Clinical Assessment of Voice

Second Edition

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Plural Publishing Inc.

PLURAL PUBLISHING
INC.

5521 Ruffin Road
San Diego, CA 92123

e-mail: info@pluralpublishing.com
Website: http://www.pluralpublishing.com

Typeset in 10/12 Palatino by Flanagan's Publishing Service, Inc.
Printed in Korea by Four Colour Print Group.

Library of Congress Cataloging-in-Publication Data

Names: Sataloff, Robert Thayer, author.
Title: Clinical assessment of voice / Robert Thayer Sataloff.
Description: Second edition. | San Diego, CA : Plural Publishing, [2017] | Clinical Assessment of Voice is part of a three-book student edition of selected chapters from the fourth edition of Professional voice: the science and art of clinical care. | Includes bibliographical references and index.
Identifiers: LCCN 2017023705 | ISBN 9781597568593 (alk. paper) | ISBN 1597568597 (alk. paper)
Subjects: | MESH: Voice Disorders--diagnosis | Voice--physiology
Classification: LCC RF510 | NLM WV 500 | DDC 616.85/5--dc23
LC record available at https://lccn.loc.gov/2017023705

Contents

Foreword

Dr. Robert Sataloff has devoted his professional career to the care and treatment of the voice. He was a professional singer and singing teacher before he began his medical career. Dr. Sataloff's dedication to the voice stems from his personal love and active involvement in singing and vocal pedagogy. His medical and scientific interests in the voice developed during his residency as his musical colleagues solicited his medical advice. Much to his surprise, he learned that there was not much written about the care of the voice, especially aspects of the singer's voice. So he pursued a fellowship in otology knowing how important the ear is to the voice. While completing that fellowship his interest in voice surged to a point that he chose to pursue the study of voice with such a force that he has become the most prolific writer of voice books for laryngologists, speech-language pathologists and voice teachers. In 1977, he began attending the meetings of the Voice Foundation in New York City. His enthusiasm grew until he focused his primary interest in the development of new approaches for medical surgical and behavioral management of voice disorders. With the support and influence of people such as Drs. Wilbur J. Gould, Friederic Brodnitz, Hans von Leden, and Paul Moore, among others, he combined his love for the voice and his medical practice into a premier center for the care of professional singers and other vocal performers from all over the world. His clinical practice and pursuit of knowledge led him to publish his first paper on professional singers in 1981 entitled, "Professional Singers: The Science and Art of Clinical Care" and the first chapter on modern voice care in an otolaryngology textbook in 1986. He eventually became Chairman of the Board of Directors of the Voice Foundation in 1989 where he has since championed the need for interdisciplinary voice care through the annual Symposium on Care of the Professional Voice sponsored by the Voice Foundation and the monthly publication of the Journal of Voice of which he is currently Editor-in-Chief.

Gifted as a surgeon and skilled in the art of expression, whether it be through his singing or his lecturing, Dr. Sataloff has taken the humble beginnings of the Voice Foundation and has made its influence felt around the world by physicians, speech-language pathologists, singing teachers, and vocal performers of all types from reggae to opera and from rap poets to the highest profile public speakers. In addition, Dr. Sataloff has trained many of the most influential laryngologists who specialize in the care of the professional voice. A cursory review of any program from the Voice Foundation's Symposium on Care of the Professional Voice attests to his influence in all aspects of voice care.

In *Clinical Assessment of Voice, Second Edition*, one of three student editions derived from chapters selected for speechlanguage pathology students and clinicians from the fourth edition of *Professional Voice: The Science and Art of Clinical Care*, Dr. Sataloff brings together a dynamic group of professionals who share his interdisciplinary philosophy of voice care that he has espoused for over 30 years. This volume is up to date with an international core of authors from varied disciplines, all actively engaged in the diagnosis and treatment voice disorders.

Clinical Assessment of Voice, Second Edition, includes chapters written by individuals with specialties in laryngology, vocal coaching and teaching of singing, voice science, and speech-language pathology, nursing and acoustics. This volume mirrors the state of the art of voice care in the 21st century.

Throughout this book, we are reminded of the interdisciplinary care that is required in the assessment of voice disorders. All aspects of voice assessment are presented in a coherent fashion. Starting with an extensive case history and following with the physical examination, the objective documentation in the voice laboratory, and the latest diagnostic imaging with laryngeal computed tomography and strobovideolaryngoscopy, the chapters delineate the possible diagnoses and treatment approaches that currently represent the state of the art in assessment of voice disorders. Added is the current information on the medical legal evaluation, now ever more important for the professional performer.

For the practicing otolaryngologist and speech-language pathologist, *Clinical Assessment of Voice,*

Second Edition is an essential guide for understanding the techniques for proper diagnosis and for organizing a plan of treatment for patients with voice disorders. For singers and performers, knowledge of the clinical voice assessment process is presented in a manner that allows them to determine what level of assessment they should pursue in search of the most current treatment.

Every effort has been made to maintain style and continuity throughout the book. *Clinical Assessment of Voice, Second Edition* brings together the generous knowledge of renowned colleagues, merged with the continuity of a seasoned editor, making this book not only a classic in voice diagnostics but an enjoyable book to read and understand the marvelous complexity of the human organ known as the voice.

—Thomas Murry, PhD
La Jolla, California

Preface

Clinical Assessment of Voice is part of a three-book student edition of selected chapters from the fourth edition of *Professional Voice: The Science and Art of Clinical Care*. That compendium fills over 2000 pages, including 120 chapters and numerous appendices, and it is not practical for routine use by students. However, *Professional Voice* was intended to be valuable to not only laryngologists, but also to speech-language pathologists, voice teachers, performers, students, and anyone else interested in the human voice. *Clinical Assessment of Voice* and other volumes of the student edition were prepared to make relevant information available to students in a convenient and affordable form, suitable for classroom use as well as for reference.

Chapter 1 reviews the information sought when taking a history on a patient with a voice complaint, and it includes introductory information on the meaning of many of the abnormal symptoms that patients reported. **Chapter 2** provides insights into specific information that should be added when evaluating actors with voice complaints. **Chapter 3** introduces the concepts and techniques used in physical examination of voice patients. **Chapter 4** has been rewritten extensively. It includes not only basic concepts in laboratory evaluation, but also our most recent practices regarding instrumentation and test protocols. It also reviews techniques such as measurements of cepstral peak prominence, as well as updated references on validity and reliability of clinical voice measures. Chapters 5 and 6 are new. In **Chapter 5**, Dr. Echternach expands extensively on the basic information presented in chapter 4 about high-speed digital imaging. **Chapter 6** provides an overview of the evolution of technology over more than a century, and its influence on the development of laryngology. **Chapter 7** on laryngeal electromyography includes clinical and technical information on this increasingly important test. **Chapter 8** reviews Dr. Eiji Yanagisawa's techniques for laryngeal photography, including all of the specific information that readers require to replicate his success. **Chapter 9** reviews remarkable developments in computed tomography technology that were developed in France to provide color images that might almost be mistaken for histologic sections. It represents the state-of-the-art in imaging. **Chapter 10** is new. It does not address commonly known technology for clinical use of MRI. Rather, it provides extraordinary insight into lesser-known MRI capabilities and their potential for expanding basic knowledge and clinical care of the voice. In **Chapter 11,** Benninger and his colleagues have updated their pioneering work on measuring voice treatment outcomes. **Chapter 12** provides a brief overview of common medical diagnoses and treatments of patients with voice disorders, reducing information that occupies entire chapters in *Professional Voice* to a paragraph or two.

Chapter 13 has also been updated and expanded extensively. It contains a discussion of a large number of studies on the aging voice that were not addressed in previous editions. **Chapter 14** is new. While pediatric voice disorders are not discussed in detail in previous editions, this chapter adds not only differential diagnosis and treatment, but also suggestions on imaging of children, which can be challenging. **Chapter 15** on hearing loss has been updated to include a review of the last literature. **Chapter 16** on endocrine function has been rewritten and contains the latest information on topics covered in the previous edition, as well as topics that have not been addressed in prior voice literature. **Chapter 17** is new. Thyroid surgery is extremely common and can have devastating consequences for voice professionals. This chapter reviews thyroid disorders and their many potential adverse effects. **Chapter 18** covers various aspects of psychological assessment and treatment of patients with voice disorders. **Chapter 19** (Allergy), and **Chapter 20** (Respiratory Dysfunction) required only moderate revisions to bring them up to date. **Chapter 21** contains substantial new information on topics such as World Trade Center Syndrome and laryngeal effects of asbestos exposure. **Chapter 22** discusses Infectious and Inflammatory Disorders of the Larynx and contains substantial new information and the most recent references. **Chapter 23** on laryngeal papilloma highlights the importance and complexity of managing this complex disorder, as well as its apparently increasing prevalence. This revision contains the most current information on this

challenging topic. **Chapter 24** on sleep science and the importance of sleep in vocal performers has been rewritten almost completely by different authors and provides valuable insights unfamiliar to most otolaryngologists and speech-language pathologists, but extremely important to performers, especially those who travel extensively. **Chapter 25** includes extensive new information on laryngopharyngeal reflux, diagnosis, treatment, and research. It cites almost 600 references including literature written since publication of the last edition, as well as classic literature that was written previously. **Chapter 26** on bodily injuries and their effects on the voice has been revised only slightly, but **Chapter 27** on performing arts-medicine has some particularly important additions. It includes a brief discussion on visual arts hazards (painting, sculpting, etc) and their implications for voice performance.

Chapter 28 reviews many of the neurological disorders that can affect the voice. **Chapter 29**, on vocal fold paresis and paralysis, includes the latest concepts in diagnosis and treatment, as well as discussions of laryngeal reinnervation and laryngeal pacemakers. **Chapter 30** not only reviews the most current literature on spasmodic dysphonia, but also specifies our current practices regarding clinical and laboratory diagnosis, as well as treatment. **Chapter 31** describes many of the structural abnormalities that may afflict the larynx and helps the students understand the differences between lesions such as nodules, cysts, and polyps. **Chapter 32** includes discussions of impairment, disability and handicap; proposals for equitable disability calculation including case examples; and the role of voice care professionals in medical-legal matters.

Every effort has been made to maintain style and continuity throughout the book. Although the interdisciplinary expertise of numerous authors has been invaluable in the preparation of this text, contributions have been edited carefully, where necessary, to maintain consistency of linguistic style and complexity; and I have written or co-authored 29 of the 32 chapters. All of us who were involved with the preparation of this book hope that readers will find it not only informative but also enjoyable to read.

—Robert T. Sataloff, MD, DMA

Acknowledgments to the Second Edition

I remain indebted to the many friends and colleagues acknowledged in the first edition of this book. As always, special thoughts and thanks go to the late Wilbur James Gould whose vision and gentle leadership formed the foundation on which so many of us have continued to build, and to the late Hans von Leden.

I am especially indebted to the many distinguished colleagues who have contributed to this edition. Those who had contributed to previous editions worked diligently to revise and update their chapters. Those who had not contributed to previous editions have added insights and expertise that have made it possible to realize my vision of what I thought this book should be.

As always, I am indebted to the National Association of Teachers of Singing for permission to use material freely from my "Laryngoscope" articles which appear in the *Journal of Singing* (formerly the *NATS Journal),* and to Vendome for permission to republish articles and color pictures from my monthly "clinic" in *Ear, Nose, and Throat Journal.* I am also grateful to John Rubin and Gwen Korovin and to Plural Publishing for permission to republish a few chapters from our book (Rubin JR, Sataloff RT, Korovin G. *Diagnosis and Treatment of Voice Disorders,* 4th ed, Plural Publishing, Inc; San Diego, CA, 2015). In addition, I am indebted for permission to republish material from *Choral Pedagogy,* 3rd ed (Smith B, Sataloff RT. Plural Publishing Inc, San Diego, CA; 2013), *The Performer's Voice* (Benninger MS, Murry T, and Johns MM, Plural Publishing, Inc, San Diego, CA, 2016), Sataloff's Comprehensive Textbook of Otolaryngology and Head and Neck Surgery (Jaypee, New Delhi, 2016), and Sataloff RT, Brandfonbrener A, Lederman R, *Performing Arts Medicine,* 3rd ed (Science and Medicine, Narberth, Pennsylvania, 2010).

Lastly, as always, I cannot express sufficient thanks to Mary J. Hawkshaw, RN, BSN, CORLN, for her tireless editorial assistance, proofreading, and scholarly contributions. I am also indebted to Christina Chenes for her painstaking preparation of the manuscript and for the many errors she found and corrected, and to my associates, Karen Lyons, MD, Amanda Hu, MD, Robert Wolfson, MD, and Frank Marlowe, MD, and to my laryngology fellows. Without their collaboration, excellent patient care, and tolerance of my many academic distractions and absences, writing would be much more difficult. I remain forever grateful to my father and partner Joseph Sataloff, MD, D.Sc., who taught me to write and edit, and who encouraged me to write my first papers and book, and mentored me throughout our years of practice together, as well as to my other primary mentors in training, Drs. Walter Work, Charles Krause and Malcolm Graham. My greatest gratitude goes to my wife Dahlia M. Sataloff, MD, FACS, and sons Ben and John who patiently allow me to spend so many of my evenings, weekends, and vacations writing.

About the Author

Robert Thayer Sataloff, M.D., D.M.A., F.A.C.S. is Professor and Chairman, Department of Otolaryngology-Head and Neck Surgery and Senior Associate Dean for Clinical Academic Specialties, Drexel University College of Medicine. He is also Adjunct Professor in the departments of Otolaryngology-Head and Neck Surgery at Thomas Jefferson University, as well as Adjunct Clinical Professor at Temple University and the Philadelphia College of Osteopathic Medicine; and he is on the faculty of the Academy of Vocal Arts. He served for nearly four decades as Conductor of the Thomas Jefferson University Choir. Dr. Sataloff is also a professional singer and singing teacher. He holds an undergraduate degree from Haverford College in Music Theory and Composition; graduated from Jefferson Medical College, Thomas Jefferson University; received a Doctor of Musical Arts in Voice Performance from Combs College of Music; and he completed Residency in Otolaryngology-Head and Neck Surgery and a Fellowship in Otology, Neurotology and Skull Base Surgery at the University of Michigan. Dr. Sataloff is Chairman of the Boards of Directors of the Voice Foundation and of the American Institute for Voice and Ear Research. In addition to directing all aspects of these two non-profit corporations, he has led other non-profit and for-profit enterprises. He has been Chairman and Chief Executive of a multi-physician medical practice for over 30 years; and he served as Vice President of Hearing Conservation Noise Control, Inc. from 1981 until the time of its sale in 2003. He has also served as Chairman of the Board of Governors of Graduate Hospital; President of the American Laryngological Association, the International Association of Phonosurgery, and the Pennsylvania Academy of Otolaryngology-Head and Neck Surgery; and in numerous other leadership positions. Dr. Sataloff is Editor-in-Chief of the *Journal of Voice*; Editor-in-Chief of *Ear, Nose and Throat Journal*; Associate Editor of the *Journal of Singing* and on the editorial boards of numerous otolaryngology journals. He has written approximately 1,000 publications, including 59 books, and has been awarded more than $5 million in research funding. His medical practice is limited to care of the professional voice and otology/neurotology/skull base surgery. Dr. Sataloff has developed numerous novel surgical procedures including total temporal bone resection for formerly untreatable skull base malignancy, laryngeal microflap and mini-microflap procedures, vocal fold lipoinjection, vocal fold lipoimplantation, and others. He has invented more than 75 laryngeal microsurgical instruments produced by Microfrance and Integra Medical, ossicular replacement prostheses produced by Grace Medical, and novel laryngeal

prostheses with Boston Medical. Dr. Sataloff is recognized as one of the founders of the field of voice, having written the first modem comprehensive article on care of singers, and the first chapter and book on care of the professional voice, as well as having influenced the evolution of the field through his own efforts and through the Voice Foundation for nearly 4 decades. He has been involved extensively throughout his career in education, including development of new curricula for graduate education. Dr. Sataloff has been instrumental in training not only residents, but also fellows and visiting laryngologists from North America, South America, Europe, Asia and Australia. His fellows have established voice centers throughout the United States, in Turkey, Singapore, Brazil, and elsewhere. He also is active in training nurses, speech language pathologists, singing teachers, and others involved in collaborative arts medicine care, pedagogy and performance education. Dr. Sataloff has been recognized by Best Doctors in America (Woodward White Athens) every year since 1992, Philadelphia Magazine since 1997, and Castle Connolly's "America's Top Doctors" since 2002. Dr. Sataloff's books include:

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To Dahlia, Ben and John Sataloff my patient and long suffering family who allow me the time to write and to Mary J. Hawkshaw, my dear friend and invaluable collaborator and to my fellows who have given me so much inspiration and pride.

1

Patient History*

Robert Thayer Sataloff

A comprehensive history and physical examination usually reveal the cause of voice dysfunction. Effective history taking and physical examination depend on a practical understanding of the anatomy and physiology of voice production.[1–3] Because dysfunction in virtually any body system may affect phonation, medical inquiry must be comprehensive. The current standard of care for all voice patients evolved from advances inspired by medical problems of voice professionals such as singers and actors. Even minor problems may be particularly symptomatic in singers and actors, because of the extreme demands they place on their voices. However, a great many other patients are voice professionals. They include teachers, salespeople, attorneys, clergy, physicians, politicians, telephone receptionists, and anyone else whose ability to earn a living is impaired in the presence of voice dysfunction. Because good voice quality is so important in our society, the majority of our patients are voice professionals, and all patients should be treated as such.

The scope of inquiry and examination for most patients is similar to that required for singers and actors, except that performing voice professionals have unique needs, which require additional history and examination. Questions must be added regarding performance commitments, professional status and voice goals, the amount and nature of voice training, the performance environment, rehearsal practices, abusive habits during speech and singing, and many other matters. Such supplementary information is essential to proper treatment selection and patient counseling in singers and actors. However, analogous factors must also be taken into account for stockbrokers, factory shop foremen, elementary school teachers, homemakers with several noisy children, and many others. Physicians familiar with the management of these challenging patients are well equipped to evaluate all patients with voice complaints.

Patient History

Obtaining extensive historical background information is necessary for thorough evaluation of the voice patient, and the otolaryngologist who sees voice patients (especially singers) only occasionally cannot reasonably be expected to remember all the pertinent questions. Although some laryngologists consider a lengthy inquisition helpful in establishing rapport, many of us who see a substantial number of voice patients each day within a busy practice need a thorough but less time-consuming alternative. A history questionnaire can be extremely helpful in documenting all the necessary information, helping the patient sort out and articulate his or her problems, and saving the clinician time recording information. The author has developed a questionnaire[4] that has proven helpful (Appendix 1–A). The patient is asked to complete the relevant portions of the form at home prior to his or her office visit or in the waiting room before seeing the doctor. A similar form has been developed for voice patients who are not singers.

No history questionnaire is a substitute for direct, penetrating questioning by the physician. However, the direction of most useful inquiry can be determined from a glance at the questionnaire, obviating the need for extensive writing, which permits

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the physician greater eye contact with the patient and facilitates rapid establishment of the close rapport and confidence that are so important in treating voice patients. The physician is also able to supplement initial impressions and historical information from the questionnaire with seemingly leisurely conversation during the physical examination. The use of the history questionnaire has added substantially to the efficiency, consistent thoroughness, and ease of managing these delightful, but often complex, patients. A similar set of questions is also used by the speech-language pathologist with new patients and by many enlightened singing teachers when assessing new students.

How Old Are You?

Serious vocal endeavor may start in childhood and continue throughout a lifetime. As the vocal mechanism undergoes normal maturation, the voice changes. The optimal time to begin serious vocal training is controversial. For many years, most singing teachers advocated delay of vocal training and serious singing until near puberty in the female and after puberty and voice stabilization in the male. However, in a child with earnest vocal aspirations and potential, starting specialized training early in childhood is reasonable. Initial instruction should teach the child to vocalize without straining and to avoid all forms of voice abuse. It should not permit premature indulgence in operatic bravado. Most experts agree that taxing voice use and singing during puberty should be minimized or avoided altogether, particularly by the male. Voice maturation (attainment of stable adult vocal quality) may occur at any age from the early teenage years to the fourth decade of life. The dangerous tendency for young singers to attempt to sound older than their vocal years frequently causes vocal dysfunction.

All components of voice production are subject to normal aging. Abdominal and general muscular tone frequently decrease, lungs lose elasticity, the thorax loses its distensibility, the mucosa of the vocal tract atrophies, mucous secretions change character and quantity, nerve endings are reduced in number, and psychoneurologic functions change. Moreover, the larynx itself loses muscle tone and bulk and may show depletion of submucosal ground substance in the vocal folds. The laryngeal cartilages ossify, and the joints may become arthritic and stiff. Hormonal influence is altered. Vocal range, intensity, and quality all may be modified. Vocal fold atrophy may be the most striking alteration. The clinical effects of aging seem more pronounced in female singers, although vocal fold histologic changes may be more prominent in males. Excellent male singers occasionally extend their careers into their 70s or beyond.[5,6] However, some degree of breathiness, decreased range, and other evidence of aging should be expected in elderly voices. Nevertheless, many of the changes we typically associate with elderly singers (wobble, flat pitch) are due to lack of conditioning, rather than inevitable changes of biological aging. These aesthetically undesirable concomitants of aging can often be reversed.

What Is Your Voice Problem?

Careful questioning as to the onset of vocal problems is needed to separate acute from chronic dysfunction. Often an upper respiratory tract infection will send a patient to the physician's office, but penetrating inquiry, especially in singers and actors, may reveal a chronic vocal problem that is the patient's real concern. Identifying acute and chronic problems before beginning therapy is important so that both patient and physician may have realistic expectations and make optimal therapeutic selections.

The specific nature of the vocal complaint can provide a great deal of information. Just as dizzy patients rarely walk into the physician's office complaining of "rotary vertigo," voice patients may be unable to articulate their symptoms without guidance. They may use the term *hoarseness* to describe a variety of conditions that the physician must separate. Hoarseness is a coarse or scratchy sound that is most often associated with abnormalities of the leading edge of the vocal folds such as laryngitis or mass lesions. Breathiness is a vocal quality characterized by excessive loss of air during vocalization. In some cases, it is due to improper technique. However, any condition that prevents full approximation of the vocal folds can be responsible. Possible causes include vocal fold paralysis, a mass lesion separating the leading edges of the vocal folds, arthritis of the cricoarytenoid joint, arytenoid dislocation, scarring of the vibratory margin, senile vocal fold atrophy (presbyphonia), psychogenic dysphonia, malingering, and other conditions.

Fatigue of the voice is inability to continue to speak or sing for extended periods without change in vocal quality and/or control. The voice may show fatigue by becoming hoarse, losing range, changing timbre, breaking into different registers, or exhibiting other uncontrolled aberrations. A well-trained singer should be able to sing for several hours without vocal fatigue.

Voice fatigue may occur through more than one mechanism. Most of the time, it is assumed to be due

to muscle fatigue. This is often the case in patients who have voice fatigue associated with muscle tension dysphonia. The mechanism is most likely to be peripheral muscle fatigue and due to chemical changes (or depletion) in the muscle fibers. "Muscle fatigue" may also occur on a central (neurologic) basis. This mechanism is common in certain neuropathic disorders, such as some patients with multiple sclerosis; may occur with myasthenia gravis (actually neuromuscular junction pathology); or may be associated with paresis from various causes. However, the voice may also fatigue due to changes in the vibratory margin of the vocal fold. This phenomenon may be described as "lamina propria" fatigue (our descriptive, not universally used). It, too, may be related to chemical or fluid changes in the lamina propria or cellular damage associated with conditions such as phonotrauma and dehydration. Excessive voice use, suboptimal tissue environment (eg, dehydration, effects of pollution, etc), lack of sufficient time of recovery between phonatory stresses, and genetic or structural tissue weaknesses that predispose to injury or delayed recovery from trauma all may be associated with lamina propria fatigue.

Although it has not been proven, this author (RTS) suspects that fatigue may also be related to the linearity of vocal fold vibrations. However, briefly, voices have linear and nonlinear (chaotic) characteristics. As the voice becomes more trained, vibrations become more symmetrical, and the system becomes more linear. In many pathologic voices, the nonlinear components appear to become more prominent. If a voice is highly linear, slight changes in the vibratory margin may have little effect on the output of the system. However, if the system has substantial nonlinearity due to vocal fold pathology, poor tissue environment, or other causes, slight changes in the tissue (slight swelling, drying, surface cell damage) may cause substantial changes in the acoustic output of the system (the butterfly effect), causing vocal quality changes and fatigue much more quickly with much smaller changes in initial condition in more linear vocal systems.

Fatigue is often caused by misuse of abdominal and neck musculature or oversinging, singing too loudly, or too long. However, we must remember that vocal fatigue also may be a sign not only of general tiredness or vocal abuse (sometimes secondary to structural lesions or glottal closure problems) but also of serious illnesses such as myasthenia gravis. So, the importance of this complaint should not be understated.

Volume disturbance may manifest as inability to sing loudly or inability to sing softly. Each voice has its own dynamic range. Within the course of training, singers learn to sing more loudly by singing more efficiently. They also learn to sing softly, a more difficult task, through years of laborious practice. Actors and other trained speakers go through similar training. Most volume problems are secondary to intrinsic limitations of the voice or technical errors in voice use, although hormonal changes, aging, and neurologic disease are other causes. Superior laryngeal nerve paralysis impairs the ability to speak or sing loudly. This is a frequently unrecognized consequence of herpes infection (cold sores) and Lyme disease and may be precipitated by any viral upper respiratory tract infection.

Most highly trained singers require only about 10 minutes to half an hour to "warm up the voice." Prolonged warm-up time, especially in the morning, is most often caused by reflux laryngitis. Tickling or choking during singing is most often a symptom of an abnormality of the vocal fold's leading edge. The symptom of tickling or choking should contraindicate singing until the vocal folds have been examined. Pain while singing can indicate vocal fold lesions, laryngeal joint arthritis, infection, or gastric acid reflux irritation of the arytenoid region. However, pain is much more commonly caused by voice abuse with excessive muscular activity in the neck rather than an acute abnormality on the leading edge of a vocal fold. In the absence of other symptoms, these patients do not generally require immediate cessation of singing pending medical examination. However, sudden onset of pain (usually sharp pain) while singing may be associated with a mucosal tear or a vocal fold hemorrhage and warrants voice conservation pending laryngeal examination.

Do You Have Any Pressing Voice Commitments?

If a singer or professional speaker (eg, actor, politician) seeks treatment at the end of a busy performance season and has no pressing engagements, management of the voice problem should be relatively conservative and designed to ensure long-term protection of the larynx, the most delicate part of the vocal mechanism. However, the physician and patient rarely have this luxury. Most often, the voice professional needs treatment within a week of an important engagement and sometimes within less than a day. Younger singers fall ill shortly before performances, not because of hypochondria or coincidence, but rather because of the immense physical and emotional stress of the preperformance period. The singer is frequently working harder and singing longer hours than usual. Moreover, he or she may be

under particular pressure to learn new material and to perform well for a new audience. The singer may also be sleeping less than usual because of additional time spent rehearsing or because of the discomforts of a strange city. Seasoned professionals make their living by performing regularly, sometimes several times a week. Consequently, any time they get sick is likely to precede a performance. Caring for voice complaints in these situations requires highly skilled judgment and bold management.

Tell Me About Your Vocal Career, Long-Term Goals, and the Importance of Your Voice Quality and Upcoming Commitments

To choose a treatment program, the physician must understand the importance of the patient's voice and his or her long-term career plans, the importance of the upcoming vocal commitment, and the consequences of canceling the engagement. Injudicious prescription of voice rest can be almost as damaging to a vocal career as injudicious performance. For example, although a singer's voice is usually his or her most important commodity, other factors distinguish the few successful artists from the multitude of less successful singers with equally good voices. These include musicianship, reliability, and "professionalism." Canceling a concert at the last minute may seriously damage a performer's reputation. Reliability is especially critical early in a singer's career. Moreover, an expert singer often can modify a performance to decrease the strain on his or her voice. No singer should be allowed to perform in a manner that will permit serious injury to the vocal folds, but in the frequent borderline cases, the condition of the larynx must be weighed against other factors affecting the singer as an artist.

How Much Voice Training Have You Had?

Establishing how long a singer or actor has been performing seriously is important, especially if his or her active performance career predates the beginning of vocal training. Active untrained singers and actors frequently develop undesirable techniques that are difficult to modify. Extensive voice use without training or premature training with inappropriate repertoire may underlie persistent vocal difficulties later in life. The number of years a performer has been training his or her voice may be a fair index of vocal proficiency. A person who has studied voice for 1 or 2 years is somewhat more likely to have gross technical difficulties than is someone who has been studying for 20 years. However, if training has been intermittent or discontinued, technical problems are common, especially among singers. In addition, methods of technical voice use vary among voice teachers. Hence, a student who has had many teachers in a relatively brief period of time commonly has numerous technical insecurities or deficiencies that may be responsible for vocal dysfunction. This is especially true if the singer has changed to a new teacher within the preceding year. The physician must be careful not to criticize the patient's current voice teacher in such circumstances. It often takes years of expert instruction to correct bad habits.

All people speak more often than they sing, yet most singers report little speech training. Even if a singer uses the voice flawlessly while practicing and performing, voice abuse at other times can cause damage that affects singing.

Under What Kinds of Conditions Do You Use Your Voice?

The Lombard effect is the tendency to increase vocal intensity in response to increased background noise. A well-trained singer learns to compensate for this tendency and to avoid singing at unsafe volumes. Singers of classical music usually have such training and frequently perform with only a piano, a situation in which the balance can be controlled well. However, singers performing in large halls, with orchestras, or in operas early in their careers tend to oversing and strain their voices. Similar problems occur during outdoor concerts because of the lack of auditory feedback. This phenomenon is seen even more among "pop" singers. Pop singers are in a uniquely difficult position; often, despite little vocal training, they enjoy great artistic and financial success and endure extremely stressful demands on their time and voices. They are required to sing in large halls or outdoor arenas not designed for musical performance, amid smoke and other environmental irritants, accompanied by extremely loud background music. One frequently neglected key to survival for these singers is the proper use of monitor speakers. These direct the sound of the singer's voice toward the singer on the stage and provide auditory feedback. Determining whether the pop singer uses monitor speakers and whether they are loud enough for the singer to hear is important.

Amateur singers are often no less serious about their music than are professionals, but generally they have less ability to compensate technically for illness or other physical impairment. Rarely does an amateur suffer a great loss from postponing a performance or permitting someone to sing in his or her

place. In most cases, the amateur singer's best interest is served through conservative management directed at long-term maintenance of good vocal health.

A great many of the singers who seek physicians' advice are primarily choral singers. They often are enthusiastic amateurs, untrained but dedicated to their musical recreation. They should be handled as amateur solo singers, educated specifically about the Lombard effect, and cautioned to avoid the excessive volume so common in a choral environment. One good way for a singer to monitor loudness is to cup a hand to his or her ear. This adds about 6 dB[7] to the singer's perception of his or her own voice and can be a very helpful guide in noisy surroundings. Young professional singers are often hired to augment amateur choruses. Feeling that the professional quartet has been hired to "lead" the rest of the choir, they often make the mistake of trying to accomplish that goal by singing louder than others in their sections. These singers should be advised to lead their section by singing each line as if they were soloists giving a voice lesson to the people standing next to them and as if there were a microphone in front of them recording their choral performance for their voice teacher. This approach usually not only preserves the voice but also produces a better choral sound.

How Much Do You Practice and Exercise Your Voice? How, When, and Where Do You Use Your Voice?

Vocal exercise is as essential to the vocalist as exercise and conditioning of other muscle systems is to the athlete. Proper vocal practice incorporates scales and specific exercises designed to maintain and develop the vocal apparatus. Simply acting or singing songs or giving performances without routine studious concentration on vocal technique is not adequate for the vocal performer. The physician should know whether the vocalist practices daily, whether he or she practices at the same time daily, and how long the practice lasts. Actors generally practice and warm up their voices for 10 to 30 minutes daily, although more time is recommended. Most serious singers practice for at least 1 to 2 hours per day. If a singer routinely practices in the late afternoon or evening but frequently performs in the morning (religious services, school classes, teaching voice, choir rehearsals, etc), one should inquire into the warm-up procedures preceding such performances as well as cool-down procedures after voice use. Singing "cold," especially early in the morning, may result in the use of minor muscular alterations to compensate for vocal insecurity produced by inadequate preparation. Such crutches can result in voice dysfunction. Similar problems may result from instances of voice use other than formal singing. School teachers, telephone receptionists, salespeople, and others who speak extensively also often derive great benefit from 5 or 10 minutes of vocalization of scales first thing in the morning. Although singers rarely practice their scales too long, they frequently perform or rehearse excessively. This is especially true immediately before a major concert or audition, when physicians are most likely to see acute problems. When a singer has hoarseness and vocal fatigue and has been practicing a new role for 14 hours a day for the last 3 weeks, no simple prescription will solve the problem. However, a treatment regimen can usually be designed to carry the performer safely through his or her musical obligations.

The physician should be aware of common habits and environments that are often associated with abusive voice behavior and should ask about them routinely. Screaming at sports events and at children is among the most common. Extensive voice use in noisy environments also tends to be abusive. These include noisy rooms, cars, airplanes, sports facilities, and other locations where background noise or acoustic design impairs auditory feedback. Dry, dusty surroundings may alter vocal fold secretions through dehydration or contact irritation, altering voice function. Activities such as cheerleading, teaching, choral conducting, amateur singing, and frequent communication with hearing-impaired persons are likely to be associated with voice abuse, as is extensive professional voice use without formal training. The physician should inquire into the patient's routine voice use and should specifically ask about any activities that frequently lead to voice change such as hoarseness or discomfort in the neck or throat. Laryngologists should ask specifically about other activities that may be abusive to the vocal folds such as weight lifting, aerobics, and the playing of some wind instruments.

Are You Aware of Misusing or Abusing Your Voice During Singing?

A detailed discussion of vocal technique in singing is beyond the scope of this chapter but is discussed in other chapters. The most common technical errors involve excessive muscle tension in the tongue, neck, and larynx; inadequate abdominal support; and excessive volume. Inadequate preparation can be a devastating source of voice abuse and may result from limited practice, limited rehearsal of a difficult piece, or limited vocal training for a given role. The

latter error is common. In some situations, voice teachers are at fault; both the singer and teacher must resist the impulse to "show off" the voice in works that are either too difficult for the singer's level of training or simply not suited to the singer's voice. Singers are habitually unhappy with the limitations of their voices. At some time or another, most baritones wish they were tenors and walk around proving they can sing high Cs in "Vesti la giubba." Singers with other vocal ranges have similar fantasies. Attempts to make the voice something that it is not, or at least that it is not yet, frequently are harmful.

Are You Aware of Misusing or Abusing Your Voice During Speaking?

Common patterns of voice abuse and misuse will not be discussed in detail in this chapter. Voice abuse and/or misuse should be suspected particularly in patients who complain of voice fatigue associated with voice use, whose voices are worse at the end of a working day or week, and in any patient who is chronically hoarse. Technical errors in voice use may be the primary etiology of a voice complaint, or it may develop secondarily due to a patient's effort to compensate for voice disturbance from another cause.

Dissociation of one's speaking and singing voices is probably the most common cause of voice abuse problems in excellent singers. Too frequently, all the expert training in support, muscle control, and projection is not applied to a singers' speaking voice. Unfortunately, the resultant voice strain affects the singing voice as well as the speaking voice. Such damage is especially likely to occur in noisy rooms and in cars, where the background noise is louder than it seems. Backstage greetings after a lengthy performance can be particularly devastating. The singer usually is exhausted and distracted; the environment is often dusty and dry, and generally a noisy crowd is present. Similar conditions prevail at postperformance parties, where smoking and alcohol worsen matters. These situations should be avoided by any singer with vocal problems and should be controlled through awareness at other times.

Three particularly abusive and potentially damaging vocal activities are worthy of note. *Cheerleading* requires extensive screaming under the worst possible physical and environmental circumstances. It is a highly undesirable activity for anyone considering serious vocal endeavor. This is a common conflict in younger singers because the teenager who is the high school choir soloist often is also student council president, yearbook editor, captain of the cheerleaders, and so on.

Conducting, particularly choral conducting, can also be deleterious. An enthusiastic conductor, especially of an amateur group, frequently sings all 4 parts intermittently, at volumes louder than the entire choir, during lengthy rehearsals. Conducting is a common avocation among singers but must be done with expert technique and special precautions to prevent voice injury. Hoarseness or loss of soft voice control after conducting a rehearsal or concert suggests voice abuse during conducting. The patient should be instructed to record his or her voice throughout the vocal range singing long notes at dynamics from soft to loud to soft. Recordings should be made prior to rehearsal and following rehearsal. If the voice has lost range, control, or quality during the rehearsal, voice abuse has occurred. A similar test can be used for patients who sing in choirs, teach voice, or perform other potentially abusive vocal activities. Such problems in conductors can generally be managed by additional training in conducting techniques and by voice training, including warm-up and cool-down exercises.

Teaching singing may also be hazardous to vocal health. It can be done safely but requires skill and thought. Most teachers teach while seated at the piano. Late in a long, hard day, this posture is not conducive to maintenance of optimal abdominal and back support. Usually, teachers work with students continually positioned to the right or left of the keyboard. This may require the teacher to turn his or her neck at a particularly sharp angle, especially when teaching at an upright piano. Teachers also often demonstrate vocal works in their students' vocal ranges rather than their own, illustrating bad as well as good technique. If a singing teacher is hoarse or has neck discomfort, or his or her soft singing control deteriorates at the end of a teaching day (assuming that the teacher warms up before beginning to teach voice lessons), voice abuse should be suspected. Helpful modifications include teaching with a grand piano, sitting slightly sideways on the piano bench, or alternating student position to the right and left of the piano to facilitate better neck alignment. Retaining an accompanist so that the teacher can stand rather than teach from sitting behind a piano, and many other helpful modifications, are possible.

Do You Have Pain When You Talk or Sing?

Odynophonia, or pain caused by phonation, can be a disturbing symptom. It is not uncommon, but relatively little has been written or discussed on this subject. A detailed review of odynophonia is beyond the scope of this publication. However, laryngologists

should be familiar with the diagnosis and treatment of at least a few of the most common causes, at least, as discussed elsewhere in this book.

What Kind of Physical Condition Are You In?

Phonation is an athletic activity that requires good conditioning and coordinated interaction of numerous physical functions. Maladies of any part of the body may be reflected in the voice. Failure to maintain good abdominal muscle tone and respiratory endurance through exercise is particularly harmful because deficiencies in these areas undermine the power source of the voice. Patients generally attempt to compensate for such weaknesses by using inappropriate muscle groups, particularly in the neck, causing vocal dysfunction. Similar problems may occur in the well-conditioned vocalist in states of fatigue. These are compounded by mucosal changes that accompany excessively long hours of hard work. Such problems may be seen even in the best singers shortly before important performances in the height of the concert season.

A popular but untrue myth holds that great opera singers must be obese. However, the vivacious, gregarious personality that often distinguishes the great performer seems to be accompanied frequently by a propensity for excess, especially culinary excess. This excess is as undesirable in the vocalist as it is in most other athletic artists, and it should be prevented from the start of one's vocal career. Appropriate and attractive body weight has always been valued in the pop music world and is becoming particularly important in the opera world as this formerly theater-based art form moves to television and film media. However, attempts at weight reduction in an established speaker or singer are a different matter. The vocal mechanism is a finely tuned, complex instrument and is exquisitely sensitive to minor changes. Substantial fluctuations in weight frequently cause deleterious alterations of the voice, although these are usually temporary. Weight reduction programs for people concerned about their voices must be monitored carefully and designed to reduce weight in small increments over long periods. A history of sudden recent weight change may be responsible for almost any vocal complaint.

How Is Your Hearing?

Hearing loss can cause substantial problems for singers and other professional voice users. This may be true especially when the voice patient is unaware that he or she has hearing loss. Consequently, not only should voice patients be asked about hearing loss, tinnitus, vertigo, and family history of hearing loss, but it is also helpful to inquire of spouses, partners, friends, or others who may have accompanied the patient to the office whether they have suspected a hearing impairment in the patient.

Have You Noted Voice or Bodily Weakness, Tremor, Fatigue, or Loss of Control?

Even minor neurologic disorders may be extremely disruptive to vocal function. Specific questions should be asked to rule out neuromuscular and neurologic diseases such as myasthenia gravis, Parkinson disease, tremors, other movement disorders, spasmodic dysphonia, multiple sclerosis, central nervous system neoplasm, and other serious maladies that may be present with voice complaints.

Do You Have Allergy or Cold Symptoms?

Acute upper respiratory tract infection causes inflammation of the mucosa, alters mucosal secretions, and makes the mucosa more vulnerable to injury. Coughing and throat clearing are particularly traumatic vocal activities and may worsen or provoke hoarseness associated with a cold. Postnasal drip and allergy may produce the same response. Infectious sinusitis is associated with discharge and diffuse mucosal inflammation, resulting in similar problems, and may actually alter the sound of a voice, especially the patient's own perception of his or her voice. Futile attempts to compensate for disease of the supraglottic vocal tract in an effort to return the sound to normal frequently result in laryngeal strain. The expert singer or speaker should compensate by monitoring technique by tactile rather than by auditory feedback, or singing "by feel" rather than "by ear."

Do You Have Breathing Problems, Especially After Exercise?

Voice patients usually volunteer information about upper respiratory tract infections and postnasal drip, but the relevance of other maladies may not be obvious to them. Consequently, the physician must seek out pertinent history.

Respiratory problems are especially important in voice patients. Even mild respiratory dysfunction may adversely affect the power source of the voice.[8] Occult asthma may be particularly troublesome.[9] A complete respiratory history should be obtained in most patients with voice complaints, and pulmonary function testing is often advisable.

Have You Been Exposed to Environmental Irritants?

Any mucosal irritant can disrupt the delicate vocal mechanism. Allergies to dust and mold are aggravated commonly during rehearsals and performances in concert halls, especially older theaters and concert halls, because of numerous curtains, backstage trappings, and dressing room facilities that are rarely cleaned thoroughly. Nasal obstruction and erythematous conjunctivae suggest generalized mucosal irritation. The drying effects of cold air and dry heat may also affect mucosal secretions, leading to decreased lubrication, a "scratchy" voice, and tickling cough. These symptoms may be minimized by nasal breathing, which allows inspired air to be filtered, warmed, and humidified. Nasal breathing, whenever possible, rather than mouth breathing, is proper vocal technique. While the performer is backstage between appearances or during rehearsals, inhalation of dust and other irritants may be controlled by wearing a protective mask, such as those used by carpenters, or a surgical mask that does not contain fiberglass. This is especially helpful when sets are being constructed in the rehearsal area.

A history of recent travel suggests other sources of mucosal irritation. The air in airplanes is extremely dry, and airplanes are noisy.[10] One must be careful to avoid talking loudly and to maintain good hydration and nasal breathing during air travel. Environmental changes can also be disruptive. Las Vegas is infamous for the mucosal irritation caused by its dry atmosphere and smoke-filled rooms. In fact, the resultant complex of hoarseness, vocal "tickle," and fatigue is referred to as "Las Vegas voice." A history of recent travel should also suggest jet lag and generalized fatigue, which may be potent detriments to good vocal function.

Environmental pollution is responsible for the presence of toxic substances and conditions encountered daily. Inhalation of toxic pollutants may affect the voice adversely by direct laryngeal injury, by causing pulmonary dysfunction that results in voice maladies, or through impairments elsewhere in the vocal tract. Ingested substances, especially those that have neurolaryngologic effects, may also adversely affect the voice. Nonchemical environmental pollutants such as noise can cause voice abnormalities, as well. Laryngologists should be familiar with the laryngologic effects of the numerous potentially irritating substances and conditions found in the environment. We must also be familiar with special pollution problems encountered by performers. Numerous materials used by artists to create sculptures, drawings, and theatrical sets are toxic and have adverse voice effects. In addition, performers are exposed routinely to chemicals encountered through stage smoke and pyrotechnic effects. Although it is clear that some of the "special effects" may result in serious laryngologic consequences, much additional study is needed to clarify the nature and scope of these occupational problems.

Do You Smoke, Live With a Smoker, or Work Around Smoke?

The effects of smoking on voice performance were reviewed recently in the *Journal of Singing*,[11] and that review is recapitulated here. Smoking tobacco is the number one cause of preventable death in the United States as well as the leading cause of heart disease, stroke, emphysema, and cancer. The Centers for Disease Control and Prevention (CDC) attributes approximately 442 000 premature (shortened life expectancy) deaths annually in the United States to smoking, which is more than the combined incidence of deaths caused by highway accidents, fires, murders, illegal drugs, suicides, and AIDS.[12] Approximately 4 million deaths per year worldwide result from smoking, and if this trend continues, by 2030, this figure will increase to about 10 million deaths globally.[13] In addition to causing life-threatening diseases, smoking impairs a great many body systems, including the vocal tract. Harmful consequences of smoking or being exposed to smoke influence voice performance adversely.

Singers need good vocal health to perform well. Smoking tobacco can irritate the mucosal covering of the vocal folds, causing redness and chronic inflammation, and can have the same effect on the mucosal lining of the lungs, trachea, nasopharynx (behind the nose and throat), and mouth. In other words, the components of voice production—the generator, the oscillator, the resonator, and the articulator—all can be compromised by the harmful effects of tobacco use. The onset of effects from smoking may be immediate or delayed.

Individuals who have allergies and/or asthma are usually more sensitive to cigarette smoke with potential for an immediate adverse reaction involving the lungs, larynx, nasal cavities, and/or eyes. Chronic use of tobacco, or exposure to it, causes the toxic chemicals in tobacco to accumulate in the body, damaging the delicate linings of the vocal tract, as well as the lungs, heart, and circulatory system.

The lungs are critical components of the power source of the vocal tract. They help generate an airstream that is directed superiorly through the trachea toward the undersurface of the vocal folds. The vocal folds respond to the increase in subglottic pressure by producing sounds of variable intensities and fre-

quencies. The number of times per second the vocal fold vibrate influences the pitch, and the amplitude of the mucosal wave influences the loudness of the sound. The sound produced by the vibration (oscillation) of the vocal folds passes upward through the oral cavity and nasopharynx where it resonates, giving the voice its richness and timbre, and eventually it is articulated by the mouth, teeth, lips, and tongue into speech or song.

Any condition that adversely affects lung function such as chronic exposure to smoke or uncontrolled asthma can contribute to dysphonia by impairing the strength, endurance, and consistency of the airsteam responsible for establishing vocal fold oscillation. Any lesion that compromises vocal fold vibration and glottic closure can cause hoarseness and breathiness. Inflammation of the cover layer of the vocal folds and/or the mucosal lining of the nose, sinuses, and oral nasopharyngeal cavities can affect the quality and clarity of the voice.

Tobacco smoke can damage the lungs' parenchyma and the exchange of air through respiration. Cigarette manufacturers add hundreds of ingredients to their tobacco products to improve taste, to make smoking seem milder and easier to inhale, and to prolong burning and shelf life.[14] More than 3000 chemical compounds have been identified in tobacco smoke, and more than 60 of these compounds are carcinogens.[15] The tobacco plant, *Nicotiana tabacum*, is grown for its leaves, which can be smoked, chewed, or sniffed with various effects. The nicotine in tobacco is the addictive component and rivals crack cocaine in its ability to enslave its users. Most smokers want to stop, yet only a small percentage are successful in quitting cigarettes; the majority who quit relapse into smoking once again.[16] Tar and carbon monoxide are among the disease-causing components in tobacco products. The tar in cigarettes exposes the individual to a greater risk of bronchitis, emphysema, and lung cancer. These chemicals affect the entire vocal tract as well as the cardiovascular system (Table 1–1).

Cigarette smoke in the lungs can lead also to increased vascularity, edema, and excess mucous production, as well as epithelial tissue and cellular changes. The toxic agents in cigarette smoke have been associated with an increase in the number and severity of asthma attacks, chronic bronchitis, emphysema, and lung cancer, all of which can interfere with the lungs' ability to generate the stream of air needed for voice production.

Chronic bronchitis due to smoking has been associated with an increase in the number of goblet (mucous) cells, an increase in the size (hyperplasia) of the mucosal secreting glands, and a decrease in the number of ciliated cells, the cells used to clean the lungs. Chronic cough and sputum production are also seen more commonly in smokers compared with nonsmokers. Also, the heat and chemicals of unfiltered cigarette and marijuana smoke are especially irritating to the lungs and larynx.

An important component of voice quality is the symmetrical, unencumbered vibration of the true vocal folds. Anything that prevents the epithelium covering the vocal folds from vibrating or affects the loose connective tissue under the epithelium (in the superficial layer of the lamina propria known as the Reinke's space) can cause dysphonia. Cigarette smoking can cause the epithelium of the true vocal folds to become red and swollen, develop whitish discolorations (leukoplakia), undergo chronic inflammatory changes, or develop squamous metaplasia or dysplasia (tissue changes from normal to a potentially malignant state). In chronic smokers, the voice may become husky due to the accumulation of fluid in the Reinke's space (Reinke's edema). These alterations in structure can interfere with voice production by changing the biomechanics of the vocal folds and their vibratory characteristics. In severe cases, cancer can deform and paralyze the vocal folds.

Vocal misuse often follows in an attempt to compensate for dysphonia and an alerted self-perception of one's voice. The voice may feel weak, breathy, raspy, or strained. There may be a loss of range, vocal breaks, long warm-up time, and fatigue. The throat may feel raw, achy, or tight. As the voice becomes unreliable, bad habits increase as the individual struggles harder and harder to compensate vocally. As selected sound waves move upward, from the larynx toward and through the pharynx, nasopharynx, mouth, and nose (the resonators), sounds gain a unique richness and timbre. Exposing the pharynx to cigarette smoke aggravates the linings of the oropharynx, mouth, nasopharynx, sinuses, and nasal cavities. The resulting erythema, swelling, and inflammation predispose one to nasal congestion and impaired mucosal function; there may be predisposition to sinusitis and pharyngitis, in which the voice may become hyponasal, the sinus achy, and the throat painful.

Although relatively rare in the United States, cancer of the nasopharynx has been associated with cigarette smoking,[17] and one of the presenting symptoms is unilateral hearing loss due to fluid in the middle ear caused by eustachian tube obstruction from the cancer. Smoking-induced cancers of the oral cavity, pharynx, larynx, and lung are common throughout the world, including in the United States.

The palate, tongue, cheeks, lips, and teeth articulate the sound modified by the resonators into speech. Cigarettes, cigar, or pipe smoking may cause

Table 1–1. Chemical Additives Found in Tobacco and Commercial Products

Tobacco Chemical Additives	*Also Found In*
Acetic acid	Vinegar, hair dye
Acetone	Nail polish remover
Ammonia	Floor cleaner, toilet cleaner
Arsenic	Poison
Benzene	A leukemia-producing agent in rubber cement
Butane	Cigarette lighter fluid
Cadmium	Batteries, some oil paints
Carbon monoxide	Car exhaust
DDT	Insecticides
Ethanol	Alcohol
Formaldehyde	Embalming fluid, fabric, laboratory animals
Hexamine	Barbecue lighter
Hydrazine	Jet fuel, rocket fuel
Hydrogen cyanide	Gas chamber poison
Methane	Swamp gas
Methanol	Rocket fuel
Naphthalene	Explosives, mothballs, paints
Nickel	Electroplating
Nicotine	Insecticides
Nitrobenzene	Gasoline additive
Nitrous oxide phenols	Disinfectant
Phenol	Disinfectants, plastics
Polonium-210	A radioactive substance
Stearic acid	Candle wax
Styrene	Insulation materials
Toluene	Industrial solvent, embalmer's glue
Vinyl chloride	Plastic manufacturing, garbage bags

a "black hairy tongue," precancerous oral lesions (leukoplakia), and/or cancer of the tongue and lips.[18] Any irritation that causes burning or inflammation of the oral mucosa can affect phonation, and all tobacco products are capable of causing these effects.

Smokeless "spit" tobacco is highly addictive, and users who dip 8 to 10 times a day may get the same nicotine exposure as those who smoke 1½ to 2 packs of cigarettes per day.[19] Smokeless tobacco has been associated with gingivitis, cheek carcinoma, and cancer of the larynx and hypopharynx.

Exposure to environmental tobacco smoke (ETS), also called secondhand smoke, sidestream smoke, or passive smoke, accounts for an estimated 3000 lung cancer deaths and approximately 35 000 deaths in the United States from heart disease in nonsmoking adults.[20]

Secondhand smoke is the "passive" inhalation of tobacco smoke from environmental sources such as