Sleep Disorders Part II:

Adults

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ABSTRACT

Although a *good night’s rest* is vital for people of all ages, it can be especially critical for children and adolescents due to the impact of sleep on growing minds and bodies. However, even young people can suffer from sleep disorders ranging from mild to debilitating, and these disorders can have an impact on the entire family.
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Continuing Education Credit Designation
This educational activity is credited for 4 hours. Nurses may only claim credit commensurate with the credit awarded for completion of this course activity.

Pharmacology content is 0.5 hours (30 minutes).

Statement of Learning Need
The current research and developments in sleep medicine highlight a need for nurses to be educated and updated on the importance of screening for childhood/adolescent sleep disorders – to support early intervention and to avoid poor health outcomes.

Course Purpose
To provide nurses and health team associates with knowledge about sleep disorders, health outcomes and treatments in children and adolescents.
Target Audience
Advanced Practice Registered Nurses and Registered Nurses
(Interdisciplinary Health Team Members, including Vocational Nurses and Medical Assistants may obtain a Certificate of Completion)

Course Author & Planning Team Conflict of Interest Disclosures
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Please take time to complete a self-assessment of knowledge, on page 4, sample questions before reading the article.

Opportunity to complete a self-assessment of knowledge learned will be provided at the end of the course.
1. Adults typically need between _____ and _____ hours of sleep each night.
   a. 6 and 8
   b. 7.5 and 9
   c. 8 and 9.5
   d. 8.5 and 10

2. Which describes a risk factor for obstructive sleep apnea?
   a. An immunocompromised state
   b. Low blood pressure
   c. Deviated septum
   d. Esophageal cancer

3. Studies have shown up to 60 percent of people with insomnia also have:
   a. restless legs syndrome
   b. leg cramps
   c. obstructive sleep apnea
   d. depression

4. Which best describes cataplexy?
   a. The complete cessation of breathing for more than 10 seconds.
   b. Chronic sleep deprivation that causes memory loss and difficulties with concentration.
   c. The loss of muscle function that may develop after strong emotion.
   d. The release of the neurotransmitter gabapentin in response to illness.

5. Which statement about sleepwalking is true?
   a. Sleepwalking is always considered a benign condition.
   b. The most common cause of sleepwalking in adults is sleep deprivation.
   c. Sleepwalking is treated with sedative-hypnotic medications.
   d. A sleepwalking person should never be awakened.
Introduction

Every person requires sleep as a normal part of daily activity and for continued health and stability. Almost everyone experiences disrupted sleep at one time or another; there may be some nights when sleep is hard to get, while on other nights, sleep cannot come soon enough. For a percentage of the population, sleep is continuously disrupted as a result of sleep disorders. These conditions impact the ability to achieve good, quality sleep and lead to chronic sleep deprivation, exhaustion, and possibly long-term health consequences.

Normal Sleep Patterns

Most people extend themselves so much every day that their sleep suffers, even without the presence of other, underlying medical conditions or sleep disorders. Many adults view sleep as an option, rather than an essential activity. They schedule many tasks and items of things to do, believing that they can cut back on sleep to get everything done. Despite feeling productive in their daily tasks, many people are often risking their health and wellness to lose sleep over getting other things done. Sleep is a critical component of daily living and ultimately affects focus and concentration, memory, emotional stability, and even weight.¹ The reality for many people is that, although they believe that they are making up time for other more important activities instead of sleeping, they are missing out on a critical element for their health.

The optimal amount of time needed for sleep among adults is less than that for children and adolescents, although adults still need between 7.5 and 9 hours of sleep each night. Most people get by on less sleep, believing that they can adequately function on only 5 or 6 hours each night. While a person
who subsists on 6 hours of sleep each night can continue to function during the day, it does not necessarily mean that the person would not perform better and feel better during the day if he or she slept more.¹ The optimal amount of time to sleep often varies considerably from the actual amount of time.

Adults who get enough sleep at night should feel alert and awake throughout the day. For someone who has a lag during the day, must take naps, or consistently feels tired and less energetic, sleep needs are most likely not being met. Because each person requires different amounts of sleep, it will do no good to make comparisons between what one person can accomplish on a few hours of sleep. Instead, each person should best determine the amount of sleep he or she needs — not just how much to get by on — and aim to get that much sleep each night.

The exact reasons for why people sleep are still not fully identified; however, researchers have concluded that there are several known and understood reasons for sleep, with many more being uncovered through continued research and study about sleep habits and processes. Some of the reasons why people need sleep include the consolidation of memories, regulation of immune function, body growth through the release of growth hormone while sleeping, and energy conservation.²

**NREM**

Non-rapid eye movement (NREM) sleep is considered to be deep, restorative sleep. It is classified into 4 stages, each of which has different characteristics and lasts for different lengths of time. NREM sleep accounts for approximately 75 to 80 percent of total sleep each night.²
NREM and REM sleep form a cycle that makes up the sleep architecture; the stages and cycles of sleep throughout the course of a night. People typically move back and forth between stages of NREM and REM sleep throughout the night in cycles that last approximately 90 minutes. A person may have 4 to 6 sleep cycles each night.¹

The first stage of NREM sleep is known simply as stage 1 sleep. It is during this stage that a person is first falling asleep, but the sleep is very light. During stage 1 sleep, a person may be awakened easily or may feel as if he or she has not been asleep at all. For the person who has ever felt as if they’ve “dozed off” in the middle of an activity or while trying to sleep, they may have been in stage 1 sleep. Stage 1 lasts only about 5 minutes.¹³

After stage 1, a person progresses to stage 2 of NREM sleep. Stage 2 is considered something of a transitional stage of sleep in which the person moves between the light sleep of stage 1 and the deep sleep of stage 3. Stage 2 sleep is deeper than stage 1 and, during the initial cycle, it lasts approximately 10 to 15 minutes. Later sessions of stage 2 are much shorter than this and may only last about 7 minutes.¹³

Stage 2 sleep is important because of some of the biological processes that occur during this stage. The heart rate slows and body temperature drops; eye movements that may have happened occasionally during stage 1 slow and come to a halt, and brain waves slow down. The brain waves are also affected during this stage by the production of spindles,¹³ which appear similar to spikes on an electroencephalogram (EEG) and are thought to be the period of time when brief bursts of brain activity signify memory and thought processing.
The later stages of NREM sleep, stages 3 and 4, are classified as deep sleep or slow wave sleep. It is during deep sleep that the body is making most repairs to the tissues and gaining energy to get up and stay awake the next day. When a person has interrupted sleep, whether due to wakening during the night or a lack of total sleep because of a sleep disorder, the most damaging effects occur with a lack of deep sleep.¹

Stages 3 and 4 produce slow brain waves that are also called delta waves. A person who is in these deep stages of sleep can be very hard to awaken; consequently, when a person does awake from this stage of sleep, he or she may feel very groggy and disoriented when compared to waking up from a different stage of sleep. The amount of oxygen that the body takes in decreases during these stages and the body ceases production of cortisol and increases secretion of growth hormone during this time. Deep sleep is also important for memory consolidation because memories are stored during this time.¹³

NREM sleep varies in its consistency and quality of sleep, as well as the amounts of time a person spends in each phase. Deep sleep is an essential component of the sleep cycle and a person who misses out on adequate amounts of deep sleep may suffer greatly from harmful physical and cognitive issues. After progressing through NREM sleep, the body then transitions toward the next stage in the cycle, which is rapid eye movement, or REM sleep.

**REM**

Rapid eye movement sleep, or REM sleep, is the stage at which a person dreams while he or she is asleep. After falling asleep, a person progresses through the stages of NREM sleep and ultimately enters the REM stage of
sleep after approximately 70 to 90 minutes. During this phase, a sleeping person can be seen to have rapid eye movements going on under the surface of the eyelids. As the night progresses, a normal sleeper will have longer periods of REM sleep and shorter periods of NREM sleep. However, REM sleep still accounts for approximately 20 to 25 percent of total sleep time each night.

REM sleep is important for recharging the mind and processing what occurred during the day. It is during REM sleep that many memories are consolidated, neural connections are strengthened, and neurotransmitters such as serotonin and norepinephrine are restocked to provide ample amounts that will be needed. If a person is lacking in REM sleep, he or she may be more likely to develop memory problems or mood disorders associated with altered levels of neurotransmitters in the brain.

Compared to NREM sleep, REM sleep is a time of increased activity in the brain as well as other physiologic processes that occur due to the increased brain activity. The heart rate and blood pressure increases; blood pressure may actually rise by up to 30 percent during REM sleep. There is an increase in sympathetic nerve activity and increased blood flow to the brain. A person’s respiratory rate increases and sexual arousal is at its highest. Alternatively, muscle activity decreases during REM sleep, to the point of muscle atonia or paralysis. This is thought to occur during REM sleep to prevent the person from acting out his or her dreams.

Although a sleeping person will progress through a sleep cycle of NREM and REM sleep after initially falling asleep, a person tends to spend more time in REM sleep during the later part of the night with more time in NREM in the earlier parts of the night. Because NREM is so important for deep,
restorative sleep, the body will achieve as much NREM as it needs early on. Once the need for deep sleep has been met, the body may then spend more time in REM sleep.\textsuperscript{13}

**Common Sleep Disorders**

Sleep deprivation can occur in almost anyone when a regular and expected night of rest does not occur. This may be due to circumstances beyond the person’s control, such as an emergency situation that keeps someone awake all night, environmental noise that is so loud that it prevents decent sleep from happening, or traveling through different time zones that disrupt normal sleep patterns. Typically, when a person is sleep deprived for these types of reasons, he or she is able to catch up on sleep again at the next opportunity.

There are some people, though, who become chronically sleep deprived because of sleep disorders. While sleep disorders can be common, their presence can impact sleep of the affected person and his or her bed partner or roommate. Sleep disorders may range from mild conditions, that are more annoying to other members of the household rather than the affected person, to such severe conditions that the person becomes chronically sleep deprived and suffers from exhaustion, physical illness, and psychological harm.

**Breathing disorders**

Some people develop difficulties with breathing while trying to sleep. Sleep-disordered breathing is a term used to describe several situations that can impact a person’s ability to breathe while sleeping, causing insufficient breathing patterns or complete absence of breathing. Sleep-disordered
breathing (SDB) causes various symptoms depending on the underlying disorder, but most people experience frequent snoring, which may impact the sleep patterns of not only the affected person but also the sleep habits of a bed or room partner. People with SDB may also suffer from disrupted sleep at night and excessive daytime sleepiness as a consequence of impaired sleep habits. Some types of sleep-disordered breathing may include obstructive sleep apnea, central sleep apnea, and upper airway resistance syndrome.⁵

**Obstructive sleep apnea**

Obstructive sleep apnea (OSA) is one of the most common types of sleep disorders and types of sleep-disordered breathing. It is characterized by interrupted breathing that is manifested as pauses in breath or the appearance of breath holding. In reality, these pauses are periods of apnea, in which the affected person is not breathing at all. Obstructive sleep apnea has characteristic sleep patterns that may be more likely to be identified by the patient’s bed partner, such as significant snoring, pauses in breathing while asleep, and choking or gasping upon awakening.

Snoring is one of the most prevalent symptoms associated with obstructive sleep apnea, although not everyone who snores would be considered to have sleep apnea. It occurs as noise generated from the back of the throat and the upper airway when a person breathes in while sleeping. Snoring may also occur when a person breathes out while sleeping; it is not associated with apnea or decreased oxygenation, and many people snore without being impacted in any other manner.⁶ That is, for many people without OSA, snoring is a routine part of sleeping that does not typically cause them to awaken at night, and it does not cause alterations in sleep patterns or
breathing disturbances. In these cases, snoring is often more disruptive to the bed partner than the person who snores.

Snoring is a symptom associated with obstructive sleep apnea, however, and a person who snores and who exhibits other symptoms of sleep loss may need further testing to determine if an underlying sleep disorder is not present. Testing for and diagnosis of obstructive sleep apnea is done through a polysomnogram (PSG), often called a sleep study. The PSG can measure how often the patient experiences apnea while sleeping, whether oxygen desaturation is present with the apnea, and any other responses that the body undergoes during the apneic episode.

It is estimated that approximately 5 to 10 percent of adults in the United States have obstructive sleep apnea. There are numerous risk factors for the development of OSA, however, obesity is the most common cause of the condition in adults. Other risk factors for OSA include enlarged tonsils (particularly in cases of OSA among children), use of tobacco, alcohol, or sedatives for sleeping, an underactive thyroid gland, nasal obstruction, and menopause among women. People who have jaw structures that involve either a receding jaw or a jutting jaw or chin, and those with enlarged or protruding tongues, are also at increased risk. Men are more likely to develop OSA than women, and certain ethnic groups, including African Americans, Asians, and Native Americans, are at higher risk of developing the condition as well.

Obstructive sleep apnea occurs when a person stops breathing while sleeping because of an obstruction of airflow through the airway passages leading to the lungs. Apnea occurs when a person stops breathing for more than 10 seconds. The obstruction that causes the absence of breathing
usually occurs when the structures in the neck and the back of the throat collapse during the relaxation that occurs with sleep. All people experience the relaxation of the muscles of the airway during sleep, but not everyone develops a blockage of the airway. People with OSA have airway structures that collapse in, causing a blockage of the airflow. Obese individuals may have more fat tissue in the neck and face, which can contribute to the obstruction. Furthermore, some people have narrow airways that collapse easily during sleep, contributing to periods of apnea.

When the sleeping person enters a state of apnea because of the obstruction, he or she stops breathing for more than 10 seconds at a time. Because the patient is not taking in more oxygenated air, the blood saturations of oxygen begin to fall and carbon dioxide levels rise. The brain eventually senses this rise in blood carbon dioxide, known as hypercapnia, and stimulates the body to take in air. The person may suddenly gasp or make a choking sound as he or she awakens slightly to breathe and stop the apnea. Often, the person is unaware that they have awakened and the episode occurs relatively quickly.

At times, instead of going into complete apnea, the person with OSA may experience hypopnea. When hypopnea occurs, similar events lead up to the reduction in breathing; the person is asleep and somehow the structures of the airway collapse upon themselves, causing a blockage in airflow. Instead of entering a state of complete absence of breathing, the person still breathes in a very shallow manner. The person may snore and take very slow breaths that are so shallow that they do not provide enough oxygen to the body. This experience is known as hypopnea. Although there is not complete absence of breathing with hypopnea, the person still suffers from
oxygen desaturations in the blood due to decreased gas exchange through breathing.\(^7\)

Obstructive sleep apnea is diagnosed when a person has more than five episodes of either apnea or hypopnea per hour while asleep.\(^7\) Often, people with OSA can have dozens or sometimes even hundreds of episodes of apnea and hypopnea through a single night of sleep. Although the person does not remember waking up to continue breathing, he or she can suffer from significantly disrupted sleep with this many episodes of awakening.

If left untreated, OSA can lead to significant complications for the affected patient. According to the University of Maryland Medical Center, obstructive sleep apnea has been linked with complications associated with many different conditions, from excessive daytime sleepiness to alterations in circulation that could lead to death.\(^7\) Excessive daytime sleepiness is a core component of OSA; in fact, diagnosis of OSA is often made based on the results of the sleep study as well as the patient’s reports of excessive daytime sleepiness.\(^7\) Feeling drowsy and tired during the day, from a lack of sleep due to OSA, is annoying and can be extremely dangerous. Many people who are excessively tired from sleeping poorly at night because of OSA can become sleepy enough during the day that they should not drive or be responsible for caring for others. They may be so tired that they forget what they should be doing, have slowed reaction times, or they may fall asleep in the middle of tasks.

Obstructive sleep apnea also increases the risk of developing cardiovascular complications such as high blood pressure, heart failure, myocardial infarction, and stroke. A patient with OSA develops an increased risk of hypertension. This may be a factor if the patient is already overweight or
obese to begin with and that is contributing to the OSA, and, ultimately, to hypertension. However, researchers have found that people with OSA who are not overweight are still prone to develop hypertension as a result of sleep apnea.\textsuperscript{7}

Heart failure is a complication that develops in approximately one-third of patients who have obstructive sleep apnea. Heart failure occurs when the heart is unable to meet the body’s needs for blood supply and cannot pump fast enough or with enough force to provide adequate oxygenated blood. Repeated periods of apnea and their accompanying desaturations in the blood may cause circulatory changes that can eventually change the structure of the heart. The damaged heart is unable to pump blood efficiently and heart failure worsens.\textsuperscript{7}

Similarly, patients with OSA are at increased risk of myocardial infarction, irregular heart rhythms, and of death from a stroke.\textsuperscript{7} Beyond cardiac disease risk, OSA may be associated with a myriad of other conditions, the connection between some of which is not entirely clear. Examples of other conditions that a patient with OSA may be at higher risk of developing include diabetes, asthma, pulmonary hypertension, high-risk pregnancy, glaucoma, headaches, and seizures.\textsuperscript{7}

Obstructive sleep apnea is also associated with mental health disturbances, and people diagnosed with post-traumatic stress disorder have been shown to have worse periods of stress and disturbances when they have coinciding obstructive sleep apnea. OSA has also been shown to worsen symptoms of depression;\textsuperscript{7} often people who cannot achieve adequate sleep and who have become significantly sleep deprived are unable to overcome depression because many of the symptoms — altered sleep patterns, insomnia, fatigue,
lethargy, and difficulties with concentration — may overlap between OSA and depression.

Diagnosis of obstructive sleep apnea is made according to several factors: the affected person has excessive daytime sleepiness to the point that it impacts his or her ability to perform work or other duties and significantly disrupts quality of life; and, if a bed or room partner reports disruptive sleep on the part of the patient by observing significant snoring, gasping, choking, or frequent awakenings. Based on the patient’s symptoms and physical exam to either rule out or support the diagnosis, the physician may order a polysomnogram (PSG) or sleep study to determine how well the patient is able to sleep or has sleep patterns associated with sleep apnea.7

The most common treatment of obstructive sleep apnea is continuous positive airway pressure (CPAP), in which the patient sleeps with a mask that provides pressurized air into his or her mouth and nose through the night while asleep. The air forces the tissues to remain open instead of collapsing onto themselves and causing an obstruction. Use of CPAP has been shown to significantly improve the quality of sleep among patients with OSA, thereby leading to increased quality of life overall because of decreased sleep deprivation.

Beyond using CPAP for the treatment of OSA, the patient may also make some lifestyle changes that can impact how well he or she sleeps. The physician may recommend weight loss for a patient who is overweight or obese, since this can contribute significantly to OSA symptoms. In some cases, weight reduction may reduce apnea episodes enough that other medical measures are not necessary.7
Because apneic episodes may occur more frequently when a person sleeps on their back, the person could also try repositioning him or herself to sleep in order to reduce the frequency of obstructions. A person with sleep apnea who sleeps on his or her back may experience more episodes of apnea when compared to someone who sleeps on their side. Changing positions to lie on the side may change the pull of gravity that causes some of the structures in the airway to collapse and may keep the airway open. A patient may try to use various pillows or even sleep with the head of the bed elevated in order to reduce the amount of apneic episodes by changing position alone.

Finally, reducing or eliminating certain lifestyle habits may have an impact on sleep quality and could affect the number of apneic episodes that a person has each night. The patient should be instructed to avoid alcohol in the evening before going to bed, as alcohol acts as a depressant and can affect breathing and sleep patterns. People who smoke are advised to quit; those who smoke more than two packs each day are 40 times more likely to develop obstructive sleep apnea when compared to those who do not smoke. Finally, avoiding caffeine, sugar, or liquids in the last few hours before bedtime may make sleeping a little easier; the patient may be more likely to fall asleep without any stimulants and may have less awakenings during the night to get up to use the bathroom.

Other forms of treatment for obstructive sleep apnea include medications, dental devices, and even surgery if the condition is significant enough. Although some people try to use medications to help them sleep when they have OSA, such as sedative-hypnotics, some drugs may actually worsen sleep apnea symptoms because they relax the muscles and the structures in the mouth too much and can further worsen an airway obstruction. Patients should be instructed to avoid over-the-counter sleep medications, sedative-
hypnotic drugs prescribed for sleep, and even the depressant effects of alcohol to try and induce sleep in this manner.

Alternatively, there is one type of medication that has been approved for use by the U.S. Food and Drug Administration (FDA) to manage the excessive sleepiness that may occur with OSA; it is called modanfinil (Provigil®). It was originally prescribed, and is still used for the treatment and management of sleepiness associated with narcolepsy; however, researchers have found that modanfinil is beneficial for patients with OSA. Ultimately, though, modanfinil is most effective when it is used in conjunction with other treatments of OSA, such as CPAP. In fact, if modanfinil is prescribed for OSA, many providers ensure that the patient has another form of breathing management to use alongside the medication.⁷

Dental appliances are another option for treatment of OSA, and may be prescribed for some patients who do not tolerate CPAP or who have not otherwise benefitted from CPAP therapy. Dental devices are often created and prescribed by a dentist or orthodontist and, typically, the patient must be fitted with the device that is specific for the structure and contours of his mouth.

A dental appliance can be a non-invasive method of managing sleep apnea; many patients who do not tolerate CPAP may successfully use dental appliances instead, although their overall effectiveness is less than that of CPAP. One of the most common types of devices is a mouth guard called a mandibular adjustment device, which keeps the mouth slightly open and pulls the jaw forward. The patient places the device in his or her mouth before going to bed and wears it throughout the night while sleeping. This type of appliance seems to work best among those who sleep on their backs.
By bringing the jaw forward slightly and opening the mouth, the structures in the mouth are less able to collapse and completely obstruct the airway.\(^7\)

A tongue-retaining device is another dental appliance that may be used for obstructive sleep apnea. This device is placed in the mouth, where it pulls the tongue forward and holds it in place while the patient sleeps. It is designed to keep the tongue from falling to the back of the mouth and obstructing the airway, particularly among those patients who sleep on their backs.\(^7\) A study in the *Journal of Clinical Sleep Medicine* found that among patients who used the tongue-retaining device and who have obstructive sleep apnea, 71 percent had partial or complete resolution of symptoms and 68 percent had a reduction in snoring.\(^8\)

Finally, surgery may be indicated among some patients who have severe and persistent obstructive sleep apnea. Surgery may be indicated for removal of enlarged tonsils or adenoids that have grown enough that they block the flow of oxygen through the airway. Alternatively, other types of surgery may change the structure of the back of the mouth so that occlusion of the structures due to relaxation during sleep may be less likely to happen.

*Central sleep apnea*

Similar to obstructive sleep apnea, central sleep apnea is a sleep disorder in which a person has periods of apnea and hypopnea while sleeping, which results in oxygen desaturations. However, the causes of the apnea are not due to obstructions in the airway that prevent airflow. Instead, the part of the brain that stimulates a person to breathe does not function in a normal manner. This part of the brain is found in the pons and the medulla; it sends messages to the respiratory system to take a breath on a regular basis.\(^9\)
This activity almost always occurs while a person is unaware of it; in other words, the person does not regularly have to think and remember to breathe, the brain sends these messages anyway.

For the person with central sleep apnea, the brain either does not signal the body to take a breath on a regular basis, or the body does not respond in a normal manner by taking a breath. Either cause results in periods of apnea and hypopnea that result in loss of oxygen coming into the body, and increased levels of carbon dioxide building up in the bloodstream. After a period of time, the body responds by taking a breath and the person is aroused from sleep to correct the situation. Again, the person may or may not be aware that they are waking up to breathe and correct the deoxygenation. If this happens multiple times during the night, the person can become significantly sleep deprived.

Central sleep apnea is more likely seen among people who have conditions that cause increased amounts of carbon dioxide to develop in the bloodstream or conditions that affect the depth and amount of breathing that occurs, resulting in low oxygen levels in the bloodstream. Some examples of situations in which a person may be more likely to develop central sleep apnea include heart failure, periodic breathing associated with higher altitudes, and the use of some medications, such as opioids or anesthetics that depress the brain’s ability to send breathing messages to the body. Additionally, some people who have had damage to parts of the brain, including those with lesions found high on the spinal cord, may also develop central sleep apnea if the parts of the brain that send messages to breathe are impacted.⁹
The person with central sleep apnea will often suffer from many of the same symptoms as the person with OSA; this is primarily because both conditions cause apnea, just in different methods, but the outcomes are similar. People with central sleep apnea may experience excessive daytime sleepiness, fatigue, morning headaches, and disrupted and poor sleep habits.10

Treatment of central sleep apnea differs from OSA because there is not an obstruction present that needs to be eliminated or modified. Treatment of central sleep apnea may include use of CPAP, particularly if the patient has a condition known as mixed apnea, which is a combination of obstructive and central sleep apnea. Sometimes, by treating the OSA, the provider and the patient may discover that the patient also has central sleep apnea as well. In other cases, the positive air pressure from CPAP alone is enough to continue to stimulate the patient with central sleep apnea to breathe.10

Another type of pressurized air delivery system may also be used with patients who have central sleep apnea. It is a system that is set up in a method similar to CPAP, but instead of delivering a constant stream of pressurized air to the patient, it is programmed to distribute the air for a breath as needed when the machine senses that the patient has stopped breathing. This method is known as adaptive servo-ventilation (ASV). The ASV machine is designed to deliver a breath after a certain amount of time if the patient is not breathing at certain points while asleep. The ASV effectively monitors the patient on a breath-by-breath basis to ensure that he or she continues to take in enough air while sleeping.10

Other forms of treatment are also available for central sleep apnea. If the patient has an underlying disorder that is contributing to the sleep apnea, treating the disorder may reduce a number of symptoms. For example, if
Central sleep apnea develops because of hypoventilation that sometimes occurs among people when they travel to high altitudes, the central apnea should disappear when the person returns to normal altitude. In other situations, such as in cases of central apnea that develops because of a brainstem or spinal cord injury, treatment of the underlying disorder to improve apnea may not always be possible.\textsuperscript{10}

Some medications may help with central sleep apnea by stimulating the patient to breathe. The most common medicines used for treatment of central sleep apnea are acetazolamide and theophylline. Acetazolamide (Diamox\textsuperscript{®}) is often used to treat altitude sickness and its debilitating symptoms. It works to inhibit certain enzymes that can impact carbon dioxide levels in the body, which may change how much carbon dioxide enters the bloodstream and how the body responds to it.\textsuperscript{11} Theophylline is sometimes used for treatment of heart failure and works as a bronchodilator to increase the size of the airway, making breathing easier. Both drugs may be prescribed in various situations for treatment or management of central sleep apnea, whether on their own or in conjunction with other forms of treatment.

\textit{Upper airway resistance syndrome}

Less common than OSA, upper airway resistance syndrome (UARS) occurs in a manner similar to OSA in that the affected person experiences a resistance or obstruction in the airway that can affect breathing, but the patient with UARS does not experience oxygen desaturation while sleeping. The affected person has increased airway resistance that disrupts airflow while sleeping, causing multiple arousals during the night. Compared to OSA, upper airway resistance syndrome does not lead to periods of apnea and desaturations in oxygen levels. Instead, the person awakens slightly when resistance to
breathing occurs while sleeping. The individual may or may not be aware that he or she is awakening frequently because of the airway obstruction.6

A further distinction between UARS and OSA is that the pauses and arousals that occur with UARS are typically much shorter in duration than the apneic episodes that develop in OSA. An event that occurs in UARS may only last for a length of 1 to 3 breaths. UARS may occur in approximately 15 percent of the adult population. It affects people of average weight and is not necessarily associated with obesity. Further, UARS may occur more in younger people rather than developing as a person gets older. People with UARS often have upper airway structures that may be more likely to become obstructed, such as by having narrow nasal passages, deviated septum, or nasal valve collapse. And, UARS seems to be more common among women than men, although the reasons for this are not entirely clear.6

People with UARS typically experience excessive daytime sleepiness similar to that felt with obstructive sleep apnea. They may be unaware that they are waking so frequently during the night but they may feel just as tired. This can be characterized by falling asleep easily, even in certain situations such as while at work; feeling tired and less energetic throughout the day, and feeling irritable. Affected patients may also complain of difficulties with concentration, memory loss, morning headaches, and impotence.6

Treatment of UARS includes CPAP therapy to promote airflow through the respiratory tract. Although a complete obstruction of the airway does not occur in patients with UARS, the CPAP will still promote continuous airflow and reduce the incidence of breathing pauses, as well as snoring that may accompany the upper airway restriction.
Insomnia

Most Americans do not get enough sleep, often because of choosing to go without sleep in order to complete deadlines or pursue other activities. However, there are some people who struggle to get enough sleep because they are unable to get to sleep or stay asleep at night due to insomnia.

Many people have occasional nights where they do not sleep well. They may stay awake worrying, they may feel pressure and stress to complete certain tasks and lie awake thinking about them, they may have medical conditions or have eaten or drank something that caused them to stay awake longer than necessary, or they may continually awaken due to environmental noises that they cannot control. Occasional lack of sleep occurs in almost everyone; however, consistent lack of sleep due to insomnia can quickly cause problems associated with sleep deprivation and its effects on the physical and emotional condition of a person.

Insomnia occurs when an individual consistently has difficulties falling asleep, staying asleep once he or she has fallen asleep, waking up too much during the night, or generally having poor quality sleep and feeling as if he or she barely slept at all after a full night. Insomnia can develop for a number of reasons and is associated with certain illnesses and physical conditions. However, there are some people who develop insomnia that is unrelated to any other underlying disorder. Approximately 50 percent of cases of insomnia have no identifiable cause. There are many other conditions that can predispose a person to developing insomnia. Some conditions that may increase the risk include advancing age, substance use, menopause in women, gastroesophageal reflux, changes in body temperature due to illness, altered hormone secretion or function, or other sleep disorders, including circadian rhythm sleep disorders.12
People who suffer from insomnia may toss and turn much of the night in an effort to try and achieve sleep. They may fall asleep briefly but never truly feel as if they are getting restful and restorative sleep. Consequently, the person with insomnia may awaken and face the day without feeling refreshed or by having a decent night’s sleep. He or she may suffer from daytime fatigue, irritability, headaches, and difficulties concentrating. When going to bed at night, the affected person may still be unable to sleep despite feeling exhausted.\(^{12}\)

Insomnia can lead to mental health issues, most commonly anxiety and depression related to lack of sleep. Often, when insomnia occurs every night, the affected person may become more anxious as evening approaches. It can be very difficult to lie in bed awake while trying to get to sleep; if the situation has continued for many nights, anxiety may increase with worrying if another sleepless night will happen. Further, while lying awake, a person often feels anxious and worries about getting too little sleep to face the day. This further compounds anxiety and may make getting to sleep more difficult.\(^{12}\)

Insomnia may also be a cause of depression, although the cause-and-effect relationship between the two conditions is not always clear. Some people with chronic insomnia may be more likely to develop depression because they typically feel isolated when they cannot sleep and others can. They may feel as if no one else understands how difficult insomnia can be; truly, it can be difficult to understand insomnia from a person who normally has no trouble sleeping at all. A person may also develop depression due to frustration at not being able to achieve sleep or not finding an appropriate treatment to resolve sleep deprivation.
Alternatively, people who suffer from depression often develop insomnia and have difficulties sleeping. The insomnia that occurs may happen because of pre-existing depression, and could be managed with treatment of depression through medications or other conventional means. Depression is so widely associated with insomnia that studies have shown up to 60 percent of people with insomnia also have depression.\textsuperscript{12}

Diagnosis of insomnia is made by taking a medical history, including any underlying medical conditions and the use of medications and substances, as well as performing a physical exam to measure vital signs and basal metabolic index (BMI). In some cases, the physician may order a sleep study if the patient’s history suggests the presence of another underlying sleep disorder. If the polysomnogram reveals another sleep disorder, the insomnia is often resolved with treatment of that disorder.

There are various approaches to treatment of insomnia. Some patients use medications to help them sleep and, while these may work, often a change in certain lifestyle factors can be even more successful. In some cases, lifestyle changes alone may be enough to promote sleep such that insomnia is resolved. Some patients also choose complementary and alternative therapies in an effort to reduce or resolve their insomnia.

Medications to induce sleep and treat insomnia include both prescription and over-the-counter varieties. Prescription sedative-hypnotics are often given by providers to improve sleep; these medications typically change the levels of neurotransmitters in the brain, which can induce drowsiness. A class of drugs known as non-benzodiazepine and benzodiazepine-receptor agonists are often prescribed because they have low levels of dependence among users and are less likely to be abused when compared to some other types
of sleep medications. Examples of these medications include zolpidem (Ambien®) and eszopiclone (Lunesta®).

Other medications that are benzodiazepines may also be used for inducing sleep associated with insomnia, however, these drugs may be more likely to cause dependence and some people may take them inappropriately. They do have a depressant effect that can cause a person to fall asleep. Examples include temazepam (Restoril®) and triazolam (Halcion®).\textsuperscript{12}

Some patients have success with using over-the-counter medications that may be either indicated for sleep or may have side effects that cause a person to feel sleepy. Non-prescription medications that could be used include pain relievers that contain extra sleep aids. People who experience difficulties sleeping because of increased pain often take these drugs, but they may also be used if insomnia is present and related to other factors. An example of this type of medication is diphenhydramine ibuprofen (Advil PM®). Additionally, using non-prescription drugs that have been designed for other purposes may also induce sleep because their side effects cause drowsiness. One of the most commonly used medications is diphenhydramine (Benadryl®). Diphenhydramine is sometimes combined with other medications into a pill that is designed to be a sleep aid,\textsuperscript{12} for example, acetaminophen diphenhydramine (Tylenol PM®) is marketed as a sleep aid, although the diphenhydramine is labeled for use in the treatment of allergies.

Changing certain lifestyle factors can make a big difference in treating insomnia and improving sleep. At times, some patients may be unaware that their choices and lifestyle habits are contributing to lack of sleep and through proper education and awareness, may be able to sleep better when
making some changes in their routines. Patients should be encouraged to avoid taking naps during the day, especially closer to dinnertime in the evening when bedtime is approaching. Avoiding other activities and substances late in the day, such as alcohol, caffeine, and exercise, can all help a person to better “wind down” while getting ready for bed. Alcohol has an initial depressant effect but can later cause a person to awaken more, ultimately having the opposite effect. Caffeine acts as a stimulant, which can inhibit sleep and should be avoided while trying to get to sleep. Exercise is beneficial and should be done during the day to improve circulation and flexibility; however, exercise late in the day may cause a person to feel more awake and have difficulties sleeping when it comes time to go to bed.

Some people spend time working on computers or watching television in the evening before bed. Reducing or eliminating these activities can also help to promote sleep. The bright light from the screen often keeps the body awake longer and the person may have difficulties slowing down into a state of sleep after significant exposure to bright light. This is why bright light therapy is sometimes used in the treatment of certain sleep disorders; the light stimulates the brain to believe that it is time to be awake and helps the person to get up. However, this has the opposite effect when used in the evening when a person is trying to go to sleep.

For some people with insomnia, it may also help to establish a solid bedtime routine, in which certain activities are performed each night that help to promote relaxation and restfulness. The bedroom should be designed as a place used only for sleep, and the person should not spend significant amounts of time in bed reading or working on a computer. The body may later have difficulties transitioning to sleep when the individual has already been in the same place and position for hours doing other activities. It may
also help to have slow, soothing activities before bed, such as taking a bath or listening to soft music, which can help to slow down the pace of the day and may make a person feel relaxed and tired.

Finally, treatment and management of other disorders that may be contributing to insomnia can be extremely helpful in improving sleep for the affected person. For example, a patient who suffers from sleep apnea and who has concurrent insomnia may sleep much better when the sleep apnea is treated. Medical conditions that contribute to insomnia, such as gastroesophageal reflux or fibromyalgia, can be treated or managed using outside therapies and medications, which can further improve sleep when these situations are managed or resolved.

There are a number of options for the treatment of insomnia, which may depend on concurrent conditions. For people who struggle to sleep because of insomnia, talking to a healthcare provider and trying different methods of treatments and lifestyle changes can often improve sleep enough that a person feels more rested.

**Circadian Rhythm Disorders**

The body maintains a 24-hour clock that keeps track of when to be awake and when to be asleep. This is known as the circadian rhythm, and it is deeply affected by outside and environmental circumstances to either help a person to sleep or stimulate him or her to stay awake. When the circadian rhythm is altered, the affected individual will have difficulties falling asleep or staying asleep at an otherwise normal time.

The circadian rhythm in the body is managed by a part of the brain called the supra-chiasmatic nucleus (SCN). The SCN is found in the hypothalamus
region of the brain and it is this part that responds to external stimuli such as environmental light levels to keep the internal clock at a pace that promotes sleep at the appropriate time. In the evening when the environmental light becomes dim and the sun goes down, the internal clock of the circadian rhythm responds to the changes in light and secretes melatonin, a hormone that is sent into the body from the pineal gland in the brain.

Melatonin is a hormone that essentially tells the body that it is tired and that it should sleep. It is released into the bloodstream and as serum levels increase, the person feels more and more sleepy. The body secretes melatonin for approximately 12 hours at a time to promote sleep, which is typically at night. During the day, blood melatonin levels may be quite low, because sunlight inhibits melatonin production. This is why most people do not easily sleep during the day, even if they have been awake all night.

Normal melatonin production keeps the circadian rhythm in check and promotes a routine cycle of sleep and wakefulness, however, there are factors that can disrupt melatonin production, resulting in sleep difficulties. These factors may be modifiable, in that a person who recognizes that his or her behavior is impacting sleep can make changes to promote more melatonin production and therefore more sleep. For instance, exposure to bright lights in the evening may inhibit production of melatonin, such as when a person consistently works at a computer screen late at night or watches television. If an affected person recognizes the effects of artificial light on sleep habits and the circadian rhythm, he or she may make lifestyle changes to reduce the amount of screen time in the evening and ultimately promote better sleep.
Alternatively, some conditions that are known as circadian rhythm disorders occur when the body’s internal clock is thrown off and melatonin production, as well as sleep, does not occur at a routine or normal time. Circadian rhythm disorders are patterns of sleep disturbances that occur due to alterations in the internal clock that acts as a sleep regulator. Primarily, a circadian rhythm disorder occurs when a person’s cycle of sleeping and wakefulness is less than optimal and they are unable to function at a normal sleep/wake cycle to produce adequate sleep. Some examples of circadian rhythm disorders include advanced sleep phase disorder and delayed sleep phase disorder, as well as other circumstances that contribute to circadian rhythm disruptions, such as shift work and jet lag.

*Advanced sleep phase disorder*

Advanced sleep phase disorder (ASPD) is a less-common circadian rhythm disorder that is characterized by a shift in sleeping times several hours earlier than normal. A person with ASPD may fall asleep early in the evening and awaken very early in the morning. While an individual with ASPD may be considered a “morning person,” he or she may have difficulties adjusting to sleeping at later times and may wish to fall asleep or awaken later. ASPD leads the affected person to feel sleepy in the late afternoon or early evening and he or she often falls asleep between 6 and 9 pm. The disorder then causes the person to awaken at an earlier time as well, sometimes between 2 and 5 am. The exact amount of time that is shifted when falling asleep with ASPD differs among patients and there is no set time amount of shifting required for diagnosis. Consequently, people diagnosed with ASPD may have various time shifts forward in their sleeping hours and the diagnosis is partly based on the degree of difficulty the shift in sleep time causes the affected person.
Advanced sleep phase disorder essentially shifts the circadian rhythm of affected people back by several hours. They may feel socially isolated because they usually sleep at different times than others: they may be falling asleep when others are still active and social in the evening; alternatively, people with ASPD may be awake and feel alone because others are still sleeping in the early hours of the morning. ASPD is impacted by age and advancing age causes an increased risk of development of the disorder. Often, ASPD may be masked by depression, or the person seeking help for sleep problems may have coinciding depression along with ASPD.²

Advanced sleep phase disorder is treated through a number of options to alter the sleep cycle so the affected individual may eventually sleep on a normal schedule. Chronotherapy involves adjusting the time of going to sleep slightly over the course of several days, weeks, or months, until the affected person has reached a sleep schedule that is acceptable. For example, if a person with ASPD normally falls asleep at 6:30 pm each evening and awakens at 3 am each morning, he or she may use chronotherapy to adjust sleep habits slightly to change the time of going to sleep. This is typically done in very short intervals to allow the client to adapt. For instance, the client may try to go to bed 15 minutes later than normal, attempting to stay up until 6:45 pm instead of 6:30. After adjusting to this time, his or her time for going to sleep is moved back again to 7 pm and so on. On the other end of the spectrum, by going to sleep later, he or she may be more likely to sleep a little later, thereby adjusting both the time that of going to sleep and the time of waking up.

Bright light therapy may be another option for a person suffering from ASPD. Because bright light, often from artificial sources, can keep a person awake, the person with ASPD may expose themselves to bright light sources in the
evening for a period of time to attempt to stay awake. By increasing exposure to bright light during the time that the client would normally fall asleep, the body is essentially tricked into thinking that it is still time to be awake. Light therapy is performed for set periods of time each evening; for instance, a client who goes to sleep at 7 pm may use bright light therapy for 30 minutes to an hour each evening to stimulate wakefulness, helping him or her to fall asleep later than the normal time. As with chronotherapy, bright light therapy takes time to adjust the circadian rhythm into a normal sleep pattern for the person with ASPD.

*Delayed sleep phase disorder*

In contrast to ASPD, delayed sleep phase disorder (DSPD) occurs when a person’s sleep rhythm is shifted to a later sleep/wake time than normal or desired. The person with DSPD may not fall asleep until after 2 am and may wake up later in the morning or afternoon, between 10 am and 12 pm. Although the individual with DSPD may be considered a “night owl,” he or she may not desire to sleep on this particular schedule and may wish for sleep to come earlier in the evening. A person with DSPD may try to go to bed at a normal time, but may simply lie in bed unable to sleep until the time that his or her body is regulated to do so.

Delayed sleep phase disorder causes difficulties with social and work obligations for people who must get up at certain times. For example, if a client is consistently unable to fall asleep before 1 am but must get up every morning at 6 am to get ready for work, this quickly leads to sleep deprivation. Although catching up on sleep on the weekends may be possible to some extent for a few people with DSPD, regular routines of work and school often begin again on Monday and they must go back to their routines of sleep deprivation. When allowed to sleep without waking up at a standard
time, most people with DSPD experience restful sleep that is appropriate in length; they are not candidates for insomnia. Alternatively, the difficulties with sleep deprivation come from shifted cycles of sleep time that are interrupted by obligations to get up earlier than desired, resulting in a lack of overall sleep.\textsuperscript{2}

Delayed sleep phase disorder is more common than advanced sleep phase disorder. DSPD also occurs more commonly among adolescents, although it can develop in someone of any age. Like ASPD, delayed sleep phase disorder can be treated through chronotherapy or bright light therapy, and both forms of treatment can be quite successful in resetting the circadian rhythm to a normal sleep time. The difference in using these therapies for DSPD when compared to ASPD is that, for people with delayed sleep phase disorder, the time setting is adjusted back rather than forward. For instance, a person who uses chronotherapy for DSPD may attempt to fall asleep 30 minutes earlier than his or her normal time; the person using bright light therapy may use it in the morning after waking up rather than in the evening as for someone with ASPD.

\textit{Jet Lag}

Jet lag is a temporary circumstance in which a person’s circadian rhythms are disrupted because of travel across several time zones.\textsuperscript{2} A person who normally lives in one time zone and has an adjusted sleep pattern to that time but who travels to a different time zone that is significantly different from normal may develop difficulties sleeping due to a disruption in the circadian rhythm. If the time zone differences are significant enough, the person experiences the feeling of attempting to stay awake during a time when he or she would normally be asleep. Alternatively, the person may also need to sleep during a time when they are usually awake.
Jet lag not only causes difficulties with sleeping, the affected person may experience problems with memory and concentration, fatigue, malaise, mood changes, and gastrointestinal disturbances. He or she may feel tired and sleepy throughout the day yet has insomnia at night while trying to sleep. Studies have shown that jet lag may be worsened depending on the direction of the time change. For example, a person who is traveling eastward or forward into new time zones may have a harder time adjusting to the time change than someone traveling westward or backward into time zones.\(^2\) Despite the degree of difficulty regarding the direction of travel, jet lag can be difficult to manage and live through regardless of the shift of the body’s internal clock.

Jet lag is typically temporary as the affected person eventually adjusts to the new time period. It may last several days before slowly resolving. Some people have had success with using supplemental melatonin to help with sleep patterns associated with jet lag. Although it can be successful, non-prescription melatonin is not technically approved for use in people with jet lag.\(^2\) Melatonin is the only hormone that is available for use without a prescription. Its action mimics the melatonin released by the brain when the body is preparing to sleep. People who take melatonin should consider its use very carefully as it is not regulated by the U.S. Food and Drug Administration. There is not one set dose recommended for age or condition for which to take melatonin for sleep; however, a general recommendation is to take 2 to 5 mg before the desired time of going to sleep and repeat the process for up to 4 days as necessary.\(^2\)

**Shift work**

Shift work disorders develop among people who work during times in which they would normally be asleep. Shift work often involves working late at
night, overnight, or very early in the morning. The person may work shifts on occasion, such as in the case of being on call or being scheduled for night shifts sporadically; alternatively, many people regularly work at night and may have overnight schedules of 3 to 5 nights per week, requiring them to sleep during the day.

Studies have shown that people with jobs that require shift work do not adjust to the altered sleep cycles required, even if they regularly work opposite hours. Most people’s circadian rhythms are programmed for them to sleep at night instead of to go to work. Consequently, people who work at night may feel sleepy, and they may have difficulties staying awake to perform tasks and may be more prone to make mistakes while on the job.2 Alternatively, working at night makes it difficult to sleep during the day, particularly when sleep is necessary to repeat a shift the next night. A person who works overnight one night and must return to work to repeat the shift the following night may feel obligated or even anxious about getting enough sleep during the day to avoid feeling exhausted when at work later.

It may be very difficult to sleep during the day in order to stay awake at night to work. Social obligations, family activities, or even medical appointments create times when sleep is disrupted in order to attend these activities. Further, the person who works alternate shifts may sometimes be required to shift back and forth between sleeping during the day and sleeping at night. After a stretch of three night shifts in a row that includes sleeping during the day for three days in a row, a night-shift worker may desire to sleep at night again on his or her night off. However, when the person must return to work a few nights later, he or she will need to readjust to staying awake again during the night and sleeping during the day again.
Some people have had success with achieving sleep through the changing sleep patterns of shift work by taking medications that induce sleep when necessary. Some prescription sedative-hypnotics, as well as over-the-counter sleep aids, may help shift workers to sleep during the day in order to stay awake longer at night. However, some of these medications can have negative side effects, such as grogginess upon awakening, and those who take them may not wish to continue their use long term. The use of medications to induce sleep to maintain a night shift schedule is individual for each person. Some people have little trouble with taking medicine to sleep on a regular basis and must continue with their chosen jobs as shift workers, while others struggle to maintain a schedule of sleep during the day and try to stay awake at night.

**Limb Disorders**

Limb disorders develop as conditions that affect sleep because of inappropriate movement of the extremities. Typically, the affected person has little to no control over the limb movements and may become quite frustrated with an inability to control his or her body and the disruptions that the limb disorder has on quality of sleep.

**Restless legs syndrome**

Restless legs syndrome (RLS) is one of the most common limb disorders that cause sleep deprivation. People with RLS report a significant impact on their quality of sleep and often develop symptoms that are severe enough that medical intervention is required. RLS is characterized by a feeling of unpleasant sensations in the lower limbs such as buzzing, tingling or burning, along with an almost irresistible need to move the legs. Moving the legs may relieve some of the sensations but the relief is usually temporary. The sensations in the legs can cause problems getting to sleep and
difficulties staying asleep for the person who must spend each night in discomfort.

Many people consider RLS to be a “made up” condition, and the name does not suggest the significance of the impact the condition can have on diagnosed patients. RLS may develop in up to 10 percent of the population, with 2.7 percent having severe enough symptoms that they need medical evaluation and treatment. RLS can significantly disrupt quality of life by causing sleep deprivation that further contributes to depression, excessive daytime sleepiness, decreased focus and attention, memory deficits, and anxiety.

Risk factors for the development of RLS consist of both preventable and non-preventable factors. Knowing these factors may help some people who suffer from the condition to make changes in order to improve symptoms and quality of life. Examples of preventable risk factors of RLS include obesity, an inactive lifestyle, alcohol use, and smoking. Alternatively, RLS is more common in women and may be more likely to develop as a person ages, and is also associated with a lower socioeconomic status. Despite the presence of these risk factors, researchers have yet to find one specific cause as to why some people develop RLS.

The incidence of episodes of RLS also varies among people. Some people report very mild and infrequent symptoms that do not have much impact on sleep. Alternatively, some unfortunate people have periods of RLS several nights a week for long periods of time. Of those diagnosed with RLS, approximately 20 percent have symptoms every night or almost every night, 40 percent have symptoms at least once per week, and another 40 percent report symptoms every few weeks or months.
Diagnosis of RLS is basically subjective, depending on what the patient describes is happening, as there is no specific test that can otherwise determine its presence. A group of researchers developed a set of criteria to help the clinician in the diagnosis of RLS. Firstly, the patient experiences symptoms underneath the skin of the lower extremities that are typically described as crackling, buzzing, tingling, or crawling. The most common occurrence is in the space between the knee and the ankle. The sensations are sometimes difficult to describe and are almost always accompanied by an irresistible urge to move the legs.

Secondly, the patient experiences these sensations, as well as the urge to move the legs, most often during times of lying down or trying to sleep. Thirdly, the unpleasant sensations are temporarily relieved by moving the legs or getting up to move, walk around, or shake the legs in response. Finally, the criteria states that the sensations almost always occur in the evening or at night; if they occur during the day, they are much less noticeable when compared to their appearance at night.24

Restless legs syndrome can be successfully treated with medications and other lifestyle changes. Currently, there are four different medications available in the United States that is approved by the FDA in the treatment of restless legs syndrome; ropinirole (Requip®), pramipexole (Mirapex®), and rotigotine patch (Neupro®) are all types of dopaminergic agonists that are currently used. Gabapentin enecarbil (Horizant®), a type of anticonvulsant medication, is another medication that has been specifically approved by the FDA for RLS.25

Alternatively, other medications may also be prescribed for RLS symptoms, but they are not necessarily intended for the treatment of RLS; however,
their off-label use has been shown to relieve some symptoms in affected patients and they may be prescribed to alleviate RLS. Examples include other anticonvulsant medications, such as lamotrigine (Lamictal®) and carbamazepine (Tegretol®), benzodiazepine-hypnotics, such as eszopiclone (Lunesta®), and alprazolam (Xanax®), and opioid analgesics such as hydromorphone (Dilaudid®) and meperidine (Demerol®).25

Many people with RLS find relief of symptoms by combining medication use with changes in some lifestyle factors. Examples of changes that may be incorporated into treatment of RLS symptoms include avoiding caffeine intake, as well as that of alcohol and nicotine, massaging the legs regularly, taking a hot bath in the evening before bed, and getting regular exercise. Studies have shown that taking supplements of iron, magnesium, and folate may also be helpful in relieving some symptoms, particularly if these mineral deficiencies are present.26

**Periodic limb movement disorder**

Somewhat similar to restless legs syndrome, periodic limb movement disorder is another type of limb disorder that can significantly disrupt sleep. Periodic limb movement disorder (PLMD) occurs as a series of limb movements during sleep that happen approximately every 20 to 40 seconds. The affected limbs are most commonly the lower legs and the movements may be described as jerking or twitching; additionally, the affected patient may repeatedly flex the feet up and down. These uncontrollable movements of the extremities can disrupt sleep of the affected individual and his or her bed partner. They can cause significant sleep disruption that can lead to excessive daytime sleepiness, lethargy, irritability, and lack of concentration when awake during the day.27
Many people with PLMD also have restless legs syndrome, although the reverse is not typically true. There has not been one identifiable cause that is associated with PLMD that explains why some people develop these limb movements that can affect them so significantly. In addition to causing complications associated with sleep deprivation, individuals with PLMD are also at an increased risk to develop other chronic conditions, such as kidney disease, diabetes, and anemia.27

Many of the treatments and lifestyle changes recommended for restless legs syndrome can work well in the management of PLMD. Affected patients should see a healthcare provider for a full history and physical exam to rule out other disorders that may be present, including medical conditions such as Parkinson’s disease or vitamin or mineral deficiencies that could be causing muscle twitching similar to PLMD.

*Sleep-related leg cramps*

A further limb disorder that may develop in some people is episodes of sleep-related leg cramps. These cramps develop when the muscles of the lower leg tighten involuntarily while a person is asleep, often causing severe pain and forcing the person to wake up. Sleep-related leg cramps usually begin quite suddenly and can last for a few seconds to several minutes, depending on the person’s response to the cramp and efforts at relieving the pain. Leg cramps may occur in some people only sporadically, developing once or twice a year; alternatively, some people have leg cramps every night or even more than once per night of sleep.28

People with diabetes, blood vessel disease, nerve or endocrine disorders, or electrolyte imbalances may be more likely to develop sleep-related leg cramps. Additionally, some other conditions, such as excessive exercise
during the day, dehydration, use of some types of medications, and immobility may also contribute to the development of leg cramps. They may increase in frequency with advancing age, although anyone of any age can develop sleep-related leg cramps. There is also an increased association of leg cramps with pregnancy; and up to 40 percent of pregnant women have reported suffering from leg cramps while sleeping.\textsuperscript{28}

When a leg cramp occurs during sleep, the affected individual typically awakens quickly in response. The pain can be sharp and intense, causing the person to sit up or get up out of bed. The muscle often feels very tight, stretched, or throbbing, and massaging or stretching the muscle relieves the pain. Even after the initial pain has gone away and the acute cramp has been resolved, the person may feel soreness in the muscle for hours to days afterward.\textsuperscript{28} If the muscle cramps occur several times at night, sleep can be disrupted as the person continuously awakens from their sleep and exerting effort to eliminate the pain.

Unfortunately, there is not one specific treatment aimed at stopping leg cramps from occurring. Most patients are advised to implement lifestyle interventions that can improve circulation and flexibility of the muscles, which may prevent the leg cramps from occurring at night. It is important that the patient who wants to incorporate exercise knows that exercise should be performed during the day and not closer to bedtime. Exercising late in the day may lead to sleep difficulties and the body may have more trouble “winding down” for sleep. However, regular exercise is extremely beneficial in controlling weight and improving sleep, and can reduce the incidence and severity of sleep-related leg cramps.
Nighttime Sleep Behaviors

Nighttime sleep behaviors, in which a person acts in an abnormal manner while asleep, are known as parasomnias. These behaviors often develop during childhood but they can actually be apparent at any age, including during adulthood. When nighttime sleep behaviors occur consistently, they can significantly impact the affected individual’s quality of sleep.

Hypersomnias

Hypersomnias are sleep disorders in which affected people suffer from sleeping too much. They often feel very tired, drowsy during the day, and struggle with excessive daytime sleepiness. At times, people with hypersomnias can fall asleep at inappropriate times, leading to difficulties with maintaining activities, jobs, or relationships.

Narcolepsy

Narcolepsy is one type of sleep disorder classified as a hypersomnia sleep disorder that is characterized by excessive daytime sleepiness and abnormalities in the REM period of sleep. The part of the brain that regulates sleep is impaired and the affected patient may experience a sudden loss of muscle control in addition to excessive sleepiness. Consequently, the patient with narcolepsy may fall asleep at inappropriate times when the brain is triggered, leading to out of place behaviors, such as falling asleep while performing specific activities or during times when the affected person is supposed to be working.

Narcolepsy most commonly presents between ages 10 and 25. Beyond excessive daytime sleepiness, people with narcolepsy suffer from other symptoms that may be triggered by emotional responses. Cataplexy is a
condition that involves a sudden loss of muscle function; and, the person with narcolepsy who experiences cataplexy may suddenly lose muscle control and drop items or fall down. Often cataplexy is triggered by significant emotions, such as crying or fear.

Narcoleptics may also experience sleep paralysis, in which they may have periods of being unable to move at all just after awakening or just prior to falling asleep. It is thought that sleep paralysis occurs more often in people with narcolepsy because of the altered transition to REM sleep that commonly occurs with the disorder. After falling asleep, most people go through a cycle of NREM sleep before transitioning to REM sleep approximately 90 minutes later. However, people with narcolepsy often fall asleep straight into REM sleep, rather than going through the deep, slow-wave sleep of the NREM cycle. Because muscle atonia or paralysis often occurs with REM sleep to prevent people from acting out their dreams, the narcoleptic may also quickly go into or revert out of muscle paralysis associated with REM sleep. If the person is not quite asleep or not quite awake, but the body still believes it is in the stage of REM sleep, the muscles may be paralyzed and the person will be unable to move.⁴

People with narcolepsy may experience other symptoms as well. Hallucinations are more common in this population, and narcoleptics may see visions or hear sounds that are not truly there just before falling asleep or just after waking up. Nighttime wakefulness may also occur when the person tries to sleep at night but may wake up repeatedly. Finally, narcoleptics also often have periods of microsleep, where they fall asleep while performing routine activities, although they wake up quickly and may be unaware that they were ever asleep.⁴
The exact cause of narcolepsy is unknown, although research has uncovered several theories that are attributable to the condition. People with narcolepsy are more likely to lack a substance in the brain known as hypocretin, which helps to regulate sleep and can help a person to wake up. The cells that secrete hypocretin are known as Hcrt cells, and scientists believe that people with narcolepsy have a decreased number of these cells overall, thereby producing less hypocretin overall. This results in the person’s inability to control how much he or she sleeps as well as his or her ability to wake up after sleeping.4

Narcolepsy can cause significant difficulties for the affected person. The narcoleptic patient may feel isolated and alone, believing that no one else understands their condition or the difficulties that they must face with the disorder. Many people with narcolepsy are unable to continue with activities that are otherwise considered routine for most people. Activities such as driving or cooking could become dangerous if the affected person falls asleep while performing them, so they are often avoided. Narcolepsy may cause sleep to become very disrupted and the affected patient then becomes sleep deprived. Chronic sleep deprivation can lead to memory impairment, difficulties with concentration and focus, and decreased power of the immune system.

Narcoleptics may also struggle in some social relationships and the potential for avoiding others can be high if they fear falling asleep or losing muscle control in social situations. Others may not understand the physical causes associated with narcolepsy and may end up being judgmental of the affected person, believing that he or she does not take care of themself, does not get enough sleep, or that they have a slow or lazy demeanor.4 Often, support groups are available for people with narcolepsy and are opportunities to
meet with others who struggle with the same condition and to gain insight about some remedies and lifestyle changes that can make a difference in their quality of life. Support groups are also important for building friendships and reducing the isolation that someone may feel when diagnosed with narcolepsy.

Narcolepsy is typically diagnosed through a series of tests that include an initial history and physical exam to rule out other causes of excessive daytime sleepiness and cataplexy, such as the presence of other medical conditions. A polysomnogram may be performed to determine the patient’s sleep patterns, brain activity, and muscle movements while asleep. The patient may also need to undergo a multiple sleep latency test, in which they sleep for short periods during the day and the provider determines if there are abnormalities in the patient’s abilities to fall asleep or if they have periods of REM sleep at inappropriate times, which is thought to contribute to the cataplexy and sleep paralysis associated with narcolepsy.¹⁷

There is no cure for narcolepsy, but many people are helped by taking certain medications that act as stimulants to protect them from falling asleep at inappropriate times. The two most common medications prescribed to treat excessive daytime sleepiness associated with narcolepsy are modafinil and sodium oxybate. These drugs are unfortunately associated with higher levels of abuse and dependence because of their effects. However, when combined with lifestyle changes, use of medications may be very effective in controlling symptoms.¹⁷

Another class of drugs that may be prescribed for the treatment of some symptoms associated with narcolepsy is antidepressants, including tricyclic antidepressants and selective serotonin and noradrenergic-reuptake
inhibitors (SSRIs). These drugs are helpful in reducing and controlling the symptoms of cataplexy in people with narcolepsy.\textsuperscript{17}

Finally, lifestyle modifications, particularly when paired with medication, can be effective in helping to treat symptoms of narcolepsy and for reducing the incidence of accidents or injuries that can occur from excessive daytime sleepiness and cataplexy. The patient with narcolepsy may benefit from avoiding certain substances in the evening, including caffeine and alcohol, in order to get a better night of sleep. It is also important to engage in regular exercise to manage weight but to also improve circulation and to regulate body systems that may promote sleep at night. If a patient does exercise during the day, it is best to engage in the exercise at least 4 hours before the normal bedtime. Developing a bedtime routine that promotes sleep is also helpful, which may include relaxing activities in the evening, sleeping in a warm and comfortable environment, and going to bed and getting up at the same time every day.\textsuperscript{17}

\textit{Idiopathic hypersomnia}

Idiopathic hypersomnia is another form of excessive sleepiness that differs from narcolepsy, but still leads a person to feel frequently drowsy and to fall asleep quickly. Idiopathic hypersomnia most often develops during childhood or young adulthood and the affected individual may struggle with the condition throughout their life. It is classified into two main types: idiopathic hypersomnia with long sleep time and idiopathic hypersomnia without long sleep time.\textsuperscript{15} The description of “idiopathic” means that the entire cause of the hypersomnia is not really known.

Researchers have yet to be able to pinpoint a genetic, environmental, or physical reason why the person exactly feels so much excess sleepiness and
the condition is not attributed to another disorder. Idiopathic hypersomnia with long sleep time is characterized by excessive daytime sleepiness and the need for naps during the day, which are often long. Despite taking one or two long naps during the day, the person continues to feel tired and drowsy; and, may also sleep for great lengths at night and be very difficult to rouse in the morning. After awakening, the affected individual is likely to have confusion upon arousal, also known as sleep drunkenness, in which he or she is confused, disoriented, and sometimes aggressive or inappropriate for a time after awakening. Often, the person does not remember such an episode.

Idiopathic hypersomnia with long sleep time may also lead to periods of sleep paralysis, hypnagogic hallucinations, which involves the patient seeing or hearing things that are not real during the period of time transitioning between sleep and wakefulness; and, the person may also experience headaches, lightheadedness, and occasional fainting during such episodes. In contrast to narcolepsy, the patient does not experience symptoms of cataplexy with this type of idiopathic hypersomnia. Idiopathic hypersomnia without long sleep time is a little more similar to narcolepsy in that the affected patient still experiences excessive daytime sleepiness and is irresistibly drawn to taking short daytime naps.

The daytime sleeping episodes may be more frequent than idiopathic hypersomnia with long sleep time, usually because they are shorter in duration. The patient often has more of a sense of feeling refreshed after a daytime nap. In contrast to idiopathic hypersomnia with long sleep time, the patient with this type of hypersomnia usually does not sleep for great lengths at night and does not have as many difficulties with awakening.
Idiopathic hypersomnia with long sleep time is diagnosed through a patient history and physical exam to rule out the potential of other conditions that could be contributing to excessive daytime sleepiness. The patient may need to keep track of how many hours they sleep, as well as naps taken, time of going to bed at night and of morning awakening, and the overall quality of their sleep. Additionally, a polysomnogram may be necessary to determine if other factors such as sleep-disordered breathing are present.\textsuperscript{15}

The patient with idiopathic hypersomnia may experience severe frustration at an inability to get enough sleep. While many people who become sleep deprived can improve their conditions by catching up on sleep and improving overall sleep habits, the person with idiopathic hypersomnia seems to never get enough sleep, and he or she continues to feel drowsy despite 10 or more hours of sleep at night and with napping during the day.

Unfortunately, there are few treatments available for idiopathic hypersomnia. Many physicians prescribe stimulant medications similar to those used in the treatment of narcolepsy and some patients have had success using these drugs. For those who use prescribed stimulant medications, many may still continue with having more than the average amount of sleep. Often, sleep must be scheduled or considered as a normal way of life for those diagnosed with this condition, and they need to make others aware of their disorder and the need for extra sleep every day.\textsuperscript{16}

**Sleepwalking**

Sleepwalking, also referred to as somnambulism, is a condition that occurs when a person gets up, walks, or performs other activities while asleep. Sleepwalking most commonly develops during childhood and may be prevalent in up to 40 percent of children for occasional episodes. It peaks
between 11 and 12 years of age and then often diminishes during adolescence. Between 0.5 and 4 percent of adults continue to sleepwalk and never outgrow the condition.¹⁹

While sleepwalking the person may be transitioning between NREM and REM sleep, which is when their brain is active but the rest of the body is acting out some of what is being dreamt. Typically, the person has no awareness of what they are doing while sleepwalking. It most commonly occurs during the first half of the night and in stages 3 and 4 of NREM sleep; however, it can occur at any time of night and in other stages of sleep as well.¹⁹

Sleepwalking is characterized by activity that is abnormal for a sleeping person, such as, getting up out of bed, walking around the room or the house, performing routine activities that would be performed during the day, or talking.

Some people also perform more bizarre activities, such as placing items in inappropriate locations or urinating on the floor. Contrary to its portrayal in the media, a sleepwalking person typically does not stumble around the room with their arms held out in front. The person does have slower movements and may appear clumsy, often with their eyes open, having a blank stare, and typically they do not track or follow what is going on in front of them. Attempts to talk to people who are sleepwalking may be unsuccessful or may be met with inappropriate or confusing responses.¹⁹

While many professionals believe that sleepwalking is a benign condition that does not hurt anyone, other researchers have disagreed. A study noted by the American Academy of Sleep Medicine found that adults who sleepwalk have higher instances of excessive daytime sleepiness, insomnia,
depression, and anxiety when compared to people who do not sleepwalk. Sleepwalking can also be dangerous if the person becomes engaged in activities that are hurtful toward others or themself. For instance, some studies have revealed that people who sleepwalk, or their bed partners, have been injured enough during the episode that they required medical care and treatment. Clearly, in these situations, sleepwalking and its associated activities is not a benign behavior.

The most common cause of sleepwalking among adults is sleep deprivation. People who are stressed and who are chronically sleep deprived are more likely to have episodes of sleepwalking if they have had them in the past. Other causes of sleepwalking episodes include using alcohol or certain psychotropic medications, chronic sleep deprivation, and the presence of other sleep disorders, such as obstructive sleep apnea. Illnesses that cause a fever can also precipitate a sleepwalking episode. Some people who have medical conditions, such as hypothyroidism or migraine headaches, may also be more likely to sleepwalk. The concept that sleepwalking is more commonly associated with mental illness is not true; sleepwalking has not been associated with a greater level of psychological disorders among affected people.

Sleepwalking is often not treated with medications or therapies and it is usually diagnosed based on the patient’s history alone. The most prominent part of managing sleepwalking is managing and improving sleep. A polysomnogram may be indicated for some people if there is a risk of another underlying disorder, such as obstructive sleep apnea. Otherwise, the management of sleep by increasing the amount of sleep at night to avoid sleep deprivation, managing stress, and avoiding the use of certain
substances, such as alcohol or sedatives, can help to reduce instances of sleepwalking.¹⁹

Some people who are known to have sleepwalking episodes benefit from taking safety precautions in the home to avoid accidents and injuries. While most sleepwalkers are able to navigate within their rooms and homes without difficulty, taking safety precautions can help to prevent a severe injury from occurring. This includes removing sharp objects, locking doors and windows, and getting rid of any items that could cause injury or be used to hurt someone else.

In cases where a sleepwalker has become injured or violent, or in other cases where episodes occur so frequently that the person is suffering from severe sleep deprivation, some medications should be prescribed to stop the frequency of episodes. Some types of medications that have been successfully used for sleepwalking include antidepressants, such as tricyclic antidepressants and selective serotonin reuptake inhibitors, and low-dose benzodiazepines.¹⁹ Treatment is most effective when medications are combined with other lifestyle changes, such as good sleep hygiene habits (discussed later in this study).

**Confusional Arousals**

While more common among children, confusional arousals occur in approximately 4 percent of adults. Confusional arousals are a type of parasomnia that is characterized by inappropriate behavior upon awakening. They most often occur when the affected patient is forced to awaken or otherwise wakes up spontaneously from stages 3 or 4 of NREM sleep.¹⁹ Because the person usually has awakened during the stages of deep sleep, it may take time to become reoriented to time and place.
Among adults, confusional arousals are classified into two different types: severe morning sleep inertia and sleep-related abnormal sexual behaviors. Severe morning sleep inertia is also referred to as *sleep drunkenness* and is most likely to occur with morning awakenings. The patient may exhibit bizarre behaviors or appear disoriented, may thrash around in bed, exhibit similar behavior to sleepwalking, cry, scream, or even become aggressive. Typically, the affected person does not remember the event after he or she becomes fully awake and any attempts to calm them or alter their behavior are unsuccessful. Most episodes last between 5 and 15 minutes, although some episodes have been shown to last for over a hour.¹⁹

Alternatively, sleep-related abnormal sexual behaviors are characterized by inappropriate sexual behaviors that occur when a person is just waking up. They often happen when the affected person is forced to awaken from sleep and has been in a deep stage of sleep. These behaviors may include sexualized behaviors, such as acting out sexual activity, masturbation, and talking in a sexually suggestive manner.¹⁹

Confusional arousals affect both men and women equally; however, like other types of parasomnias, they are most often associated with chronic sleep deprivation and stress. Other factors that also contribute to more episodes of confusional arousals include use of alcohol, which acts as a central nervous system depressant, and the presence of other sleep disorders, including obstructive sleep apnea and periodic limb movement disorders. Additionally, conditions or circumstances that change the rhythm and schedule of sleep, including shift work or altered sleep routines, may lead to episodes of confusional arousals.¹⁹
Diagnosis of confusional arousals takes time and often includes more than one sleep study. A polysomnogram can detect changes in the transition between NREM and REM sleep, as well as the presence of short bursts of sleep, called microsleeps. However, not all patients experience episodes of confusional arousals with one sleep study, which may indicate the need for successive studies. Many patients and their families keep sleep journals, in which the patient can track how much and how often they slept, as well as the quality of sleep. The family can report the patient’s behavior of when they had a confusional arousal. It may also be necessary to complete video recordings of the patient’s behavior that can be used in conjunction with polysomnogram findings to determine a diagnosis.¹⁹

Treatment of confusional arousals involves lifestyle modifications and medication, if necessary. Often, getting higher quality sleep and sleeping for longer periods can reduce the effects of sleep deprivation that contributes to confusional arousals. The patient should determine what areas of life are causing the most stress and work to adapt those situations so that they may experience better sleep and fewer confusional arousal episodes. Severe cases of confusional arousals have also been managed with complementary and alternative medicine (CAM) therapies, such as hypnosis and progressive relaxation.¹⁹

Medications that may be used for treatment typically include antidepressants or benzodiazepines. Use of antidepressants does not necessarily indicate that the patient is depressed when treating confusional arousals; the use of antidepressants is considered to be successful in off-label methods for treatment of the condition. The antidepressants may help with stress levels and can work to alter levels of neurotransmitters in the brain that could contribute to some of the confused activity. Alternatively, benzodiazepines
promote sleep and work to eliminate sleep deprivation, which is a common source of the confusional arousals.\textsuperscript{19}

**REM Behavior Disorder**

Another type of parasomnia, REM behavior disorder, occurs with bizarre or sometimes aggressive behavior patterns that appear to be of a person acting out his or her dreams. REM behavior disorder occurs when the individual is in the stage of REM sleep but often does not have muscle paralysis or atonia that is normally associated with the stage.\textsuperscript{19} Instead, while the person dreams, he or she may be physically able to move and act on some of the occurrences that are happening in dreams. The episodes may be more likely to occur later in the night or in late morning when there is a greater amount of REM sleep.

People who experience REM behavior disorder may get up out of bed, move around the room, scream, cry, or become aggressive toward others. In some instances, REM behavior disorder has been associated with violence toward and injury of a bed partner or roommate. The affected person has closed eyes and often acts in a defensive manner. The episode ends when the person abruptly awakens and stops the behavior; he or she can usually recall much of what the dream was about at that time.\textsuperscript{19}

REM behavior disorder is classified into three different types: subclinical REM behavior disorder, parasomnia overlap syndrome, and status dissociatus. The *subclinical REM behavior disorder* type is usually only determined during a polysomnogram, when the person has brain and muscle activity associated with the disorder but does not act out. This subtype is associated with later development of full-blown behaviors that are characteristic of the disorder.
Parasomnia overlap syndrome includes REM behavior disorder that is also associated with other types of parasomnias, including sleepwalking, night terrors, and confusional arousals. It may be difficult to determine the difference between REM behavior disorder and some other types of parasomnias because often their behaviors may mimic each other. However, each parasomnia does have distinct differences that classify them accordingly. For example, sleepwalking and REM behavior disorder may appear similar initially, particularly if the sleepwalker is showing aggressive behavior, but a sleepwalker typically has open eyes with a blank stare and may or may not remember the event or wake up. Alternatively, an individual acting out through REM behavior disorder usually has closed eyes and wakes up from the episode with memory of the dream that was occurring.¹⁹

Status dissociatus is usually caused by an underlying medical disorder that contributes to the behavior. This type of REM behavior disorder has been shown to appear during different stages of NREM and REM sleep, and activities are not well correlated with a specific sleep stage. Status dissociatus is most likely seen with conditions such as Parkinson’s disease, narcolepsy, alcohol withdrawal, and dementia. Approximately 60 percent of causes are considered idiopathic.¹⁹

REM behavior disorder more commonly develops in adults and can actually be considered a condition that progressively worsens with aging, particularly when underlying conditions, such as Parkinson’s disease, are present. Diagnosis includes a history and physical, a polysomnogram test, and a brain MRI to rule out other brain abnormalities or underlying medical conditions that contribute to the behaviors. The patient may need more than one sleep study to determine changes that occur with the REM behavior disorder episodes, particularly if an episode does not happen during the first
polysomnogram. Video recording of the events may also be helpful to distinguish some of the actions or characteristics of the REM behavior disorder from other types of parasomnias, such as sleepwalking.

The disorder may be treated with medications and there are a variety of options available for treatment. One of the most common drugs prescribed is clonazepam, which has been shown to reduce symptoms in up to 87 percent of people with REM behavior disorder. Other types of drugs that have been successful with treatment include imipramine and bupropion, which are types of antidepressants; and, levodopa, which is often used in the treatment of symptoms associated with Parkinson’s disease and carbamazepine, which is an anti-seizure medication.

**Sleep Disorders Secondary To Illness/Injury**

While some sleep disorders develop as primary conditions, there are many situations in which underlying health issues contribute to sleep problems and cause excessive daytime sleepiness or insomnia among affected patients. Illnesses and injuries can create pain, discomfort, and changes in body systems that impact sleep.

**Injury and Chronic Pain**

People who experience chronic pain as a result of a previous injury or due to a condition that causes unrelenting discomfort may have considerable difficulties with achieving adequate sleep at night. Sleep difficulties have also been associated with medical conditions that cause chronic pain, including fibromyalgia, arthritis, chronic fatigue syndrome, and cancer.

Although many people who have chronic pain may complain of sleep disturbances, pain in itself is not a sleep disorder. The presence of pain
should not explain all of the reasons why a person is having sleep
difficulties; instead, the affected person should have a sleep study to
determine if there is another underlying disorder present that is causing the
sleep difficulties. Additionally, proper diagnosis and treatment of the
syndrome causing the pain can make a significant different in relieving sleep
difficulties.

People who have chronic pain have been shown to have changes in the EEG
portion of the polysomnogram sleep test. Sleep studies of people with
chronic pain have shown that they tend to spend more sleep time in the
lighter stages of sleep, rather than achieving deep NREM sleep that is
restorative. This creates a vicious cycle of further sleep deprivation that
exacerbates chronic pain symptoms. People with chronic pain have also
shown EEG changes that are known as alpha intrusions, which are
characteristic brain wave patterns that have been associated with chronic
fatigue syndromes and chronic pain disorders.\(^{21}\)

While treatment of alpha intrusions is not available, people with chronic pain
who are experiencing sleep difficulties would do well to have a pain workup
that investigates the cause of the pain. The connection between pain and
sleep is profound, as both are impacted by the central nervous system.\(^{21}\)
Unfortunately, it may be difficult to determine which condition is causing the
other; whether sleep deprivation is worsening chronic pain or if pain is
causing further sleep problems. Either situation needs a full investigation to
determine underlying cause and may need individual treatment and
management. With treatment of one condition, a relief of symptoms of the
second system will often follow.
**Obesity**

Obesity can have a significant impact on sleep habits and the volume of excess weight can affect how much and the quality of sleep a person gets. It is well known that obesity contributes to a number of health problems, including cardiovascular disease and diabetes, and some of the symptoms of these conditions can cause sleep problems. For example, a person who has diabetes may be at risk of developing diabetic neuropathy, a condition that leads to numbness, burning pain, and tingling in the extremities, particularly in the feet. This discomfort can significantly impact the diabetic’s ability to get quality sleep if the pain is causing him or her to wake up frequently.

Obesity is a significant contributor to obstructive sleep apnea, which affects approximately 18 million people in the United States. As people continue to gain weight, fat that accumulates around the neck and face can place more pressure on the airway and the structures that must normally remain open while breathing during sleep. Apnea during sleep leads to excessive daytime sleepiness, which can further promote obesity when the person is too tired during the day to get in extra activities that could lead to weight loss.\(^\text{22}\)

Unfortunately, lack of proper sleep may contribute to obesity and being overweight. Some people who lose enough sleep are more prone to weight gain, regardless of whether there is an underlying illness or disease present. According to Harvard Medical School, hormones that the body produces that control appetite and feelings of fullness can be impacted by lack of sleep. Ghrelin is a hormone that stimulates appetite and causes a person to feel like they want to eat. Alternatively, leptin is another hormone that counteracts the ghrelin by telling the brain to stop eating when satisfied.
When a person is deprived of sleep, ghrelin levels have been shown to increase, further stimulating a person’s appetite and driving him or her to eat more. Alternatively, leptin levels drop with sleep deprivation, so the brain receives fewer messages to stop eating when full. Ultimately, the sleep-deprived person may be more likely to gain weight because of these hormone disruptions that impact eating habits.¹

Sometimes, the best method of managing obesity is to treat the sleep problems that are happening at the same time. For example, in the case of an obese person who has sleep apnea, weight loss efforts may be more successful after a person has had time treating the sleep apnea with CPAP. The person may be less likely to have excessive daytime sleepiness because they are sleeping better at night with the CPAP. Improved sleep then leads to improved activity during the day, as well as improved feelings of well-being, which can contribute further to weight loss.²²

**Mental Illness**

Sleep problems can be associated with certain mental health conditions. At times the cause of the sleep disturbance may be the mental illness but, in some cases, the mental illness may be causing the sleep disturbance. Often, there is a negative cycle of symptoms of sleep deprivation intertwined with negative behaviors and emotions that can make it difficult to determine which problem started first.

Sleep disturbances are most commonly associated with illnesses such as depression, anxiety, and bipolar disorder; they are also associated with attention deficit hyperactivity disorder (ADHD) among children and teens. One of the classic signs of depression is sleep-related problems, whether sleeping too much or an inability to sleep or insomnia. Alternatively, the
Sleep problems may develop before the mental health crises occur. A study noted by Harvard University reported that people with insomnia were four times more likely to develop major depression when the insomnia was not adequately treated.23

People with depression and who subsequently have sleep problems are less likely to respond to treatment when compared to people who are depressed but do not have sleep problems.23 Although sleep difficulties are common symptoms of depression, they are not common in all patients. However, many people with depression have difficulties sleeping because of anxiety, worry, or ruminations about events of the day. Insomnia can also create feelings of isolation within a person when he or she feels alone in having sleep difficulties.

Anxiety is another mental health issue that has been associated with sleep disorders. A person with anxiety may have trouble sleeping because they are awake at night worrying or thinking, or they may have experienced insomnia in the past and may feel increased anxiety as bedtime is approaching because they fear an inability to sleep. Approximately 50 percent of patients with generalized anxiety disorder have some type of sleep difficulty. Sleep problems are also associated with other kinds of anxiety disorders including obsessive-compulsive disorder, post-traumatic stress disorder, and panic disorder.23

Various studies have shown an increased risk of sleep problems among people diagnosed with bipolar disorder; results of a systematic review by Harvard University have been reported as being between 69 and 99 percent of patients who claimed that they experienced insomnia during manic episodes. A lack of sleep and chronic insomnia may contribute to the
development of manic episodes in patients with bipolar disorder. Alternatively, up to 78 percent of patients experiencing bipolar depressive symptoms may develop hypersomnia and sleep excessively.\textsuperscript{23}

Treatment of sleep problems associated with mental health disorders is geared toward treating and managing the underlying disorder and making positive lifestyle changes. The affected patient can develop good sleep habits that are more likely to promote sleep, such as a regular bedtime routine and avoiding certain substances such as alcohol or nicotine before going to bed. Using other measures, such as hypnosis, guided imagery, or meditation may also be helpful in reducing anxiety and improving sleep habits.

Patients who are treated for mental illness by using medications may have resolution of sleep problems through medication. For example, some patients with depression experience a decrease in sleep problems when they treat their depression with antidepressant medications. They may experience relief of depressive symptoms and resolution of sleep problems with one medication.\textsuperscript{23}

Patients treated with medications for anxiety disorders may also experience relief of sleep problems by drug use to treat the anxiety itself. Many anti-anxiety medications work by providing a calming effect, which may induce sleep in some people. Additionally, patients with bipolar disorder who are experiencing manic episodes may need drugs to induce sleep when they suffer insomnia. Often, some of the drugs prescribed, such as benzodiazepine medications or anticonvulsants work well to promote sleep during times when mania is causing sleep deprivation.\textsuperscript{23}
Heart Disease

The heart beats faster or slower at night, depending on the stage of sleep a person is in; when the heart does not function properly and a person has developed heart disease, it can increase the risk of some types of sleep disorders. Alternatively, some pre-existing sleep disorders can increase the risk of developing certain types of cardiac conditions.

Obstructive sleep apnea is a common denominator associated with a number of different types of heart disease. People who have OSA are more likely to develop cardiovascular diseases, including hypertension, heart failure, and coronary artery disease. When a person with OSA repeatedly has episodes of apnea, the blood oxygen level drops. The heart, in response, beats faster in an effort to make up for loss of oxygen. This causes an increased amount of work for the heart and results in an increase in overall blood pressure. Over time, blood pressure levels may remain high, leading to chronic hypertension. Hypertension is a risk factor for the development of coronary artery disease as well, because of the increased stress placed on the blood vessels with high blood pressure.20

Heart failure can lead to chronic sleep problems for various reasons; it may lead to decreased and disrupted sleep because of symptoms, and it may be associated with specific sleep disorders that also cause sleep deprivation. A person with heart failure has a heart that does not pump efficiently enough to provide oxygenated blood to the tissues; excess fluid often builds up in circulation and in the tissues, which is why the condition is sometimes referred to as congestive heart failure. When a patient has congestive heart failure, he or she may have significant sleep difficulties, particularly if the congestion has reached the circulation surrounding the lungs. The patient may have difficulties breathing, which obviously impacts sleep; he or she
may need to sleep in an elevated position or use supplemental oxygen to help with breathing.

People with heart failure are more likely to have central sleep apnea, a disruption between the brain’s signals to breathe and the body’s response to take a breath. Approximately 40 percent of people with heart failure have central sleep apnea. Unfortunately, for those involved, the two conditions create a cyclical effect in which each worsens the symptoms of the other. The heart failure may increase the episodes of central sleep apnea, causing more pauses in breathing and decreased oxygenation throughout the body. The heart attempts to compensate against the deoxygenation and works harder, but because of the heart failure it is already stressed and damaged. The cycle between the two conditions continues to prolong sleep deprivation and can worsen cardiovascular disease.

Heart disease overall impacts sleep when the affected patient must make accommodations for both the disease affecting the heart and the associated sleep disorders. This often means using medications to treat the heart disease, using other methods of management, such as supplemental oxygen or CPAP, and incorporating lifestyle modifications to better manage both heart disease and sleep problems.

**Sleep Tests**

Various tests and procedures may be performed as diagnostic tools for determining if a sleep disorder is present. The patient with sleep issues may undergo a number of tests to confirm a diagnosis; some tests are more invasive than others. The gold standard of sleep testing is polysomnography, or an overnight sleep study; however, there are a number of other tests that
are also useful for confirming sleep disorders among patients experiencing excessive sleepiness or sleep deprivation.

**Polysomnography (sleep study)**

Polysomnography is the technical term for a sleep study, and is a procedure for diagnosing sleep disorders and other problems that may be causing difficulties with behavior or mood and may be related to sleep deprivation. It is typically performed at a sleep center where the patient must attend to be monitored while he or she is asleep.

Most patients undergo overnight polysomnography studies while they spend the night sleeping at a sleep center. A typical study involves the patient arriving at the center approximately 2 hours before their normal time for going to sleep. The sleep center staff connects the patient to a number of sensors that monitor the patient’s vital signs and sleep cycles. The patient’s brain activity while they sleep is recorded through an EEG and a sleep medicine specialist can later read the results to verify if there are disturbances in sleep patterns, or whether there are other problems affecting the patient from progressing through the normal stages of sleep.⁷

Sleep studies are used to diagnose a number of sleep disorders; they allow the sleep medicine specialist to not only read the results of brain patterns that occur during sleep, but he or she may also be able to watch a recording of the sleeping individual to look for behaviors that occur during sleep, such as excessive limb movements, sleepwalking, or sleep talking. A sleep study is also used to diagnose obstructive sleep apnea after determining if the patient has significant episodes of apnea and associated oxygen desaturations. If a patient is diagnosed with sleep apnea through a sleep study, the physician will then typically prescribe CPAP for use. The patient
must then return to the sleep center to have another sleep study using the CPAP to determine if it is effective in treating the obstructive sleep apnea and to adjust the settings if necessary.\(^7\)

Before starting a polysomnogram, a patient may complete a sleep diary, in which he or she records such factors as the time they go to bed, the time of falling asleep, the number of times awakened while sleeping, and the total time spent asleep. Additionally, the patient may also record other factors that can influence sleep, such as activities before bed, food intake, or mood. The patient records this information in the sleep diary over a period of time, often for several weeks, so that the sleep medicine specialist can review the information and determine if there are patterns occurring that are impacting the patient’s sleep. Sometimes, there are obvious situations that a physician can find and point out to the patient; when the patient changes these circumstances then sleep may be improved dramatically with little or no effort.\(^2\)

Alternatively, if the sleep diary does not point to problems that can be readily explained or treated, further management of the patient’s condition is necessary. It should be noted that the patient’s sleep diary is subjective and the information included is based on his or her expressions, descriptions, and opinions. Often, diagnosis and treatment of sleep disorders requires testing that will produce objective results that can be measured in order to fully facilitate treatment for the patient.

While sleep studies are very useful, especially in conjunction with a sleep journal from the patient, they do not diagnose all different kinds of sleep disorders. In some situations, a sleep study may be unnecessary, such as with sleep-related leg cramps or other disorders where diagnosis may be
made on the basis of patient description. Further, some people do not sleep normally in a sleep laboratory, particularly when they are connected to sensors and someone is watching them attempt to sleep. When this occurs, the affected patient may not demonstrate a routine night of sleeping that is comparable to what he or she experiences at home. Other forms of testing may be necessary or supplemented with the sleep test. Ultimately, the sleep study can be very useful in diagnosing many types of sleep disorders, including circadian rhythm disorders, insomnia, narcolepsy, and most commonly, obstructive sleep apnea.

**Maintenance of Wakefulness**

Maintenance of wakefulness (MWT) testing determines how well a person is able to stay awake in a situation. The MWT is particularly useful for people who experience excessive daytime sleepiness and fall asleep quickly and sometimes inappropriately. It may also be required in some situations where a person with a sleep difficulty needs to stay awake for an important job, such as with air traffic control or transportation.48

During the MWT, the patient attends a sleep lab where he or she is placed in a darkened room and connected to various sensors that signal when the patient is asleep and awake. After being connected to the sensors, the patient lies down in a comfortable bed and is asked to lie on their back and stay awake for as long as they can. If the patient falls asleep, they are awakened after 90 seconds. If the patient has not fallen asleep within 40 minutes, the test is complete. The MWT test is repeated for four trials of attempting to stay awake.

According to the American Academy of Sleep Medicine, up to 59 percent of patients with normal sleep are able to go through the MWT and stay awake
for the 40 minutes of each of the four trials. Over 97 percent of people are able to stay awake for at least 8 minutes or more during the trials. If a person falls asleep in less than 8 minutes during one of the sleep trials, it is significant for further testing of a sleep disorder.\textsuperscript{48}

The MWT test may be used in conjunction with other types of sleep testing; particularly when confirmation or diagnosis of a specific sleep disorder and planned treatment is necessary. The MWT is useful in recognizing such disorders as obstructive sleep apnea or narcolepsy. It can also determine the effectiveness of treatment for some types of sleep disorders when a patient has started therapy and needs to find out how well it is working.

**Multiple Sleep Latency Test**

In contrast to situations where people have sleep testing while sleeping at night, the multiple sleep latency test (MSLT) challenges certain patients while sleeping during the day. The multiple sleep latency test is typically used as a diagnostic tool among people who complain of excessive daytime sleepiness, usually as a result of some type of sleep disorder. The MSLT studies how quickly a patient falls asleep when taking a nap during the day.

The patient is connected to sensors that measure such items as eye and chin movements, as well as brain waves through an EEG. The MSLT can determine how much time a person spends in NREM and REM sleep stages. It also helps to gain a better idea of whether the affected person is having difficulty falling asleep as well as spending abnormal amounts of time in one or more sleep stages when they do fall asleep.\textsuperscript{29} Additionally, the MSLT can determine how quickly a person moves through the phases of sleep and if he or she moves into REM sleep at an abnormally fast pace; faster than the average time it usually takes for a sleeping person to progress to this stage.
The MSLT is often used for the diagnosis of narcolepsy. Because people with narcolepsy often complain of excessive daytime sleepiness and typically move quickly into the REM stage of sleep after falling asleep, this test can act as a diagnostic tool for this condition. Alternatively, the multiple sleep latency test may also be used to diagnose idiopathic hypersomnia. Although people with idiopathic hypersomnia do not usually move directly into REM stage sleep after falling asleep, the MSLT can be diagnostic when evaluating excessive daytime sleepiness associated with the condition.29

Before the MSLT, the patient may need to keep a sleep journal for at least a week, which can give the clinician a better idea of the patient’s sleep habits, periods of awakening, amounts of daytime sleepiness, and quality of sleep overnight. Before the study, the patient typically must also refrain from such activities as smoking, drinking caffeine, or taking medications that could impact the results of the study. The MSLT is also typically performed after an overnight sleep study, as the results can be compared between nighttime sleeping and daytime naps.29

During the test the patient has five opportunities to take a nap and is tested on how quickly he or she goes to sleep. If the patient had an overnight sleep study prior to the MSLT, the first nap opportunity may come approximately 1 to 3 hours after the completion of the overnight study. The patient is connected to the appropriate sensors and then allowed to lie down in a dark room that is being monitored by professionals who will eventually read the results. The room is kept dark, quiet, and comfortable in order to better facilitate sleep. The patient basically lies down and tries to go to sleep. Once the patient has fallen asleep, their activity is recorded for approximately 15 minutes and then they are awakened. The nap sessions are then repeated four more times throughout the day. If the patient is unable to fall asleep
After 20 minutes, the session is discontinued, the sensors are removed, and the patient waits until the next nap trial a couple of hours later.\textsuperscript{29}

After the last nap trial of the day, the patient is free to go home and they will receive the results later. A sleep medicine specialist who can diagnose the presence of a sleep disorder, such as a hypersomnia sleep condition, must read the results. The diagnosis is made by determining how long it takes for the patient to fall asleep during each of the nap trials. Additionally, the physician checks for how quickly the patient enters the stage of REM sleep and how much time is spent in NREM sleep to determine if the sleep cycles are occurring normally. Deviations from normal in these situations often indicate the presence of a sleep disorder. Further testing may be warranted in some situations if the patient is showing signs of sleep disturbances but the results are not entirely clear through the MSLT.

**Actigraphy**

Actigraphy is a diagnostic tool that can be used in diagnosing several types of sleep disorders. Actigraphy involves placement of a sensor on the patient, who wears the device for several days including during the day and at night while sleeping. The device records the patient’s activity both while awake and at rest. The information is downloaded to an electronic program where a physician can review it.

Actigraphy is not designed to replace an overnight sleep study test, but it can be a useful tool for documenting sleep patterns. It has been used prior to performing a multiple sleep latency test and it is useful in evaluating the presence of specific disorders, such as circadian rhythm disorders. It may also be used concurrently with treatment methods for sleep-disordered breathing to determine the effectiveness of such treatments as CPAP.
Furthermore, it has been shown to be useful when evaluating the effects of sleep on some medical conditions, such as depression and dementia.\textsuperscript{46}

There are certain advantages that actigraphy can provide over certain types of sleep evaluations, such as a sleep journal. When patients are asked to keep a sleep journal, they typically record their sleep habits over the course of several days to weeks. However, this information is sometimes inaccurate because it relies on the patient’s memory of the situation and it is entirely subjective information provided by the patient and their family. A study in the journal \textit{CHEST} showed that when actigraphy was used in conjunction with a sleep journal, the results were different between the journal and the actigraph. For example, in one report, the bedtimes reported by the patient in the sleep journal were a full hour before the recorded times found in the actigraphy.\textsuperscript{46} Most patients do not intend to provide false data, but memory and recall of events may be distorted when recording items in a sleep journal, particularly during sleep deprivation.

Actigraph use is prescribed by a physician and is a small monitor that is worn on the wrist; the average length of time of wear is 1 to 2 weeks. It continuously monitors activity and sleep habits of the patient while it is worn and records and downloads the information for the physician to read and interpret. It can record information constantly while worn, although there are certain situations in which it should be removed, such as when showering or bathing.

An actigraph may also have a light sensor that can record changes in light levels that indicate when the patient is asleep. If the patient is undergoing light therapy as a treatment for a circadian rhythm disorder, the light sensor on the actigraph can record and determine adherence to light therapy.
treatment as well. Actigraphy may be used in recording the sleep habits of people who suffer from insomnia. Sleep journals of patients with insomnia may or may not be entirely accurate for the number of hours of sleep and for the amount of sleep deprivation that has occurred. This is especially true in situations where sleep deprivation impacts concentration and memory for recalling events.

When a person undergoes a sleep study for the first time, he or she may not go to sleep or may have difficulties following through with the study to produce “normal” results because of trying to sleep in a lab and not at home. It may take several sleep studies to gain an example of a routine night of sleep for someone with insomnia. Alternatively, actigraphy may be used in place of a polysomnogram in some cases of insomnia to record light levels in the room and the patient’s actual times of sleeping and wakefulness.

Sleep actigraphy does not necessarily measure sleep stages accurately enough to be considered a valid resource for this data. Additionally, if a person lies completely still at night but is actually awake, the actigraphy may incorrectly note that the individual is asleep. Actigraphy is typically not designed to take the place of an overnight sleep study, however, it can be a valid and useful device for recording sleep habits, particularly when used in conjunction with a sleep journal for some patients.

**Imaging and Lab Tests**

Because underlying medical conditions may cause some sleep disorders, there are situations in which laboratory testing and imaging studies are warranted to rule out specific conditions. Checking the blood and determining whether hormone levels are altered or if there are other
indications that a disease is present can detect some diseases that impact sleep. For example, a patient with hypothyroidism may have difficulties with sleeping that could be diagnosed as insomnia. Laboratory testing to check thyroid levels and to perform thyroid function tests may pinpoint hypothyroidism and sleep could then be improved with its treatment.

Other types of blood tests that could be necessary for ruling out the presence of other conditions include: arterial blood gases, which measure the amount of oxygen and carbon dioxide levels in the bloodstream and may be useful in determining the consequences of sleep-disordered breathing; tests for glucose levels to determine the presence of diabetes; and tests of cholesterol levels, triglycerides, and C-reactive protein to confirm the presence of heart disease or factors that are contributing to decreased circulation or other problems with the cardiovascular system.

Imaging studies are particularly useful in diagnosing sleep-disordered breathing; they typically provide an image of the structures of the inside of the mouth and throat that can confirm problems associated with sleep apnea, snoring, or upper airway resistance syndrome. A CT scan of the head and neck may be useful for examining parts of the airway that are difficult to see from other types of physical exams. The head and neck CT may determine if a patient has an enlarged tongue or extensive tissue in the neck or at the back of the throat that could be contributing to obstructive sleep apnea.47

A specific type of x-ray known as a cephalometric x-ray may take images of the head to determine if there are skull or jaw abnormalities contributing to sleep difficulties. This type of x-ray would be most useful in determining if there are structural abnormalities in the upper or lower jaw, the nasal
bones, or the hyoid bone that could also contribute to obstructions found in OSA.\textsuperscript{47}

Pharyngoscopy is a procedure that involves inserting a tube with a small camera on its end into the patient’s pharynx to look at the structures at the back of the mouth. The pharyngoscopy takes pictures of the structures and can better determine if the patient has excess tissue or other structures that would be more likely to collapse during relaxation while sleeping, further contributing to obstructive sleep apnea.\textsuperscript{47}

Imaging studies and laboratory tests are all part of the diagnostic process of determining the cause of sleep problems. When a patient presents with sleep difficulties and the physician has narrowed down possibilities for a diagnosis, these types of studies may help to confirm one way or another, which type of sleep disorder is present or if there is another problem that is causing the sleep difficulties that should be treated differently.

**Treatments For Sleep Disorders**

Treatments for sleep disorders may vary depending on the type of disorder and the presence of any underlying medical conditions that accompany it. After a patient undergoes diagnostic procedures and has a diagnosis confirmed of a sleep disorder, there may be a number of treatments available that can help to induce better sleep. Some treatments may be combined with others to ensure positive results.

**Behavior Modifications**

There are several behavioral modifications that may be included as part of treatment for sleep disorders. Some sleep problems can be treated with
behavior modifications and lifestyle changes alone, while in other cases, behavior modification is combined with other forms of medical treatment.

_Cognitive-behavioral therapy_ (CBT) is a behavior modification that may be used for some types of sleep disorders. It has been effective in the treatment of insomnia. A therapist serves as a guide for the patient to coach him in learning to recognize the factors that are contributing to sleep problems. For example, a patient with insomnia may learn to recognize those thoughts and ideas that he or she consistently thinks about every night that sometimes prevent asleep from occurring. After learning to recognize the cognitive factors that lead to sleep impairment, the patient then learns behavioral factors that can counteract the cognitive disturbances.

Some types of behavioral changes that may be successful include making changes in sleep hygiene habits, such as by avoiding the bedroom unless using it for sleep, keeping the bedroom quiet and dark when trying to sleep, moving the clock to avoid checking the time too frequently, and eliminating exterior light and noise that can prevent sleep. Other examples of behavior modifications include progressive relaxation, meditation, prayer, and mental imagery.49

In a situation where a patient is trying to go to sleep but cannot, using _paradoxical intention_ may be helpful. Paradoxical intention is the process of trying to perform the opposite of the intended effect as a method of tricking the mind into actually getting the body to engage in the opposite behavior.50 For example, a patient who cannot sleep because of insomnia due to continued ruminations might benefit from paradoxical intention by telling themself not to go to sleep and focusing on trying to stay awake. The
paradoxical intent may trick the mind into going to sleep when the patient attempts to stay awake.

Finally, sleep restriction therapy may be another option that can help a person with sleep difficulties to get to sleep. Many people who have difficulty falling asleep lie in bed for hours, trying to force themselves to sleep. Sleep restriction therapy uses the guideline that if the person is unable to fall asleep within a certain amount of time, he or she should get up and leave the bedroom and rest in another location until ready to try and sleep again. By doing this, sleep restriction prevents a person from developing anxiety that may occur while lying in bed and trying too hard to sleep.\(^5\)

Behavioral interventions and modifications can successfully help some patients with sleep disturbances because these activities alter the sleep environment as well as the patient’s approach and thoughts about sleeping. While some people need extensive treatment and therapy for the treatment of sleep disorders, many others can benefit from cognitive or behavioral modifications alone to eliminate sleep disruptions.

**CPAP and BiPAP**

Continuous positive airway pressure (CPAP) is a device used as treatment for some types of sleep disorders, particularly those associated with sleep-disordered breathing, such as obstructive sleep apnea and upper airway resistance syndrome. CPAP is a machine that is used to deliver pressurized air directly into the airway through a mask that is worn over the patient’s nose or mouth and nose. The pressurized air keeps the collapsible structures at the back of the mouth and the throat from occluding the airway during sleep. Consequently, the patient who wears CPAP is then less likely to have apneic episodes and periods of hypopnea due to an occluded airway.
CPAP is prescribed by a healthcare provider and usually is ordered after a patient has gone through a sleep study for diagnosis of sleep-disordered breathing or another need for the CPAP machine.

Often, a patient will undergo a sleep study for diagnosis of a sleep disorder. If the provider determines that CPAP is necessary, the patient will return for another sleep study with a trial of CPAP to determine its effectiveness and to adjust the settings. Once the correct level has been determined and the amount of pressure necessary for the patient has been discovered, the patient may then begin to use CPAP at home.

The patient or their family often must obtain a CPAP machine from a medical service provider that either rents or sells medical equipment. Depending on the patient’s situation and financial coverage, buying a CPAP machine is often an option for someone who would need to use it on a long-term basis. Alternatively, if the patient has other options for treatment of sleep-disordered breathing, such as weight loss or surgery, rental of a CPAP machine for a short period of time may be a better fit.

The patient typically keeps the machine at the bedside to use at night while sleeping. The CPAP machine consists of a box that is approximately 3 pounds in weight and contains the motor, which generates the air and where the settings can be adjusted. A set of tubing is connected to the machine, which extends to the patient; the air from the machine flows through this tubing to reach the patient. Finally, a mask fits over the patient’s nose or mouth and nose, where he or she takes in the air while sleeping.

The patient typically places the mask on their face and starts the machine before going to sleep, adjusting the mask as necessary for comfort. Most
masks have a strap that encircles the back of the head to keep the mask in place and prevent it from slipping off during sleep. For people who are prone to mouth breathing, a chinstrap may be necessary to keep the mouth closed and prevent air from entering the nose and escaping through the open mouth. Additionally, a chinstrap can prevent excessive drying of the oral mucous membranes that may develop from excess airflow.

Some patients use a humidifier that provides moist air and prevents excessive drying of the nasal passages. This can help particularly if CPAP causes nasal stuffiness or congestion, which is a side effect of use. Although CPAP typically provides pressurized air only, there are some people who also need supplemental oxygen. A physician must order this to be used in conjunction with the CPAP and it requires an extra tank to fit with the machine. The amount of oxygen to deliver can be set and then blended in with the air coming in from the CPAP.

Even though it can be very effective for treating sleep-disordered breathing, CPAP takes a little time to adjust. Many people struggle a bit at first by immediately starting to wear a mask to sleep all night because it is a different sensation. Some people may have a feeling of being enclosed or suffocating while using the mask, so short periods of wearing the mask may help to adjust. CPAP is most effective when it is used at least 6 to 7 hours at a time during sleep.

Occasionally, the CPAP mask may cause irritation to the face; this occurs primarily when the mask does not have a proper fit. A patient with facial irritation from the mask should see their prescribing provider for adjustment of the mask to avoid further skin irritation. Some moisturizers or skin balms may help to soothe chafed skin.
People who wear CPAP for months or years for treatment of sleep-disordered breathing often must have periodic readjustments to the CPAP settings to determine if it is continuing to be effective for the patient. This may include another periodic sleep study where the patient wears the CPAP device; if the study determines that adjustments need to be made, the provider can then prescribe a change in settings, such as by increasing or decreasing the amount of pressure delivered.

Many people who use CPAP for sleep-disordered breathing find that once they adjust to the machine and wear it on a nightly basis, they have considerably improved sleep habits. They feel better during the day and are not as sleepy, they have improved memory and better concentration, and they are less irritable. Some other associated health problems may also resolve or at least improve with the use of CPAP. Its use has been shown to decrease the risks of heart disease that may be more likely to develop in patients with OSA and in some cases, it has been shown to reduce chronic high blood pressure.⁷

Another form of treatment for sleep-disordered breathing is bi-level positive airway pressure, or BiPAP. This method is similar to CPAP in that it provides air to keep the structures of the mouth and throat open for breathing, but the method of delivery is slightly different than CPAP. Instead of providing a constant air pressure that has been programmed at a set level, BiPAP adjusts the amount of air pressure delivered during both inspiration and expiration.⁵¹

A higher amount of air pressure is typically delivered as the patient breathes in and a smaller amount of air delivered when the patient breathes out with the use of BiPAP. This method is designed to decrease mean airway pressure
overall, particularly when CPAP pressure is too constant or too high for the patient to tolerate on a continuous basis.\textsuperscript{51} A patient with a sleep disorder and another type of medical condition, such as COPD, may more likely benefit from BiPAP over CPAP. The patient does not have to work as hard to exhale against higher pressures of air with the use of BiPAP; instead, he or she can breathe out against a lower amount of pressure for exhalation, which may help the patient’s breathing patterns overall.

BiPAP may be more expensive in some cases when compared to CPAP. It is not necessarily recommended as a first line of treatment for someone with sleep apnea, however, in certain situations, such as COPD or other types of barotrauma that are contributing to sleep difficulties, it may be a positive option to improve sleep.\textsuperscript{51}

**Medications**

Various medications are used in the treatment of sleep disorders, whether they are prescribed to help reduce excessive daytime sleepiness or to assist patients with getting to sleep at night. Medications work in a variety of ways. A healthcare provider prescribes medications to patients in order to help them to better manage a sleep disorder. However, the consistent use of medications, particularly over-the-counter drugs known as sleep aids, will not necessarily fix the situation causing the sleep disorder. While medications can be beneficial, a diagnostic workup is important to get to the root of the problem and to determine what treatments, including medications, may be necessary.

Medications that may be prescribed for insomnia, circadian rhythm disorders, or other situations whereby a patient has difficulties falling asleep, include sedative-hypnotics, which include benzodiazepines and non-
benzodiazepines. They are classified as controlled substances because of their risk of abuse. These drugs cause a person to feel sleepy and may help people to stay asleep longer; they are also used in the treatment of anxiety, whether or not it leads to sleep problems.\textsuperscript{52}

Melatonin is a supplement that is available over the counter and can be taken to induce sleep in some people who have difficulties getting to sleep. Melatonin may be most effective in certain types of sleep disorders, such as circadian rhythm disorders. The body naturally produces melatonin from a gland in the brain, but if environmental factors are disrupting the body’s natural rhythm, it may have difficulties secreting enough melatonin to induce sleep. Melatonin is a hormone that makes a person feel sleepy during a normal time in the evening when sleep would naturally begin.

Although melatonin can be purchased without a prescription, people who take it as a sleep aid should consult with a healthcare provider for dosage instructions and side effects. There is not one exact dose that is recommended; additionally, because the U.S. Food and Drug Administration (FDA) does not regulate supplements, the exact amount listed on the bottle may not be the same as what the patient is taking. Many over-the-counter supplements are prone to toxic elements within their products as well, which could lead to harmful effects.

When taken appropriately, melatonin can improve sleep in people who are sleep deprived and who need assistance with getting to sleep. When taken in the evening approximately one hour before going to bed, melatonin often helps a person to feel sleepy enough that he or she can fall asleep.
In some cases, such as hypersomnias, a patient has more trouble staying awake instead of falling asleep. When this happens, a different type of medication may be necessary to help the patient feel more alert and to reduce excessive daytime drowsiness. These drugs have stimulant effects and typically work by impacting the effects of neurotransmitters in the brain to help keep the affected person awake longer. People who take stimulants to stay awake may also suffer some of the side effects of these drugs; they may make the person who takes them feel wide awake and eventually have difficulty sleeping. Other side effects may include tremor and irritability.53

Medications may cause some problems when used over a long period of time. Some medications are at higher risk of being abused or causing dependence among users, particularly prescription drugs that contain sedatives or opioids. Over time, a patient may also develop a tolerance to a drug, so that although it worked well in the beginning, the effects slow over time and are not as successful. Medications can also be dangerous because they can cause drug interactions with other prescription or over-the-counter drugs and they may have undesirable side effects. To determine the most effective method of treatment, a healthcare provider should monitor medications used in the treatment of sleep disorders, such as prescription, over-the-counter, and herbal preparations.

**Surgical Treatment**

Surgical treatment of some sleep disorders may be available, depending on the patient’s health status and the significance of the sleep disorder on his or her life. Often patients go through other forms of treatment first to manage sleep disorders, or other underlying diseases that may affect sleep, and then turn to surgery as another option.
Surgical treatment is most commonly performed among patients with sleep-disordered breathing, particularly obstructive sleep apnea. Often, an ear-nose-throat (ENT) physician performs surgical procedures after the patient has typically tried other forms of treatment, such as CPAP, before resorting to surgery. Because obstructive sleep apnea may be caused by enlarged tissues in the mouth and throat or the collapse of throat structures that block the airway during sleep, some surgical procedures can change these structures so that they no longer impede airflow.

One such procedure is uvulopalatopharyngoplasty (UPPP), in which the surgeon removes some of the soft tissues of the uvula, the soft palate, and the pharynx at the back of the mouth. If the patient has enlarged tonsils or adenoids, they may be removed during this procedure as well. The UPPP is meant to enlarge the space at the back of the mouth to avoid the risk of the structures enclosing around the airway and blocking airflow. It may also help to improve muscle tone in the airway, which can further help to keep the airway open while the patient sleeps. The UPPP is obviously an invasive procedure and the patient requires anesthesia and usually an overnight stay in the hospital. The patient may be at higher risk of bleeding in the back of the mouth and the throat because the structures that have been altered are made of very delicate and soft tissue. Many patients complain of significant pain with the UPPP procedure as well.

If a patient has sleep-disordered breathing as a result of nasal problems, such as a deviated septum or nasal valve collapse, nasal surgery may be warranted. Nasal surgery often involves straightening the structures that contribute to disrupted airflow, such as the nasal septum and the nasal turbinates. The septum may be moved to a slightly different position and the nasal turbinates may be reduced in size if they are large enough that they
are blocking air passage through the nose. For most people who have nasal surgery for sleep disorders, the procedure is well tolerated and short; it usually includes an outpatient stay in the hospital and a fairly rapid recovery time.14

Another type of procedure that may be used in the treatment of obstructive sleep apnea is called the pillar palatal implant, or the pillar procedure. During this procedure, the surgeon inserts three small pillars, or rods, into the soft palate. The body responds to the presence of the rods as foreign objects and typically develops inflammation in the area. This inflammation of the soft tissues that surround the rods may make the soft palate firmer and a little stiffer. Because this happens, the tissue is less likely to collapse or otherwise contact the back of the throat to cause an obstruction while breathing when the tissues are relaxed during sleep. The pillar procedure can be done on an outpatient basis and is often even performed in a clinic or physician’s office using local anesthesia.7,14

For patients who have sleep-disordered breathing due to an enlarged tongue or the tongue muscle falling against the back of the throat and obstructing the airway, there are a couple of surgical procedures that may be options for treatment. A hyoid advancement procedure involves surgically moving the hyoid bone slightly forward to prevent airway collapse. The hyoid bone is found in the neck where the muscles that control the base of the tongue meet with the pharynx. The hyoid advancement procedure is fairly straightforward and most patients experience few complications; they are often able to go home soon after surgery.14

Another procedure that involves the tongue is the tongue advancement procedure. This type of surgery is more invasive than the hyoid
advancement and recovery time may be longer for the patient. The surgeon moves the genioglossus muscle, one of the main muscles that controls tongue movement, and pulls it slightly forward to prevent the tongue from falling backward during sleep and obstructing airflow. Despite the fact that this procedure is more invasive, it has a fairly high success rate with improving breathing for patients affected with sleep apnea.\textsuperscript{14}

**Summary**

This study module covers sleep deprivation in the adult population. Sleep disorders can occur in almost anyone when a regular and expected night of rest does not occur, and may be due to circumstances beyond the person’s control. The patient with sleep issues may undergo a number of tests to confirm a diagnosis. The gold standard of sleep testing is polysomnography, which is an overnight sleep study. Other tests that are also useful for confirming sleep disorders have also been discussed.

Despite the numbers of people who struggle with sleep deprivation as a result of sleep disorders, there are treatments available that can help. Those who must spend their days with excessive sleepiness and their nights drained of sleep do have some options for testing and treatment. These measures can provide hope for those who may wonder if they will find restful sleep again.

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Completing the study questions is optional and is NOT a course requirement.
1. Adults typically need between _____ and _____ hours of sleep each night.
   a. 6 and 8  
   b. 7.5 and 9  
   c. 8 and 9.5  
   d. 8.5 and 10

2. People typically move back and forth between stages of NREM and REM sleep throughout the night in cycles that last approximately:
   a. 15 minutes  
   b. 60 minutes  
   c. 90 minutes  
   d. 2 ½ hours

3. Which best describes what occurs during stages 3 and 4 of NREM sleep?
   a. Cortisol production ceases  
   b. Production of growth hormone declines  
   c. Serotonin levels are restocked  
   d. Blood pressure rises by 30 percent

4. Which describes a risk factor for obstructive sleep apnea?
   a. An immunocompromised state  
   b. Low blood pressure  
   c. Deviated septum  
   d. Esophageal cancer
5. Those who smoke more than two packs each day are _____ times more likely to develop obstructive sleep apnea when compared to those who do not smoke.
   a. 2  
   b. 5  
   c. 20  
   d. 40

6. The one medication that has been approved for use by the U.S. Food and Drug Administration to manage the excessive sleepiness that may occur with OSA is called:
   a. modanfinil  
   b. melatonin  
   c. eszopiclone  
   d. zolpidem

7. Studies have shown up to 60 percent of people with insomnia also have:
   a. restless legs syndrome  
   b. leg cramps  
   c. obstructive sleep apnea  
   d. depression

8. A circadian rhythm disorder that is characterized by a shift in sleeping times several hours earlier than normal is known as:
   a. advanced sleep phase disorder  
   b. jet lag  
   c. delayed sleep phase disorder  
   d. shift work
9. Adjusting the time of going to sleep slightly over the course of several days, weeks, or months, until the affected person has reached a sleep schedule that is acceptable is known as:
   a. phototherapy
   b. sleep hygiene
   c. chronotherapy
   d. paradoxical intention

10. Which of the following is an example of a preventable risk factor for developing restless legs syndrome?
   a. female gender
   b. obesity
   c. African American ethnicity
   d. Parkinson’s disease

11. Which medication would most likely be prescribed for the treatment of RLS?
   a. sodium oxybate
   b. ropinirole
   c. candesartan
   d. amlodipine

12. Which best describes cataplexy?
   a. The complete cessation of breathing for more than 10 seconds.
   b. Chronic sleep deprivation that causes memory loss and difficulties with concentration.
   c. The loss of muscle function that may develop after strong emotion.
   d. The release of the neurotransmitter gabapentin in response to illness.
13. Which statement about sleepwalking is true?
   a. Sleepwalking is always considered a benign condition.
   b. The most common cause of sleepwalking in adults is sleep deprivation.
   c. Sleepwalking is treated with sedative-hypnotic medications.
   d. A sleepwalking person should never be awakened.

14. Which of the following is associated with confusional arousals?
   a. An inability to wake up before 7 am
   b. Violent and injurious behavior that requires detainment
   c. Inappropriate sexual behavior
   d. Periods of hypersomnia followed by periods of insomnia

15. Which medical condition may most likely be associated with sleep deprivation?
   a. Leukemia
   b. Basal cell carcinoma
   c. Norovirus infection
   d. Fibromyalgia

16. A hormone that stimulates appetite and causes a person to feel like he or she wants to eat is called:
   a. ghrelin
   b. prostacyclin
   c. amylin
   d. leptin

17. Which sleep disorder would most likely be diagnosed through a multiple sleep latency test?
   a. restless legs syndrome
   b. insomnia
   c. narcolepsy
   d. upper airway resistance syndrome
18. The guideline that if a person is unable to fall asleep within a certain amount of time, he or she should get up and leave the bedroom is known as:
   a. paradoxical intention
   b. progressive relaxation
   c. sleep metaphor
   d. sleep restriction

19. A patient with upper airway congestion who uses CPAP may benefit most from which added option to the machine?
   a. light restriction
   b. humidity
   c. positive airflow maintenance
   d. supplemental oxygen

20. A surgical procedure in which the surgeon inserts three small rods into the soft palate to alter its structure and improve airflow is called a(n):
   a. uvulopalatopharyngoplasty
   b. hyoid advancement
   c. pillar procedure
   d. tongue advancement

21. Maintenance of wakefulness (MWT) testing
   a. determines how well a person is able to stay awake in a situation.
   b. is useful for people who experience excessive daytime sleepiness
   c. may be required for persons who work an important job requiring them to stay awake, such as with air traffic control
   d. *All of the above.
22. True or False. A sleep disturbance is a medical condition for which behavioral interventions and modifications generally are of no benefit.
   a. True
   b. *False

23. Diagnosis of confusional arousals may require
   a. time and often including more than one sleep study
   b. keeping a sleep journal, by the patient and family members
   c. video recordings of the patient’s behavior used in conjunction with a polysomnogram
   d. *All of the above.

24. A polysomnogram can detect all EXCEPT:
   a. changes in the transition between NREM and REM sleep.
   b. presence of short bursts of sleep or microsleeps.
   c. *whether a person has sleep apnea.
   d. whether there is a sleep disturbance.

25. Sleepwalking most commonly develops during
   a. *childhood.
   b. adulthood.
   c. elderly people, especially those with dementia.
   d. during late puberty adolescence.

26. True or False. Sleepwalking peaks between 11 and 12 years of age and then often diminishes during adolescence; however, a small percentage of adults never outgrow the condition.
   a. *True
   b. False
27. Approximately ________ percent of cases of insomnia have no identifiable cause.
   a. 15
   b. 25
   c. *50
   d. None of the above.

28. Conditions potentially predisposing a person to insomnia include:
   a. advancing age
   b. substance use
   c. gastroesophageal reflux
   d. *All of the above.

29. True or False. Periodic limb movement disorder (RLMD) is another term for restless leg syndrome (RLS) and represent the same condition.
   a. True
   b. *False

30. Periodic limb movement disorder (PLMD) involves a series of limb movements during sleep that happen approximately every ________________.
   a. *20 to 40 seconds
   b. 1 to 2 minutes
   c. 5 to 10 minutes
   d. 30 minutes

31. Uncontrollable movements of the extremities can disrupt sleep of affected individuals. Symptoms can include all, EXCEPT
   a. excessive daytime lethargy
   b. irritability
   c. poor concentration
   d. *nightmares
32. People experiencing leg cramps that disrupt sleep should perform leg exercises
   a. just before bed
   b. *during the day
   c. when cramping to bring circulation to the area
   d. during the day and just before bed

33. Types of sleep-disordered breathing may include all, EXCEPT
   a. obstructive sleep apnea.
   b. central sleep apnea.
   c. upper airway resistance syndrome.
   d. *COPD.

34. Insomnia due to anxiety or mania may be treated by drugs, such as
   a. benzodiazepines
   b. anticonvulsants
   c. antipsychotics
   d. *Answers a and b above.

35. Actigraphy may be used for
   a. alerting parents their baby is awake.
   b. *recording sleep habits.
   c. sleeping patterns of newborn babies.
   d. Answers a and c above.

36. People with narcolepsy often
   a. *fall straight into REM sleep
   b. have delayed REM sleep
   c. go through deep, slow-wave sleep
   d. remain for a prolonged time in the NREM cycle of sleep
37. Muscle atonia or paralysis
   a. prevent people from acting out their dreams.
   b. often occurs with the NREM cycle of sleep.
   c. is associated with REM sleep.
   d. *Answers a and c above.

38. Sleep restriction therapy uses the guideline that if the person is unable to fall asleep within a certain amount of time, he or she should
   a. not take a nap during the following day no matter how tired
   b. *get up, leave the bedroom and rest in another location
   c. remain in bed, but turn the light on and perform relaxation exercises until sleep ensues.
   d. take a sleep aid 3 – 4 hours before the usual bedtime and avoid going to bed they feel ready to sleep.

39. True or False. According to Harvard Medical School, hormones that the body produces that control appetite and feelings of fullness can be impacted by lack of sleep.
   a. *True
   b. False

40. ________________ is a hormone that stimulates appetite and causes a person to feel like they want to eat.
   a. *Ghrelin
   b. Leptin
   c. Cortisol
   d. Thyroid stimulating hormone (TSH)
Correct Answers:

| 1 | B | 21 | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2 | C | 22 | B |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3 | A | 23 | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4 | C | 24 | C |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5 | D | 25 | A |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6 | A | 26 | A |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 7 | D | 27 | C |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 8 | A | 28 | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 9 | C | 29 | B |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|10 | B | 30 | A |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|11 | B | 31 | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|12 | C | 32 | B |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|13 | B | 33 | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|14 | C | 34 | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|15 | D | 35 | B |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|16 | A | 36 | A |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|17 | C | 37 | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|18 | D | 38 | B |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|19 | B | 39 | A |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|20 | C | 40 | A |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
References Section

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