After reading this chapter, the student should be able to:

- Demonstrate an understanding of anatomical, neurological bases of vocal behavior, and physiological processes of normal voice production.
- Demonstrate an understanding of the historical aspects of normal voice production and advances in the profession of otolaryngology.
- Demonstrate an understanding of current theories in voice production.
- Demonstrate an understanding of current research areas in the area of normal voice production and voice disorders.
- Demonstrate knowledge of the occurrence, classification, and symptoms of voice disorders.
- Describe appropriate counseling strategies and features of vocal hygiene.
- Demonstrate knowledge of laryngectomy including physiological changes, and the various options for alaryngeal speech.
- Describe sociocultural influences in voice disorders.
The use of voice is an integral part of communication. Dogs bark, growl, and howl. Cats purr and mew. Birds use different calls to warn other birds about threats or food. Each animal has a distinct voice, and all animal species have some form of set vocal patterns that they use to communicate. The use of voice allows animals to recognize each other and convey messages like “get away,” “danger,” and “that feels good.” Humans also use voice to communicate basic needs and wants. Because humans have also developed the capacity to use language, our use of voice has become more specialized. When we open our mouths to speak, the voice we use is uniquely special to us. Our voice is one of the defining features of our individuality, and it shares a lot of information about you. Infants are able to recognize their caregivers on the basis of voice. Your voice tells others if you are happy or sad, healthy or unwell, young or old. Our voice can also reveal to others our background, such as the region of the world where we live, and even our social economic status. Although some people are expert at voice impersonations, our voice is what helps to define who we are. Indeed, many past and present celebrities are readily identifiable as a result of their voice. A list of some well-known voices is provided in Table 8–1. A “normal voice” is one that is pleasing to the ear, has a balance of sound through the mouth and nose, and matches a person’s size, age, and sex. When a voice is produced that is perceived by others as unusual or strange and draws attention to the person who is speaking, it is quite likely the person is demonstrating a voice disorder.

| Table 8–1. Unmistakable Voices of Well-Known and Some Not So Well-Known Celebrities |
|----------------------------------|------------------|
| Humphrey Bogart                  | Actor            |
| Bette Davis                      | Actor            |
| Janeane Garofalo                 | Actor            |
| Cary Grant                       | Actor            |
| Arnold Schwarzenegger            | Actor            |
| Sylvester Stallone              | Actor            |
| Luciano Pavarotti                | Singer           |
| Elvis Presley                    | Singer           |
| Justin Timberlake                | Singer           |
| Madonna                          | Singer           |
| Kanye West                      | Singer           |
| Bing Crosby                      | Singer           |
| Barbra Streisand                 | Singer           |
| Christopher Martin               | Singer           |
| Nat King Cole                    | Singer           |
| Dan Castellaneta                 | Voice of Homer Simpson |
| James Earl Jones                 | Voice of Darth Vader |
| Andy Serkus                      | Voice of Gollum—Lord of the Rings |
| Frank Oz                         | Voice of Yoda—Star Wars |
| Mel Blanc                        | Voice of Looney Tunes cartoon characters |
| Don Pardo                        | Voice of Saturday Night Live introduction |
| Jim Henson                       | Voice of Kermit the Frog |

Voice disorders occur in people of all ages. Voice disorders are also likely to be found among individuals whose
occupation is dependent on having a healthy voice. These vocal performers work in a variety of settings such as the music industry, theatre, clergy, the courtroom, or the classroom. Voice disorders reflect a special form of communication disorder that involves a close working relationship between the patient, speech-language pathologist, and medical personnel. Amazingly, most instances of voice disorders are preventable by simply taking the proper precautionary steps. The fact that many voice disorders could be prevented also makes this form of communication disorder unique.

TERMINOLOGY AND DEFINITIONS

The key anatomical structures required for the production of voice can be found within the framework of the larynx. The larynx consists of a number of muscles and cartilages that work cooperatively to produce voice. To appreciate the nature of various voice disorders, it is necessary to reacquaint ourselves with the basic anatomy and physiology of the larynx that was covered in Chapter 3. The larynx is positioned between the base of the tongue and the top of the trachea (windpipe), the passageway to the lungs. The larynx is not designed for the daily wear and tear we place on it for the production of voice. The key function of the larynx is to protect the breathing airway from foreign matter (i.e., food, liquid) that may be heading toward the lungs. The primary muscle involved in the generation of voice is the thyroarytenoid muscle, which is the formal term for the vocal folds. The thyroarytenoid muscle is composed of two bands of smooth muscle tissue that lie opposite each other and sit prominently over the trachea. One end of the muscle is inserted to the inside of the thyroid cartilage. The other end is attached to the arytenoid cartilages. When the vocal folds are abducted (open), a space forms between the two folds known as the glottis. During breathing, air flows in and out of the lungs and passes through the glottis. When the vocal folds are adducted (closed), the space (or glottis) disappears. During heavy duty activities such as lifting or pulling, as well as during moments of swallowing, the vocal folds are adducted. A depiction of the vocal folds in abducted and adducted positions is shown in Figure 8–1.

To produce voice, we exploit the structures of the larynx by adducting the vocal folds and causing them to vibrate. The technical term for the physiological process of generating voice is phonation. To produce voice, the brain precisely coordinates a series of events involving the three subsystems of voice: (1) respiration, (2) phonation, and (3) resonance. The respiratory system

FYI

A bird’s larynx, called a syrinx, is anatomically simpler than that found in humans. Instead of being located at the top of the windpipe (trachea), it is located at the bottom, much closer to the lungs. This close proximity to the lungs is what allows very small birds to sing so loudly.
serves as the driving force of voice production. Without the forward (exhaled) flow of air from the lungs, we would not be able to produce voice smoothly. Upon exhalation of inspired air, the phonatory system is then responsible for closing the vocal folds in a deliberate but relaxed fashion. Once the vocal folds close, air from the lungs builds up underneath them until they are blown open, causing them to vibrate and produce sound. This sound then travels outward through the oral and nasal cavities, which serve to shape or resonate the sound quality as it leaves our mouth. The number of vocal fold vibrations per second determines the fundamental frequency (F0; or pitch) of our voice. A person’s voice pitch can be high or low, variable (sing-song) or flat (monotonic). An individual might also demonstrate natural pitch breaks, such as the case when young males undergo puberty. These hormonal changes can affect voice production as a young male’s voice pitch begins to lower with age.

**FYI**

A *castrato* is a male singer with an artificially created falsetto (high-pitched) voice, the result of castration in childhood that stunts the growth of the larynx. The combination of the larynx of a boy and the chest and lungs of a man produced a powerful voice of great range and unique sound. Castrati were especially popular in churches and opera in Europe during the 17th and 18th centuries.
Voice quality refers to the subjective aspect of voice that is perceived by listeners. The size and shape of the vocal folds, as well as the size and shape of the oral and nasal cavities, help to determine the quality of voice. Terms such as a breathy voice (i.e., excessive and audible air leakage), hoarse voice (i.e., a grating voice with pitch breaks), or hyper/hyponasal voice (e.g., too much or too little voice through the nasal cavity) are examples of qualitative descriptions of voice. Another aspect of voice quality is the dynamic range or register of voice. The term register was originally used to describe church pipe organs, where different regions of pipes combined to produce specific tones. A typical speaking voice has three registers that cover the low, middle, and high range of voice. The lowest register is called pulse register and refers to the pulse-like quality that is produced with a low pitch. The middle register is called modal register and is the region of our voice that is used during normal speaking behavior. The top range is called falsetto and is rarely used in daily speaking. This voice quality may come into play when laughing loudly or when singing a high note. Voice loudness is somewhat self-explanatory. A voice can be produced excessively soft or loud. The term voiced sounds encompasses all vowels, as well as approximately one half of all consonants.

A voice disorder is a condition whereby a person’s voice pitch, quality, or loudness differs from that of people of the same sex, age, geographic region, or cultural background. Dysphonation refers to any type of impaired voice and includes a condition called aphonia, which is the inability to produce any sort of voice. The term phonatory disorder is synonymous with a voice disorder. Edema is a buildup of fluid in tissue that is a natural, protective reaction to trauma or misuse. The vocal folds are a delicate muscle that is prone to edema, even under the slightest instances of misuse. Edema may also develop in tissue as a side effect to certain drugs. Hyperfunctional voice refers to speaking with excessive muscular effort and force resulting in a tense, high-pitched voice. In contrast, hypofunctional voice reflects inadequate muscle tone of the laryngeal mechanism during the production of voice often resulting in a weak, low-pitched voice that may also sound breathy. An otolaryngologist is a surgeon who specializes in disorders of the ear, nose, and throat (i.e., ENT surgeon, or otolaryngology, head, and neck surgeon). These professionals provide the initial diagnosis of a voice disorder. Most recently, the physicist Ingo Titze, who is one of the world leaders in the scientific study of the human voice, coined the term vocology to reflect the clinical practice of voice rehabilitation (Figure 8–2).

Whistle register is the highest register of the human voice. The sound in this register resembles a flute. The ability to produce a voice in this register is believed to be rare. Minnie Riperton (1947–1979) was a famous vocalist of the 20th century who popularized whistle register. This style of singing is also used by the pop artist Mariah Carey.
Man has sung through the ages, and so it is not surprising to find accounts of normal or unusual voice production dating back many centuries. Hippocrates described the importance of the lungs, trachea, lips, and tongue in phonation in the early 5th century BC. In 350 BC, Aristotle was the first to mention the larynx in his book, Historia Animalium, in which he describes the neck as the part between the face and the chest. He noted that the larynx was located at the front of the neck, and it was through this structure that speech and breathing occurred.

Claudius Galen (129–200 AD) of Pergamum (Figure 8–3) was a physiologist considered the most important contributor to medicine following Hippocrates, and the founder of laryngology and voice science. Because dissections of human corpses were against Roman law in the second century, Galen uncovered information about laryngeal physiology and anatomy based on dissections of apes and pigs. Galen was the first to recognize that the larynx was the primary organ of voice, as well as for the regulation of breathing, and called it “an instrument of pneuma.” Galen theorized that the larynx functioned similarly to a flute, where the vocal folds were the beak (mouthpiece) and the trachea was the body of the flute. Even though Galen learned much about the larynx, he had no ability to observe how it worked in a living person; therefore, knowledge regarding the specific aspects of voice production would not come about for many centuries.

Julio Casserius (1552–1616) was an Italian anatomist who made a major contribution to the study of voice with his 1600 publication of The Anatomy of Voice.
and Hearing. The book contained plates of the anatomy of the larynx in humans and mammals that were remarkably accurate from an artistic standpoint.

In 1741, a French anatomist Antoine Ferrein (1693–1769; Figure 8–4) concluded that the larynx functioned similarly to that of a stringed instrument, in which the loudness and variety of tones produced by the voice were a result of different degrees of tension and length. The concept of a vibrating string led Ferrein to develop the term vocal cords.

Henri Dutrochet (1776–1847; Figure 8–5) was a French botanist who was primarily interested in plant physiology. His research involved investigations of the mechanisms responsible for physical movement in plants that led to his discovery of cell biology. His interest in the natural biological movement of organisms also carried over to the examination of certain excitability responses in animals, namely the production of voice. In 1806, he published A New Theory of Voice and theorized about the manner in which the vocal folds vibrated. His view was different from that of Ferrein—he recommended dropping the term vocal cords in favor of the term vocal folds because of the observation that the vocal ligaments of the larynx did not act as cords but like a reed of a clarinet.

In early days, the larynx was often times singled out as the root cause of various diseases. The primary symptom of many diseases such as diphtheria, typhus, and tuberculosis was a marked change in voice or coughing. Because the voice failed to function normally, considerable interest grew in examining the larynx from both a physiological and a clinical viewpoint. By the early part of the 19th century, there was an overwhelming curiosity to visualize the interior of the larynx through the development of various types of viewing

**FIGURE 8–4.** Antoine Ferrein, the 18th-century French anatomist who coined the term vocal cords.

**FIGURE 8–5.** Henri Dutrochet theorized about the manner in which the vocal folds vibrated.
instruments. However, it was not until the Spaniard Manuel García (1805–1906) created the laryngeal mirror in 1855 that clear examinations of the larynx were possible. García was an opera singer who had a personal interest in the physiology of voice production. Using a dentist’s mirror, he placed the mirror in the back of the throat, and by positioning it at a proper angle, he was able to see the reflection of his vocal folds in an opposing mirror (Figure 8–6). The procedure was originally referred to as auto-laryngoscopy but today is referred to as indirect laryngoscopy. García was hardly the first to look into the physiology of voice, but what made his work different was that he experimented on himself, seeking the cause of his own voice ailment.

Elizabeth Blackwell (1821–1910; Figure 8–7) was the first woman to obtain a medical degree in the United States. The first female physician in the United States.
States by graduating at the top of her class from the Geneva Medical College of New York. Blackwell enabled many more women to follow in her footsteps, including one of the first female otolaryngologists, **Margaret F. Butler** (1861–1931). Dr. Butler initially decided to specialize in gynecology but recognized the need for her skills in otolaryngology. She was a clinical professor of laryngology and chief of the nose and throat department at the Woman’s Medical College of Pennsylvania in 1906. She was the sole representative from the United States at the First International Congress of Rhinolaryngology held in Vienna in 1908. She invented a number of ENT surgical instruments, including a device to remove tonsils, called the Butler tonsil snare.

The assessment and management of voice disorders remained exclusively within the domain of otolaryngologists or singing teachers throughout the 19th century and the early 20th century. **Friedrich Brodnitz** (1899–1995) was a German physician who introduced the concept of phoniatrics (i.e., voice science) in the late 1930s (Figure 8–8). When he arrived in the United States in 1937, he was something of a novelty among ENT surgeons, having been trained in both otolaryngology and speech therapy. Prior to this time, there was little interest in the field of voice disorders among otolaryngologists. He established one of the first clinics in the United States for voice disorders and devoted his life to problems of the voice, especially if they interfered with the livelihood of opera singers, actors, or other professional voice users. Dr. Brodnitz was a pioneer in the so-called chewing method, which were exercises designed to strengthen and realign the throat muscles to produce less strain and better control of the vocal folds.

The development of the speech-language pathology profession served to greatly advance assessment and treatment approaches to voice disorders. Two textbooks were published
in the 1930s that contained material concerning voice disorders that were specifically designed for use by speech-language pathologists in their clinical practice. The first of these books was *The Rehabilitation of Speech* (West, Kennedy, & Carr, 1937), followed by *Speech Correction: Principles and Methods* (Van Riper, 1939).

It is rare for a voice problem to occur instantaneously; they do not occur overnight. Rather, it is likely for a voice disorder to result from daily lifestyle behaviors, including occupational or social demands on the voice, as well as issues related to overall health. Voice disorders are classified according to the causal basis of the disorder. Colton, Casper, and Leonard (2006) have organized voice disorders into three categories, those resulting from: (1) vocal misuse, (2) nervous system involvement, or (3) organic disease and trauma. Some of the more frequently encountered voice disorders found in each of these categories are highlighted below. A comprehensive list of the wide range of voice disorders can be found in Table 8–2.

**Vocal Misuse**

The first type of voice disorders are those related to vocal misuse. In these instances, the basic anatomy of the larynx is normal, but the manner in which the larynx is being used contributes to a voice disorder. Vocal misuse (also called *phonotrauma*) is any improper or inefficient speaking behavior that can damage the vocal folds and cause temporary or permanent changes in vocal function, voice quality, and possible loss of voice. Examples of vocal misuse include excessive talking, throat clearing, coughing, inhaling irritants, smoking, screaming, or yelling. The term *vocal misuse* is preferred over *vocal abuse* because “abuse” places blame for the disorder on the patient due to purposeful damaging actions. In reality, there are instances when the patient is simply using their voice incorrectly with little knowledge as to any vocal wrong doing. Disorders of vocal misuse are the most prevalent and preventable types of voice dis-

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**FYI**

The term *ventriloquism* comes from Latin *venter* and *loqui*, which translates to “belly-speaking.” It is not actually possible to throw your voice across the room. Rather, the effect used by ventriloquists is to disguise their voice to make it appear that it is coming from another voice (i.e., a dummy). This unusual manner of speaking can place strain on the voice.
orders as people of all ages who use their voice excessively may experience phonotrauma. Young children, teachers, lawyers, cheerleaders, and professional voice users such as singers and actors are prone to voice disorders of this nature. Some disorders resulting from vocal misuse are laryngitis, vocal nodules, and vocal polyps. Each of these various disorders of vocal misuse represents a form of hyperfunctional voice disorder.

**Laryngitis**

Inflammation or swelling of the vocal folds results in laryngitis (Figure 8–9). Some symptoms associated with laryngitis are a sore throat and swallowing
difficulty. The condition may be caused by excessive use of the voice, bacterial or viral infections, or irritants, such as inhaled chemicals or the backup of stomach acid into the throat (i.e., **acid reflux**). The voice of someone with laryngitis will often sound breathy and hoarse. Laryngitis occurs in two forms: (1) acute, which lasts only a few days, and (2) chronic, which persists over a period of weeks or months. Chronic laryngitis can result in the development of a more severe and long-lasting voice disorder. In addition, children who experience severe forms of laryngitis can run the risk of breathing difficulty because inflamed vocal folds can serve to narrow the air passage leading to the lungs.

**Vocal Nodules**

Small, benign (noncancerous) callus-like bumps that form on the vocal folds are called **vocal nodules** (Figure 8–10). They can form on one or both of the folds, are located on the front one-third of the vocal folds, and range in size from a pinhead to a split pea. Nodules develop from irritation caused by repeated pressure on the same area of the vocal folds, much like a callus forms on areas of a person’s hands or feet following repeated physical activity. During normal voice production, the vocal folds should naturally meet together at a midline position. However, when a vocal nodule is present, the vocal folds are unable to close completely, resulting in excessive air escaping during the production of voice. Not surprisingly, the voice of a person who has vocal nodules usually sounds hoarse and slightly breathy. Voice pitch is also abnormally low as a result of the additional mass of the nodule on the vocal folds during vibration. Vocal nodules are a prevalent type of voice disorder resulting from vocal misuse. This condition is also referred to as “singer’s nodes” because it is a frequent problem among professional singers. The inability to sing high notes is a hallmark feature of nodules. When the individual tries to sing in a high voice, there is a delay in the onset of the sound with an audible escape of air.

**Vocal Polyp**

A small, noncancerous growth on one or both of the vocal folds results in a **vocal**
polyp (also termed polypoid degeneration). Just as a vocal nodule is much like a hard callus, a vocal polyp is much like a soft blister (Figure 8–11). Symptoms of vocal polyps include abnormal voice quality, vocal fatigue, and the sensation of a lump in the throat that involves constant throat clearing. A polyp typically forms on only one vocal fold. Although polyps occur most often as a result of sudden vocal trauma, a specific type of polyp (known as Reinke’s edema) results from long-term cigarette smoking, creating the well-known smoker’s voice. People who develop a vocal polyp usually have a low-pitched, hoarse, breathy voice, similar to the voices of people who have vocal nodules.

**Puberphonia**

A fourth type of vocal misuse is puberphonia, also called mutational falsetto. Puberphonia refers to a condition in which an adult (usually an adolescent male) continues to speak with a high-pitched voice well after the age when a natural lowering in voice pitch should have occurred. The condition is rare and is believed to reflect a form of psychogenic disorder. A psychogenic voice disorder is thought to result from an underlying psychological disturbance. In the case of puberphonia, there is no structural reason for the voice disorder. However, because the voice is not being used normally, a condition such as puberphonia is classified as a disorder of vocal misuse.

**Nervous System Involvement**

The nervous system consists of the brain, spinal cord, and an enormous network of sensory and motor nerves throughout the body. Malfunctions of the nervous system may result from disease, abnormal growths, or trauma. Nervous system damage can also impair normal voice production. Two particular conditions that reflect voice disorders having a nervous system origin are: (1) neurogenic disorders and (2) spasmodic dysphonia. These disorders are not related to trauma, as this forms the basis of organic voice disorders (see later section).

**Neurogenic Voice Disorders**

Two nervous system disorders that have an associated voice disorder are Parkinson disease and Amyotrophic Lateral Sclerosis, also known as motor neuron disease. The condition of Parkinson disease is a progressive neurological disorder affecting movements such as walking, talking, and writing. The disease generally affects people beyond the age of 40 years. The three main symptoms of Parkinson disease are tremor, stiffness, and bradykinesia (i.e., slowness of movement). These conditions can carry over into the production of voice, with approximately 50 to 80% of all patients with Parkinson disease demonstrating a
voice disorder. The voice features found in Parkinson disease are monotonic voice and a low-pitched voice, as well as considerable variation in the loudness of voice. The condition of amyotrophic lateral sclerosis is a progressive chronic disease of the nerves that are responsible for supplying electrical stimulation to the muscles used for any and all movement. The disease causes gradual muscle weakness and wasting. The disease generally affects people over the age of 40 years, with a typical life span of less than three years from the date of diagnosis. The muscles responsible for the production of voice are not spared among individuals with amyotrophic lateral sclerosis. Early symptoms include a hoarse voice accompanied by vocal spasm. As the disease progresses, the voice becomes weaker and is characterized by breathiness and hypernasality. The increase in nasality results from weakness in the muscles responsible for closing off the nasal cavity from the oral cavity during normal voice production.

**Spasmodic Dysphonia**

A spasm is an involuntary and abnormal contraction of a muscle. In the case of spasmodic dysphonia, the particular voice disorder appears to be one of involuntary and abnormal functioning of the muscles responsible for voice production. Spasmodic dysphonia is perhaps the most mysterious of all voice disorders because we still do not know what causes it and how best to treat it. The disorder was originally thought to be a type of psychogenic condition, and because there was no identifiable physical cause to the problem, researchers believed it must result from some level of mental distress. This way of thinking is evident in use of the term hysterical dysphonia, which has since been dropped in favor of the term spasmodic dysphonia. Research over the past 30 years now indicates that the disorder probably reflects a motor disturbance deep in the brain.

There are two types of spasmodic dysphonia, based on whether the spasm affects the closing or opening phases of vocal fold vibration. **Adductor type** spasmodic dysphonia results in a severe hyperfunctional voice. The patient demonstrates obvious struggle in attempting to produce a clear voice. The vocal folds show intermittent spasms causing them to close and stiffen. Patients find it difficult, if not impossible, to shout, but surprisingly the spasms are usually absent while laughing, singing, or speaking on inhalation. **Abductor type** spasmodic dysphonia is more rare and essentially the opposite to that of the adductory type. In abductor spasmodic dysphonia, sudden involuntary muscle movements or spasms cause the vocal folds to open. The vocal folds are unable to vibrate when fully abducted causing periods of aphonia. The open position of the vocal folds also allows air to escape from the lungs during speech. As a result, the voices of these individuals sound weak and breathy. As with adductor spasmodic dysphonia, the spasms are often absent during activities such as laughing or singing. The prevalence of either type of spasmodic dysphonia in the general population is unknown. There is no difference in regard to its occurrence in men and women. The disorder is rarely found in children and young adults, with most cases occurring in middle-aged adults.

**Organic Disease and Trauma**

The third type of voice disorders are those that affect the structure of the
vocal mechanism as a result of an organic disease or some form of physical trauma. Two voice disorders resulting from these conditions are: (1) papilloma and (2) cancer of the larynx.

**Papilloma**

Papillomas are benign epithelial (surface-level) tumors caused by infection with the human papilloma virus. The tumors can develop in various parts of the body, including the larynx. Laryngeal papillomas appear as numerous warty growths on the surface of the vocal folds (Figure 8–12). Laryngeal papillomas are most often found among children, and between 60 to 80% of cases occur in children, usually before the age of three. Although papillomas are benign, their rapid growth on the vocal folds can cause obstruction of the airway that could potentially lead to asphyxiation if not promptly treated. Like warts, papillomas are very stubborn lesions that tend to grow back no matter if they are completely removed. This is particularly the case among children. In adults, laryngeal papillomas tend to be less aggressive. Papillomas generally cause no physical pain with the most obvious symptom of the disorder being a hoarse-sounding voice.

**Carcinoma**

Cancer can develop in any part of the body, and the larynx is no exception (Figure 8–13). Laryngeal cancer comprises approximately 5% of all forms of cancer. If allowed to develop without treatment, the condition can be life threatening. The primary cause of laryngeal cancer is smoking. In addition to laryngeal cancer, smoking is the major cause of cancers of the lungs, oral cavity, and esophagus. The ratio of men to women who develop laryngeal cancer is 5 to 1, although this ratio is rapidly decreasing with the rise in smoking among women. Smoking serves as an irritant to the vocal folds causing edema. It also decreases lung function, and without good lung power, more stress is placed upon the larynx when speaking or singing. This is why heavy, long-term smokers’ voices are often hoarse and low in pitch. These voice features are also the prime symptoms or warning signs of laryngeal cancer.

**FIGURE 8–12.** Example of vocal papilloma.  
**FIGURE 8–13.** Example of vocal carcinoma.
CURRENT THEORIES OF VOICE DISORDERS

One of the earliest modern theories of normal voice production was proposed by the French scientist Raoul Husson in 1950, who sparked considerable debate as far as the physiology of the vibration of the vocal folds is concerned. In his neurochronaxic theory, he suggested that the frequency of vocal fold vibration was dependent on excitation of nerve cells from the laryngeal nerve (part of cranial nerve X). For example, if the vocal folds were to vibrate at a rate of 200 Hz, this theory suggests that 200 nerve impulses per second are sent to the thyroarytenoid (vocal fold) muscle. Husson’s theory was eventually found to be invalid because we now know that nerves are unable to discharge at such high rates. This theory was eventually replaced by the myoelastic aerodynamic theory of phonation in 1959 by the Dutch scientist, Janwillem van den Berg (1926–1985; Figure 8–14). The title of the theory is self-explanatory in regard to the process of producing voice. The theory is that normal vocal fold vibration involves coordination of muscle tension and breath pressure. To produce voice, there needs to be air pressure and flow. Elastic muscular movement of the structures composing the vocal mechanism is also necessary, and the entire process is dynamic, involving movement and change. Over the past 50 years, the various intricate steps in vocal fold vibration have been more critically examined; however, the general concept of producing voice is still captured within the myoelastic aerodynamic theory of phonation.

More recently, Roy and Bless (2000) proposed a personality and emotional adjustment theory of voice disorders. The premise of the theory is that an individual’s personality and behavioral patterns may contribute to the eventual development of a voice disorder such as nodules. In turn, the subsequent voice disorder that develops creates further emotional problems and personality effects for the individual with the disorder. For example, a person with an impulsive, preservative personality who is misusing their voice may be unable to normally cease in misusing their voice, thereby contributing to a more long-lasting voice disorder. The role of personality and issues such as impulsivity have not been considered in previous theories concerning voice disorders. If personality issues are found to show a direct link to some voice disorders, advancements in the diagnosis and treatment of these disorders will likely occur.
At any given time, approximately 6% of the general population experience a voice disorder, and a majority of these individuals tend to be female (Roy, Merrill, Gray, & Smith, 2005). Approximately 30% of the entire population will experience a form of voice disorder, either fleeting or long-term, at some point in their lives. Most instances of voice disorders occur in people between the ages of 40 to 60 years, although voice disorders are also found in children. Among children, there is a greater likelihood of voice disorders in boys compared with girls, with boys more often implicated in vocally abusive behaviors, such as shouting and screaming. Anyone who experiences vocal discomfort for more than two weeks should consider seeking an assessment of their voice. In some cases, the speech-language pathologist may be the first individual to encounter a patient complaining of a voice problem. The speech-language pathologist may perform an initial evaluation of the patient’s voice; however, appropriate ethical practice requires the speech-language pathologist to immediately refer the patient to an otolaryngologist because of the possible underlying medical condition. The otolaryngologist will examine the individual’s laryngeal mechanism and determine if a medical condition is indeed the root cause of the voice problem.

The assessment of voice disorders involves subjective and objective procedures. Both approaches are essential to obtaining the detail necessary to accurately diagnose the cause, type, and severity of voice disorder. A subjective assessment of voice entails listening and observing the patient while they are speaking, and the collection of a case history. When listening to the patient’s voice, the speech-language pathologist will complete a rating of the patient’s voice quality, which is based on having the patient prolong isolated vowels, read aloud, and speak in a conversational setting. This is where the speech-language pathologist may use terms such as “breathy” or “hoarse” to describe the patient’s voice. The speech-language pathologist will also observe the patient’s general body movements during speaking, in particular, examining for excessive neck tension and irregular breathing patterns. Obtaining a patient’s case history provides the speech-language pathologist with background information that may hold relevance to diagnosing the voice disorder. The speech-language pathologist collects information about the patient’s occupation, daily use of voice, onset and duration of the voice problem, and expectations for improving their voice. An example of a voice case history form is provided in Table 8–3.

Objective assessments involve use of instruments to examine the dynamic process of voice production. Two frequently employed instrumental approaches in voice diagnosis are indirect and direct laryngoscopy (Paparella & Shumrick, 1991). Both approaches are illustrated in Figure 8–15. The steps to performing an indirect laryngoscopy have changed little since the original method established by Manuel García in 1855. The patient is seated upright, and the otolaryngologist inserts a small hand mirror to the back of the throat. Prior to inserting the mirror, an anesthetic is sprayed in the back of the throat to prevent gagging. A light is projected into the throat and deflected off the
### Table 8–3. Example of a Case History Form Used in the Assessment of Voice Disorders

<table>
<thead>
<tr>
<th>Voice History Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: _______________________ Age: ______</td>
</tr>
<tr>
<td>Did concern over your voice begin with: □ Illness □ Trauma (injury) □ Surgery?</td>
</tr>
</tbody>
</table>

**Voice History**

- Please list previous voice problems: _________________________________________
- Please list previous voice treatments: _________________________________________

**Current Status of Voice**

- Is your voice today typical of how it sounds since the voice problem began? □ Yes □ No
- Does your voice vary with: □ Seasons/Weather? □ Time of day?
- Do you ever experience voice loss where you are only able to whisper? □ Yes □ No

**Medical History**

- Do you currently have or have you ever had any of the following conditions?
  - □ Pain, tightness in throat
  - □ Sinus
  - □ Allergies
  - □ Breathing difficulties
- Please list current medications: _________________________________________
- How much caffeine (coffee, tea, soft drinks, etc.) do you drink per day? Cups: ______
- How much alcohol do you drink? _________________________________________
- Do you smoke? □ Yes □ No  How much? _________________________________________
- Are you frequently in a situation where you are breathing noxious fumes? □ Yes □ No

**Voice Use**

- How many hours do you spend?
  - □ In conversation (friends, family, work, etc.): ______
  - □ Talking in noise (work, machines, restaurants, taverns, crowds, etc.): ______
  - □ Yelling (sporting events, coaching, etc.): ______
  - □ Teaching, instructions, or training: ______
  - □ Singing: ______
- Are you using your voice less than usual because of the problem? □ Yes □ No
Self-Perception of Voice Concern

Please rate the importance of the following:

Use of voice for work:  □ Unimportant  □ Somewhat Important  □ Very Important
Use of voice for socializing:  □ Unimportant  □ Somewhat Important  □ Very Important

Please rate each of the following potential problems that most closely apply to you. (1 = No problem, 2 = Slight problem, 3 = Moderate problem, 4 = Severe problem)

- My voice is not loud enough for people to hear me in some situations. ______
- My voice is too loud for some situations. ______
- My pitch is too high. ______
- My pitch is too low. ______
- My voice quality is not good. I sound harsh or hoarse. ______
- I’m bothered by the way people react to my voice. ______
- My voice gets tired and fatigued with talking. ______

Table 8–3. continued

**Figure 8–15.** Examples of indirect and direct approaches to examining the larynx. **A.** An indirect examination of the larynx using a lamp and head mirror. **B.** Direct examination of the larynx using a flexible fiberoptic endoscope.

mirror toward the vocal folds to illuminate the area. The same mirror is also used to visualize the vocal folds. The patient is asked to sustain vowels (“say eee”) during the examination. A direct laryngoscopy is most often performed after the indirect method to allow for viewing of a greater area of the larynx.
Direct laryngoscopy is easily accomplished using a flexible endoscope, which consists of hundreds of fiberoptic strands that serve as both a light source for illumination, as well as a camera for examination. The scope is inserted through one of the nostrils and is guided toward the back of the throat and rests slightly above the vocal folds. This particular view is valuable for direct examination of the surface of the vocal folds and any existing vocal pathology.

**Indirect Therapy**

Techniques associated with indirect therapy include voice rest and patient education. **Voice rest** is the process of easing the strain placed on the vocal folds by not allowing any form of speaking, singing, or whispering for several days. Voice rest in itself is not a cure for most disorders. The purpose of voice rest is to hasten recovery time in conditions where the vocal folds have been traumatized. It is generally believed that if a person must absolutely speak during a prescribed period of vocal rest, regular phonation is preferred over whispering. The use of whispering does not allow the voice to rest. During whispering, the vocal muscles are still active. This action combined with air passing between the vocal folds actually has an irritating effect on the vocal folds. Patient education consists of informing the patient about laryngeal anatomy and the manner in which voice is produced. This might include a simplified interpretation of the myoelastic aerodynamic theory of phonation. As well, the patient is educated about the subsequent long-term vocal damage that may result from not producing voice normally.

**Direct Therapy**

The use of direct therapy involves alteration of a patient’s existing speaking behavior in an attempt to increase vocal efficiency and improve voice quality. Four examples of direct therapy are: (1) vocal function exercises, (2) respiratory training, (3) use of confidential voice, and (4) the **Lee Silverman Voice Treatment**. **Vocal function** exercises are a form of calisthenics designed to strengthen and improve coordination of laryngeal
musculature. Examples of vocal function exercises include maximum vowel prolongations and smoothly raising and lowering pitch along a musical scale. **Respiratory training** is one of the major methods for enhancing vocal function. Respiratory training focuses on coordinating muscles used for breathing and vocalizing. Professional singers are well aware of the importance of respiration in maintaining a normal healthy voice. **Confidential voice** therapy involves using a soft, breathy voice. The term is based on the concept of speaking softly with another individual so as to not be too obvious. This is not the same as using a whispered voice. From a physiological standpoint, speaking with soft voice reduces laryngeal muscle tension. Somewhat opposite to confidential voice therapy is Lee Silverman Voice Treatment (LSVT). The LSVT is a structured, programmatic approach to voice therapy. The premise of the approach is to encourage a full, loud speaking voice to improve overall voice quality as well as to improve aspects of speech clarity. The treatment has gained widespread acceptance for working with individuals with Parkinson disease (see also Chapter 9).

**Phonosurgery**

In some instances, indirect or direct therapy is not sufficient to improve one’s voice. In these cases, an operation may be necessary to repair the vocal folds or remove growths from the vocal folds. The term **phonosurgery** denotes restoration of voice by using various surgical techniques. The term was originally used by the otolaryngologist Hans von Leden (b. 1918) in the 1950s to describe any surgery performed specifically to improve voice. In most cases, some form of postoperative voice therapy is required following surgery. Two routine types of phonosurgeries performed by an otolaryngologist are: (1) phonomicrosurgery and (2) injection laryngoplasty. Both surgeries take place in an operating room with the patient asleep. **Phonomicrosurgery** involves use of a microscope to view the area of surgery, and the operation is carried out using special micro-instruments and lasers (Figure 8–16). Phonomicrosurgery is performed to remove vocal nodules and polyps. A guiding principle of this surgery is to maintain normal vocal function by only removing the growth found on the superficial tissue of the vocal folds. It is seldom performed on children’s voices because nodules and polyps often reappear in developing children, so repeated phonosurgery would likely cause long-lasting damage to the vocal folds. Injection laryngoplasty entails use of a syringe to insert material (such as collagen) into one or both of the vocal folds to “plump up” the overall size and shape of the muscle. Injection laryngoplasty has been successfully used to treat vocal fold paralysis. An effective treatment for reducing the symptoms of spasmodic dysphonia is injections of very small amounts of botulinum toxin (Botox) directly into the affected muscles of the larynx. The toxin weakens muscles by blocking the nerve impulses to the muscle. Botox has gained widespread attention for its use as a form of cosmetic facial surgery. For treating spasmodic dysphonia the toxin blocks nerve activity to the vocal folds, thereby freeing up the muscle to vibrate in a more normal fashion. Botox injections improve the voice for a period of four months after which voice symptoms gradually return. This treatment
requires continual injections to maintain a good speaking voice.

A laryngectomy is the complete surgical removal of the larynx, most likely resulting from cancer of the larynx. In nearly all cases of laryngectomy, the individual was a cigarette (or cigar) smoker. A person who has undergone a laryngectomy no longer breathes through the nose or mouth, but through an opening in the neck called a stoma. The individual is incapable of producing a normal voice because the primary laryngeal structures needed to generate voice have been removed (Figure 8–17). Several alternative methods exist for producing alaryngeal speech. One of these methods involves use of a small handheld device known as an electro-larynx (see Figure 8–17). The device produces a buzzing sound that is transferred into the vocal tract by holding it firmly against the neck. The patient learns to modulate this sound by shaping the lips, tongue, and jaw as they normally would if they still had a larynx. The quality of the sound is unnatural, but many patients use the device for basic communication needs. Another method for producing speech is referred to as esophageal speech. Esophageal speech is a type of speaking in which air is purposely injected into the back of the esophagus in a manner similar to burping to create speech. This form of speaking is difficult to master. Although most of us are probably able to utter one or two words on a single burp, a skilled esophageal speaker is able to produce short phrases. A very popular method of speech used following laryngectomy is tracheoesophageal speech, which is similar to esophageal speech, but uses a device to redirect air from the trachea into the esophagus. This is done through a small shunt placed through an open-
ing made between the trachea and esophagus called a tracheoesophageal puncture. A small one-way valve placed into this opening allows the patient to force air from their lungs into the mouth to create speech (Figure 8–18).

Prevention

Most voice disorders are preventable. Strategies that raise a person’s awareness of inappropriate voice use and vocal health are essential to the prevention of voice disorders. **Vocal hygiene** refers to the healthy habits that patients should follow to take care of their voices. This includes being aware of how various speaking behaviors, as well as food and drinks, can have on one’s voice and overall health. Vocal hygiene is analogous to taking care of your automobile. When you drive your car, you expect it to work perfectly at all times. For this to happen, you need to be aware of how the car works and the steps needed to keep the car mechanically sound. The same logic applies to using and taking care of your voice. Examples of good vocal hygiene are listed in Table 8–4. The various examples can be summarized using the acronym developed by voiceproblem.org, VOICE:

\[
\begin{align*}
V &= \text{Value your voice through healthy diet and lifestyle.} \\
O &= \text{Optimize your voice with vocal warm-ups before use.} \\
I &= \text{Invest in your voice with training in proper voice technique.} \\
C &= \text{Cherish your voice by avoiding voice misuse, overuse, and abuse.} \\
E &= \text{Exercise your voice to increase endurance and power.}
\end{align*}
\]

**FIGURE 8–17.** Depiction of vocal anatomy before (A) and after (B) a laryngectomy.
A Figure 8–18. A. Use of an electrolarynx following a laryngectomy. B. Use of tracheoesophageal speech.

Table 8–4. Examples of Good Vocal Hygiene

- Control the amount of shouting or yelling.
- Minimize or avoid using a whispered voice.
- Control the amount of caffeine and alcohol consumption.
- Reduce and avoid excessive coughing and throat clearing.
- Minimize grunting or vocalization during exercise.
- Limit the amount of talking in loud and noisy environments.
- Do not smoke and limit your exposure to second-hand smoke.
- Conserve your voice during periods of excessive fatigue and stress.
- Keep hydrated by drinking water every day.
- Maintain a healthy diet and minimize laryngopharyngeal reflux.
- Be aware of potentially traumatic vocal behaviors.

### FYI

Each of us has a **habitual pitch**, or level at which we speak most frequently, and an **optimum pitch**, or the level at which we can produce our strongest voice with minimal effort. One way to determine your optimum pitch is through the yawn-sigh technique. Do just what the technique describes: yawn (or take a deep breath), and then sigh (usually we sigh, “ahh”). The pitch of the sigh is your optimum pitch.
The occurrence of various types of voice disorders does not appear to differ significantly across racial and ethnic groups. However, a combination of social and cultural factors seems to influence voice and the subsequent development of voice disorders. For example, Japanese women tend to speak with a higher pitch ($F_0$) level than Western female counterparts. The high-pitch voice is assumed to project a vocal image associated with femininity. In contrast, Japanese men tend to use a lower pitch level compared with Western males that is used to emphasize masculinity. In both of these situations, the differences in $F_0$ are not due to anatomical differences in size of the larynx. Rather, the use of $F_0$ is altered due to sociocultural reasons. Presumably, this somewhat unnatural use of $F_0$ may place Japanese speakers at a higher risk for voice disorders due to possible misuse of the voice.

Society and culture also impact individuals who have undergone a sex change and require a subsequent change in speaking voice. Gender typically is demonstrated in a number of physical and behavioral ways, one of which is speaking voice. Transsexual individuals frequently undertake voice therapy as part of a female/male gender transition in order to make their voices sound appropriate and, therefore, facilitate their entrance (and acceptance) as females/males in society. **Voice feminization** is the desired goal of changing a perceived male sounding voice to a perceived female sounding voice. **Voice masculinization** is the opposite of voice feminization—the change of a voice from feminine to masculine. There is a greater likelihood of vocal misuse occurring in the process of voice feminization compared with masculinization due to the need to consistently maintain hyperadducted vocal fold behavior when speaking.

Other examples of society and culture influencing voice production can be found from the music industry and sporting events. A common anthem shared by today’s youth is, “If it’s too loud—you’re too old.” Examples of this perspective can be found in musical groups whose song lyrics tend to verge on shouting and yelling. Although this form of music may be accepted culturally and socially, there are clear risks of entertainers developing phonotrauma. Most sporting events consist of teams of athletes competing against each other, with the added sideline attraction of cheerleaders (both male and female). There is a cultural and social expectation that cheerleaders shout and yell as a means of supporting their team. Not

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**FYI**

Adult men have a lower speaking voice ($F_0$) than adult women; however, among some elderly individuals, the reverse can be found. The raising of pitch among elderly men is attributed to a stiffening (calcification) of the vocal folds. The lowering in pitch among elderly women is attributed to a thinning and loss of elasticity (tension) of the vocal folds.
surprisingly, cheerleaders are at high risk of developing voice disorders due to vocal misuse.

CURRENT RESEARCH IN VOICE DISORDERS

Laryngeal Imaging

The ability to visualize the vocal folds is important in the diagnosis of a voice disorder, as well as monitoring progress in voice improvement. Technological advancements are taking place that are helping to improve visualization of the vocal folds (Hillman, 2013). One of these advancements is in the area of visual clarity provided by nasoendoscopes and videostroboscopes. Further improvements are found in the speed (or resolution) of the images provided by these scopes. It is now possible to visualize cycle-to-cycle movements of the vocal folds. Finally, the images are getting deeper, with advances in the development of multidimensional displays of the larynx.

Spasmodic Dysphonia

The precise cause of spasmodic dysphonia remains unknown. The mystery surrounding this unusual voice disorder is of high research interest. The search for a specific gene linked to spasmodic dysphonia has been elusive. This is primarily due to the rarity of the disorder and the difficulty in finding family members with a history of spasmodic dysphonia. In 2009, the National Institutes of Health (Office of Rare Diseases Research) started a five-year study designed to improve the diagnosis of the disorder. Research centers across the United States are using (1) questionnaires, (2) clinical examinations, and (3) laryngeal endoscopic examinations in attempt to identify the most important indicators of spasmodic dysphonia. So in spite of the difficulties in pinpointing the cause for spasmodic dysphonia, steps are being taken to improve the accurate diagnosis of the condition.

Teachers

Approximately 10% of individuals rely on their voice as part of their profession. Perhaps foremost among these professionals are teachers. Vocal wear and tear is the greatest occupational hazard for teachers (Roy & Tanner, 2013). Teachers are required to speak for several hours each day, often in noisy and poorly soundproofed environments. A teacher’s voice is put under a great deal of strain on a regular basis. Several studies completed in Australia, Europe, and the United States have shown that voice problems occur more frequently with teachers than with any other occupation. In the United States, for example, the prevalence of voice disorders among teachers is 12% compared with the 6% occurrence found in the general population (Roy et al., 2005). The occurrence of a voice disorder can trigger a whole series of problems including: (1) loss of the ability to communicate normally, (2) loss of employment, (3) loss of income, and subsequently, (4) loss of professional identity.

VOICE DISORDERS ON THE WORLD WIDE WEB

Listed below are websites that provide further information on the topic of voice disorders. At the time of publication, each website was freely accessible.
Index of Voice Disorders Videos
http://www.fauquierent.net/voice.htm

The Voice Foundation
http://www.voicefoundation.org/

The Voice and Swallowing Center Video
http://www.entandallergy.com/vas/media.php

The Voice Problem Website
http://www.voiceproblem.org/

Voice Disorders Resources
http://www.voicedoctor.net/media/videos

STUDY QUESTIONS

1. What are the major structures of the larynx, and how is voice produced?
2. What are the classifications and types of voice disorders?
3. What are the similarities and differences in indirect and direct laryngoscopy?
4. List and describe the four examples of direct voice therapy.
5. What are the various types of phonomicrosurgery?

REFERENCES


