include disturbances due to dementia, Alzheimer's disease, and movement disorders such as Parkinson's disease.

Parasomnias

A **parasomnia** is an unwanted physical movement or action during sleep. Commonly occurring parasomnias include walking and talking in sleep. This group of sleep disorders is classified by disorders of arousal from NREM sleep, those associated with REM sleep, and other parasomnias.

Disorders of Arousal from NREM Sleep

Confusional Arousals

A **confusional arousal** occurs when a person awakens in a confused state. This usually occurs when awakening from slow wave sleep during the first third of the night, but can occur upon awakening from any stage of sleep. Upon awakening, a person with a confusional arousal may be confused about who they are, where they are, and what is happening around them. Their speech may be slurred and their mental processes slowed. Other sleep disorders such as insomnia or hypersomnia can increase the prevalence of confusional arousals, as can shift work or sleep deprivation.

Sleepwalking

Sleepwalking is a disorder characterized by certain behaviors during slow wave sleep such as sitting up in bed, walking, or jumping up and running from the bed. Sleepwalking can range from common behaviors such as walking calmly through the bedroom or house to violent, unusual, or dangerous behaviors such as jumping out of a second story window. Because of this, sleepwalking has received much interest over the years. Behaviors such as sexual activity, texting, or even homicide have been known to occur during sleep. Sleepwalking is common in children and is considered normal in most prepubescent cases.

Sleep Terrors

Sleep terrors, also known as **night terrors**, are characterized by awakenings from slow wave sleep with feelings of intense fear. These events begin with a loud scream or cry and typically involve the patient jumping out of bed and often committing violent acts. Upon going back to sleep after a sleep terror, the patient will usually return directly to slow wave sleep and have no recollection of the event in the morning.

Sleep-Related Eating Disorder

Sleep-related eating disorder is characterized by repeated episodes of eating and/or drinking during arousals from sleep. This often occurs on a nightly basis or even several times per night, and the patient usually chooses junk foods that are not typically eaten during the day. The patient may eat strange combinations of foods or even dangerous substances. Most patients with this disorder are very difficult to awaken during these episodes and have no recollection of them in the morning. Patients with this disorder will often gain weight as a result of the high volume of junk foods eaten during the night. They may also injure themselves while cooking during sleep.

REM-Related Parasomnias

REM Sleep Behavior Disorder (RBD)

REM sleep behavior disorder (RBD) consists of physical events or activities occurring during REM sleep. In normal sleepers, muscle atonia occurs during REM. In patients with RBD, muscle tone is maintained during REM sleep, and the muscles may twitch or move. Periodic limb movements frequently occur during REM in patients with RBD. Patients with RBD often demonstrate **isomorphism**, or acting out dreams. Upon awakening, the patient is likely to remember the dream he or she acted out. Occasionally, the patient may act out violently, performing such acts as flailing the arms, hitting, kicking, yelling, and so on. Polysomnograms performed to diagnose RBD typically include arm leads to detect muscle twitches or movements and extra EEG leads to rule out seizure activity.

Recurrent Isolated Sleep Paralysis

Sleep paralysis, a symptom sometimes associated with narcolepsy, refers to the inability to move at sleep onset (hypnagogic) or upon awakening (hypnopompic). Periods of sleep paralysis may last a few seconds to several minutes. Because sleep paralysis is a common symptom of narcolepsy, diagnostic criteria for **recurrent isolated sleep paralysis** call for a negative diagnosis of narcolepsy. Sleep paralysis is often caused by periods of sleep deprivation or shifting sleep times or habits.

Nightmare Disorder

A **nightmare** is a common occurrence in which a person has an intense, frightening dream that causes an awakening. Often upon awakening, the person is still frightened because of the intensity of the nightmare. Nightmares are very common in children and are considered normal for this age group. As a person grows into adolescence, nightmares typically reduce in frequency and intensity. Nightmares are common in patients with **posttraumatic stress disorder (PTSD)**. A patient with PTSD is likely to experience nightmares that relive or cause the patient to re-experience the event(s) that led to PTSD. Nightmares occur during REM sleep, which is when most dreaming occurs, and often cause the person to delay falling back to sleep.

Other Parasomnias

Exploding Head Syndrome

Exploding head syndrome is a sleep disorder characterized by an imagined loud noise or sense of explosion in the head while falling asleep or awakening. Occasionally, the patient may believe that he or she sees a flash of bright light. No other physical complaints occur with this disorder, and there are no malignant physical effects to these episodes other than occasional feelings of pain in the head.

Sleep-Related Hallucinations

Like sleep paralysis, **sleep-related hallucinations** are common features of narcolepsy. Hypnagogic and hypnopompic hallucinations often occur in patients with narcolepsy; the patient experiences a visual hallucination either just before sleep onset or at awakening. These hallucinations are often related to sleep onset REM periods, and may be frightening and vivid enough to cause the patient to jump out of bed and occasionally injure him- or herself. Diagnostic criteria for sleep-related hallucinations require the absence of other sleep disorders such as narcolepsy that could be the primary cause. These episodes occur more frequently in adolescents and young adults, and can be a secondary feature of Parkinson's disease or dementia.

Sleep Enuresis

Also called **nocturnal enuresis** or **bedwetting**, **sleep enuresis** is characterized by repeated episodes of involuntary urination during sleep. Patients suffering from this disorder do not respond to bladder sensations by awakening or restricting the flow of urine. This is very common in children and infants, and is considered normal in subjects of this age group. Diagnostic criteria for sleep enuresis require the patient to be at least five years of age and wet the bed at least twice a week. Secondary sleep enuresis can occur in patients with PTSD, those who are victims of abuse, or those who are experiencing the enuresis as a result of a medical condition such as diabetes.

Parasomnias Due to Medical Disorder

These disorders are secondary to a medical condition that leads to the parasomnia. Certain neurological disorders such as Parkinson's disease or dementia can lead to sleep-related hallucinations.

Parasomnias Due to Medication or Substance

These disorders are secondary to drug or medication use or abuse. Some medications, including tricyclic antidepressants and some treatments for Alzheimer's disease, can cause RBD. Consuming large amounts of caffeine can also lead to RBD.

Isolated Symptoms and Normal Variants

Sleep Talking

Talking during sleep can occur at any age, during any stage of sleep, and in people who are otherwise normal and healthy. **Sleep talking** is often considered benign unless it disturbs the sleep of the talker or the bed partner, or is associated with other behaviors in sleep. Many people talk in their sleep without knowing it until they begin to share their room with someone else.

Sleep-Related Movement Disorders

Sleep-related movement disorders are a class of sleep disorders characterized by simple, often repetitive movements during sleep or wake that can disrupt the sleep of the patient, the bed partner, or both.

Restless Legs Syndrome (RLS)

Restless legs syndrome (RLS) is a disorder characterized by the irresistible urge to move the body in an effort to stop uncomfortable or odd sensations, most often in the legs. These sensations or feelings are typically described as creeping, crawling, itchy, burning, or tingling feelings. These feelings and symptoms tend to increase during periods of relaxation, such as while watching television, reading, or attempting to fall asleep. Because these feelings usually occur at night while the individual is attempting to fall asleep, restless legs syndrome often leads to complaints of insomnia.

Individuals suffering from RLS often find themselves rubbing or slapping their legs, twitching their muscles, bouncing their feet, jerking their legs, and getting up to walk around the room in order to alleviate the feelings of

restlessness. The amount of time required to alleviate the symptoms of RLS can range anywhere from a few minutes to over an hour.

Restless legs syndrome onset can occur at any age, including infancy. RLS in children is often misdiagnosed as hyperactivity or growing pains. Most RLS sufferers begin experiencing symptoms by young adulthood and continue to experience these symptoms throughout their lives. RLS affects more than 5% of the total population in the United States. The severity and frequency of RLS symptoms tend to vary with stress, pain, illness, or other factors. They often appear during pregnancy and disappear immediately after pregnancy. The most commonly associated medical condition with RLS is iron deficiency. Obstructive sleep apnea, Parkinson's disease, diabetes, and rheumatoid arthritis are other medical conditions that are commonly seen in RLS patients. Certain medications such as antihistamines, antidepressants, and antipsychotics can worsen the symptoms of RLS. Medications used to treat RLS often include dopamine agonists, opioids, benzodiazepines, and anticonvulsants. Massage and musculoskeletal manipulations have also been found to be helpful in some cases.

Sleep technicians should watch their patients carefully for signs of RLS and make note of them for the physician. Because patients are often not aware of this disorder, it is important for the technician to ask the patient appropriate questions to help the physician determine if RLS is present. Many patients with RLS also have **periodic limb movement disorder (PLMD)**.

Periodic Limb Movement Disorder (PLMD)

Periodic limb movement disorder, also called **periodic limb movements in sleep (PLMS)**, and formerly known as nocturnal myoclonus, is a common sleep disorder affecting approximately one third of adults over the age of 60 years. This disorder occurs when the patient involuntarily moves the limbs (usually the legs) during sleep, and other symptoms occur as a result of this movement. These movements are repetitive and occur in periodic episodes, and are seen mostly in stage N2. The symptoms of PLMD are not usually seen during REM sleep because of the muscle atonia that occurs during REM.

The most common symptoms of periodic limb movement disorder include fragmented sleep architecture, daytime sleepiness, and frequent EEG arousals. These symptoms tend to increase with stress and certain medications such as tricyclic antidepressants. Periodic limb movement disorder not only affects the sleep of the individual suffering from the disorder, but also can often, and in some cases more severely, affect the sleep of the bed partner who is being kicked during the night. As a result, PLMD patients are often referred to the physician by the spouse or bed partner.

The most common treatments for PLMD include the use of certain medications. Benzodiazepines, which suppress the muscle contractions, are perhaps the most commonly prescribed medications for PLMD. Dopaminergic agents have been shown to regulate muscle movements during sleep. Anticonvulsant agents have also been effective in inhibiting the muscle contractions, and GABA agonists also help relax muscle contractions.

On the polysomnogram, periodic limb movements last 0.5 to 5 seconds. Periodic limb movements occur within 5 to 90 seconds of each other, and at least four of these movements occur in a series. The required amplitude of these limb movements is at least 8 μV higher than the resting electromyogram (EMG) amplitude.

A **PLM index** is calculated by dividing the total number of periodic limb movements by the total sleep time in hours, giving an average number of periodic limb movements per hour of sleep time. PLMD may be diagnosed if the patient has a PLM index greater than 15 per hour, or 5 per hour in children.

The sample shown in **Figure 2–14** shows a series of six periodic limb movements on a 300-second epoch. They are not associated with respiratory events, and they occur during NREM sleep.

The sample in **Figure 2–15** shows another 300-second epoch in which four periodic limb movements occur. In this example, both legs are showing movement.

Finally, in the sample shown in **Figure 2–16** we again see limb movements (outlined with dark circles) in a 300-second epoch. However, the limb movements in this case are preceded by respiratory events (outlined with lighter circles on the line below). Because the respiratory events appear to be the primary cause of the limb movements, these would not be considered part of a PLMD diagnosis. If periodic limb movements persisted after the respiratory events were corrected, the patient may then be diagnosed with PLMD.

Sleep-Related Leg Cramps

This disorder is characterized by intense and sudden muscle cramps in the legs during sleep. These muscle cramps are often painful, and result in the patient waking up from sleep, thereby disturbing the sleep period. Occasional **sleep-related leg cramps** are very common in the elderly, and have been reported only occasionally in infants and young children.

Sleep-Related Bruxism

Bruxism is grinding the teeth or clenching the jaw during sleep. This parasomnia is usually discovered or initially suspected by the patient's dentist, who may see evidence of the teeth grinding. **Sleep-related bruxism** can occasionally cause the patient to awaken, but is often more disruptive to the bed partner. The patient may experience muscle soreness or headaches in the morning, but more importantly can grind down the enamel of the teeth. Bruxism is most commonly seen among children and adolescents, who typically grow out of the disorder; however, some people experience bruxism their entire lives. For many, a dental appliance such as a mouth guard is appropriate and can be effective in preventing further damage to the teeth.

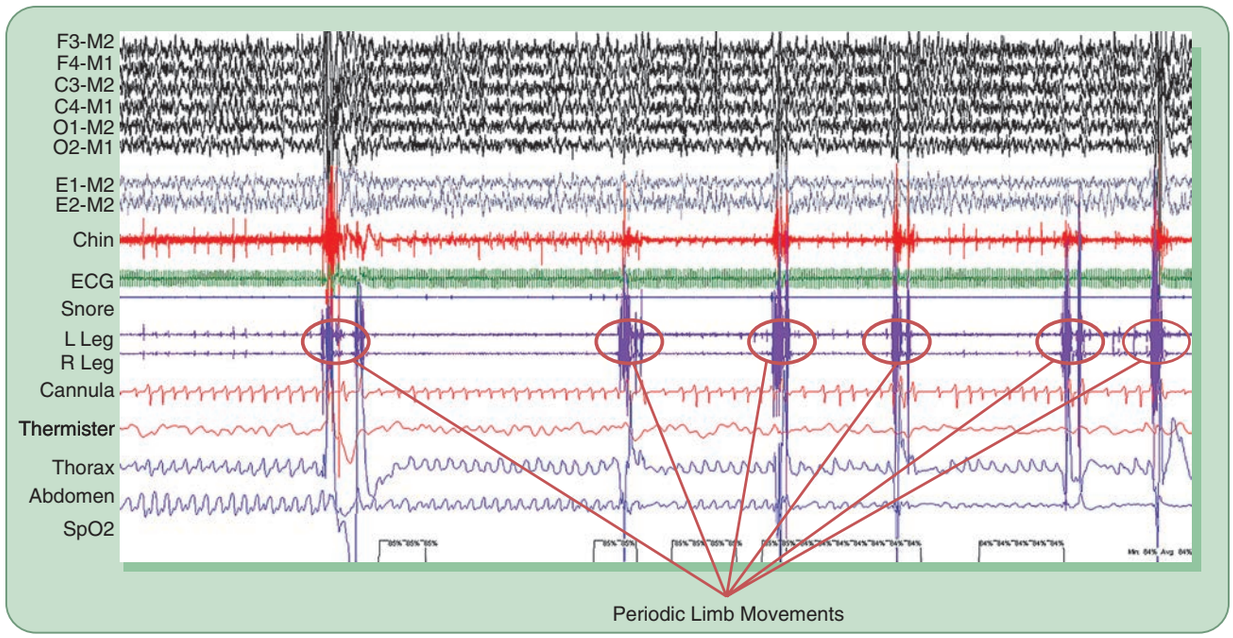

FIGURE 2–14 A series of six periodic limb movements on a 300-second epoch.

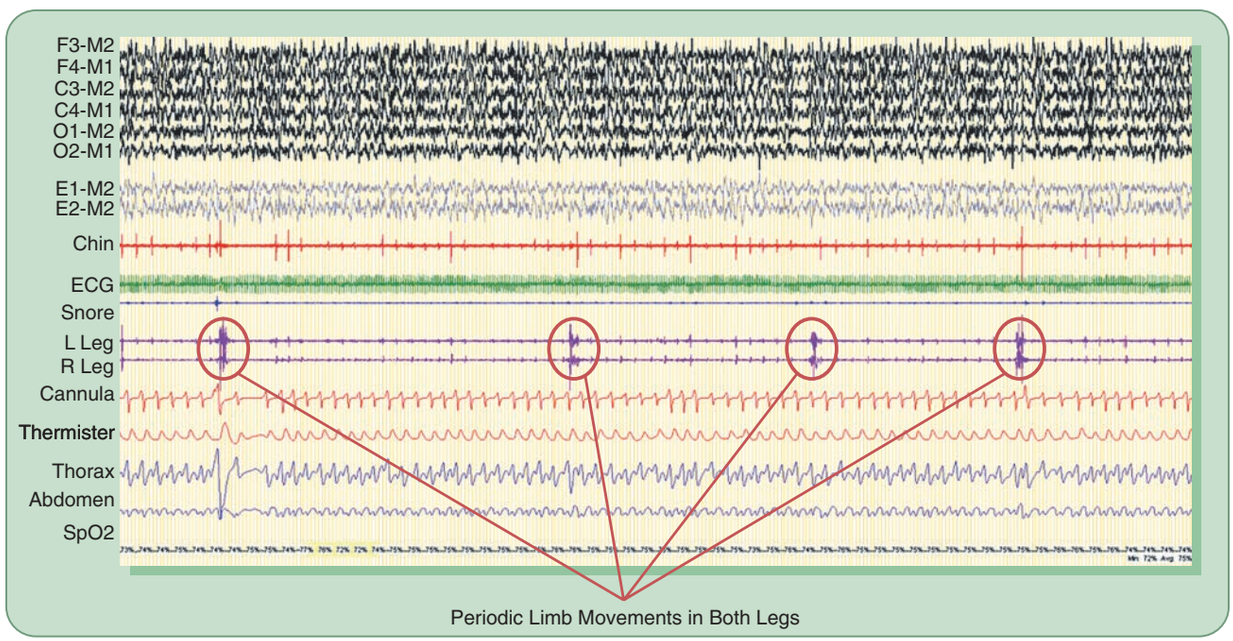

FIGURE 2–15 Another 300-second epoch, this one showing four periodic limb movements.

The sample epoch in **Figure 2–17** shows a patient with sleep-related bruxism. The events directly under the arrows show disruptions in the EEGs, electro-oculograms (EOGs), chin EMG, and snore channel. When a patient clenches the jaw or grinds the teeth, many muscles in the face, head, jaw, and neck will tighten, causing disruption in several channels, as shown in the figure. Heavy snoring can cause the same effect, so it is important that the technician make note of snores. In this case, the technician saw these events and noted that no snoring was present.

The arrows in the sample shown in **Figure 2–18** again point to episodes of bruxism, or grinding of the teeth or clenching of the jaw.

The sample epoch in **Figure 2–19** shows another example of sleep-related bruxism. The episodes of jaw

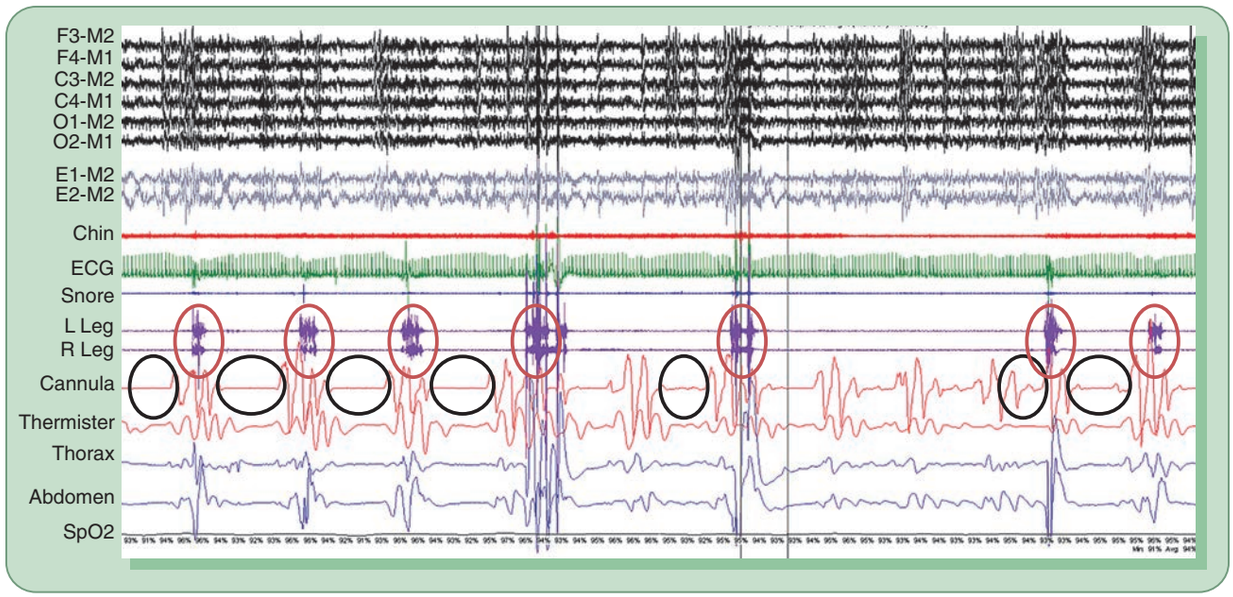

FIGURE 2–16 Limb movements in a 300-second epoch preceded by respiratory events.

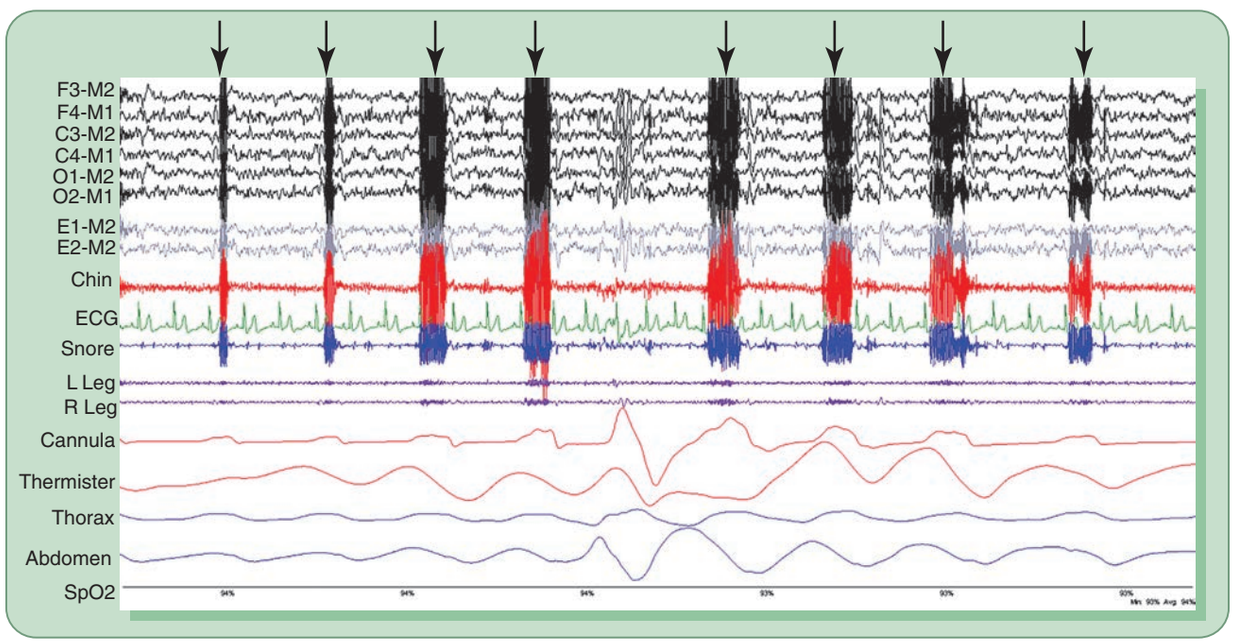

FIGURE 2–17 Sleep-related bruxism.

clenching or teeth grinding are shown underneath the arrows. Again, the muscle activity is shown throughout all the leads on the head.

Sleep-Related Rhythmic Movement Disorder (RMD)

Also known as **body rocking** or **head banging**, **sleep-related rhythmic movement disorder** is characterized by repetitive body movements during drowsiness or sleep. As the names suggest, body rocking refers to the entire body moving back and forth, whereas head banging refers to movements of the head. A majority of patients affected with this disorder are infants, and it is considered normal for infants to perform rhythmic motions like this on occasion. By the age of five, very few children have these symptoms. These movements can cause a disturbance to sleep, and may occasionally cause harm to the person inflicted or to the bed partner.

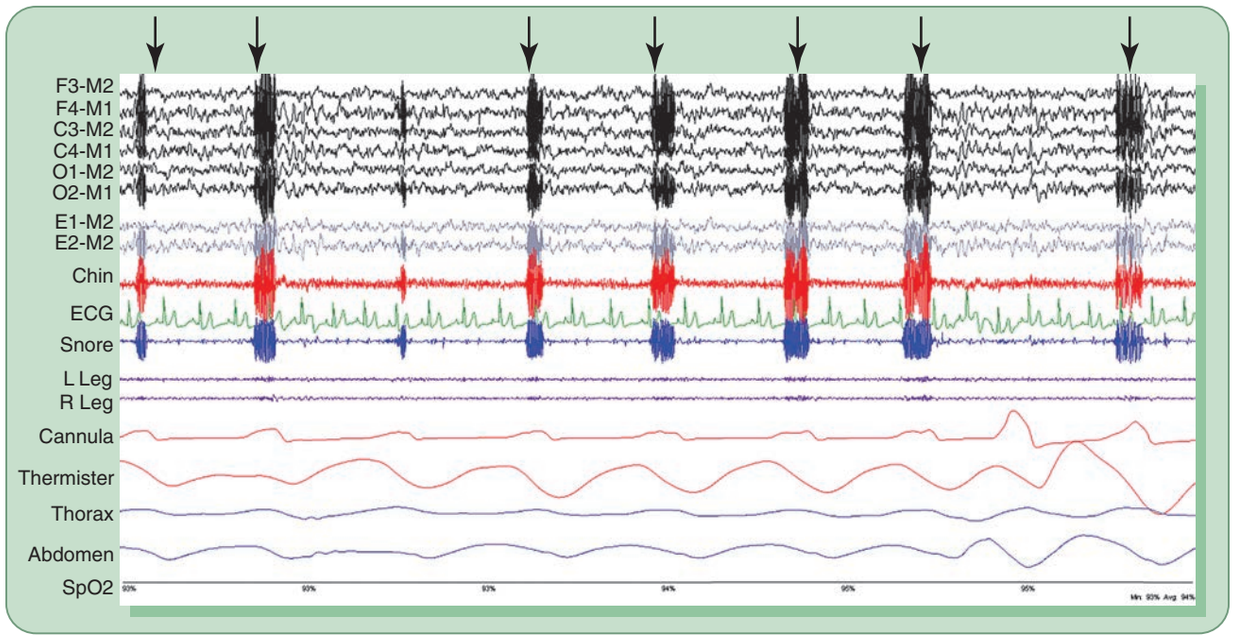

FIGURE 2–18 Another episode of bruxism.

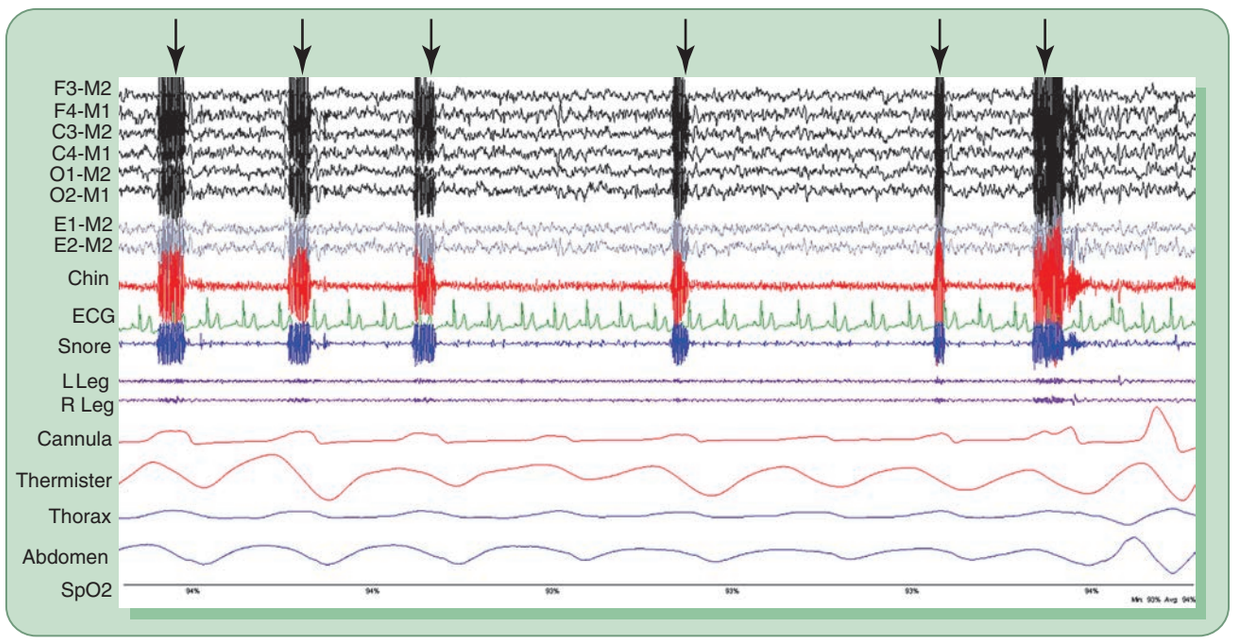

FIGURE 2–19 A third example of sleep-related bruxism.

Benign Sleep Myoclonus of Infancy (BSMI)

Myoclonus, or limb jerks or movements during sleep, can occur at any age; however, it is very rarely seen in infants. In the cases in which these repetitive leg jerks or movements have been noted during infancy, they have typically resolved by the age of six months and do not appear to pose any serious threat to the infant's sleep or health, other than occasional arousals from sleep.

Propriospinal Myoclonus at Sleep Onset (PSM)

Propriospinal myoclonus at sleep onset (PSM) are events similar to sleep starts but mainly involve body movements in the abdominal, trunk, and neck areas.

They typically occur at sleep onset or during brief arousals from sleep.

Sleep-Related Movement Disorder Due to Medical Disorder

This disorder is classified as movement disorders caused by a medical condition. Certain medical conditions such as Parkinson's disease can cause involuntary muscle movements during sleep, disrupting the sleep period.

Sleep-Related Movement Disorder Due to Medication or Substance

This category is reserved for movement disorders in sleep that are caused by drug use or abuse.

Isolated Symptoms and Normal Variants

This group of sleep disorders consists of characteristics that are borderline abnormal, but are not otherwise specific disorders.

Excessive Fragmentary Myoclonus

Excessive fragmentary myoclonus is characterized by frequent small twitches of fingers, toes, or muscles of the mouth during wake or sleep. They are typically insignificant and benign in nature. They occur during NREM sleep, and persist for at least 20 minutes.

Hypnagogic Foot Tremor (HFT) and Alternating Leg Muscle Activation (ALMA)

Hypnagogic foot tremor (HFT) is characterized by rhythmic leg or foot movements at sleep onset. **Alternating leg muscle activation (ALMA)** is similar, but presents itself as a movement by one leg followed by a movement in the other leg. These events can cause brief arousals or awakenings from sleep but are otherwise typically benign in most patients.

Sleep Starts (Hypnic Jerks)

A **sleep start**, also called a **hypnic jerk**, is a sudden muscle jerk or movement at sleep onset often accompanied by feelings of surprise or fear. They often accompany feelings of falling, but are typically benign. They can disturb the sleep of the bed partner, and sometimes cause difficulty returning to sleep.

Other Sleep Disorders

These disorders are not classified in other categories because either they overlap categories or they are relatively new or proposed disorders that need more research. Although the ICSD-3 does not specifically list any sleep disorders in this category, the ICSD-2 listed **environmental sleep disorder** here. Environmental sleep disorder can consist of many different factors, including a disorder held by the bed partner that is causing a disruption. For example, if a person has PLMD, the bed partner is likely to experience sleep disruptions, causing EDS, fatigue, or insomnia. This would be considered an environmental sleep disorder. Other factors in the environment can cause these disruptions, such as poor room temperature or lighting, music, or leaving the television on.

Chapter Summary

Man has known about the existence of sleep disorders for centuries, but until the past few decades has not extensively researched and categorized them.

Seven main classes of sleep disorders have been identified by the American Academy of Sleep Medicine and are outlined and detailed in the ICSD-3. The main classes of sleep disorders are insomnia, sleep-related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep–wake disorders, parasomnias, sleep-related movement disorders, and other sleep disorders.

Insomnia is the inability to initiate or maintain sleep or restful, restorative sleep. Insomnia can be caused by a wide variety of factors. Paradoxical insomnia, also known as sleep state misperception, occurs when a person believes they have slept very little or not at all during the night, when in actuality they were asleep during much or all of the night. Poor sleep hygiene can be a common contributor to insomnia, but is easily corrected. Proper sleep hygiene refers to practices such as maintaining a comfortable bedroom temperature, not consuming caffeine shortly before bedtime, and not watching television in bed.

Sleep-related breathing disorders are also very common, and occur most frequently in overweight and obese individuals. Obstructive sleep apnea occurs when an individual is unable to maintain an open airway during the night, resulting in breathing stoppages. Apneas can lead to excessive daytime sleepiness, morning headaches, frequent awakenings during the night, hypertension, memory loss, and other symptoms. Central sleep apnea differs from OSA in that the patient is not attempting to breathe during the events. Rather than an obstruction in the upper airway causing the apnea, the central nervous system is the underlying cause.

Central disorders of hypersomnolence cause excessive daytime sleepiness and include disorders such as narcolepsy that can be very debilitating and disruptive to normal daytime functions. Narcolepsy is characterized by periods of REM at times when REM should not present itself, including during wakefulness. Symptoms of narcolepsy can include excessive daytime sleepiness, hypnagogic hallucinations, sleep paralysis, and cataplexy.

Circadian rhythm sleep–wake disorders are characterized by disruptions to the normal 24-hour sleep–wake cycle. These disruptions may be self-induced, externally induced, or caused by medical conditions or

drugs. One of the most common circadian rhythm sleep disorders is jet lag disorder. This occurs when a person experiences insomnia or excessive daytime sleepiness as a result of traveling across two or more time zones. Shift work is another common cause of circadian rhythm disorder. Individuals who work shifts that overlap into their normal sleep schedule are more likely to experience fatigue, EDS, insomnia, and lack of concentration.

Parasomnias are sleep disorders in which the individual performs some sort of undesirable or unwanted action during sleep. These can cause disturbances to the individual's sleep and can put the patient and those nearby in physical danger. Sleepwalking is a parasomnia in which the individual will arise from bed during NREM sleep to walk, run, or perform other normal activities. In some cases, the individual may jump out of a high window or assault the bed partner. Sleep enuresis is a parasomnia in which the individual has limited or no bladder control during sleep.

Sleep-related movement disorders are a class of sleep disorders that cause smaller, less significant, and often rhythmic or repetitive movements during sleep. Perhaps the most common of these is periodic limb movement disorder. Patients with PLMD exhibit frequent, repetitive movements of the limbs during sleep. These movements can disturb the sleep of the patient or the bed partner. Sleep-related bruxism is another common movement disorder in which the individual grits or grinds the teeth or clenches the jaw during sleep. This can disrupt the sleep period and can damage the individual's teeth.

The final class of sleep disorders is called other sleep disorders, and is reserved for disorders that may overlap other classes or that need to be researched further before being properly classified.

Chapter 2 Questions

Please consider the following questions as they relate to the material in this chapter.

1. What are the classes of sleep disorders? Why are they grouped the way they are?
2. What are some important features of sleep hygiene? Why are these important practices for everyone to follow?
3. Why is OSA important to diagnose and treat quickly and effectively?
4. What is narcolepsy? What social impacts might narcolepsy have on an individual?
5. How do delayed sleep–wake phase disorder and advanced sleep–wake phase disorder differ from each other?
6. What is a night terror? In what ways can a night terror be dangerous?
7. How does RLS differ from PLMD? In what ways are they similar?
8. What are hypnic jerks, and how can they affect a person's sleep?

FOOTNOTES

1. American Academy of Sleep Medicine. (2014). *The international classification of sleep disorders* (3rd ed.). Darien, IL: American Academy of Sleep Medicine.
2. American Academy of Sleep Medicine. (2014). *The international classification of sleep disorders* (3rd ed.). Darien, IL: American Academy of Sleep Medicine.
3. American Academy of Sleep Medicine. (2014). *The international classification of sleep disorders* (3rd ed.). Darien, IL: American Academy of Sleep Medicine.
4. Sleep Management Services. (2002). *Principles of polysomnography*. South Jordan, UT.