

Vocal Health

by

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VOCAL HEALTH - KEY FACTS

1. Voice disorders are common. Almost everyone experiences at least temporary hoarseness from time to time.
2. Good vocal quality and endurance are extremely important for personal and professional communication.
3. Some changes in voice quality or endurance indicate the presence of serious disease. Consequently, all voice disorders warrant thorough evaluation and accurate diagnosis.
4. Most voice problems are correctable.
5. Voice disorders may lead to permanent voice impairment. Accurate diagnosis and treatment often avoids long-term problems.
6. The state-of-the-art and medical standard of voice care have improved dramatically beginning in the late 1970s and 1980s.

INTRODUCTION

The human voice is remarkable, complex and delicate. It is capable of conveying not only sophisticated intellectual concepts, but also subtle emotional nuances. Although the uniqueness and beauty of the human voice have been appreciated for centuries, medical scientists have begun to really understand the workings and care of the voice only since the late 1970s and early

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1980s.

ANATOMY AND PHYSIOLOGY

What is the voice, and how does it work?

The wonderful sound we call voice results from interaction among numerous parts of the body. The larynx (voice box) is essential to normal voice production, but voice production is not limited to the larynx. The total vocal mechanism includes the abdominal and back musculature, rib cage, lungs, and the pharynx (throat), oral cavity and nose. Each component performs an important function in voice production, although it is possible to produce voice even without a larynx, for example in patients who have undergone laryngectomy (removal of the larynx) for cancer. In addition, virtually all parts of the body play some role in voice production and may be responsible for voice dysfunction. Even something as remote as a sprained ankle may alter posture, thereby impairing abdominal muscle function and resulting in vocal inefficiency, weakness and hoarseness.

What is the larynx?

The larynx is a structure found in the neck and composed of four basic anatomic units: skeleton, intrinsic muscles, extrinsic muscles and mucosa. The most important parts of the laryngeal skeleton are the thyroid cartilage, cricoid cartilage, and two arytenoid cartilages (Figure 1). Muscles of the larynx are connected to these cartilages. One of the intrinsic muscles (within the larynx), the vocalis muscle (part of the thyroarytenoid muscle), extends on each side from the arytenoid cartilage to the inside of the thyroid cartilage just below and behind the "Adam's apple," forming the body of the vocal fold (popularly called the vocal cord) (Figure 2). The vocal folds act as the oscillator or voice source (noise maker) of the vocal tract. The space between the vocal folds is called the glottis and is used as an anatomic reference point. The intrinsic muscles alter

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the position, shape and tension of the vocal folds, bringing them together (adduction), apart (abduction) or stretching them by increasing longitudinal tension. They are able to do so because the laryngeal cartilages are connected by soft attachments that allow changes in their relative angles and distances, thereby permitting alteration in the shape and tension of the tissues suspended between them. The arytenoids are also capable of rocking, rotating and gliding, permitting complex vocal fold motion (Figure 3) and alteration in the shape of the vocal fold edge. All but one of the muscles on each side of the larynx are innervated by one of the two recurrent laryngeal nerves. Because this nerve runs a long course from the neck down into the chest and then back up to the larynx (hence, the name "recurrent"), it is easily injured by trauma, neck surgery and chest surgery, which may result in vocal fold paralysis. The remaining muscle (cricothyroid muscle) is innervated by the superior laryngeal nerve on each side which is especially susceptible to viral and traumatic injury. It produces increases in longitudinal tension important in volume, projection and pitch control. The "false vocal folds" are located above the vocal folds and unlike the true vocal folds, do not make contact during normal speaking or singing.

Because the attachments of the laryngeal cartilages are flexible, the positions of the cartilages with respect to each other change when the laryngeal skeleton is elevated or lowered. Such changes in vertical height are controlled by the extrinsic (outside the larynx) laryngeal muscles, or strap muscles of the neck (Figure 4). When the angles and distances between cartilages change because of this accordion effect, the resting length of the intrinsic muscles is changed as a consequence. Such large adjustments in intrinsic muscle condition interfere with fine control of smooth vocal quality. This is why classically trained singers are generally taught to use their extrinsic muscles to maintain the laryngeal skeleton at a relatively constant height

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regardless of pitch. That is, they learn to avoid the natural tendency of the larynx to rise with ascending pitch, and fall with descending pitch, thereby enhancing unity of quality throughout the vocal range. Singing techniques may be different in selected Asian, Indian, Arabic and other musical traditions with different aesthetic values.

The soft tissues lining the larynx are much more complex than originally thought. The mucosa forms the thin, lubricated surface of the vocal folds which makes contact when the two vocal folds are closed. It looks like the mucosa lining the inside of the mouth. However, the vocal fold is not simply muscle covered with mucosa (Figure 5). The thin, lubricated squamous epithelium lines the surface. Immediately beneath it, connected by a complex basement membrane, is the superficial layer of the lamina propria, also known as Reinke's space, which consists of loose, fibrous components and matrix. It tends to accumulate fluid, and it contains very few fibroblasts (cells that cause scar formation). The epithelium is connected to the superficial layer of the lamina propria by a sophisticated basement membrane. The intermediate layer of the lamina propria contains primarily elastic fibers and a moderate number of fibroblasts. The deep layer of the lamina propria is rich in fibroblasts and consists primarily of collagenous fibers. It overlies the thyroarytenoid or vocalis muscle. The various layers have different mechanical properties important in allowing the smooth shearing action necessary for proper vocal fold vibration.

Mechanically, the vocal fold structures act more like three layers consisting of the cover (epithelium and superficial layer of the lamina propria), transition (intermediate and deep layers of the lamina propria), and body (the vocalis muscle).

What happens above the larynx?

The supraglottic vocal tract (above the larynx) includes the pharynx, tongue, palate, oral

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cavity, nose and other structures. Together, they act as a resonator and are largely responsible for vocal quality or timbre and the perceived character of all speech sounds. The vocal folds themselves produce only a "buzzing" sound. During the course of vocal training for singing, acting, or healthy speaking, changes occur not only in the larynx, but also in the muscle motion, control and shape of the supraglottic vocal tract.

What happens below the larynx?

The infraglottic (or subglottic) vocal tract (below the larynx) serves as the power source for the voice. Singers and actors refer to the entire power source complex as their "support" or "diaphragm." Actually, the anatomy of support for phonation is especially complicated and not completely understood; and performers who use the terms "diaphragm" and "support" do not always mean the same thing. Yet, it is quite important because deficiencies in support are frequently responsible for voice dysfunction.

The purpose of the support mechanism is to generate a force which directs a controlled airstream between the vocal folds which is necessary for vocalization to occur. Active respiratory muscles work together with passive forces. The principle muscles of inspiration are the diaphragm (a dome-shaped muscle that extends along the bottom of the rib cage), and the external intercostal (rib) muscles. During quiet breathing, expiration is largely passive. The lungs and rib cage generate passive expiratory forces under many common circumstances such as after a full breath.

Many of the muscles used for active expiration are also employed in "support" for phonation. Muscles of active expiration either raise the intra-abdominal pressure forcing the

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diaphragm upward, or lower the ribs, and sternum ("breast bone") to decrease the dimensions of the thorax, or both, thereby compressing air in the chest. The primary muscles of expiration are "the abdominal muscles," but internal intercostals, and other chest and back muscles are also involved. Trauma or surgery that alters the structure or function of these muscles or ribs undermines the power source of the voice as do diseases that impair expiration, such as asthma.

Deficiencies in the support mechanism often result in compensatory efforts which utilize the laryngeal muscles, not designed for power source functions. Such behavior can result in decreased voice function, rapid fatigue, pain and even structural pathology including vocal fold nodules. Currently, expert treatment (voice physical therapy) for such problems focuses on correction of the underlying malfunction. This often cures the problem, avoiding the need for laryngeal surgery.

How does it all work together to make a voice?

The physiology (functioning) of voice production is exceedingly complex. Production of voice begins in the cerebral cortex of the brain. Many other brain centers are involved in sending appropriate impulses to the nerves and muscles required for phonation. The brain also receives tactile (feeling) and auditory (hearing) feedback information and makes adjustments in order to control the voice sounds produced.

Phonation (using the vocal folds to make sound) requires interaction among the power source, oscillator and resonator. The voice may be likened to a brass instrument such as a trumpet. Power is generated by the chest, abdomen and back musculature producing a high pressure air stream. The trumpeter's lips open and close against the mouth piece producing a

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buzz similar to the sound produced by the vocal folds. This sound then passes through the trumpet which has resonance characteristics that shape the sound we associate with trumpet music. The non-mouthpiece portion of a brass instrument is analogous to the supraglottic vocal tract.

During phonation, rapid, complex adjustments of the infraglottic system are necessary because the resistance changes almost continuously as the glottis closes, opens and changes shape. At the beginning of each phonatory cycle, the vocal folds are together. As air pressure builds up against them, they are pushed apart and snap back together. Sound is actually produced by the closing of the vocal folds, in a manner similar to the sound generated by hand clapping. Contrary to popular opinion, the vocal folds are not “cords” that vibrate like piano or guitar strings. Also like hand clapping, the more forcefully the vocal folds snap together, the louder the sound; and the more frequently they open and close, the higher the pitch.

The sound produced by the vocal folds is a complex tone. As it passes through the supraglottic vocal tract, the pharynx, oral cavity and nasal cavity act as a series of interconnected resonators, more complex than a trumpet because the walls and shape are flexible. The ultimate voice quality is determined as the sound produced by the vocal folds passes through the resonator.

MEDICAL CARE OF VOICE DISORDERS

What is new in medical care?

Until the 1980's, most physicians caring for patients with voice disorders asked only a few basic questions such as: How long have you been hoarse? Do you smoke? etc. The physician's

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ear was the sole "instrument" used routinely to assess voice quality and function. Visualization of the vocal folds was limited to looking with a mirror placed inside the mouth using regular light, or to direct laryngoscopy (looking directly at the vocal folds through a metal pipe or endoscope) under anesthesia in the operating room. Treatment was generally limited to medicines for infection or inflammation, surgery for bumps or masses, and no treatment if the vocal folds looked "normal." Occasionally "voice therapy" was recommended, but the specific nature of therapy was not well controlled, and results were often disappointing. Since the early 1980s, the standard of care has changed dramatically.

What kind of questions are expected from one's doctor?

Correct medical diagnosis in all fields often hinges on asking the right questions, and listening carefully to the answers. This process is known as "taking a history." Recently, medical care for voice problems has utilized a markedly expanded comprehensive history that recognizes that there is more to the voice than simply the vocal folds. Virtually any body system may be responsible for voice complaints. In fact, problems outside the larynx often cause voice dysfunction in people whose vocal folds appear fairly normal; these individuals would have received no effective medical care until just a few years ago.

What is involved in physical examination of a person with voice problems?

Physical examination of a person with voice complaints involves a complete ear, nose, and throat assessment and examination of other body systems, as appropriate. In 1854, a singing teacher named Manuel Garcia devised the technique of indirect laryngoscopy. He used the sun as a light source and a dental mirror placed in the mouth to look at the vocal folds of his students. This rapidly became a basic tool for physicians, and it is still in daily use, although we now use an

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electric light rather than the sun (Figure 6). This technique is valuable, but has many shortcomings. Effective magnification and photographic documentation are difficult, and standard light does not permit assessment of the rapid and complex motion of the vibratory margin of the vocal folds. After 130 years, the 1980's finally saw technological advances that address these and other shortcomings (Figure 7).

In the last few years, subjective examination has been supplemented by technological aids that improve our ability to "see" the vocal mechanism, and allow quantification of most aspects of its function. When singing the note middle C, for example, the vocal folds come together and separate approximately 250 times per second. Stroboscovideolaryngoscopy (slow-motion visualization of the vocal folds) uses a laryngeal microphone to trigger a stroboscope which illuminates the vocal folds, allowing the examiner to assess them in slow motion. This technology allows detection of small masses, vibratory asymmetries, adynamic segments due to scar or early cancer, and other abnormalities that were simply missed in vocal folds that looked "normal" under continuous light (as opposed to stroboscopic, or pulsed, light). The instruments contained in a well-equipped clinical voice laboratory assess six categories of vocal function: vibratory, aerodynamic, phonatory, acoustic, electromyographic and psychoacoustic. State-of-the-art analysis of vocal function is extremely helpful in diagnosis, therapy, and evaluation of progress during treatment of voice disorders.

COMMON DIAGNOSES AND TREATMENTS

Introduction

Following a thorough history, physical examination and clinical voice laboratory analysis, it is usually possible to arrive at an accurate explanation for voice dysfunction. Treatment

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depends upon the etiology (cause), of course. Fortunately, as technology has improved voice medicine, the need for laryngeal surgery has diminished. In a great many cases, voice disorders result from respiratory, neurological, gastrointestinal, psychological, endocrine, or some other medical cause that can be treated. Many conditions require prescription of drugs. However, medications must be used with caution because many of them have adverse side effects that alter voice function, as discussed above. Consequently, close collaboration is required among all specialists involved in the patient's care to be certain that treatment of one causal condition does not produce a secondary dysfunction that is also deleterious to the voice. When the underlying problem is corrected properly, the voice usually improves; but collaborative treatment by a team of specialists is most desirable to assure general and vocal health, and optimize voice function.

What is hoarseness?

Most people with voice problems complain of "hoarseness" or "[laryngitis](#)." A more accurate description of the problem is often helpful in identifying the cause. Hoarseness is a coarse, scratchy sound caused most commonly by abnormalities on the vibratory margin of the vocal fold. These may include swelling, roughness from inflammation, growths, [scarring](#), or anything that interferes with symmetric, periodic vocal fold vibration. Such abnormalities produce turbulence which we perceive as hoarseness. Breathiness is caused by lesions (abnormalities) that keep the vocal folds from closing completely, including paralysis, muscle weakness, cricoarytenoid joint injury or arthritis, vocal fold masses, or atrophy of the vocal fold tissues. These abnormalities permit air escape when the vocal folds are supposed to be tightly closed. We hear this air leak as breathiness.

Fatigue of the voice is inability to continue to phonate for extended periods without change in vocal quality. The voice may fatigue by becoming hoarse, losing range, changing

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timbre, breaking into different registers or by other uncontrolled behavior. These problems are especially apparent in actors and singers. A well-trained singer should be able to sing for several hours without developing vocal fatigue. Fatigue is often caused by misuse of abdominal and neck musculature, or over-use (singing or speaking too loudly, too long). Vocal fatigue may be a sign of general tiredness, or serious illnesses such as myasthenia gravis.

Volume disturbance may present as inability to speak or sing loudly or inability to phonate softly. Each voice has its own dynamic range. Professional voice users acquire greater loudness through increased vocal efficiency. They learn to speak and sing more softly through years of laborious practice that involves muscle control, and development of the ability to use the supraglottic resonators effectively. Most volume problems are secondary to intrinsic limitations of the voice or technical errors in voice production, although hormonal changes, aging and neurological disease are other causes. Superior laryngeal nerve paralysis will impair the ability to speak loudly. This is a frequently unrecognized consequence of herpes infection (such as "cold sores") and may be precipitated by an upper respiratory tract infection.

Even nonsingers normally require only about ten to thirty minutes to warm-up the voice. Prolonged warm-up time, especially in the morning, is most often caused by reflux laryngitis, a condition in which stomach acid refluxes up the esophagus and ends up burning the throat. Tickling or choking during speech or singing is often associated with laryngitis or voice abuse. Often a symptom of pathology of the vocal fold's leading edge, this symptom requires that voice use be avoided until vocal fold examination has been accomplished. Pain while vocalizing can indicate vocal fold lesions, laryngeal joint arthritis, infection, or gastric (stomach) acid reflux irritation of the arytenoids; but it is much more commonly caused by voice abuse with excessive

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muscular activity in the neck rather than acute pathology on the leading edge of a vocal fold, and it does not usually require immediate cessation of phonation pending medical examination.

Does age affect the voice?

Age affects the voice significantly, especially during childhood and older age. Children's voices are particularly fragile. Voice abuse during childhood may lead to problems that persist throughout a lifetime. It is extremely important for children to learn good vocal habits, and for them to avoid voice abuse. This is especially true among children who choose to participate in vocally taxing activities such as singing, acting and cheerleading. Many promising careers and vocal avocations have been ruined by enthusiastic but untrained voice use. For children with vocal interests, age-appropriate training should be started early. Any child with unexplained or prolonged hoarseness should undergo prompt, expert medical evaluation performed by a laryngologist (ear, nose and throat doctor) specializing in voice care.

In geriatric patients, vocal unsteadiness, loss of range and voice fatigue may be associated with typical physiologic aging changes such as vocal fold atrophy (wasting). In routine speech, such vocal changes allow a person to be identified as "old" even over the telephone. Among singers, they are typically associated with flat pitch and a "wobble" often heard in older amateur choir singers. However, recent evidence has shown that many of these acoustic phenomena are not caused by irreversible aging changes. Rather, they may be consequences of poor laryngeal respiratory and abdominal muscle condition undermining the power source of the voice. The medical history usually reveals minimal aerobic exercise, and shortness of breath climbing stairs. With appropriate conditioning of the body and voice, many of the characteristics associated with vocal aging can be eliminated, and a youthful sound can be

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restored.

What are the effects of voice use and training?

The amount of voice use and training also affects voices. Inquiry into vocal habits frequently reveals correctable causes for voice difficulties. Extensive untrained speaking under adverse environmental circumstances is a common example. Such conditions occur, for example, among stock traders, sales people, restaurant personnel, and people who speak over the telephone in noisy offices. The problems are aggravated by habits that impair the mechanics of voice production such as sitting with poor posture and bending the neck to hold a telephone against one shoulder. Subconscious efforts to overcome these impediments often produce enough voice abuse to cause vocal fatigue, hoarseness, and even nodules (callous-like growths, usually on both vocal folds). Recognizing and eliminating the causal factors usually results in disappearance of the nodules and improved voice.

What about singers, actors and other voice professionals?

It is also essential for the physician to know the extent to which any patient uses his or her voice professionally. Professional singers, actors, announcers, politicians and others put "Olympic" demands on their voices. Interest in the diagnosis and treatment of special problems of professional voice users is responsible for the evolution of voice care as a subspecialty of otolaryngology. These patients are often best managed by subspecialists familiar with the latest concepts in professional voice care.

How about smoke and other things in the air?

Exposure to environmental irritants is a well recognized cause of voice dysfunction.

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Smoke, dehydration, pollution and allergens may produce hoarseness, frequent throat clearing and voice fatigue. These problems can generally be eliminated by environmental modification, medication, or simply breathing through the nose rather than the mouth since the nose warms, humidifies and filters incoming air.

The deleterious effects of tobacco smoke upon the vocal folds have been known for many years. Smoking not only causes chronic irritation, but moreover can result in histologic (microscopic) alterations in the vocal fold epithelium. The epithelial cells change their appearance, becoming more and more different from normal epithelial cells. Eventually, they begin to pile up on each other, rather than lining up in an orderly fashion. Eventually, they escape normal homeostatic controls, growing rapidly without restraint and invading surrounding tissues. This drastic change is called squamous cell [carcinoma](#), or cancer of the larynx.

Can foods or drugs affect the voice?

The use of various foods and drugs may affect the voice, too. Some medications may even permanently ruin a voice, especially androgenic (male) hormones such as those given to women with endometriosis, or with post-menopausal sexual dysfunction. Similar problems occur with anabolic steroids (also male hormones) used illicitly by body builders. More common drugs also have deleterious vocal effects, usually temporary. Antihistamines cause dryness, increased throat clearing and irritation, and often aggravate hoarseness. Aspirin contributes to vocal fold [hemorrhages](#) because of the same anticoagulant properties that make it a good drug for patients with vascular disease. The propellant in inhalers used to treat asthma often produces laryngitis. Many neurological, psychological and respiratory medications cause tremor that can be heard in the voice. Numerous other medications cause similar problems. Some foods may also be

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responsible for voice complaints in people with "normal" vocal folds. Milk products are particularly troublesome to some people because the casein they contain increases and thickens mucosal secretions.

How about other parts of the body?

The history must also assess the status of the respiratory (breathing), gastrointestinal (gut), endocrine (hormone), neurological and psychological systems. Disturbances in any of these areas may be responsible for voice complaint. Selected common examples are discussed or illustrated later in this booklet.

Problems anywhere in the body must be elicited during the medical history. Because voice function relies on such complex brain and other nervous system interactions, even slight neurological dysfunction may cause voice abnormalities; and voice impairment is sometimes the first symptom of serious neurological diseases such as myasthenia gravis, multiple sclerosis and Parkinson's disease.

A history of a sprained ankle may reveal the true cause of voice dysfunction, especially in a singer, actor or speaker with great vocal demands. Proper posture is important to optimal function of the abdomen and chest. The imbalance created by standing with the weight over only one foot frequently impairs support enough to cause compensatory vocal strain, leading to hoarseness and voice fatigue. Similar imbalances may occur after other bodily injuries. These include not only injuries that involve support structures, but also problems in the head and neck, especially whiplash injuries. Naturally, a history of laryngeal trauma or surgery pre-dating voice dysfunction raises concerns about the anatomical integrity of the vocal fold; but a history of

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interference with the power source through abdominal or thoracic surgery may be just as important in understanding the cause and optimal treatment of vocal problems.

Do stomach problems or hiatal hernia affect the voice?

Gastrointestinal disorders commonly cause voice complaints. The sphincter (a one-way valve) between the stomach and esophagus is notoriously weak. In gastroesophageal reflux laryngitis, stomach acid refluxes through this weak sphincter into the throat allowing droplets of the irritating gastric acid to come in contact with the vocal folds, and even to be aspirated into the lungs. Reflux may occur with or without a hiatal hernia. Common symptoms of reflux laryngitis are hoarseness especially in the morning, prolonged vocal warm-up time, bad breath, sensation of a lump in the throat, chronic sore throat, cough, and a dry or "coated" mouth. Typical heartburn is frequently absent. Over time, uncontrolled reflux may cause cancer of the esophagus and larynx. So, this condition should be treated aggressively and conscientiously.

Physical examination of the larynx usually reveals a bright red, often slightly swollen appearance of the arytenoid mucosa which helps establish the diagnosis. A barium esophagogram with water siphonage may provide additional information but is not needed routinely. In selected cases, 24 hour pH monitoring provides the best analysis and documentation of reflux. The mainstays of treatment are elevation of the head of the bed (not just sleeping on pillows), use of antacids, and avoidance of food for 3 or 4 hours before sleep. Avoidance of alcohol and coffee is also beneficial. Medications that block stomach acid secretion are also useful, including cimetidine (Tagamet), ranitidine (Zantac), famotidine (Pepcid), nizatidine (Axid), omeprazole (Prilosec), lansoprazole (Prevacid), and others. In some cases, surgery to repair the lower esophageal sphincter and cure the reflux may be more appropriate than life-long

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medical management. This option has become much more attractive since the development of laparoscopic surgery which has drastically decreased the morbidity associated with this operation.

Do lung problems cause voice disorders?

Respiratory problems are especially problematic to singers, other voice professionals, and wind instrumentalists, but they may cause voice problems in anyone. Support is essential to healthy voice production. The effects of severe respiratory infection are obvious and will not be enumerated. Restrictive lung disease such as that associated with obesity may impair support by decreasing lung volume and respiratory efficiency. However, obstructive pulmonary disease is the most common culprit. Even mild obstructive lung disease can impair support enough to cause increased neck and tongue muscle tension and abusive voice use capable of producing vocal nodules. This scenario occurs even with unrecognized asthma and may be difficult to diagnose unless suspected, because many such cases of asthma are exercised-induced. Vocal performance is a form of exercise, whether the performance involves singing, giving speeches, sales or other forms of intense voice use. Individuals with this problem will have normal pulmonary function clinically and may even have normal or nearly normal pulmonary function test findings at rest. However, as the voice is used intensively, pulmonary function decreases, effectively impairing support and resulting in compensatory abusive technique. When suspected, this entity can be confirmed through a methacholine challenge test performed by a pulmonary (lung) specialist.

Treatment of the underlying pulmonary disease to restore effective support is essential to resolving the vocal problem. Treating asthma is rendered more difficult in professional voice

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users because of the need in some patients to avoid not only inhalers but also drugs that produce even a mild tremor. The cooperation of a skilled pulmonologist specializing in asthma and sensitive to problems of performing artists is invaluable.

What about hormones?

Hormones are complex, natural chemicals that affect a variety of bodily functions. Endocrine (hormone-producing organs) problems also have marked vocal effects, primarily by causing accumulation of fluid in the superficial layer of the lamina propria, altering the vibratory characteristics. Mild hypothyroidism typically causes a muffled sound, slight loss of range and vocal sluggishness. Similar findings may be seen in pregnancy, during use of oral contraceptives (in about 5% of women), for a few days prior to menses and at the time of ovulation. Premenstrual loss of vocal efficiency, endurance and range is also accompanied by a propensity for vocal fold hemorrhage which may alter the voice permanently. The use of some medications with hormonal activity can also permanently injure a voice. This is particularly true of substances that contain androgens (male hormones) as discussed above.

Does anxiety have anything to do with the voice?

When the principal cause of vocal dysfunction is anxiety, the physician can often accomplish much by assuring the patient that no organic (physical) difficulty is present and by stating the diagnosis of anxiety reaction. The patient should be counseled that anxiety-related voice disturbances are common, and that recognition of anxiety as the principal problem frequently allows the disorder to be overcome. Tranquilizers and sedatives are rarely necessary and are undesirable because they may interfere with fine motor control, affecting voice adversely. Recently, Beta-adrenergic blocking agents such as propranolol hydrochloride (eg, Inderal) have

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achieved some popularity in the treatment of pre-performance anxiety in singers and instrumentalists. Beta-blockers should not be used routinely for voice disorders and pre-performance anxiety. They have significant effects on the cardiovascular system and many potential complications, including hypotension, thrombocytopenic purpura, mental depression, agranulocytosis, laryngospasm with respiratory distress, and bronchospasm. In addition, their efficacy is controversial. If anxiety or other psychological factors are an important cause of a voice disorder, their treatment by a psychologist or psychiatrist with special interest and training in voice problems is extremely helpful. This therapy should occur in conjunction with voice therapy.

Can abusing the voice create problems?

Voice abuse through technical dysfunction is an extremely common source of hoarseness, vocal weakness, pain and other complaints. In some cases, voice abuse can even create structural problems such as [vocal nodules](#), [cysts](#) and [polyps](#). Now that the components of voice function are better understood, techniques have been developed to rehabilitate and train the voice in speech and singing. Such voice therapy improves breathing and abdominal support, decreases excess muscle activity in the larynx and neck, optimizes the mechanics of transglottal (through the vocal fold area) airflow and maximizes the contributions of resonance cavities. It also teaches vocal hygiene, including techniques to eliminate voice strain and abuse, maintain hydration and mucosal function, mitigate the effects of smoke and other environmental irritants and optimize vocal and general health. A voice therapy team includes an otolaryngologist (ear, nose and throat doctor) specializing in voice, a speech-language pathologist specially trained in voice, a singing voice specialist with training in vocal injury and dysfunction, and when needed, an arts-medicine psychologist, psychiatrist, pulmonologist, neurologist, exercise physiologist, or

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other specialist. Progress is monitored not only by listening to the patient and observing the disappearance of laryngeal pathology when it is present, but also by quantitative measurement parameters in the clinical voice laboratory. However, in some cases there are structural problems in the larynx that are correctable only with surgery.

What are vocal nodules?

Small, callous-like bumps on the vocal folds called nodules are caused by voice abuse (Figure 8). Occasionally, laryngoscopy reveals asymptomatic vocal nodules that do not appear to interfere with voice production; in such cases, the nodules need not be treated. Some famous and successful singers have had untreated vocal nodules throughout their entire careers. However, in most cases nodules are associated with hoarseness, breathiness, loss of range, and vocal fatigue. They may be due to abuse of the voice during either speaking or singing. Voice therapy always should be tried as the initial therapeutic modality and will cure the vast majority of patients even if the nodules look firm and have been present for many months or years. Even in those who eventually need surgical excision of the nodules, preoperative voice therapy is essential to prevent recurrence.

Caution must be exercised in diagnosing small nodules in patients who have been speaking or singing actively. In many people, bilateral, symmetrical soft swellings at the junction of the anterior and middle thirds of the vocal folds develop after heavy voice use. No evidence suggests that people with such "physiologic swelling" are predisposed to development of vocal nodules. At present, the condition is generally considered to be within normal limits. The physiologic swelling usually disappears with 24 to 48 hours of rest from heavy voice use.

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What are cysts?

Submucosal cysts of the vocal folds are usually also traumatic lesions that produce blockage of a mucous gland duct, although they may also occur for other reasons and may even be present at birth. They often cause contact swelling on the opposite vocal fold and are usually initially misdiagnosed as nodules. Often, they can be differentiated from nodules by stroboscovideolaryngoscopy when the mass is obviously fluid-filled. They may also be suspected when the nodule (contact swelling) on the other vocal fold resolves with voice therapy but the mass on one vocal fold persists. Cysts may also be found on one side (Figure 9) (occasionally both sides) when surgery is performed for apparent nodules that have not resolved with voice therapy. The surgery should be performed superficially and with minimal trauma, as discussed later.

What are polyps?

Many other structural lesions may appear on the vocal folds. Of course, not all respond to nonsurgical therapy. Polyps are usually unilateral (or one side) masses, and they often have a prominent feeding blood vessel coursing along the superior surface of the vocal fold and entering the base of the polyp (Figure 10). The pathogenesis of polyps cannot be proven in many cases, but the lesion is thought to be traumatic in many patients. At least some polyps start as vocal hemorrhages. In some cases, even sizable polyps resolve with relative voice rest and a few weeks of low-dose corticosteroid therapy. However, many require surgical removal. If polyps are not treated, they may produce contact injury on the contralateral (opposite) vocal fold. Voice therapy should be used to assure good relative voice rest and prevention of abusive behavior before and after surgery. When surgery is performed, care must be taken not to damage the leading edge of the vocal fold, especially if a laser is used.

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Do allergy and post-nasal drip bother the voice?

Allergies and post-nasal drip alter the viscosity (thickness) of mucous secretions, the patency of nasal airways, and have other effects that impair voice use. Many of the medicines commonly used to treat allergies (such as antihistamines) have undesirable effects on the voice. When allergies are severe enough to cause persistent throat clearing, hoarseness and other voice complaints, a comprehensive allergy evaluation and treatment by an allergy specialist is advisable. "Post-nasal drip," the sensation of excessive secretions, may or may not be caused by allergy or sinus disease. Contrary to popular opinion, the condition usually involves secretions which are too thick, rather than too abundant. If post-nasal drip is not caused by allergy, it is usually managed best through hydration, and mucolytic agents such as those discussed below in the section on drugs for voice dysfunction. Reflux laryngitis can cause symptoms very similar to post-nasal drip, and it should always be considered in people who have the sensation of throat secretions, a lump in the throat, and excessive throat clearing.

What is the effect of upper respiratory tract infection without laryngitis?

Although mucosal irritation usually is diffuse, patients sometimes have marked nasal obstruction with little or no sore throat and a "normal" voice. If the laryngeal examination shows no abnormality, a person with a "head cold" should be permitted to speak or sing but advised not to try to duplicate his or her usual sound, but rather to accept the insurmountable alteration caused by the change from the infection in the supraglottic vocal tract. This is especially important in singers. The decision as to whether appearing under those circumstances is advisable professionally, rests with the singer and musical associates. Throat clearing should be avoided, as this is traumatic. If a cough is present, medications should be used to suppress it;

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preferably non-narcotic preparations.

How about laryngitis with serious vocal fold injury?

Severe inflammation and swelling, hemorrhage in the vocal folds and mucosal disruption (a tear) may occur with laryngitis and are contraindications to voice use. When these are observed, the treatment includes strict voice rest in addition to correction of any underlying disease. Vocal fold hemorrhage is most common in premenstrual women who are using aspirin products. Severe hemorrhage and mucosal scarring may result in permanent hoarseness. In some instances, surgical intervention may be necessary. The potential gravity of these conditions must be stressed so that patients understand the importance of complying with voice restrictions.

Should I use my voice if I have laryngitis without serious vocal fold injury?

Infectious laryngitis may be caused by bacteria or viruses. Subglottic involvement frequently indicates a more severe infection, which may be difficult to control in a short period of time. Indiscriminate use of antibiotics must be prevented. However, when the physician is in doubt as to the cause and when a major voice commitment is imminent, vigorous antibiotic treatment is warranted. Corticosteroids (steroids) may also be helpful in selected cases. These are different from anabolic steroids that have gained notoriety through abuse by athletes.

Mild to moderate edema (swelling) and erythema (redness) of the vocal folds may result from infection or from noninfectious causes. In the absence of mucosal disruption or hemorrhage, they are not absolute contraindications to voice use. Noninfectious laryngitis commonly is associated with excessive voice use in pre-performance rehearsals. It may also be

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caused by other forms of voice abuse and by mucosal irritation produced by allergy, smoke inhalation, and other causes. Mucous stranding between the anterior and middle thirds of the vocal folds often indicates voice abuse. Laryngitis sicca (dry voice) is associated with dehydration, dry atmosphere, mouth breathing, and antihistamine therapy. It may also be a symptom of diabetes and other medical problems. Deficiency of lubrication causes irritation and coughing and results in mild inflammation. If no pressing professional need for voice use exists, inflammatory conditions of the larynx are best treated with relative voice rest in addition to other modalities. However, in some instances speaking or singing may be permitted. The more good voice training a person has, the safer it will be to use the voice under adverse circumstances. The patient should be instructed to avoid all forms of irritation and to rest the voice at all times except during warm-up and performance. Corticosteroids and other medications discussed later may be helpful. If mucosal secretions are excessive, low-dose antihistamine therapy may be beneficial, but it must be prescribed with caution and should generally be avoided. Copious, thin secretions are better than scant, thick secretions or excessive dryness. Individuals with laryngitis must be kept well hydrated to maintain the desired character of mucosal lubrication.

Does voice rest help laryngitis?

Voice rest (absolute or relative non-speaking) is an important therapeutic consideration in any case of laryngitis. When no professional commitments are pressing, a short course (up to a few days) of absolute voice rest may be considered, as it is the safest and most conservative therapeutic intervention. This means absolute silence and communication with a writing pad or other assistive device. The patient must be instructed not even to whisper, as this may be an even more traumatic vocal activity than speaking softly. Whistling through the lips also requires vocal fold motion and should not be permitted. Absolute voice rest is necessary only for serious

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vocal fold injury such as hemorrhage or mucosal disruption. Even then, it is virtually never indicated for more than 7 to 10 days. Three days are often sufficient. In many instances of mild to moderate laryngitis, considerations of finances and reputation mitigate against a recommendation of voice rest in professional voice users. In advising performers to minimize vocal use, Dr. Norman Punt of London, England used to counsel, "Don't say a single word for which you are not being paid." His admonition frequently guides the ailing voice user away from pre-performance conversations and post-performance greetings. Patients with such vocal problems should also be instructed to speak softly (not whisper), as infrequently as possible, often at a slightly higher pitch than usual and with a slightly breathy voice; to avoid excessive telephone use; and to speak with abdominal support as they would in singing. This is relative voice rest, and it is helpful in most cases. An urgent session with a speech-language pathologist is extremely valuable in providing guidelines to prevent voice abuse. Nevertheless, the patient must be aware that some risk is associated with performing with laryngitis even when voice use is possible. Inflammation of the vocal folds is associated with increased capillary fragility and increased risk of vocal fold injury or hemorrhage. Many factors must be considered in determining whether a given voice commitment is important enough to justify the potential consequences.

What other treatments may be used for laryngitis?

Steam inhalations deliver moisture and heat to the vocal folds and tracheobronchial tree and are often useful. Some people use nasal irrigations, although these have little proven value. Gargling also has no proven efficacy, but it is probably harmful only if it involves loud, abusive vocalization as part of the gargling process. Ultrasonic treatments, local massage, psychotherapy, and biofeedback directed at relieving anxiety and decreasing muscle tension may be helpful adjuncts to a broader therapeutic program. However, psychotherapy and biofeedback,

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in particular, must be supervised expertly if used at all.

What happens if a blood vessel in a vocal fold ruptures?

Vocal fold hemorrhage, the result of a ruptured blood vessel, is a potential vocal disaster. Hemorrhages resolve spontaneously in most cases, with restoration of normal voice. However, in some instances, the hematoma (collection of blood under the vocal fold mucosa) organizes and fibroses, resulting in the formation of a mass and/or scar. This alters the vibratory function of the vocal fold and can result in permanent hoarseness. In specially selected cases, it may be best to avoid this problem through surgical incision and drainage of the hematoma. In all cases, vocal fold hemorrhage should be managed with absolute voice rest until the hemorrhage has resolved and normal vascular and mucosal integrity have been restored. This often takes six weeks, and sometimes longer. Recurrent vocal fold hemorrhages are usually due to weakness in a specific blood vessel. They may require surgical cauterization of the blood vessel using a laser.

What are the hazards of laryngeal trauma?

The larynx can be injured easily during altercations and motor vehicle accidents. Steering wheel injuries are particularly common. Blunt anterior neck trauma may result in laryngeal fracture, dislocation of the arytenoid cartilages, hemorrhage and airway obstruction. Late consequences such as narrowing of the airway may also occur. Laryngeal injuries are frequently seen in association with other injuries such as scalp lacerations, and the laryngeal problem is often overlooked initially even though it may be the most serious or life-threatening injury. Hoarseness or other changes in voice quality following neck trauma should call this possibility to mind. Prompt evaluation by visualization and radiological imaging should occur. In many cases, surgery is needed.

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What about vocal fold paralysis?

Paralysis may involve one or both vocal folds, and one or both nerves to each vocal fold. When paralysis is limited to the superior laryngeal nerve, the patient loses his or her ability to control longitudinal tension (stretch) in the vocal fold. Although superior laryngeal nerve paralysis involves only one muscle (cricothyroid), the problem is difficult to overcome. The vocal fold sags at a lower level than normal, and the patient notices difficulty elevating pitch, controlling sustained tones and projecting the voice. Superior laryngeal nerve paralysis is caused most commonly by viral infection, especially the herpes virus that causes cold sores. The recurrent laryngeal nerve controls all the other intrinsic laryngeal muscles. When it is injured, the vocal fold cannot move toward or away from the midline, although longitudinal tension is preserved and the vocal fold remains at its appropriate vertical level if the superior laryngeal nerve is not injured. If the opposite (normal) vocal fold is able to cross the midline to meet the paralyzed side, the vocal quality and loudness may be quite good. Compensation often occurs spontaneously during the first six to twelve months following paralysis, with the paralyzed vocal fold moving closer to the midline. Unilateral vocal fold paralysis may be idiopathic (cause unknown), but it is also seen fairly commonly following surgical procedures of the neck such as thyroidectomy, carotid endarterectomy and anterior cervical fusion, and some chest operations. Vocal fold paralysis should be treated initially with voice therapy. At least six months (and preferably 12 months) of observation are needed unless it is absolutely certain that the nerve has been cut and destroyed, because spontaneous recovery of neuromuscular function is common. If voice therapy fails, vocal fold motion remains impaired, and voice quality or ability to cough is unsatisfactory to the patient, surgical treatments are generally quite satisfactory.

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What is spasmodic dysphonia?

Spasmodic (or "spastic") dysphonia (voice disturbance) is a diagnosis given to patients with specific kinds of voice interruptions. These patients may have a variety of diseases that produce the same vocal result, which is called a laryngeal dystonia (involuntary movement disorder). There are also many interruptions in vocal fluency that are incorrectly diagnosed as spasmodic dysphonia. It is important to avoid this error, because different types of dysphonia require different evaluations, treatments and carry different prognostic implications. Spasmodic dysphonia is subclassified into adductor and abductor types.

Adductor spasmodic dysphonia is the most common and is characterized by hyperadduction of the vocal folds producing an irregularly interrupted, effortful, strained, staccato voice. It is generally considered neurologic in etiology and its severity varies substantially among patients and over time. It is considered a focal dystonia. In many cases, the voice may be normal or more normal during laughing, coughing, crying or other non-voluntary vocal activities, or during singing. Adduction may involve the true vocal folds alone, or the false vocal folds and the supraglottis may squeeze shut. Because of the possibility of serious underlying neurologic dysfunction or association with other neurologic problems as seen in Meige's syndrome (blepharospasm involving the eyes, mild facial spasm and spasmodic dysphonia), a complete neurological and neurolaryngological evaluation is required. Adductor spasmodic dysphonia may also be associated with spastic torticollis (wry neck), and more generalized neurologic problems such as extrapyramidal dystonia.

Abductor spasmodic dysphonia is similar to adductor spasmodic dysphonia except that voice is interrupted by breathy, unphonated bursts, rather than constricted and shut off. Like

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adductor spasmodic dysphonia, various causes may be responsible. The abductor tend to be most severe during unvoiced consonants, better during voiced consonants, and absent or least troublesome during pronunciation of vowels. Both abductor and adductor spastic dysphonia characteristically progress gradually, and both are aggravated by psychological stress.

After comprehensive work up to rule out treatable organic causes, treatment for spasmodic dysphonia should begin with voice therapy. Adductor spastic dysphonia is much more common, and most speech therapy and surgical techniques have been directed at treatment of this form. Unfortunately, traditional voice therapy is often not successful. Speaking on inhalation has worked well in some cases. Patients who are able to sing without spasms or interruptions but are unable to speak may benefit from singing lessons. We have used singing training as a basic approach to voice control, and then bridged the singing voice into speech. In a few patients, medications such as Baclofen [Watson] or Dilantin [Parke Davis] have also been helpful, but these patients are in the minority. When all other treatment modalities fail, various invasive techniques have been used. Recurrent laryngeal nerve section produces vocal fold paralysis and improves spasmodic dysphonia initially in many patients. However, there is a high incidence of recurrence. We do not generally recommend this approach. Other surgical techniques that alter vocal fold length and modify the thyroid cartilage may also be efficacious. A new technique for sectioning the nerve branch to only one muscle also shows promise. However, the most encouraging treatment at present for patients disabled by severe spasmodic dysphonia is botulinum toxin injection. Botulinum toxin is a natural poison that causes paralysis. Injected in small, carefully controlled amounts, it has numerous medical uses. Laryngeal injection is usually done with electromyographic guidance, and the technique produces temporary paralysis of selected muscles. This results in relief or resolution of the spasmodic dysphonia. However, the

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injections need to be repeated periodically in most patients.

Are there other neurological voice disorders?

Many other neurological problems commonly cause voice abnormalities. These include myasthenia gravis, Parkinson's disease, essential tremor, and numerous other disorders. In some cases, voice abnormalities are the first symptoms of these diseases.

What about cancer of the vocal folds?

Cancers of the larynx are common, and are usually associated with smoking, although cancers also occur occasionally in non-smokers (Figure 11). In many cases, the reason is unknown. However, it appears as if other conditions such as chronic reflux laryngitis and laryngeal papillomas may be important predisposing factors. Persistent hoarseness is one of the most common symptoms. Laryngeal cancers may also present with throat pain, or referred ear pain. If diagnosed early, they respond to therapy particularly well and are often curable. Treatment usually requires radiation, surgery, or a combination of the two modalities. It is usually possible to preserve or restore voice, especially if the cancer is detected early.

What drugs are used for vocal dysfunction?

Antibiotics

When antibiotics are used to treat vocal dysfunction secondary to infection, high doses to achieve therapeutic blood levels rapidly are recommended and a full course (usually 7 to 10 days) should be administered. Starting treatment with an intramuscular injection may be helpful if there is time pressure.

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Antihistamines and Mucolytics

Antihistamines may be used to treat allergies. However, because they tend to cause dryness and are frequently combined with sympathomimetic or parasympatholytic agents (decongestants) that further reduce and thicken mucosal secretions, they may reduce lubrication to the point of producing a dry cough. This dryness may be more harmful than the allergic condition itself. Mild antihistamines in small doses should be tried between voice commitments, but they should generally not be used for the first time immediately before performances if the vocalist has had no previous experience with them. Their adverse effects may be counteracted to some extent with mucolytic expectorants that help liquify thick mucous and increase the output of thin respiratory tract secretions. Guaifenesin, the most commonly prescribed mucolytic, thins and increases secretions. Humibid [Adams] is one of the convenient and most effective preparations of guaifenesin available. Entex [Baylor] is a useful expectorant and vasoconstrictor that increases and thins mucosal secretions. These drugs are relatively harmless and may be very helpful to patients who experience thick secretions, frequent throat clearing, or "postnasal drip." Steroids are a highly effective alternative to antihistamines for treating an acute allergic insult prior to voice commitment.

Steroids

Corticosteroids are potent anti-inflammatory agents and may be helpful in managing acute inflammatory laryngitis. Although many laryngologists recommend using steroids in low doses (methylprednisone 10 mg), the author has found higher doses for short periods to be more effective. Depending on the indication, dosage may be prednisolone 60 mg or dexamethasone 6 mg intramuscularly once, or a similar starting dose orally, tapered over 3 to 6 days. Regimens such as a dexamethasone [Decadron] or methylprednisolone [Medrol] dose pack may also be

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used. If any question exists that the inflammation may be of infectious origin, antibiotic coverage is generally recommended. Care must be taken not to prescribe steroids excessively. Anabolic steroids which have received so much attention because of their abuse by athletics, are not used for voice treatment, and may damage (masculinize) the voice.

Diuretics

In the premenstrual period, altered estrogen and progesterone levels are associated with changes in pituitary activity. An increase in circulating antidiuretic hormone results in fluid retention in Reinke's space (superficial layer of the lamina propria) as well as other tissues. The fluid retained in the vocal fold during inflammation and hormonal fluid shifts is bound, not free water. Diuretics do not remobilize this fluid effectively and dehydrate the patient. Additionally, they produce decreased lubrication, thickened secretions, and persistently edematous vocal folds. They have no place in the treatment of pre-menstrual voice disorders. If they are used for other medical reasons, their vocal effects should be monitored closely.

Aspirin and Other Pain Medicines

Aspirin and other analgesics frequently have been prescribed for relief of minor throat and laryngeal irritations. However, the platelet dysfunction caused by aspirin predisposes to hemorrhage, especially in vocal folds traumatized by excessive voice use in cases of vocal dysfunction. Mucosal hemorrhage can be devastating to a professional voice user, and people who depend on extensive voice use should avoid aspirin products altogether unless they are absolutely necessary for treatment of special medical conditions. Acetaminophen is the best substitute, as even most common nonsteroidal anti-inflammatory drugs such as ibuprofen may interfere with the clotting mechanism.

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Pain is an important protective physiologic function. Masking it risks incurring grave vocal damage that may be unrecognized until after the analgesic or anesthetic wears off. If a patient requires analgesics or topical anesthetics to alleviate laryngeal discomfort, the laryngitis is severe enough to warrant canceling a vocal performance. If the analgesic is for headache or some other discomfort not intimately associated with voice production, symptomatic treatment should be discouraged until demanding vocal commitments have been completed.

Sprays and Inhalants

The use of analgesic topical sprays is extremely dangerous and should be avoided. Diphenhydramine hydrochloride [Benadryl], 0.5% in distilled water, delivered to the larynx as a mist is a formerly popular treatment that may be helpful for its vasoconstrictive properties, but it is also dangerous because of its analgesic effect. It should not be used. Other topical vasoconstrictors that do not contain analgesics may be beneficial in selected cases. Oxymetazoline hydrochloride [Afrin] is particularly helpful in rare, extreme circumstances. Propylene glycol 5% in a physiologically balanced salt solution may be delivered by large-particle mist and can provide helpful lubrication shortly before performance, particularly in cases of laryngitis sicca after air travel or in dry climates. Such treatment is harmless and may also provide a beneficial placebo effect. Water or saline solution delivered via a vaporizer or steam generator is frequently effective and sufficient. This therapy should be augmented by oral hydration, which is the mainstay of treatment for dehydration. Voice users should monitor their state of hydration by observing their urine color ("pee pale").

What else can be done to help a person with voice problems?

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Voice lessons given by an expert teacher are invaluable for singers and even many non-singers with voice problems. When technical dysfunction is suspected or identified, the singer should be referred to the teacher. Even when an obvious physical abnormality is present, referral to a voice teacher is appropriate, especially for younger singers. Numerous "tricks of the trade" permit a singer to safely overcome some of the disabilities of mild illness safely. If a singer plans to proceed with a performance during an illness, he or she should not cancel voice lessons as part of the relative voice rest regimen; rather, a short lesson to assure optimum technique is extremely useful. For non-singers, training with a knowledgeable singing teacher under medical supervision is often extremely helpful for patients with voice problems. In conjunction with therapy under the direction of a certified, licensed speech-language pathologist, appropriate singing lessons can provide the patient with many of the athletic skills and "tricks" used by performers to build and enhance the voice. Once singing skills are mastered even at a beginner level, the demands of routine speech become trivial by comparison.

Special skills can be refined even further with the help of an acting voice trainer who may also be part of a medical voice team. Such training is invaluable for any public speaker, teacher, salesperson, or anyone else who cares to optimize his/her communication skills.

What about voice therapy?

Voice therapy is generally provided under the supervision of a certified, licensed, speech-language pathologist (SLP). An SLP usually has a masters degree or Ph.D., and is a trained health professional. However, an individual's training may or may not include skills in management of voice disorders. SLPs care for many other problems such as swallowing therapy following strokes. Hence, it is important to find an SLP with special interests, training, and expertise in

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voice problems.

Therapy generally begins with procedures to analyze the voice problem. The analysis process includes subjective assessment by the SLP, as the patient speaks and performs a variety of vocal tasks. Objective voice analysis is also extremely helpful and is available in more sophisticated centers. The process uses a variety of instruments to measure, quantify and analyze various aspects of the voice-producing system. The information obtained from voice therapy can be extremely helpful when designing voice therapy that accomplishes the desired goals optimally and quickly.

Voice therapy is really a form of physical therapy for the voice. It usually involves exercises that help a person eliminate abusive vocal habits, relax unnecessarily tense muscles, and learn to use the voice efficiently and effectively. Patients need to practice between therapy sessions in order to achieve the desired results. Therapy generally results in improvement in vocal quality, ease, and endurance. In some cases, it may also produce resolution (cure) of structural abnormalities such as nodules.

What should be considered when voice surgery is contemplated?

Principles

Surgery can cure many voice problems, but it may also result in complications that worsen the voice. Scar tissue occurs in response to trauma, including surgery. If scar tissue replaces the normal anatomic layers, the vocal fold becomes stiff and adynamic (non-vibrating). This results in asymmetric, irregular vibration with air turbulence that we hear as hoarseness, and/or incomplete vocal fold closure allowing air escape which makes the voice sound breathy. Such a vocal fold

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may look normal on traditional examination, but will be seen as abnormal under stroboscopic light. Conveniently, most benign pathology (nodules, polyps, cysts, etc) is superficial. Consequently, surgical techniques have been developed to permit removal of lesions from the epithelium or superficial layer of the lamina propria without disruption of the intermediate or deeper layers in most cases. All of these delicate microsurgical techniques are now commonly referred to as phonosurgery, although the term was originally introduced by Dr. Hans von Leden in referring to operations designed to alter vocal quality or pitch.

Techniques (Endoscopic)

Most voice surgery is performed through the mouth after placement of a metal tube called an operating laryngoscope, utilizing a microscope, and is called endoscopic (or internal) laryngeal surgery. Surgical treatment of laryngeal abnormalities can be performed using microscopic scissors and other instruments, or lasers. Lesions involving the vibratory margin are still removed most safely using traditional instruments and magnification through an operating microscope. Such lesions include nodules, polyps and cysts that have not responded to voice therapy. Current techniques allow the surgeon to remove virtually nothing but the diseased tissue. Such atraumatic surgery may not even require post-operative voice rest, and rapid healing with good voice quality usually follows. Although lasers are "high tech," they are not always the best choice for laryngeal surgery -- at least not the lasers currently utilized. The potential problem with the carbon dioxide (CO₂) laser in standard surgical use is the associated heat which may damage surrounding tissues. At the power densities required for surgical ablation and the laser beam spot diameters generally used, there is a heat halo around the beam. When used on the vocal fold edge, the heat may be sufficient to provoke scarring. This produces an adynamic segment on the vocal fold, and hoarseness. The CO₂ laser is, however, extremely useful for

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selected lesions such as varicosities that lead to vocal fold hemorrhages, vaporization of blood vessels that supply laryngeal polyps, papillomas (lesions caused by the wart virus) and selected cancers.

When surgery is indicated for vocal fold lesions, it should be limited as strictly as possible to the area of abnormality. Virtually no place exists for "vocal cord stripping" in patients with voice problems. Even when there is good reason to suspect malignancy, more precise surgery can and should be performed in most cases.

Precautions

A detailed discussion of laryngeal surgery is beyond the scope of this publication. However, a few points are worthy of special emphasis. Surgery for vocal nodules should be avoided whenever possible and should almost never be performed without an adequate trial of expert voice therapy, including patient compliance with therapeutic suggestions. In most cases, a minimum of 6 to 12 weeks of observation should be allowed while the patient is using therapeutically modified voice techniques under the supervision of a certified speech-language pathologist and possibly a singing teacher. Proper voice use rather than voice rest (silence) is correct therapy. The surgeon should not perform surgery prematurely for vocal nodules under pressure from the patient for a "quick cure" and early return to voice performance. Permanent destruction of voice quality is a very real complication. Even after expert surgery, voice quality may be diminished by submucosal scarring. This situation produces a hoarse voice with vocal folds that appear normal on routine indirect (mirror) examination, although under stroboscopic light the adynamic segment is obvious. No reliable cure exists for this complication.

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There are also other potential complications of voice surgery. Although they are uncommon or rare, they may be seen occasionally even if the surgeon and patient do everything right. They include the following (among others): 1) swelling with airway obstruction requiring tracheotomy; 2) chipping or fracture of a tooth by the laryngoscope; 3) bleeding; 4) infection; 5) recurrence of the problem (or a new mass such as a cyst or granuloma) requiring additional therapy (medications, voice therapy and/or surgery); 6) injury to the larynx, such as arytenoid dislocation; and others.

Techniques (External)

New techniques of external laryngeal surgery to modify the laryngeal skeleton have become extremely useful in treating vocal fold paralysis, a common consequence of viral infection, surgery and cancer. Until recently, vocal fold paralysis was most often managed by endoscopic injection of Teflon into the tissues beside the paralyzed vocal fold. This pushed the paralyzed side toward the midline, allowing the normal vocal fold to meet it, thus permitting glottic closure and improving voice. Although Teflon is relatively inert, granulomatous reactions to the foreign body are not uncommon, and stiffness of the vocal fold edge frequently impairs voice quality. Teflon infiltrated into tissues is hard to remove if the results are unsatisfactory. Teflon injection has been largely replaced by fat injection or thyroplasty. Thyroplasty is a technique in which a window is cut in the laryngeal skeleton, and a piece of thyroid cartilage is depressed inward and held in place with a silicone block. This pushes the vocal fold toward the midline fairly reversibly, without injecting a foreign body into the tissues. We have also introduced an injection technique similar to Teflon, which uses the patient's own fat, harvested from the abdomen. This eliminates the disadvantages of Teflon, but it may have other problems such as resorption of the fat in some cases. Fat may also be used to improve vocal fold scar in selected cases.

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Can surgery change the pitch of a voice?

Surgery of the laryngeal skeleton can also be used to modify vocal pitch. Although such operations are done infrequently, they are valuable in certain circumstances. By closing the space between the cricoid and thyroid cartilages (an extreme version of cricothyroid muscle function), the vocal folds can be lengthened and tensed, and the voice raised. By cutting out vertical sections of the thyroid cartilage, the vocal folds can be shortened and their tension decreased, lowering pitch. While these techniques are not sufficiently predictable for elective use in singers or other professional voice users, they are valuable in treating selected voice abnormalities and in altering vocal pitch in patients who have undergone transsexual surgery.

What can be done about a voice that is worse after surgery?

Too often, the laryngologist is confronted with a desperate patient whose voice has been "ruined" by vocal fold surgery, recurrent or superior laryngeal nerve paralysis, trauma, or some other tragedy. Occasionally, the cause is as simple as a recently dislocated arytenoid that can be reduced. However, if the problem is an adynamic segment, decreased bulk of one vocal fold after "stripping," bowing caused by superior laryngeal nerve paralysis, or some other serious complication in a mobile vocal fold, great conservatism should be exercised. Voice therapy is nearly always helpful in optimizing compensatory strategies and minimizing fatigue, but it usually will not restore normalcy of the patient's voice. None of the available surgical procedures for these conditions is consistently effective. If surgery is considered at all, the procedure and prognosis should be explained to the patient realistically and pessimistically. It must be understood that the chances of returning the voice to excellent quality are slim, and that it may be made worse. Zyderm Collagen [Xomed] injection and fat injection are currently the most common approaches in these difficult cases. However, a great deal more research will be needed to

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determine the efficacy of the treatments currently available for vocal fold scarring and to establish the treatment of choice.

How can the voice be kept healthy?

Preventive medicine is always the best medicine. The more people understand about their voices, the more they will appreciate their importance and delicacy. Education helps us understand how to protect the voice, train and develop it to handle our individual vocal demands, and keep it healthy. Even a little bit of expert voice training can make a big difference. Avoidance of abuses, especially smoke, is paramount. If voice problems occur expert medical care should be sought promptly. Interdisciplinary collaboration among laryngologists, speech-language pathologists, singing teachers, acting teachers, many other professionals, and especially voice users themselves has revolutionized voice care since the early 1980s. Technological advances, scientific revelations, and new medical techniques inspired by interest in professional opera singers have brought a new level of expertise and concern to the medical profession, and improved dramatically the level of care available for any patient with voice dysfunction.

How can a "normal" voice be made better?

Voice building is possible, productive, and extremely gratifying. Speaking and singing are athletic. They involve muscle strength, endurance, and coordination. Like any other athletic endeavor, voice use is enhanced by training that includes exercises designed to enhance strength and coordination throughout the vocal tract. Speaking is so natural that the importance of training is not always obvious. However, running is just as natural. Yet, most people recognize that, no matter how well a person runs, he or she will run better and faster under the tutelage of a good track coach. The coach will also provide instruction on strengthening, warm-up and cool-

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down exercises that prevent injury. Voice training works the same way.

Voice building starts with physical development. Once vocal health has been assured by medical examination, training is usually guided by a voice trainer (with schooling in theater and acting voice techniques), singing teacher or a speech-language pathologist. In the author's setting, all three specialists are involved under the guidance of a laryngologist, and additional voice team members are utilized, as well, including a psychologist or psychiatrist (for stress-management), pulmonologist, neurologist, and others. Initially, training focuses on the development of a physical strength, endurance and coordination. This is accomplished not only through vocal exercises, but also through medically supervised bodily exercise that improves aerobic conditioning and strength in the support system. Singing skills are developed (even in people with virtually no singing talent at all) and used to enhance speech quality, variability, projection and stamina. For most people, marked voice improvement occurs quickly. For those with particularly challenging vocal needs, voice building also includes training and coordinating body language with vocal messages, organizing presentations, managing adversarial situations (interviews, court appearances, etc.), television performance techniques, and other skills that make the difference between a good professional voice user and a great one.

The process of voice building is valuable not just for premiere professional voice users. Virtually all of us depend upon our voices to convey our personalities and ideas. The right subliminal vocal messages can be as important in selling a product or getting a job as they are in winning a presidential election. The initial stages of voice building are no more complex than the initial stages of learning to play tennis or golf; and their potential value is unlimited. A strong, confident, well-modulated voice quietly commands attention, convinces, and conveys a message

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of health, strength, youth and credibility.

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Figure Legends

- FIGURE 1 -** Cartilages of the larynx.
- FIGURE 2 -** The intrinsic muscles of the larynx.
- FIGURE 3 -** Actions of the intrinsic muscles.
- FIGURE 4a & b -** Extrinsic muscles of the larynx(A) and their actions(B).
- FIGURE 5 -** The structure of the vocal fold.
- FIGURE 6-** Traditional laryngeal examination. The laryngologist uses a warmed mirror to visualize the vocal fold indirectly. The tongue is grasped, and the patient is asked to say "ee".
- FIGURE 7-** Normal appearance of the vocal fold showing the true vocal folds (V), false vocal folds (F), epiglottis (E), and arytenoids (A).
- FIGURE 8-** Typical appearance of vocal nodules.
- FIGURE 9-** Right vocal fold cyst.
- FIGURE 10-** Right vocal fold polyp and left vascular mass. There is also reactive edema of

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the left vocal fold from traumatic contact by the polyp.

FIGURE 11-

Left vocal fold cancer.