

Professional Voice
The Science and Art of Clinical Care

Fourth Edition

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Robert Thayer Sataloff, MD, DMA





5521 Ruffin Road
San Diego, CA 92123

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

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Preface to the Fourth Edition

Like the first (1991), second (1997), and third (2005) editions of *Professional Voice: The Science and Art of Clinical Care*, the fourth edition was written primarily for physicians. Also, like the first three editions, it is intended to be useful for speech-language pathologists, singing and acting voice specialists, nurses, voice teachers, performers, and anyone else interested in the human voice. The book contains vastly more information than any previous edition, or any other reference book in the field. For the first time, it will be accessible to individuals and libraries electronically, as well as in print. As a 120 chapter reference work, I hope that this book will be available in libraries of medical schools, schools that teach speech-language pathology, music schools, nursing schools, and other libraries that provide access to science, healthcare, and music content, so that the book can be available to students and junior faculty who might not be able to obtain personal copies. The book strives to provide a practical understanding of most specialized aspects of clinical care of not only professional voice users, but also to provide most of the information necessary to provide state-of-the-art diagnosis and treatment for any patient with a voice disorder. When the first edition of this book was published, few comprehensive texts were available in which an interested otolaryngologist could find such information compiled conveniently. The first edition was used widely and seemed to have been helpful for physicians in facilitating superior voice care by providing a basis from which new ideas and research developed. Speech-language pathologists reported it to be of similar value, especially because most speech-language pathology training programs provided little instruction in professional voice care and virtually no training on how to work with the speaking voices of professional singers. The favorable responses from singing teachers and singers were particularly gratifying; they reported that the book was useful not only in the study of vocal pedagogy, but also as a practical reference. Nurses and other health care professionals also have found it helpful as a text and reference book to guide their evaluation and treatment as laryngologic nurse clinicians.

The expansion of *Professional Voice: Science and Art of Clinical Care* from 1991 to the present (as discussed below) is a reflection of the extraordinary evolution of our field. When the specialty of medical voice care developed as a fledgling discipline in the early 1980s, there were only a few voice laboratories in the United States, equally few otolaryngologists who recognized the complexities of voice care and even considered that it might develop into a defined subspecialty, only a few speech-language pathology programs that taught anything beyond the most rudimentary voice course, few music schools that included scientifically based courses in vocal pedagogy, no singing voice specialists, no acting voice specialists, and no laryngological nurse clinicians. In 1991, there also were only a handful of voice scientists. Now, there are PhD researchers scattered throughout the world who come from various disciplines and have devoted their careers to studying the human voice. Laryngology has been recognized as a subspecialty throughout the world. Fellowship training in the United States is available from coast to coast, and laryngology is a specialty included on most otolaryngology residency faculties and on board examinations. Specialized laryngology also is practiced in private practices not only in the United States, but throughout the world, many led by international fellows trained in Philadelphia, in Los Angeles under the mentorship of Hans von Leden, and elsewhere. Sophisticated voice courses are available in many speech-language pathology undergraduate and graduate schools; and voice pedagogy has become a standard course in music schools. Hans von Leden and G. Paul Moore (laryngologist and speech pathologist) formed a collaboration at Northwestern University in the 1950s. When we hired a singing teacher (Linda Carroll) in 1981 as a full-time member of our voice team (which already included a speech pathologist), she was the first singing teacher so employed; and together we evolved and named the specialty of “singing voice specialist.” Now, singing voice specialists are available in many centers in the United States, South and Central America, Europe, and Asia. The number of acting voice specialists is increasing slowly; and a

growing number of nurses have developed special expertise in the management of voice patients. In the fourth edition, we have tried to compile the latest information (practical, common, rare, and cutting edge) to make available in one convenient source the intellectual advances that have permitted such remarkable interdisciplinary growth in voice care and science.

The first edition contained 33 chapters. The second edition was expanded to 68 chapters and contained much new information. The third edition consisted of 106 chapters in three volumes, and served as a convenient reference for most of the information a voice care professional or performer might want to know about voice. Similarly, the 120-chapter fourth edition is intended as a clinically useful compendium of current knowledge in laryngology, as well as selected speculation on the future of the field. Even the most sophisticated basic science chapters provide enough introductory information to render them accessible to readers without an extensive science background who are interested in the subjects covered. Many of the topics that have been added review material discovered since the third edition was written. Some chapters highlight the treatment of more general otolaryngologic problems with an emphasis on their management in voice professionals.

As a compendium of information about care of the professional voice user, this book naturally includes information of practical value for the singer, actor, or other professional voice user. In fact, much of the material presented has been included in my courses on pedagogy taught at the Academy of Vocal Arts since 1980 and at other music schools, as well as in courses for physicians and other health care providers. Voice students, singing teachers, acting-voice trainers, and others report having found this information valuable in augmenting their traditional teaching approaches, in understanding healthy functioning of the voice, recognizing voice dysfunction early, knowing when to refer, and in knowing how to assess the quality of medical care rendered. It also appears that students trained with this information appreciate the importance of maintaining vocal health; and they seem to spend less time sick, injured, or in a physician's office (especially for preventable problems) than their colleagues without such training.

Volume I begins with two introductory chapters on the history of voice disorders and their treatment. Chapters 1 and 2 in the fourth edition have been updated slightly from the third edition. **Chapter 1** provides perspective on modern voice medicine and a brief historical overview of its development from the time of Hippocrates.

Chapter 2, which begins the section on basic voice science, is a classic treatise on the history of the larynx and voice over the centuries, updated slightly by Hans von Leden before his death in 2014. **Chapter 3** provides introductory information about the physics of sound. **Chapter 4** has been added and contains fascinating basic information on laryngeal development. **Chapter 5** on laryngeal embryology is unchanged. **Chapter 6** also contains substantial additions. It reviews what is known about the genetics of voice from a clinical perspective. **Chapter 7** has been rewritten heavily and offers extraordinarily lucid insight into the complex topics of genomics and proteomics as they relate to the larynx. **Chapter 8** on clinical anatomy and physiology of the voice has been rewritten and expanded. It 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 9** offers clear additional insights into neuroanatomy and physiology synthesized by Christy Ludlow. **Chapter 10** is an exceptionally interesting chapter on Music and the Brain, and it has been updated extensively. It reviews much of what is known currently about central development and processing of musical information; and this science should be extremely valuable in expanding the vision of voice researchers and clinicians. **Chapter 11** on arytenoid cartilage movement is a classic chapter that presents unique clarification of this often misunderstood subject, and has not been altered. Chapters 12 and 13 contain much new information. In **Chapter 12**, Susan Thi-beault et al summarize their extraordinary insights into structural response to vocal fold injury. In **Chapter 13**, Ashley Ferster and Leslie Malmgren (now deceased) crystallized current knowledge regarding cellular and molecular mechanics of vocal fold aging. **Chapter 14**, Baken's overview of laryngeal function, has been updated with minor changes. **Chapter 15** has been revised. In this chapter, Scherer expands on the information in Baken's chapter and provides insights into many more complex aspects of laryngeal function. Sundberg has rewritten and updated **Chapter 16** on vocal tract resonance. **Chapter 17** on chaos and voice disorders also has been revised and expanded to contain fascinating new ideas on applications of non-linear dynamics to voice care and research. Baken's revised **Chapter 18** expands the concepts presented in Chapter 17 on applications of chaos theory in understanding and caring for the human voice.

Beginning the section on clinical assessment of voice disorders, **Chapters 19** and **21** have been

expanded to summarize more of the information that was covered only as complete chapters (rather than summary paragraphs) previously. Some of those chapters have been deleted from this edition. **Chapter 20** on special considerations for actors has only minor changes. **Chapter 22** 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 23 and 24 are new. In **Chapter 23**, Echternach expands extensively on the basic information about high-speed digital imaging that was introduced in chapter 22. **Chapter 24** provides an overview of the evolution of technology over more than a century, and its influence on the development of laryngology. **Chapter 25** on laryngeal electromyography has been expanded to include more technical information and more information regarding use of this important technology, as well as new references on efficacy and clinical applications of laryngeal EMG. **Chapter 26** updates Dr. Eiji Yanagisawa's techniques for laryngeal photography including all of the specific information a reader might require to replicate his success. **Chapter 27** reviews remarkable computed tomography technology developed in France that provides color images that might be mistaken for histologic sections. It represents the state-of-the-art in imaging. **Chapter 28** 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 29**, Benninger and his colleagues have updated their pioneering work on measuring voice treatment outcomes.

Chapter 30, which begins Volume II with a section on disorders commonly managed without surgery, has been expanded to include new entities, and to provide more information on disorders that were covered as only separate chapters in previous editions. **Chapter 31** also has 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 32** 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 33** on hearing loss has been updated to include a review of the last literature. **Chapter 34** is new and reviews what is known about the influence of hearing

on phonation. **Chapter 35** has been revised to include the most recent techniques in refractive surgery and their implications for performing artists. **Chapter 36** on ophthalmologic care in performers required no changes. **Chapter 37** 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 38** 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 39** also is new and provides the most current information on the vocal effects of birth control medications. **Chapter 40** on breast cancer has been revised to include the latest information on surgical and adjunctive therapy and the implications of breast cancer treatment on singing performance. **Chapter 41** is a new chapter on autoimmune disorders and their affects on the voice. **Chapter 42** also has been rewritten extensively. In addition to covering various aspects of psychological assessment and treatment, it integrates information on the role of psychological professionals and others involved in management of voice patients. **Chapter 43** (Allergy), **Chapter 44** (The Nose), **Chapter 45** (Rhinosinusitis) and **Chapter 46** (Respiratory Dysfunction) required only moderate revisions to bring them up to date. **Chapter 47** offers a new and practical discussion of cough and the unified airway (from *Diagnosis and Treatment of Voice Disorders*). **Chapter 48** contains substantial new information on topics such as World Trade Center Syndrome and laryngeal effects of asbestos exposure. **Chapters 49** (Pyrotechnics in the Entertainment Industry), **50** (Pyrotechnics: Health Effects), **51** (Artificial Fogs and Smokes), **52** (Infectious and Inflammatory Disorders of the Larynx), and **53** (Pharyngitis) all contain substantial new information and the most recent references. **Chapter 53** (Pharyngitis) remains a separate chapter because of the importance of the complex issue of "sore throat" in professional voice users. It is included to review current practice and to serve as a reminder that pharyngitis still can be a serious, even life-threatening condition. Minor changes were made in **Chapter 54** on halitosis. **Chapter 55** 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 56** 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, but extremely important to

performers, especially those who travel extensively. **Chapter 57** on chronic fatigue syndrome has been updated to include the latest literature and clinical management paradigms. **Chapter 58** on nutrition has been largely rewritten and includes important recent changes in criteria and strategy, reflecting developments in nutritional science over the last decade. **Chapter 59** includes extensive new information on laryngopharyngeal reflux, diagnosis, treatment, and research. It cites almost 600 references including literature written since publication of the third edition, as well as classic literature that was written previously. **Chapter 60** (Seating Problems and Vocalists) has only minor changes. **Chapter 61** on bodily injuries and their effects on the voice has been revised slightly, but **Chapter 62** 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 63** is a new discussion of respiratory behavior and vocal tract issues in wind instrumentalists. It addresses the facts behind the long-standing controversy about simultaneous study of voice and wind instruments.

Chapter 64 on neurological disorders also has been revised extensively and contains the latest information about many conditions, including some rarely covered in the laryngologic literature. **Chapter 65** on vocal fold paresis and paralysis has been expanded. It includes the latest concepts in diagnosis and treatment, including reinnervation and the use of laryngeal pacemakers. **Chapter 66** on spasmodic dysphonia has been revised not only to review the most current literature but also to describe our current practices regarding clinical and laboratory diagnosis and treatment. Other uses of Botulinum toxin are covered separately in another chapter (70).

Five chapters on medications follow. **Chapter 67** on medications and their effects on the voice has been updated and revised extensively. **Chapter 68** reviews for laryngologists the psychiatric manifestations of medicines that we prescribe commonly. Most of us do not think about these issues routinely; but we need to be aware of them especially in voice professionals in whom such complications might lead to performance disasters. Little is known about the effects of chemotherapy on the voice. **Chapter 69** reviews the actions of common classes of chemotherapeutic drugs and speculates on their probable voice effects. It is intended to serve as a call for research. **Chapter 70** provides an extensive discussion of Botulinum toxin and its various uses in otolaryngology, including many that were not discussed in the third edition. A discussion of Botulinum toxin type B is included.

Chapter 71 on medications for traveling performers has been revised to delete medications no longer used frequently and add various medications and drug classes that were not included in previous editions.

The section on voice therapy and treatment begins with **Chapter 72**, Introduction to Treating Voice Abuse, and **Chapter 73**, Speech-Language Pathology and the Professional Voice User, which are unchanged. **Chapter 74** on voice therapy has been rewritten extensively to include substantially more detail regarding specific therapeutic techniques that were not included in the first three editions, highlighting our current practices. **Chapter 75** on voice rest has been revised to include additional information published on this controversial topic since the last edition. Only minor changes were necessary in **Chapter 76**, Increasing Vocal Effectiveness. **Chapter 77**, The Singing Teacher in the Age of Voice Science, is a classic chapter by the late Richard Miller that was retained unchanged, as was his chapter (78) which provides a historical overview of voice pedagogy. It is interesting not only for singers, but also provides information useful for laryngologists and speech-language pathologists who may need to understand the basis and thinking of various schools of voice training through which their patients have been influenced by their teachers. **Chapter 79** on the singing voice specialist has been rewritten extensively to include the most current techniques for management of the singing voice, for using singing techniques to help nonsingers, and to reflect our latest beliefs and practices, as well as the most recent information from the evolving literature in this field. **Chapter 80**, (The Use of Instrumentation in the Singing Studio) also needed only minor updates. **Chapter 81** includes not only revisions of the previous chapter, but also new material on choral pedagogy for geriatric singers. **Chapter 82** is a new chapter on pedagogy for children that provides insights into the training and approaches to teaching voice in primary and secondary. **Chapter 83**, The Role of the Acting-Voice Trainer on the Medical Care of Professional Voice Users needed only minor changes. **Chapter 84** has been modified from the fourth edition of *Diagnosis and Treatment of Voice Disorders* to update material published in the third edition of this book on laryngeal manipulation. Written by an osteopathic physician and two laryngologists, this topic was added because laryngeal manipulation has been used for decades by voice therapists and for centuries by singing teachers. This chapter is intended to provide introductory medical perspective on the subject. **Chapter 85** reviews important information on postural analysis, a subject more familiar to other medical specialties

(such as psychiatry) than to otolaryngology. **Chapter 86** on exercise physiology has been rewritten completely by new authors and includes the most recent concepts and literature on this topic. Understanding exercise physiology is critical to understanding voice training and rehabilitation.

Volume III begins with a section on structural disorders and surgery. **Chapter 87** and **Chapter 88**, historical chapters on phonosurgery and phonomicrosurgery, contain relatively minor revisions. **Chapter 89** has been revised extensively. It includes a great deal of surgical information and illustrations not included in previous editions. Topics covered in depth include, among others, patient selection, informed consent, approaches to anesthesia, selection of instrumentation, indirect laryngoscopic approaches, direct laryngoscopy, laryngeal framework surgery, and other subjects. The chapter is replete with details and “how I do it” suggestions. There are new sections on supraglottoplasty, subglottic stenosis, vocal fold injection, removal of Radiesse, false vocal fold medialization, mini-thyrotomy, viscosity of injectable materials, fascia injection, and other topics. **Chapter 90** has been modified only slightly. The most current information on techniques and controversies of laryngeal laser surgery are discussed in detail in **Chapter 91**. **Chapter 92** is new. In-office surgery is being performed more and more frequently in the United States and elsewhere, but it is not without hazard. This chapter reviews the safety of procedures performed in an office setting. **Chapter 93** on structural abnormalities of the larynx has been revised. In addition to updating information on entities covered in previous editions, additional disorders and new illustrations are included. **Chapter 94** on vocal fold hemorrhage has been updated with the most current references. **Chapter 95** on vocal fold scar has been expanded and rewritten to include the latest literature and concepts. **Chapter 96** on laryngeal trauma has been revised and expanded. **Chapter 97** provides detailed and updated information on diagnosis and management of cricoarytenoid and cricothyroid joint injury, including references to the most recent publications. **Chapter 98** reviews the classification and complex management of posterior glottic stenosis and has been revised to include the most recent research. **Chapter 99** reviews the complex subject of gender reassignment (sex change). It covers the voice therapeutic, behavioral (not psychological), and laryngeal surgical approaches through which we may assist gender reassignment patients. In **Chapter 100**, Courey reviews current surgical approaches to the management of sleep disorders and their implications for singers and actors. **Chapter 101**

has been rewritten and includes additional information on cosmetic procedures and their implications for voice professionals. **Chapter 102** on premalignant lesions has been revised; and **Chapter 103** on laryngeal cancer has been revised to include the most current management approaches, some of which have become popular since the third edition was written.

The final section of the book begins with a new chapter (**104**) on establishing a professional voice practice. **Chapters 105** on nursing considerations and **106** on voice care professionals required just minor revisions. **Chapter 107** has been revised and expanded to include more extensive discussion of impairment, disability, and handicap; proposals for equitable disability calculation; case examples; and a discussion of the laryngologists’ role in selected legal matters. It also contains a new review of the development of the AMA guides from impairments 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 108** also is new to this book. It provides practical information on the laryngologist’s role in medical-legal matters, as well as suggestions to minimize the risks of becoming a defendant in voice-related litigation. **Chapter 109** has been added to this edition. It provides the laryngologist with guidance on serving as an expert witness in legal matters. **Chapter 110**, by Judith A. Gic, a registered nurse and attorney (now deceased), discusses legal considerations for physicians involved with voice disorders and their management. It includes case law citations. **Chapter 111** was new in the third edition and has been updated extensively for the fourth edition. It is a chapter about which I remain 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 hope that this chapter may inspire new clinical approaches to objective voice assessment. In **Chapter 112**, Clark Rosen and Kimberly Steinhauer have revised their thought-provoking overview of controversies in the care of singers. **Chapter 113** addresses the complex and controversial ethical issues faced by singing teachers with students or prospective students who refuse to undergo medical evaluation even when that is recommended by the teacher. **Chapter 114** has been revised substantially to include our current perspective on the near-future horizons in laryngology and voice research. **Chapter 115** discusses the important and often neglected topic of education in laryngology. **Chapter 116** discusses the academic practice of

medicine, which the author views as a state of mind, rather than a place of employment. It is new to this book. **Chapter 117**, Interdisciplinary Opportunities for Creativity in Medicine is unchanged. **Chapter 118** is also new to this book, and it discusses “teamwork,” a philosophy and behavior that is critical to the interdisciplinary practice of laryngology.

Chapter 119, is a new chapter about the importance of studying music in general. **Chapter 120** on Physicians Studying the Arts, required no revision.

The appendices also have been updated. They include a summary of the phonetic alphabet in five languages, clinical history and examination forms, a special history form translated into 15 languages, sample reports from a clinical voice evaluation, voice therapy exercise lists, and a multidisciplinary glossary that has been revised and expanded for the fourth edition. The fourth edition also contains many more color photographs, illustrations, and case examples than were published in the third edition. In addition to updating and rewriting chapters for

the fourth edition, seven chapters from previous editions have been deleted, and 21 new chapters have been added.

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 79 of the 120 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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I remain indebted to the many friends and colleagues acknowledged in the first, second, and third editions 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 the fourth 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 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, Johns MM, Plural Publishing, Inc, San Diego, CA; 2016), *Sataloff’s Comprehensive Textbook of Otolaryngology and Head and Neck Surgery*

(Jaypee, New Delhi, 2016), *Performing Arts Medicine*, 3rd ed. (Sataloff RT, Brandfonbrener A, Lederman R, Science and Medicine, Narberth, PA; 2010) and to the publisher of *Annals of Otolaryngology, Rhinology and Laryngology* for permission to republish my American Laryngological Association Baker Lecture on education in laryngology.

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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 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 Otolaryngology, 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, the American Society of Geriatric Otolaryngology, 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. 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 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 modern comprehensive article on care of singers (1981), and the first chapter (1986) and book (1991) 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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Contributors

Mona M. Abaza, MD, MS

Associate Professor
Department of Otolaryngology-Head and Neck
Surgery
University of Colorado
Denver, Colorado

Jean Abitbol, MD

Ancien Chef de Clinique
Faculty of Medicine of Paris
Oto-Rhino-Laryngologiste
Phoniatric–Chirurgie
Paris, France

Patrick Abitbol, MD

Faculty of Medicine of Paris
Oto-Rhino-Laryngologiste
Paris, France

Mark T. Agrama, MD

Department of Otolaryngology-Head and Neck
Surgery
River Region Health System
Vicksburg, Mississippi

Kenneth W. Altman, MD, PhD

Professor, Vice Chair for Clinical Affairs
Department of Otolaryngology-Head and Neck
Surgery
Baylor College of Medicine
Houston, Texas

Dawn D. Anderson, MD

MIT Medical Services
Cambridge, Massachusetts

Timothy D. Anderson, MD

Director, Division of Voice and Swallowing
Department of Otolaryngology-Head and Neck
Surgery
Lahey Clinic
Burlington, Massachusetts

Joseph Anticaglia, MD

Ear, Nose, and Throat Associates of New York
Flushing, New York

R. J. Baken, PhD

Professor Emeritus
Columbia University
New York, NY
Senior Lecturer
New York Medical College
Valhalla, NY

Margaret M. Baroody, MM

Instructor
Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Singing Voice Specialist
Voice Technologist
American Institute for Voice and Ear Research
Philadelphia, Pennsylvania

Michael S. Benninger, MD

Chairman, Head and Neck Institute
Professor of Surgery
Lerner College of Medicine
The Cleveland Clinic
Cleveland, Ohio

Rajeev Bhatia, PhD

Computer and Information Science
Electrical Engineer
Narberth, Pennsylvania

Ed Blake, MSc (Phy), MCST, SRP

Physiatrist
Specialist in Dance and Vocal Medicine
Physio-Ed Medical
London, England

Ronald S. Bogdasarian, MD

Trinity Health
Ann Arbor, Michigan

Linda M. Carroll, PhD, CCC-SLP

Senior Voice Research Scientist
Department of Surgery, Division of Otolaryngology-
Head and Neck Surgery
The Children's Hospital of Philadelphia
New York, New York

Professor, Program Director
 Graduate School of Speech and Language
 Pathology
 Yeshiva University
 Research Assistant
 Department of Otolaryngology-Head and Neck
 Surgery
 Montefiore Medical Center
 Bronx, New York

Donald O. Castell, MD
 Professor of Medicine
 Director of Esophageal Disorders Program
 Department of Gastroenterology and Hepatology
 Charleston, South Carolina

Albert Castro, MD
 Radiologue
 Directeur Centre d'Imagerie Médicale Numérisée
 Monceau
 Paris, France

Susan E. Cline, MS, CCC-SLP
 Clinical Voice Specialist
 The Voice Care Center at Presbyterian Hospital
 Charlotte, North Carolina

John R. Cohn, MD, FCCP
 Professor of Medicine and Pediatrics
 Thomas Jefferson University
 Philadelphia, Pennsylvania

Mark S. Courey, MD
 Professor
 Department of Otolaryngology-Head and Neck
 Surgery
 Division Chief of Laryngology
 Vice Chair of Quality
 Mount Sinai Health System
 New York, New York

Linda Dahl, MD
 Clinical Assistant Professor
 Department of Otolaryngology-Head and Neck
 Surgery
 New York Presbyterian Hospital/Weill Cornell
 Medical Center
 Dahl Otolaryngology Center
 New York, New York

Nyree Dardarian, MS, RD, LDN, CSSD, FAND
 Assistant Clinical Professor
 Director, Center for Nutrition & Performance
 Coordinator, Individualized Supervised Practice
 Pathway
 Drexel University
 Philadelphia, Pennsylvania

William J. Dawson, MD
 Performing Artist in Residence
 Duke University Hospital
 Music Teaching Fellow
 Duke Children's Hospital
 Durham, North Carolina

Carole M. Dean, MD
 Otolaryngologist
 Northside Hospital
 Atlanta, Georgia

Daniel A. Deems, MD, PhD
 University ENT Associates
 Sarasota, Florida

Cynthia Del'Aria
 Colorado Voice Clinic
 Denver, Colorado

Joseph D. DePietro, MD
 Otolaryngologist
 Boston Medical Center
 Boston University School of Medicine
 Boston, Massachusetts

Matthias Echternach, MD
 Professor
 Institute of Musicians Medicine
 Freiburg University
 Freiburg, Germany

Kate Emerich, BM, MS, CCC-SLP
 Singing Voice Specialist
 Voice Pathologist
 Owner, Vocal Essentials, LLC
 Denver, Colorado

Erynne A. Faucett
 Resident
 University of Arizona College of Medicine-Tucson
 Department of Otolaryngology-Head & Neck
 Surgery
 Tucson, Arizona

Ashley P. O'Connell Ferster, MD
 Department of Surgery
 Division of Otolaryngology-Head and Neck
 Surgery
 Penn State Milton S. Hershey Medical Center
 Hershey, Pennsylvania

Sharon L. Freed, BA, MFA
 Voice and Speech Consultant
 Philadelphia, Pennsylvania

Oren Friedman, MD
 Associate Professor

Department of Otorhinolaryngology
Perelman School of Medicine
The University of Pennsylvania
Philadelphia, Pennsylvania

Glendon M. Gardner, MD

Department of Otolaryngology-Head and Neck
Surgery
Department of Neurology
Henry Ford Hospital
Detroit, Michigan

Joanne E. Getsy, MD, FCCP, FAASM

Professor of Medicine
College of Medicine
Drexel University
Chief, Sleep Section
Program Director, Sleep Medicine Fellowship
Medical Director, Drexel Sleep Center
Medical Director, Hahnemann University
Hospital
Neurodiagnostics Sleep Disorders Center
Philadelphia, Pennsylvania

Judith A. Gic, RN, CRNA, JD, FCLM (deceased)
West Hartford, Connecticut

Stephen A. Goldstein, MD

Associate Professor of Otolaryngology
Director, Facial Plastic and Reconstructive Surgery
University of Arizona
Tucson, Arizona

Rodolphe Gombergh, MD

Radiologue, Directeur du Centre d'Imagerie
Médicale Numérisée Monceau
Paris, France

Steven D. Gray, MD (deceased)

Formerly Professor and Hetzel Presidential Chair
Division of Otolaryngology-Head and Neck
Surgery
Department of Surgery
University of Utah
Salt Lake City, Utah

Reena Gupta, MD, FACS

Director, Division of Voice and Laryngology
Osborne Head and Neck Institute
Los Angeles, California

Tom M. Harris, MA, FRCS

Consultant ENT Surgeon
University Hospital Lewisham
Director, The Voice Clinic
Queen Mary's Hospital

Honorary Senior Lecturer, Guy's King's St. Thomas'
Medical Schools
London, United Kingdom

Mary J. Hawkshaw, RN, BSN, CORLN

Research Professor
Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Philadelphia, Pennsylvania

Yolanda D. Heman-Ackah, MD

Medical Director
Philadelphia Voice Center
Clinical Professor
Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Adjunct Associate Professor
Department of Otolaryngology-Head and Neck
Surgery
Thomas Jefferson University
Philadelphia, Pennsylvania

David H. Henick, MD

Clinical Assistant Professor
Department of Otolaryngology
Albert Einstein College of Medicine
New York, New York

Reinhardt J. Heuer, PhD

Professor Emeritus
Department of Communication Sciences and
Disorders
Temple University
Adjunct Professor
Department of Otolaryngology-Head & Neck
Surgery
Drexel University College of Medicine
Philadelphia, Pennsylvania

Matthew Hoch, DMA

Associate Professor
Department of Music
Auburn University
Auburn, Alabama

Harry F. Hollien, PhD

Courtesy Professor
Department of Communication Sciences and
Disorders
University of Florida
Gainesville, Florida

Michelle Horman, M.A., CCC-SLP

Instructor

Department of Otolaryngology-Head & Neck
Surgery
Drexel University College of Medicine
Voice Pathologist
American Institute for Voice and Ear Research
Philadelphia, Pennsylvania

Amanda Hu, MD, FRCSC

Associate Professor
Department of Otolaryngology-Head & Neck
Surgery
Drexel University College of Medicine
Philadelphia, Pennsylvania

Barbara H. Jacobson, PhD

Associate Professor
Department of Hearing and Speech Services
Vanderbilt Voice Center
Vanderbilt University Medical Center
Nashville, Tennessee

Aaron J. Jaworek, MD

Clinical Instructor
Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Philadelphia, Pennsylvania
Specialty Physician Associates
Bethlehem, Pennsylvania

Hala Kanona

Otolaryngology Registrar
Royal Ear Nose and Throat Hospital
London, England

Philip O. Katz, MD

Professor
Department of Medicine
Division of Gastroenterology
Weill Cornell Medical Center
New York, New York

Michael E. Keesler, JD, PhD

Post-Doctor Fellow
Clinical Neuropsychology
Diversified Psychological Resources, PC
Philadelphia, Pennsylvania

Karen M. Kost, MD, FRCSC

Professor
Department of Otolaryngology-Head and Neck
Surgery
McGill University Health Center
Montreal, Canada

Frederic B. Kremer, MD

Director, Kremer Laser Eye Surgery Center (retired)

King of Prussia, Pennsylvania
Ophthalmologist

Jeffrey T. Laitman, PhD, D.Med.Sc (hon), FAAAS, FAAA, FALA

Distinguished Professor
Icahn School of Medicine at Mount Sinai
New York, New York

Kevin P. Leahy, MD, PhD, FACS

Assistant Professor
Department of Otorhinolaryngology
Perelman School of Medicine
The University of Pennsylvania
Philadelphia, Pennsylvania

Robert S. Lebovics, MD

Surgical Consultant
National Institutes of Health
Bethesda, Maryland

James A. Letson, Jr., MD

Associate Clinical Professor
Michigan State University
Adjunct Faculty Member
Central Michigan University
Valley ENT Associates
Saginaw, Michigan

Steven H. Levy, MD, PhD

Medical Director
Psych Arts Center
Philadelphia, Pennsylvania

Jacob Lieberman, DO, MA

Osteopathic Physician and Psychotherapist
London, United Kingdom

Jessica W. Lim, MD

Assistant Professor, SUNY Downstate Health
Sciences Center
Otolaryngology Program Site Director Lenox Hill
Hospital
New York, New York

Sue Ellen Linville, PhD

Professor
Department of Speech Pathology and Audiology
Marquette University
Milwaukee, Wisconsin

Christy L. Ludlow, PhD

Professor
Department of Communication Sciences and
Disorders
James Madison University
Harrisonburg, Virginia

Karen M. Lyons, MD

Clinical Associate Professor

Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Philadelphia, Pennsylvania

Leslie T. Malmgren, PhD (deceased)

Professor
Department of Otolaryngology and
Communication Sciences
SUNY Upstate Medical Center
Syracuse, New York

Steven Mandel, MD

Clinical Professor of Neurology
Lenox Hill Hospital
Hofstra Northwell School of Medicine
Hempstead, New York

Alexander Manteghi, DO

Pediatric Otolaryngology Fellow
University of California-San Diego
San Diego, California

Lesley Mathieson, DipCST, FRCSLT

Visiting Lecturer in Voice Pathology
The University of Reading
Reading, United Kingdom

Jillian Mattioni, DO

Department of Otolaryngology-Head and Neck
Surgery
Philadelphia College of Osteopathic Medicine
Philadelphia, PA

Brian McGovern, Sc.D, FAAA, CCC-A

Instructor
Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Philadelphia ENT Associates
Philadelphia, Pennsylvania

Kirsten Meenan, BS

Drexel University College of Medicine
Philadelphia, Pennsylvania

Richard Miller, DHL (deceased)

Professor of Singing
Director, Otto B. Schoepfle Vocal Arts Laboratory
Oberlin College, Conservatory of Music
Oberlin, Ohio

Claudio F. Milstein, PhD

Director of the Voice Center
Head and Neck Institute
Cleveland Clinic
Cleveland, Ohio

Vidisha Mohad

Division of Otolaryngology-Head and Neck
Surgery
Department of Surgery
Wisconsin Institute for Medical Research
Madison, Wisconsin

Jaime Eaglin Moore, MD

Assistant Professor
Department of Otolaryngology-Head and Neck
Surgery
Adjunct Professor, Department of Music
Virginia Commonwealth University

Jennifer A. Nasser, PhD, RD

Associate Professor
Director
PhD Program in Nutrition Science
Department of Nutrition Science
Drexel University
Philadelphia, Pennsylvania

Michael C. Neuenschwander, MD

Director and Facial Plastic Consultant
Skin and Body Rejuvenation Center
ENT of Georgia
Riverdale, Georgia

Drew M. Noden, PhD

Professor
Anatomy and Animal Development
College of Veterinary Medicine
Cornell University
Ithaca, New York

Richard N. Norris, MD

Private Practice
Physical Medicine and Rehabilitation
Florence, Massachusetts

David A. Opperman, MD

Otolaryngologist
Colorado Voice Clinic
Denver, Colorado

Patricia A. Padams, RN, BSN, CEN

Nurse Manager and Clinical Research Coordinator
(In association with John R. Cohn, MD)
Thomas Jefferson University
Philadelphia, Pennsylvania

Julia A. Pfaff, DO, MPH

Department of Otolaryngology-Head and Neck
Surgery
Philadelphia College of Osteopathic Medicine
Philadelphia, PA

Edmund A. Pribitkin, MD

Professor
Department of Otolaryngology-Head and Neck
Surgery
Sidney Kimmel College of Medicine
Thomas Jefferson University
Philadelphia, Pennsylvania

George R. Pronesti, MD

Ophthalmologist
Kremer Laser Eye Center
King of Prussia, Pennsylvania

Bonnie N. Raphael, PhD

Professor Emeritus
Professional Actor Training Program
Department of Dramatic Art
University of North Carolina at Chapel Hill
Chapel Hill, North Carolina

Robert Rider, PhD

Diversified Psychological Resources, PC
Philadelphia, Pennsylvania

Jennifer P. Rodney, MD

Resident Physician
Department of Otorhinolaryngology
University of Oklahoma Health Sciences Center
Oklahoma City, OK

Jonathan J. Romak, MD

Instructor
Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Philadelphia, Pennsylvania

Christin Coffee Rondeau, MM

Voice Teacher
Dayton, Ohio

Bridget Rose, MM, MS

Instructor
Department of Otolaryngology-Head and Neck
Surgery
Drexel University College of Medicine
Senior Speech Language Pathologist
Philadelphia Ear, Nose, and Throat Associates
Philadelphia, Pennsylvania

Clark A. Rosen, MD

Director
University of Pittsburgh Voice Center
Professor
Department of Otolaryngology-Head and Neck
Surgery
University of Pittsburgh School of Medicine
Pittsburgh, Pennsylvania

Deborah Caputo Rosen, RN, PhD

President
Caputo Rosen Consulting
Philadelphia, Pennsylvania

Monona Rossol, MS, MFA

Industrial Hygienist
President: Arts, Crafts and Theater Safety, Inc
New York, New York

Adam D. Rubin, MD

Adjunct Assistant Professor
Michigan State University School of Medicine
Department of Otolaryngology-Head and Neck
Surgery
University of Michigan Medical Center
Director, Lakeshore Professional Voice Center
Lake Shore Ear, Nose and Throat Center
St. Clair Shores, Michigan

John S. Rubin, MD, FRCS, FACS

Consultant ENT Surgeon
University College London
Hospitals NHS Trust
Lead Clinician
Voice Disorders Unit
Royal National Throat, Nose and Ear Hospital
Co-Lead
Voice and Swallowing Unit
National Hospital for Neurology and Neurosurgery
Honorary Visiting Professor
School of Health Sciences
City University London
Honorary Senior Lecturer
University College London

Amy L. Rutt, DO

Assistant Professor
Department of Otorhinolaryngology-Head and
Neck Surgery
Mayo Clinic Hospital
Jacksonville, Florida

Hilary M. Caruso-Sales, DO

Department of Otolaryngology-Head and Neck
Surgery
Philadelphia College of Osteopathic Medicine
Medical University of South Carolina
Philadelphia, Pennsylvania

Mary J. Sandage, PhD, CCC-SLP

Assistant Professor
Department of Communication Disorders
Auburn University
Auburn, Alabama

David A. Sasso, MD, MPH

Assistant Clinical Professor

Child Study Center
Yale School of Medicine
New Haven, Connecticut

Dahlia M. Sataloff, MD
Chairman, Department of Surgery
Pennsylvania Hospital
Professor of Clinical Surgery
University of Pennsylvania
Perelman School of Medicine
Philadelphia, Pennsylvania

Jonathan B. Sataloff, BS, BA
Harvard Medical School
Harvard University
Boston, MA

Joseph Sataloff, MD, DSc (deceased)
Professor
Department of Otolaryngology-Head and Neck
Surgery
Thomas Jefferson University
Philadelphia, Pennsylvania

Robert Thayer Sataloff, MD, DMA
Professor and Chairman
Department of Otolaryngology-Head and Neck
Surgery
Senior Associate Dean for Clinical Academic
Specialties
Drexel University College of Medicine
Chairman, The Voice Foundation
Chairman, American Institute for Voice and Ear
Research
Faculty, Academy of Vocal Arts
Philadelphia, Pennsylvania

Ronald C. Scherer, PhD
Distinguished Research Professor
Department of Communication Disorders
Bowling Green State University
Bowling Green, Ohio

Morgan A. Selleck, MD
Resident
Department of Otolaryngology-Head and Neck
Surgery
Chapel Hill School of Medicine
University of North Carolina
Chapel Hill, North Carolina

Rupali N. Shah, MD
Clinical Assistant Professor
Division of Voice and Swallowing
Department of Otolaryngology-Head and Neck
Surgery

University of North Carolina Hospitals
Chapel Hill, North Carolina

H. Steven Sims, MD
Associate Professor
Department of Otolaryngology-Head and Neck
Surgery
University of Illinois School of Medicine
Director
Chicago Institute for Voice Care
Chicago, Illinois

Catherine F. Sinclair, MD
Director
Division of Head and Neck Surgery
St. Luke's and Roosevelt Hospital Centers New York
Assistant Clinical Professor
Albert Einstein School of Medicine
New York, New York

Marcel J. Sislowitz, MD, FACS
Assistant Clinical Professor
Mt. Sinai Medical School
New York, New York

Brenda J. Smith, DMA
Associate Professor of Music (Voice)
School of Music
University of Florida
Gainesville, Florida

Carol A. Smith, MD, PhD
Medical Director, Kremer Laser Eye Center
Cherry Hill, New Jersey

Dominic A. Solimando, Jr., MA FAPhA, FaSHP
President, Oncology Pharmacy Services, Inc.
Arlington, Virginia

Joseph R. Spiegel, MD, FACS
Associate Professor
Department of Otolaryngology-Head and Neck
Surgery
Thomas Jefferson University
Philadelphia, Pennsylvania

Kevin Stavrides
Department of Otolaryngology-Head and Neck
Surgery
Philadelphia College of Osteopathic Medicine
Philadelphia, Pennsylvania

Kimberly M. Steinhauer, PhD
University of Pittsburgh Voice Center
Department of Communication Science and
Disorders

University of Pittsburgh School of Health and
Rehabilitation Sciences
Pittsburgh, Pennsylvania

Johan Sundberg, PhD

Professor, Department of Speech Communication
and Music Acoustics
Royal Institute of Technology
Stockholm, Sweden

Thomas Swirsky-Sacchetti, PhD

Clinical Associate Professor Neurology and
Psychiatry
Jefferson Medical College
Thomas Jefferson University
Philadelphia, Pennsylvania

Mausumi N. Syamal

Oakland University William Beaumont School of
Medicine
Rochester, Michigan

Sharon S. Tang, MS, CCC-SLP

Predocctoral Fellow, Research Assistant
University of Wisconsin-Madison
Department of Communication Sciences and
Disorders
Department of Surgery
Division of Otolaryngology-Head and Neck
Surgery
Madison, Wisconsin

Renny Tatchell, PhD, CCC-SLP

Speech-Language Pathologist
Mt. Pleasant, Michigan
Chairman, Department of Communication
Disorders
Central Michigan University
Saginaw, Michigan

Susan L. Thibeault, PhD, CCC-SLP

Professor, Diane M. Bless Endowed Chair
Division of Otolaryngology-Head and Neck
Surgery
Department of Surgery
Wisconsin Institute for Medical Research
Madison, Wisconsin

Valerie L. Trollinger, PhD

Associate Professor of Music
College of Visual and Performing Arts
Kutztown University of Pennsylvania
Kutztown, Pennsylvania
Adjunct Associate Professor

Department of Otolaryngology- Head and Neck
Surgery
Drexel University College of Medicine
Philadelphia, Pennsylvania

Thomas R. Van De Water, PhD

Director
Cochlear Implant Research Program
Department of Otolaryngology-Head and Neck
Surgery
University of Miami
Miller School of Medicine
Miami, Florida

Hans von Leden, MD (deceased)

Consultant in Otolaryngology
Los Angeles, California

Julie A. Wang, MD

Assistant Professor
Division of Internal Medicine
Drexel University College of Medicine
Philadelphia, PA

Michelle White, BA

Drexel University College of Medicine
Philadelphia, Pennsylvania

Carol N. Wilder, PhD (deceased)

Professor of Speech Science
Teachers College
Columbia University
New York, New York

Eiji Yanagisawa, MD, FACS

Clinical Professor of Otolaryngology
Yale University School of Medicine
New Haven, Connecticut

Ken Yanagisawa, MD, FACS

Assistant Clinical Professor
Yale University School of Medicine
New Haven, Connecticut

Riita Ylitalo, MD

Associate Professor
Huddinge University Hospital
Department of Logopedics and Phoniatrics
Karolinska Institute
Stockholm, Sweden

Steven M. Zeitels, MD, FACS

Eugene B. Casey Professor of Laryngeal Surgery
Harvard Medical School
Director, Center for Laryngeal Surgery and Voice
Rehabilitation
Massachusetts General Hospital
Boston, Massachusetts

George Ziade, MD

Department of Otolaryngology-Head and Neck

Surgery

American University of Beirut Medical Center

Beirut, Lebanon

Video References

Some of the topics in this book may be made more clear through related video examples. The following list represents a small number of the many resources available online. It is not intended to be all inclusive. Neither is it intended to imply that these are the best available videos for all of the topics in this book. We hope that the reader will find these suggested videos useful and will search the internet for more video resources on the human voice.

The Voice Foundation

This link will take the reader to approximately 40 Voice Foundation (TVF) videos and more are added periodically.

The Voice Foundation video link:

<https://www.youtube.com/channel/UCHsajYigayU0ORdZv1YgyDw>

Selected videos from TVF YouTube channel:

<https://www.youtube.com/watch?v=r3q1HiaFKi0> Regulatory Motion of the Voice In Singing

<https://www.youtube.com/watch?v=xM29eI12YeA> Surgery of the Voice, Robert Thayer Sataloff

<https://www.youtube.com/watch?v=vlHFvK94cgk> Function of the Larynx, Hans Von Leden

Other

<https://www.youtube.com/watch?v=S20XBwGO0AY> Engineered Vocal Fold Tissue

<https://www.youtube.com/watch?v=-XGds2GAvGQ> Vocal Folds - Singing

Voice Laboratory (including power spectrum)

<https://www.youtube.com/watch?v=LQnpOlhnFHw>

<https://www.youtube.com/watch?v=YVJbi0WPqPw>

<https://www.youtube.com/watch?v=i9PtKp0kNbc> CSL&MDVP Demo

<https://www.youtube.com/watch?v=1br8o22Krh4> Acoustic Evaluation

Voice Samples

https://www.youtube.com/watch?v=gXeR__rbrl4 Vocal Fold Polyp

<https://www.youtube.com/watch?v=Ylerwo7TeAg> Types of Vocal Fold Paralysis

<https://www.youtube.com/watch?v=xoReRcwt2v0> Vocal Granuloma

What singing looks like on a MRI Invisible Motion

https://www.ted.com/talks/michael_rubinstein_see_invisible_motion_hear_silent_sounds_cool_creepy_we_can_t_decide?language=en

MRI while Singing

<https://www.facebook.com/quartznews/videos/1176008672432833/>

Plural Publishing Videos

Plural Publishing has a Voice playlist on its YouTube channel at:

<https://www.youtube.com/playlist?list=PLBrjggf2e5iJIfno--mY4dKIBgMmzIGDt>

Dedication to the Fourth Edition

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.

Dedication to the Third Edition

To my wife Dahlia Sataloff, MD, my sons Benjamin Harmon Sataloff and Johnathan Brandon Sataloff, my parents Joseph Sataloff, MD and Ruth Sataloff, and my friend and editorial assistant Mary J. Hawkshaw RN, BSN, for their unfailing patience and support.

and

To Wilbur James Gould, MD, friend, scholar, educator, and founder of the Voice Foundation, who devoted his life to improving, understanding, and caring for the human voice.

and

To Howell S. Zulick, my voice teacher for twenty-nine years and an inspiration for life.

and

To Walter P. Work, Charles J. Krause, and Malcolm D. Graham, the professors who trained me and cultivated the love for academic medicine inspired by my father and for which he wisely sent me to Ann Arbor.

Dedication to the Second Edition

To my twin sons Benjamin Harmon Sataloff and Johnathan Brandon Sataloff.

Dedication to the First Edition

To Wilbur James Gould, MD, friend, scholar, and educator, who has devoted his life to improving, understanding, and caring for the human voice, and who has inspired and assisted so many colleagues to join in this endeavor.

and

To my wife Dahlia M. Sataloff, MD, parents Joseph Sataloff, MD, and Ruth Sataloff, and editorial assistant Mary J. Hawkshaw, RN, BSN for their unfailing patience and support.

VOLUME I

Basic Science and Clinical Assessment

PART I

INTRODUCTION

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.

Various other relevant works are listed in the citations above and in subsequent chapters in this book by von Leden and Zeitels (see Chapters 2, 87, and 88).

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. Stroboscopic 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 producing 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) (Appendix I). 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 profes-

sionals, but we also have incorporated information, thought processes, and problem-solving strategies from these various disciplines into our clinical thinking, 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 questions, and how to go about answering those questions. Our future promises continued advances in all of those areas and more.

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