

Neurolaryngology

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Preface

When I was contacted by two publishers about writing a book on neurolaryngology, I considered the invitations with enthusiasm. As a laryngologist and neurotologist, I have had a natural, long interest in neurolaryngology, the newest subspecialty of laryngology. Because of my fascination with neurolaryngology, I had included a great deal of information on the topic in my recent books. However, after assembling a tentative table of contents for a neurolaryngology textbook, and after reviewing the contents of my recent works, I was surprised to find that the book was all but finished already. After synthesizing material from the 4th edition of *Diagnosis and Treatment of Voice Disorders*,¹ published in 2014, and *Professional Voice: The Science and Art of Clinical Care, Fourth Edition*,² which is in production currently and will be released early in 2017, along with *Laryngeal Electromyography, Third Edition*,³ I discovered that we had already prepared all of the materials for the neurolaryngology book except for several chapters that required revision to focus on the topic, one chapter from the laryngeal EMG book that required extensive updating, and one chapter that had to be written anew.

Neurolaryngology brings together in one volume the latest concepts in this important and developing field, compiling, updating, and adding materials to books with which I have been involved recently (one of which is so new that it has not even been released, yet). In order to make this book as useful as possible for clinicians, selected chapters on general concepts important to clinical care have been included, including chapters on history, physical examination, clinical voice laboratory assessment, common diagnosis and treatments, and other topics important to all voice patients, including those with neurolaryngological complaints.

Chapter 1 provides perspective on modern voice medicine including neurolaryngology, and a brief historical overview of the development of laryngology from the time of Hippocrates. **Chapters 2 and 3** include fascinating basic information on laryngeal development. **Chapter 4** reviews what is known about the genetics of voice from a clinical perspective. **Chapter 5** on clinical anatomy and physiology

of the voice contains a great deal of information about laryngeal anatomy, neuroanatomy, respiratory function and other topics that, to the best of my knowledge, have not been synthesized in similar detail in a single source elsewhere. **Chapter 6** on arytenoid cartilage movement presents unique clarification of this often misunderstood subject. In **Chapter 7**, Sanders provides exceptional and sophisticated insights in the microanatomy and innervation of laryngeal muscles. **Chapter 8** offers clear additional insights into neuroanatomy and physiology, synthesized by Dr. Christy Ludlow. **Chapter 9** is an exceptionally interesting chapter on Music and the Brain. It reviews much of what is known currently about central development and processing of musical information; and this neuroscience should be extremely valuable in expanding the vision of voice researchers and clinicians. In **Chapter 10**, Ferster and Malmgren (now deceased) crystallize current knowledge regarding cellular and molecular mechanics of vocal fold aging. Baken's overview of laryngeal function in **Chapter 11** offers an extraordinarily accessible practical distillation of this complex topic. In **Chapter 12**, Scherer expands on the information in Baken's chapter and provides insights into many more complex aspects of laryngeal function. **Chapter 13** on vocal tract resonance is a classic review of the findings from Sundberg's seminal research, as well as the work of other scientists. **Chapter 14** on chaos and voice disorders contains fascinating new ideas on applications of non-linear dynamics to voice care and research, a topic of great relevance in neurolaryngology. **Chapter 15** expands on the concepts presented in **Chapter 14**, particularly on applications of chaos theory in understanding and caring for the human voice.

Beginning the section on clinical assessment of voice disorders, **Chapters 16 and 17** describe the current, sophisticated approach to history and physical examination recommended for patients with neurolaryngological and other voice disorders. **Chapter 18** 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 important for neurolaryngologic and other voice patients. **Chapter 19** is one about which I am particularly enthusiastic. Dr. Harry Hollien is one of the world's experts on forensic voice science. He presents that fascinating field in this chapter. I believe that much of the information and technology in forensic voice science is potentially applicable to clinical voice analysis, and I hope that this chapter inspires new clinical approaches to objective voice assessment in patients with neurolaryngological and other voice disorders. In **Chapter 20**, Echternach expands extensively on the basic information about high-speed digital imaging that was introduced in **Chapter 18**. Neurological disorders may disrupt not only voice but also normal swallowing; and laryngologists should be familiar with comprehensive evaluation of dysphagia. **Chapter 21** reviews transnasal esophagoscopy, and other swallowing assessment is discussed in Chapter 43. **Chapter 22** on laryngeal electromyography includes technical and other information regarding use of this important technology, as well as details and references on efficacy, interpretation and clinical applications of laryngeal EMG. **Chapter 23**, Clinical Applications of Laryngeal Electromyography: Case Studies, expands discussion of laryngeal EMG through illustrative case studies, and **Chapter 24** offers a comprehensive review of the latest concepts in intraoperative laryngeal nerve monitoring. **Chapter 25** details Dr. Eiji Yanagisawa's latest techniques for laryngeal photography including all of the specific information a reader might require to replicate his success and document clinical findings. **Chapter 26** reviews remarkable computed tomography (CT) technology developed in France that provides color images that might be mistaken for histologic sections. It represents the state-of-the-art in CT imaging. **Chapter 27** does not address commonly known for clinical uses of MRI. Rather, it provides extraordinary insight into lesser-known MRI capabilities and MRI's potential for expanding basic neurolaryngologic knowledge and clinical care of the voice. In **Chapter 28**, Benninger and his colleagues have updated their pioneering work on measuring voice treatment outcomes. **Chapter 29** provides a detailed overview of voice disorders commonly managed without surgery. Aging changes are sometimes hard to differentiate from neurologic impairment. **Chapter 30** summarizes a large number of recent studies and concepts on the aging voice. **Chapter 31** on pediatric voice disorder covers not only differential diagnosis and treatment, but also suggestions on imaging of children, which can be challenging especially when trying to

identify subtle motion abnormalities. **Chapter 32** on hearing loss includes a review of the latest literature. Hearing impairment is common in patients with neurolaryngologic problems; and hearing should be assessed routinely in this population. **Chapter 33** is a novel chapter that reviews what is known about the influence of hearing on phonation. In addition to covering various aspects of psychological assessment and treatment, **Chapter 34** covers neurolaryngologic and other information on the role of psychological and other professionals involved in management of voice patients. **Chapter 35** offers a new and practical discussion of cough and the unified airway. Neurogenic cough is a common and challenging problem. **Chapter 36** on sleep science and the importance of sleep in vocal performers provides valuable insights unfamiliar to most otolaryngologists, but extremely important to performers, particularly those who travel extensively, and especially those who already have voice fatigue from neurolaryngologic disorders. **Chapter 37** on neurological disorders contains the latest information about many conditions, including some rarely covered in the laryngologic literature. It highlights diagnosis and treatment of a wide array of motor and sensory disorders that may impair voice. **Chapter 38** on vocal fold paresis and paralysis discusses the latest concepts in diagnosis and treatment, including reinnervation and the use of laryngeal pacemakers. **Chapter 39** offers a more expansive review of the particularly challenging problem of bilateral vocal fold paralysis. **Chapter 40** on spasmodic dysphonia not only reviews the most current literature but also describes our current practices regarding clinical and laboratory diagnosis, and treatment. Other uses of Botulinum toxin are covered separately in **Chapter 41**. **Chapter 42** summarizes the neurology of stuttering; and **Chapter 43** provides an in-depth expose of diagnosis and treatment of swallowing dysfunction, including functional endoscopic evaluation of swallowing and sensory testing (FEESST). **Chapter 44** on voice therapy includes substantial detail regarding specific therapeutic techniques, highlighting our current practices for treating neurolaryngologic and other voice patients. **Chapter 45** on voice rest includes the latest information published on this controversial topic. **Chapter 46** on the singing voice specialist details the most current techniques for management of the singing voice, for using singing techniques to help nonsingers, and reflects our latest beliefs and practices, as well as the most recent information from the evolving literature in this field. High-performance voice training can be an invaluable component of the treatment of paresis. **Chapter 47**, The Role of the Acting-Voice Trainer on

the Medical Care of Professional Voice Users, presents similar high performance techniques used during projected speech. **Chapter 48** on exercise physiology offers the most recent concepts and literature on this topic. Understanding exercise physiology is critical to understanding voice training and rehabilitation, especially in patients with neuromuscular weakness. **Chapter 49** includes a great deal of surgical information and illustrations on general principles and specific neurolaryngological procedures. Topics covered in depth include, among others, patient selection, informed consent, approaches to anesthesia, selection of instrumentation, indirect laryngoscopic approaches, direct laryngoscopy, laryngeal injection, laryngeal framework surgery, management of complications of medialization surgery, and other subjects. The chapter is replete with details and “how I do it” suggestions. There are sections on vocal fold injection, removal of hydroxylapatite, false vocal fold medialization, mini-thyrotomy, viscosity of injectable materials, fascia injection, and other topics. In-office surgery is being performed more and more frequently in the United States and elsewhere, but it is not without hazard. **Chapter 50** reviews the safety of procedures performed in an office setting. In **Chapter 51**, Dr. Harvey Tucker reviews the classic approach to laryngeal reinnervation; and in **Chapter 52**, Jean-Paul Marie presents the newest concepts in this fascinating subject. Vocal fold hypomobility from structural dysfunction must be differentiated from paresis and paralysis; and **Chapter 53** provides detailed and updated information on diagnosis and management of cricoarytenoid and cricothyroid joint injury, including references to the most recent publications. **Chapter 54** offers extensive discussion of impairment, disability and handicap, which are associated commonly with neurolaryngologic impairment; proposals for equitable disability calculation; case examples; and a discussion of the laryngologist’s role in selected legal matters. It also contains a review

of the development of the AMA Guides for evaluation of Impairment and Disability, information from the 6th edition of the Guides on rating voices, and comments on the Americans with Disabilities Act as it relates to voice patients. **Chapter 55** includes our current perspective on the near-future horizons in laryngology and voice research, including neurolaryngologic and related topics.

Every effort has been made to maintain style and continuity throughout this 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. I have written or coauthored 31 of the 55 chapters and made every effort to preserve the spirit, concept and continuity of a single author text while integrating outstanding and extensive contributions from colleagues, rather than the often more compartmentalized style of an edited text. This paradigm was used in a conscious effort to minimize repetition and provide consistent reading from cover to cover. All of us who have contributed to this text hope that readers will find it not only useful clinically, but also thought provoking; and that today’s readers will be tomorrow’s contributing authors.

—Robert T. Sataloff, MD, DMA

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Acknowledgments

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I am indebted also to my coauthors/coeditors of books from which the selected chapters have been republished or modified, including John Rubin, Gwen Korovin, Steve Mandel, Yolanda Heman-Ackah, Mona Abaza, and the late Ramon Mañon-Españat.

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About the Author



Robert Thayer Sataloff, MD, DMA, FACS, 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 is the 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 61 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 lipoinplantation, and others. He has invented more than 75 laryngeal microsurgical instruments produced by 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 modern 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.

Introduction

Robert Thayer Sataloff

The human voice is extraordinary. It is capable of conveying not only complex thought, but also subtle emotion. In an instant, it can communicate the terror of a scream or the beauty of a song. As appreciated as the uniqueness and power of the human voice have been for centuries, only in the last few decades have we begun to understand how the voice works and how to care for it. The importance of the human voice in modern society cannot be overstated. It is the primary instrument through which most of us project our personalities and influence our compatriots. Professional voice users constitute an ever-increasing segment of our population, and their need for expert care has inspired new interest in understanding the function and dysfunction of the human voice. Professional voice users provide exciting challenges and special responsibilities for physicians and other health care professionals. Professional voice users include not only singers and actors, but also attorneys, politicians, clergy, educators (including some physicians), telephone receptionists, and others. Although they span a broad range of vocal sophistication and voice needs, they share a dependence on vocal endurance and quality for their livelihoods. However, the vocal needs of performing artists are especially great. In this book, we emphasize the problems of professional actors and especially singers, because they are the Olympic athletes of the voice world. Their extreme anatomic, physiologic, and therapeutic demands tax our clinical and research skills; but what we learn from them is applicable to the care of all voice patients. In most cases, mastery of the science and art of caring for professional singers provides the physician with sufficient expertise to treat other professional voice users as well, so long as the physician takes the trouble to really understand

the special needs and problems associated with various voice-dependent professions.

Voice problems may arise from laryngeal or systemic disease, trauma, or improper treatment. The consequences of voice dysfunction may be devastating; if permanent (or even temporary) vocal problems result from suboptimal medical care, they may result in substantial claims for damages. Possibly spurred by the striking increase in litigation, but largely to provide good medical care for its own sake, a great many physicians have recently turned their attention to professional voice care. Interdisciplinary research has resulted in new understanding and technology that have improved the standard of practice of laryngologists, speech-language pathologists, singing teachers, and acting-voice trainers. It is no longer sufficient for a physician to glance at a singer's vocal folds with a laryngeal mirror and continuously light and declare, "Your cords are fine. It must be the way you sing." Similarly, it is no longer sufficient to say, "The voice sounds bad" or "The voice sounds better," anymore than we would tolerate such vagueness in describing hearing.

Although physicians frequently are called on to care for singers and other voice professionals, most doctors still have little or no training in sophisticated analysis and treatment of subtle problems of the voice. Voice disorders are complex. Initially, voice complaints may seem vague and subjective, especially to health care professionals unfamiliar with the jargon of singers and actors. However, accurate diagnosis and rational treatment may be achieved through systematic inquiry based on understanding of the anatomy, physiology, psychology, and psychoacoustics of voice production. More thorough understanding of voice is valuable not only in caring

for voice problems themselves, but also in providing good medical care by recognizing systemic diseases that present with laryngeal manifestations. Just as otologists routinely diagnose diabetes and hypothyroidism that cause dizziness or fluctuating hearing loss, laryngologists should be alert to xerophonia as a sign of diabetes, muffling of the voice from hypothyroidism, fatigue from myasthenia gravis, and many other similar problems. Hypochondriasis is rare among serious singers and most other voice professionals. In general, failure to establish a diagnosis in a professional vocalist with a voice complaint is due to lack of expertise on the part of the physician rather than an imaginary complaint on the part of the singer or actor.

History

Fascination with the human voice has prompted study for centuries, as reviewed in Dr. Hans von Leden's classic chapter, "A Cultural History of the Larynx and Voice," in this book. A brief overview helps put the evolution of voice medicine, and modern developments in voice care, into perspective. In *Corpus Hippocraticum*, Hippocrates in the fifth century BC provided some of the earliest medical speculation on the workings of the voice, recognizing the importance of the lungs, trachea, lips, and tongue in phonation. Aristotle expanded knowledge on the scientific workings of the voice and commented on the close relationship between the voice and the soul, recognizing its importance in emotional expression. Claudius Galen, who practiced from AD 131 to 201, is hailed as the founder of laryngology and voice science. He wrote an essay on the human voice (among his over 300 books) that is frequently referenced but has, unfortunately, been lost. He recognized the workings of the voice, described the larynx, recognized the importance of the brain in controlling phonation, and, for the first time, distinguished between speech and voice. Galen's work went virtually unchallenged for more than 15 centuries, and some of it is still regarded as correct.

Major advancement did not come until the Renaissance and the writings of Leonardo da Vinci, particularly *Quaderni D'Anatomia* in 1500. Additional important Renaissance writers who advanced knowledge of the voice included Andreas Vesalius, Bartolomeus Eustachius, and Fabricius ab Aquapendente. Fabricius wrote three books on the larynx, including *De Larynge Vocis Instrumento*. Similar important advances occurred in the east, particularly in the ninth century when Rhazes the Experi-

enced, in Baghdad, described disorders of the voice and hoarseness and recommended respiratory and voice training. There are also excellent descriptions of voice production and disorders in the *Quanun*, written by Avicenna the Persian. The *Quanun* was a standard medical textbook for more than 500 years. Major additional advances occurred in the 18th century through the efforts of Giovanni Morgagni, who first related dysphonia to abnormalities in the larynx. Also in the 18th century, Antoine Ferrein described physiological experiments on animal and human cadaver larynges and coined the term *vocal cords*, comparing the vocal folds to the strings of an instrument. Albrecht von Haller described the anatomy of vocal resonance. Later, Johannes Müller in Germany described the mechanisms of vocal fold vibration. In the 19th century, Hermann von Helmholtz essentially started the experimental science of acoustics with experiments that are still considered valid. All of the scientists mentioned above laid the foundation for the close liaison that has existed between physicians and singers.

However, the clear and widely recognized beginning of arts-medicine in the voice world dates from the time of Manuel García, who was born in 1805. García was a world-famous opera singer while in his teens. Although he was the son of an acclaimed singer and director, his probably faulty technique and extensive operative singing impaired his voice sufficiently to cause him to retire while still in his 20s. Thereafter, he became a thoughtful, effective, and famous teacher and was made Professor of Singing at the Conservatoire de Paris at the age of 30. In 1854, García bought a dental mirror and invented the technique of indirect laryngoscopy using the sun as his light source. The laryngeal mirror is still the basic tool for visualizing vocal folds and is used daily by otolaryngologists. García observed larynges closely with his new tool and presented his findings before the Royal Society of Medicine in 1855. He was considered the greatest singing teacher of his age; on his 100th birthday in 1905, he was honored by physicians, music teachers, and scientists from all over the world.¹ Voice medicine continued to develop slowly throughout the first seven decades of the 20th century.

The development of modern voice medicine and surgery may be traced to Hirano's description of the anatomy of the vibratory margin of the vocal fold in 1975, first published in English in 1977.² Hirano's observations led to our understanding of the layered structure of the vocal fold and to the realization that we need also to conceptualize vocal fold pathology and vocal fold surgery in layers. This paradigm evolved simultaneously with additional scientific

discoveries and voice laboratory instrumentation that permitted more accurate assessment of voice function and treatment outcome.

In the past four decades, increasing interest and new technology have generated unprecedented activity within a number of disciplines. Since 1972, laryngologists, voice scientists, physicists, computer scientists, speech-language pathologists, singing teachers, acting teachers, voice coaches, singers, actors, and other professionals have met at the Voice Foundation's week-long annual Symposium on Care of the Professional Voice, started by Dr. Wilbur James Gould. At this unique meeting, formerly held at the Juilliard School of Music and now located in Philadelphia, experts have gathered to report their research and share their ideas. The resultant interdisciplinary understanding and cooperation have produced great advances and hold even greater promise for future understanding. These activities have rendered care of the professional voice the most advanced discipline within the new specialty of arts medicine. They have also inspired numerous successful interdisciplinary publications, including the *Journal of Voice*. This important journal abandons traditional specialty boundaries and brings together in one peer-reviewed journal, with international distribution, articles of high quality on all subjects relating to the voice.

In many ways, the status of voice care is still analogous to that of otology 40 years ago. Until recently, voice evaluation was reminiscent of ear examinations with a head mirror instead of a microscope or whispered voice tests instead of audiograms. In many places, it still is. Fortunately, expert research has led to greater understanding of the voice and development of instrumentation for sophisticated assessment and quantitative analysis to facilitate clinical management and research. Although efforts have focused largely on professional singers and actors, the knowledge they have accrued has advanced our understanding of voice in general and modified substantially the state of the art in clinical care of all persons with voice disorders. Still, the field is new. The first extensive article in the English literature intended to teach clinicians how to approach professional singers was not published until 1981,¹ and the first major American general textbook of otolaryngology containing a chapter on care of the professional voice was not published until 1986.³ The first modern comprehensive textbook in English on medical care of the professional voice was not published until 1991 (the first edition of this text).⁴ However, it should be remembered that, although these contributions in English helped signal the arrival and acceptance of voice as a subspecialty, there were noteworthy pre-

decessors who discussed voice; some even touched on the type of professional voice user.⁵⁻¹¹

The importance of interdisciplinary voice care to the evolution of modern voice care cannot be overemphasized. Although there were a few scattered collaborations in the 19th and 20th centuries, the first formal, academically based interdisciplinary voice clinic in the United States was established by Drs. Hans von Leden and Paul Moore at Northwestern University Medical School in 1954. These pioneers, a laryngologist and a speech pathologist, established a clinic in which they saw patients simultaneously, sharing insights and optimizing patient care. They continued this approach separately after von Leden moved to Los Angeles and Moore moved to the University of Florida in Gainesville, although it was not always possible for them to practice as closely with interdisciplinary colleagues "under one roof." This concept was expanded in Philadelphia in 1981 when the author (RTS) hired a singing teacher and a speech-language pathologist as full-time employees of his medical practice. His expanded interdisciplinary voice team now includes three singing teachers, three speech-language pathologists, a psychologist, a voice scientist, an acting-voice trainer, and two otolaryngologic nurse-clinicians. It also includes the very close collaboration of arts-medicine colleagues located nearby, including a pulmonologist, psychiatrist, neurologist, gastroenterologist, endocrinologist, ophthalmologist, and others. He anticipates further expansion of this interdisciplinary approach, because it has proven so valuable in advancing patient care and stimulating creative research.

In the past several years, many new centers and academic training programs have acquired voice laboratories and begun practicing and teaching modern, advanced voice care, but more time will be required before state-of-the-art care is available in most geographical areas.

At present, new understanding of special aspects of the history and physical examination of professional voice users has been supplemented by technological advances through voice analysis, which are readily available to interested clinicians. Flexible fiberoptic laryngoscopy has been indispensable. The development and refinement of laryngeal stroboscopy are singularly important advancements. Strobovideolaryngoscopic evaluation of vocal fold behavior in slow motion allows diagnoses that are simply missed without it. High-speed video and videokymography are promising newer techniques that may improve our ability to assess the mucosal wave. Spectrography, electroglottography, electromyography, airflow analysis, and other techniques have also

enhanced our ability to analyze and treat voice disorders reliably.

When physicians encounter a patient with a voice problem, they approach the problem using a combination of art (style, empathy, intuition) and science (objective analysis based on facts). Both components are important, and no physician, speech-language pathologist, singing teacher, or acting voice teacher can be considered excellent if she or he abandons the art of practice in favor of dispassionate scientific analysis alone. However, care is at least as bad when we are forced to depend on intuition almost exclusively, because of insufficient knowledge. This is popularly called “winging it,” and it is a fair description of most voice care prior to the last two decades. Fortunately, science has provided us with an understanding that the voice consists of at least three principal components (power source, oscillator, resonator), that each component is designed to control specific aspects of voice production, and that there are ways to identify and quantify the performance of each component. This information provides voice care professionals with a framework and language with which we can think about voice problems. This has permitted us to add not only scientific fact, but also scientific thought to voice care.

The knowledge acquired through medical and basic science research has advanced not only clinical care but also the teaching of voice. Modern singing, acting, and speech teachers have acquired new scientific understanding of the voice and use their new knowledge to augment and refine their traditional approaches to voice training. This should lead to consistently healthier and more efficient voice training. There are many other fascinating potential implications as well. For example, to sing correctly is essentially an athletic endeavor. In this century, most athletic records have been broken. Often this has been the result of technological advancements, such as computer analysis of a runner’s form using high-speed photography or stroboscopy. Through these and other methods, the marathon, pole vault, high jump, and swimming records of 50 years ago are barely qualifying marks for today’s high school students. Similar principles have just begun to be applied to the proper training of the voice. It is tempting to speculate about the results. Perhaps, as in other athletic pursuits, we shall find that the healthy limits of human vocal potential are far greater than we think.

Major advances in physician education have had substantial impact on patient care nationally and internationally. Development and voluntary standardization of content of laryngeal fellowships have been particularly important.¹² Fellowships are pro-

ducing well-trained laryngologists who understand not only voice, but also other aspects of the field, and they are entering academic medicine in the United States and elsewhere so that they can pass on state-of-the-art knowledge to the next generation of otolaryngologists. Substantial strides also have been made in public awareness, particularly through international celebrations of World Voice Day, and summarized by Sataloff.¹³ Laryngologists also are learning how to build a professional voice practice so that voice professionals can have access to centers of excellence in voice care.¹⁴

Discretion

The excitement and glamour associated with caring for a famous performer naturally tempt the physician to talk about his or her distinguished patient. However, this tendency must be tempered. It is not always in a singer’s or actor’s best professional interest to have it known that he or she has consulted a laryngologist, particularly for treatment of a significant vocal problem. Famous singers and actors are ethically and legally entitled to the same confidentiality we assure for our other patients.

Notation

In speech-language pathology, voice science, and academic music, sounds are designated using the International Phonetic Alphabet (IPA). This is standard notation and will be used throughout this book. Readers should familiarize themselves with IPA notation and use it, because its meaning is well defined and widely understood.

Conclusion

For centuries, most physicians functioned in relative isolation, having only limited daily interaction and intellectual discourse with colleagues outside of medicine.¹⁵ During the last 4 decades, that model has changed. Laryngologists not only *collaborate* with voice scientists, speech-language pathologists, singing and acting teachers, physicists, chaoticians, molecular geneticists, computer scientists, neurologists, pulmonologists, pathologists, endocrinologists, pharmacologists, psychiatrists, and other professionals, but we also have incorporated information, thought processes, and problem-solving strategies from these various disciplines into our clinical think-

ing, research, and educational programs. This fundamental change has broadened our vision and provided us with new intellectual tools that we use daily and that underlie dramatic improvements in knowledge and patient care. In laryngology fellowships and a growing number of residencies, programs are evolving to provide our trainees with not only new information but also with the ability to think more broadly and collaboratively, not just within the new, expanded paradigms, but even further “outside the box.”

Great progress has been made toward understanding the function, dysfunction, and treatment of the human voice. Because so many of the advances have involved collaboration among physicians, voice scientists, speech-language pathologists, singing and acting teachers, singers, and actors, they have been applied practically much more quickly than usual. The dramatic progress that has occurred in the last 4 decades has resulted in great diagnostic and therapeutic benefits for all patients with voice complaints and in the emergence of a new medical specialty in voice. Scientific advances and collaboration have given us not merely new tools, but rather a whole new approach to the voice. No longer must we depend on intuition and mysticism in the medical office or voice studio. We now have the knowledge and vocabulary necessary for accurate analysis of voice problems and systematic, logical solutions. Thus, we finally have enough information to include effectively in our voice armamentarium the most important missing component—rational thought. It has raised the standard of voice care and training forever.

We have much reason to be proud of the recent advances in the state of the art in laryngology, although it is somewhat disappointing to note the paucity of good, prospective, controlled studies in laryngology that might confirm or refute our growing body of belief which still is grounded largely in papers that do not meet the highest standards of evidence-based research.¹⁵ We know vastly more than we did 40 years ago about diagnosis, nonsurgical and surgical treatment, quantification of voice function, outcomes assessment, important unanswered ques-

tions, and how to go about answering those questions. Our future promises continued advances in all of those areas and more.

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