Voice Disorders

FIFTH EDITION

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Plural Publishing Inc.

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Contents

Foreword

It is with profound respect and admiration that I introduce the fifth edition of *Voice Disorders* by Drs. Christine Sapienza and Bari Hoffman. This latest edition represents not only a continuation of their long-standing contributions to the field of voice science and care but also a significant advancement in how we understand, teach, and treat voice disorders in the modern clinical era.

Drs. Sapienza and Hoffman are internationally recognized as leading voices in laryngeal and respiratory physiology. They are true teacher–scientist–clinicians whose careers have been marked by a deep commitment to evidence-based practice, academic excellence, and patient-centered care. In this edition, they bring together the most current research, expansive clinical knowledge, and real-world teaching experience to create a textbook that is as informative as it is inspiring.

This edition begins, as in previous versions, with a foundational focus on respiration, an intentional and distinctive feature that sets this text apart. The decision to lead with the respiratory system underscores its critical role in phonation and voice production. These opening chapters have been substantially revised and beautifully illustrated, offering readers a clear, engaging, and in-depth understanding of respiratory and laryngeal anatomy and physiology. The visual and written content are seamlessly integrated to support learning at all levels, from novice students to seasoned professionals.

The fifth edition also offers expanded coverage of contemporary topics shaping today's voice-care landscape. Chapters on laryngeal biomechanics, immunological factors, medication effects, and gender-affirming voice care reflect the authors' dedication to inclusivity, clinical relevance, and scientific rigor. They engaged their respected colleagues in voice to assist them in providing the best and most accurate information to readers for theoretical, evaluative, and management approaches. A thoroughly updated chapter on head and neck cancer includes modern surgical techniques, including robotic procedures, and offers practical guidance for clinicians supporting patients through complex care journeys.

What continues to distinguish this book is its exceptional balance of science and application. Therapy approaches are not only described but also contextualized within real clinical scenarios, empowering clinicians to make informed, individualized treatment decisions. The chapter dedicated to singers and vocal performers is a standout, demonstrating the authors' deep connection to the performing arts community and offering thoughtful strategies for working with elite voice users. In this chapter, and throughout the book, unique content, such as discussion of the Alexander Technique and the Feldenkrais Method, illustrates the authors' holistic approach to voice rehabilitation.

Beyond content, this book captures the authors' passion for mentoring future professionals. Their ability to take complex concepts and make them accessible, teachable, and clinically applicable is a testament to their skill as educators. This text serves not only as a reference but also as a trusted guide that will inform classroom instruction, shape clinical practice, and inspire the next generation of voice professionals.

Having had the privilege of reviewing earlier editions and working alongside these authors in both academic and clinical contexts, I can attest that this edition represents their most comprehensive and impactful work to date. It reflects their tireless pursuit of excellence, their respect for the voice and those who use it, and their unwavering commitment to elevating the field of voice disorders.

Voice Disorders, Fifth Edition, is a definitive resource for anyone studying or practicing in this field. It will continue to influence how we understand and care for the human voice for many years to come.

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Preface

The human ability to produce voice, shape it into meaningful tones and sounds, and use it for so many varied purposes is truly special. Those who seek the opportunity to study voice will experience teachings from many disciplines and observe outcomes both in clinical use and from the literature that exemplify a truly emerging relationship between knowledge and practice.

With enhancements in medical technologies and medical care, treatment plans are reaching an efficiency that optimizes vocal recovery in a favorable and timely manner. Continual education is critical to stay contemporary and abreast of new techniques and technologies and to respond to the ever-changing clinical environment. You will find an increasing responsibility to collaborate and communicate with all members of the patient's health-care team and a need to familiarize yourself with the ever-changing medical models. You must continue to educate yourself to keep up with the advances in technology. This need may be due not only solely to a rapidity of change in your discipline but also to the swiftness of change in other disciplines (e.g., imaging, molecular biology, surgery, artificial intelligence).

The physical, social, and spiritual dimensions of patient care increasingly require clinicians to possess not only technical proficiency but also a broad and evolving knowledge base. This includes expertise in human anatomy and physiology; neuroanatomy and neurophysiology; instrumentation; computer applications; and an array of medical management topics, including phonosurgical interventions and pharmacological treatments. Equally important is the clinician's ability to communicate effectively, understand family systems, and navigate variables that contribute to the complex landscape of modern patient care.

As clinicians, we must constantly adapt to change that is sometimes abrupt and far-reaching and at other times is gradual and subtle. In writing this fifth edition of *Voice Disorders*, we aim to provide students with contemporary, accessible information. We take pride in the original, anatomical illustrations—designed for clarity and anatomical accuracy—created specifically for this text. Additionally, we have included clinical laryngeal examinations, digital examples of phonosurgical procedures, and outcome analyses to give you visual and contextual references that enhance understanding.

This edition continues to present complex content in an approachable format. Features include glossary terms; explanatory sidebars; and real-world case studies, such as those in the vocal pathologies and therapy chapter, the singer's voice chapter, an updated chapter on neurological voice disorders, and the expanded chapter on head and neck cancer. Updated statistics on voice user demographics help guide you through clinical pathways that promote efficient, evidence-based, and cost-effective outcomes. Disease pathophysiology is clearly explained, allowing for informed treatment decisions. Case examples, paired with audio samples, support the development of your clinical reasoning and assessment skills. We have also updated references and online resources for expanded exploration.

We urge you to make the most of your learning. Voice care has evolved from a behaviorally based practice to one that firmly intersects with the medical domain. Today's voice

pathologist may also be a vocal imaging specialist, a researcher, a therapist, a voice coach, a counselor, and more. Our field has produced key position statements—such as *The Role of the Speech-Language Pathologist and Teacher of Singing in the Remediation of Singers With Voice Disorders* (1992)—as well as professional training guidelines for endoscopy, and stroboscopy (2001), and tracheoesophageal prosthesis management (2004). These position statements highlight the importance of developing clinical competencies before performing certain assessments or interventions.

In current clinical settings, we frequently encounter syndromic complexities and patients with multiple coexisting conditions or polypharmacy concerns. Meanwhile, healthcare delivery is undergoing rapid restructuring, with changes in ownership, regulation, service delivery, and care coordination. These shifts are driven by cost pressures, competition, technological innovation, evolving patient expectations, and the aging and increasingly diverse population.

Today's clinicians must also produce objective treatment outcomes and analyze data to support clinical decision-making. While laryngeal imaging has advanced rapidly, physiological subsystems for generating subglottal pressure and airflow remain crucial to assess. However, efficiency is key. As the saying goes, "If it walks like a duck and quacks like a duck, it's a duck." If additional data will not alter the treatment plan, subjecting the patient to more procedures may be unnecessary.

Since 1998, medicine has seen groundbreaking advances, including:

- pharmacogenomics
- neuroscience and spinal cord injury care
- cancer therapies and virology
- antibiotics and resistant infections
- autoimmune disease management
- efforts to slow aging processes
- artificial intelligence

Our field has also benefited from technological progress: functional MRI, high-speed digital imaging, computer-assisted biofeedback, advanced animal models, and refined surgical techniques. Notably, the first human laryngeal transplant was performed in 1999 at the Cleveland Clinic by Dr. Marshall Strome and colleagues, an event that changed what we thought possible in voice care.

These achievements are built on foundational research, like Van den Berg's pioneering work in Groningen, Netherlands, which culminated in the 1958 publication of the myoelastic-aerodynamic theory of voice production. That landmark contribution continues to inform modern voice science.

We hope this fifth edition of *Voice Disorders* supports your graduate education and clinical training. We believe it provides the essential foundation for your journey in voice care. For those entering practice, we expect proficiency in the following:

- understanding the normal physiology of voice production
- identifying the causes of voice disorders
- examining and interpreting laryngeal structure and function
- utilizing instrumentation for assessment
- applying diagnostic principles
- recognizing differences across the lifespan
- differentiating among structural, functional, idiopathic, and neurologically based disorders
- designing treatment plans aligned with patients' functional goals

Our comprehensive workbook, available via the PluralPlus companion website, supports

your learning through test questions, reflective exercises, and problem-solving scenarios.

Additional coursework we recommend includes continuum of care, interdisciplinary practice, pharmacology, medical terminology, patient advocacy, and health-care accreditation. While not exhaustive, this list underscores the expanding competencies required in our field—and the need for academic programs and professional literature to evolve accordingly.

Finally, we want you to be prepared to respond to professional standards including ethical, regulatory, and interdisciplinary expectations while advancing your role as a voice specialist.

By embedding evidence-based practice-oriented position statements into the core of this fifth edition, we aim to support your transition from student to evidence-informed clinician capable of delivering high-standard, accountable, and modern voice care.

ASHA Position Statements & Evidence-Based Practice in Voice Care

The American Speech-Language-Hearing Association (ASHA) has continued to reinforce the centrality of evidencebased practice (EBP) in voice care and emphasized clinical decisionmaking grounded in research, professional judgment, and patient values. Highlights include the following.

ASHA's Commitment via CRISP

Since 2015, ASHA's Committee on Clinical Research, Implementation Science, and Evidence-Based Practice (CRISP) has unified efforts to support clinicians in integrating research findings into practice, reducing the gap between evidence and clinical use resources to facilitate EBP across domains, including voice disorders.

Preferred Practice Patterns

ASHA's Preferred Practice Patterns for Speech-Language Pathology outline core clinical responsibilities in voice assessment and intervention and emphasizes the use of appropriate instrumentation, patient-directed communication, and interdisciplinary follow-up to address comorbidities and ensure meaningful outcomes.

Guidelines on Clinical Voice Assessment Protocols

In collaboration with SIG 3 (Voice & Upper Airway Disorders), ASHA initiated efforts to standardize instrumental voice assessment. Their ad hoc committee has advanced metric specifications for endoscopic, acoustic, and aerodynamic evaluations to support comparability and validity in clinical research and practice.

Diagnostic laryngoscopy is recommended before initiating voice therapy, especially when serious pathology is suspected or when dysphonia persists beyond 4 weeks.

- Voice therapy is strongly recommended as the first line treatment for amenable voice disorders, including benign lesions, spasmodic dysphonia, and functional dysphonia. When used adjunctively in surgical cases, voice therapy can enhance outcome and reduce invasiveness.

- Clinicians should not prescribe antibiotics or antireflux medication as empirical treatment for isolated dysphonia without objective laryngeal visualization and diagnostic confirmation.
- Clinicians must document symptom changes or quality-of-life outcomes following intervention or observation to support accountability and continuation decisions.

These action statements are in alignment with ASHA's overarching evidencebased practice principles and reinforce the need for coordinated evaluation and treatment planning across professions.

About the Authors

Dr. Christine Sapienza, PhD, CCC-SLP, is a nationally recognized academic leader, researcher, and innovator in health care and higher education. She currently serves as executive vice president for partnerships and development at Jacksonville University (JU), following a transformative tenure as provost and founding dean of the Brooks Rehabilitation College of Healthcare Sciences. Her leadership helped launch JU's flagship graduate health programs, state-of-the-art simulation labs, and the foundation for a new College of Osteopathic Medicine.

Internationally known for her pioneering research on the interaction between voice and respiratory function, Dr. Sapienza has built a career advancing the science and clinical care of neurorehabilitation. She co-invented the Expiratory Muscle Strength Trainer, now used worldwide to improve respiratory and vocal function in clinical populations. Her work has been supported by the National Institutes of Health, US Department of Veterans Affairs, and other major funding agencies. She has authored over 125 peer-reviewed publications and the widely adopted textbook *Voice Disorders*.

Dr. Sapienza is also a dedicated educator and mentor, having guided dozens of doctoral students and received multiple honors for excellence in teaching and research. As cofounder of the Women's Health Innovation Network, she champions women's health through science, entrepreneurship, and cross-sector collaboration. She has served on numerous nonprofit boards, advancing health-care and education initiatives across the region.

Bari Hoffman, PhD, CCC-SLP, is an associate dean for clinical affairs and health-care innovation in the College of Health Professions and Sciences and professor in the Department of Communication Sciences and Disorders, with a joint appointment in internal medicine within the College of Medicine at the University of Central Florida. A nationally recognized academic leader, Dr. Hoffman brings extensive expertise in clinical practice, scientific inquiry, and strategic leadership across health professions education and health-care innovation.

Internationally regarded for her contributions to clinical voice care and voice/speech science, Dr. Hoffman's work focuses on the acoustic, aerodynamic, and endoscopic analysis of voice and laryngeal function disorders, spanning professional voice users, individuals with

head and neck cancer, complex neurologic conditions, and upper airway disorders. For more than two decades, Dr. Hoffman served as director of the Center for Voice Care and Swallowing Disorders at the Ear, Nose, Throat and Plastic Surgery Associates. In this role, she provided clinical care while demonstrating administrative and thought leadership, growing the center's clinical reach and scholarly productivity.

Dr. Hoffman received her doctoral degree from the University of Florida in 2001. Her current research involves studying novel treatment technologies and biomechanical mechanisms for disorders of laryngeal function while defining the high impact on quality-of-life factors. She implements 3-D computer modeling of upper and lower airway function, coping strategies of individuals with dysphonia, and respiratory muscle strength paradigms in a variety of patient groups. Dr. Hoffman has a significant record of peer-reviewed publications, has contributed to more than 25 book chapters, and coauthored two other textbooks: *Cases in Head and Neck Cancer: A Multidisciplinary Approach* and *Respiratory Muscle Strength Training*. She actively lectures nationally and internationally on these topics.

A trailblazer in health-care technology integration and higher education leadership, Dr. Hoffman has spearheaded efforts in immersive and AI-driven innovations, including extended reality platforms, smart clinical and home environments, and holoportation/hologram technologies to transform clinical training and interprofessional care. In recognition of her contributions to teaching, research, and service, she has received numerous awards within her university, state, and national associations, including fellowships from both the American Speech-Language-Hearing Association and the National Academies of Practice. Dr. Hoffman's career reflects a sustained commitment to advancing translational research, pioneering health-care and education innovation, and shaping the future of clinical practice.

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Companion Website

Purchase of *Voice Disorders*, Fifth Edition, comes with complimentary access to supplementary student and instructor materials on a PluralPlus companion website. To access the materials, log into the website using the URL and instructions located inside the front cover of your copy of *Voice Disorders*, Fifth Edition.

Student Website

Included on the student website is a comprehensive workbook. The workbook will allow you to reflect on the reading and help you practice your knowledge and skills through test questions and problem-solving assignments. Throughout the textbook you will find this icon that directs you to the workbook exercises.

Look for the multimedia icon that directs you to laryngoscopic examinations, many of which include audio of the voice quality, surgical video, surgical still images, and a number of comprehensive case studies.

The student website also includes all of the still images printed in the text. These images, where applicable, are available in color. Combined use of the textbook and these ancillary resources will enhance your overall learning proficiency.

Instructor Website

Included on the instructor website are PowerPoint slides, a test bank, an image bank, videos, audios, and case studies to aid instructors in the delivery of content.

CHAPTER 1

Respiratory Anatomy and Physiology

This chapter explores the structure and function of the human respiratory system and explains how it supports voice production. Anatomy is the study of structures, and physiology is the study of how structures function to produce a particular action. Anatomy refers to the study of bodily structures, while physiology focuses on how those structures function to enable specific actions. In the case of voice production, the respiratory structures play a very crucial role by providing the necessary driving force (pressure) to initiate and sustain vocal fold vibration.

Breathing may seem like a relatively simple process, seemingly automatic and unconscious. Yet, it is highly controlled and complex. And, breathing for voice production is a unique process distinct from regular breathing, involving a specialized, voluntary control mechanism not required for the life purpose of exchanging oxygen and carbon dioxide. The respiratory structures necessary for breathing include the nose, trachea, bronchi, lungs, diaphragm, and supporting abdominal muscles, all of which work together to draw in oxygen and expel carbon dioxide from the body.

After reading this chapter, you will:

- understand the basic components of respiratory anatomy
- understand the passive and active forces involved in breathing
- understand the role of the respiratory system for producing voice
- understand how disordered respiratory function may affect voice production

Ventilation refers to the physiological process of moving air in and out of the lungs, allowing for the exchange of oxygen and carbon dioxide between the external environment and the alveoli. **Circulation**, on the other hand, involves the transport of oxygenated blood from the lungs to tissues throughout the body via the cardiovascular system as well as the return of carbon dioxide–laden blood back to the lungs for exhalation.

The Lungs

The lungs are composed of elastic tissue that inflate and deflate and, as a result of the inflation and deflation, move air to enable airflow in and out of the body. Anatomically, the right lung has three lobes, and the left lung has two lobes. The right lung is larger than the left lung to make room for to accommodate the heart (Figure 1–1).

Inspiration is the act of taking air into the lungs, while **expiration** is the act of expelling air. By bringing air into the lungs during inspiration, oxygen can be circulated into the bloodstream to the cells in the body. Inhaled oxygen enters the alveoli, where it diffuses into the bloodstream and is transported to body tissues. Expiration allows for the release of carbon dioxide (CO_2), a byproduct of cellular metabolism.

For airflow into the lungs to increase, a greater pressure differential between the atmosphere and the intrapulmonary space must be created. This is typically achieved by the contraction of the diaphragm and external intercostal muscles, which expand the thoracic cavity, lower intrathoracic pressure, and allow more air to flow in. The greater the difference in pressure, the faster and more forcefully air moves into the lungs.

In a clinical context, the term hypercapnia refers to an abnormally elevated level of CO_2 in the bloodstream, typically resulting from hypoventilation or inadequate alveolar gas exchange. This condition can arise in various respiratory disorders, such as chronic obstructive pulmonary disease (COPD), neuromuscular dysfunction, or central respiratory depression, and may lead to symptoms like headache, confusion, flushed skin, and in severe cases, respiratory acidosis or altered consciousness.

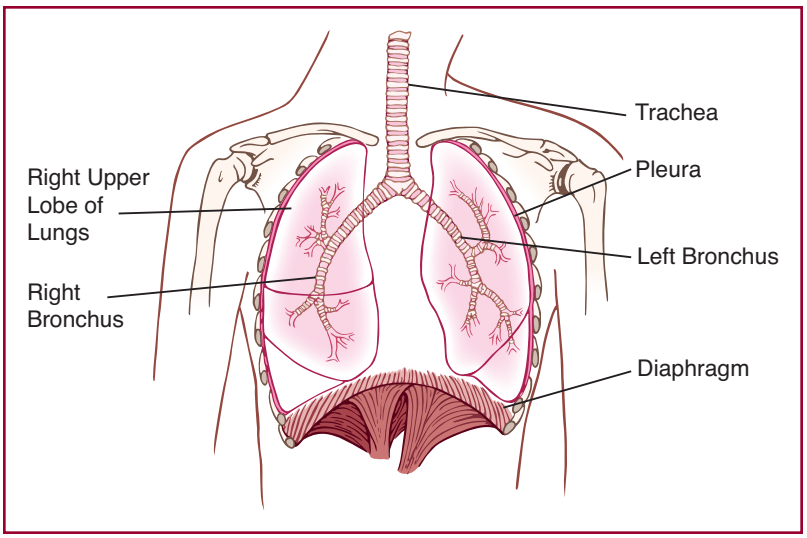

Figure 1–1. Lower airway and right and left lungs.

The Trachea

The trachea is a cartilaginous structure that allows air to pass from the nose and mouth into the lungs. It is made up of approximately 16 cartilaginous rings. The larynx sits on top of the uppermost tracheal ring. Damage to the trachea is potentially life-threatening. Tracheal injury can be life-threatening and often requires immediate medical intervention. In such cases, a tube may be inserted into the airway, a process known as intubation, to facilitate breathing. Intubation may be necessary due to trauma, illness, or surgical procedures where respiratory muscles are temporarily paralyzed.

The Bronchi

There are two main bronchi branching from the trachea, each leading to a lung. These bronchi further divide into smaller branches known as secondary bronchi. The right lung receives three secondary bronchi; the left lung, two. These continue branching into bronchioles, which are defined as the smallest airways, leading to the alveoli where gas exchange occurs.

The cartilage and mucous membranes of the primary bronchi are similar to those in the trachea. However, the amount of hyaline cartilage decreases with each successive branch. Hyaline cartilage is absent in the smallest bronchioles. By the time air reaches the bronchioles, hyaline cartilage is typically no longer present (Figure 1–2).

Hyaline cartilage forms most of the fetal skeleton and is found in the trachea, larynx (see Chapter 2), and joint surfaces of the adult.

The Thorax

The thorax, commonly referred to as the chest cavity, is a vital anatomical region that houses and protects key components of the respiratory and cardiovascular systems. It encloses the lungs, heart, trachea, esophagus, and major blood vessels, along with the bronchial tree. The bronchial tree is a branching system of airways that conducts air from the trachea into the lungs. Structurally, the thorax is formed by the thoracic vertebrae posteriorly, the sternum anteriorly, and the ribs laterally, all supported by associated muscles such as the intercostals. These elements create a protective cage that not only shields internal organs from mechanical injury but also facilitates respiration by allowing for expansion and contraction during breathing.

The most inferior boundary of the thorax is the diaphragm, a dome-shaped skeletal muscle that plays a crucial role in ventilation.

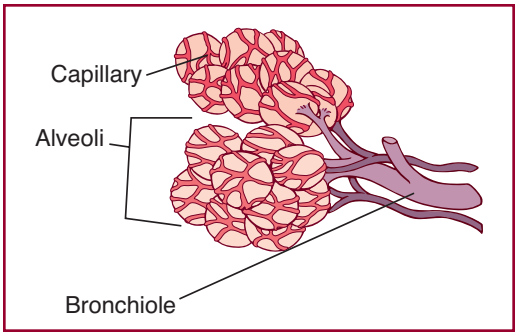

Figure 1–2. Final branches of the respiratory tree where primary gas exchange occurs.

During inhalation, the diaphragm contracts and flattens, increasing the volume of the thoracic cavity and reducing intrathoracic pressure, thereby drawing air into the lungs. This coordinated action among the thoracic structures is essential for effective respiratory function.

The Ribs

There are 12 pairs of ribs:

- Ribs 1–7 are called **true ribs**, directly attaching to the sternum.
- Ribs 8–10 are **false ribs**, connecting indirectly via cartilage.
- Ribs 11 and 12 are **floating ribs**, with no anterior attachment to the sternum.

The Diaphragm

The diaphragm anatomically separates the chest from the abdomen and is the **primary muscle** of inspiration (Figures 1–3 and 1–4). At rest, it sits in a dome shape. Upon contraction, it flattens and moves downward, expanding the thoracic cavity. As the diaphragm contracts, it interacts with the **abdominal wall**, which resists the downward force. This resistance raises **intra-abdominal pressure** and pushes the lower rib cage outward, expanding thoracic volume and facilitating air intake (Goldman et al., 1986).

When the diaphragm contracts during normal breathing, it moves down about 1 to 2 cm and, interestingly, can move as much as 10 cm during deep inspiration.

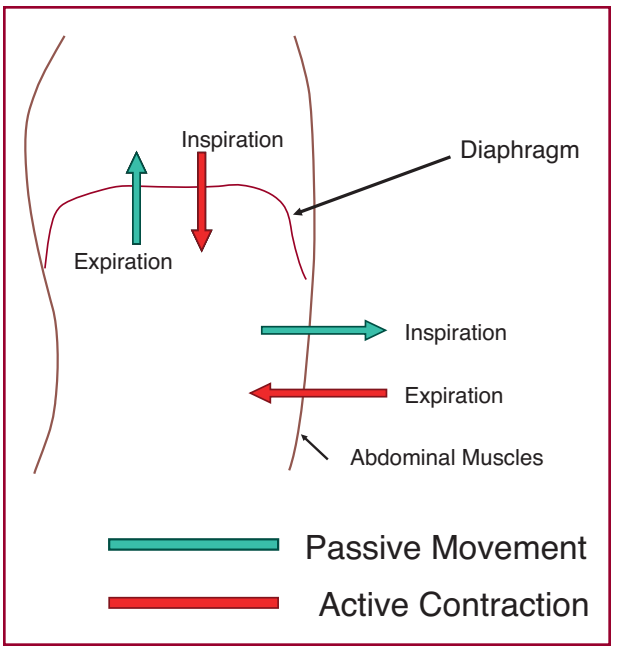

Figure 1–3. Direction of thoracic cavity movement with inspiration and expiration.

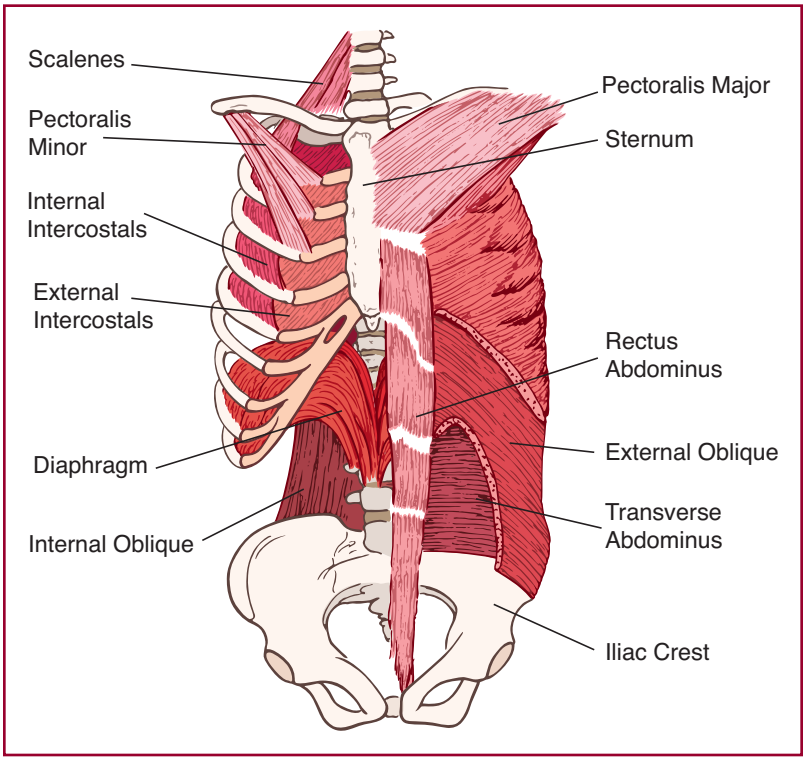

Figure 1–4. The diaphragm muscle and the supporting abdominal muscle structures.

The Abdominal Wall

The abdominal wall comprises several muscular layers: external, internal, and innermost. These muscles arise from the ribs and pelvic girdle and have both **passive and active roles**.

- During passive expiration, the abdominal wall recoils inward.
- During forceful actions—like coughing, sneezing, or loud voicing—**abdominal muscles actively contract**, compressing abdominal contents and increasing intra-abdominal pressure.

This function is also critical for **non-respiratory actions**, such as defecation and childbirth. The next section describes other important anatomical structures to the respiratory system.

Sternum

The sternum consists of three parts that serve as muscle attachment sites:

1. **Manubrium:** connects to ribs 1 and 2.
2. **Body (Corpus):** connects to ribs 2–7.
3. **Xiphoid Process:** the smallest part, anchors abdominal and other respiratory muscles.

The first seven ribs are attached to the sternum. The manubrium appears as a handle

and serves as an attachment for ribs 1 and 2; the corpus is the body of the sternum and serves as the attachment for ribs 2 to 7; and the xiphoid process is the smallest of the three parts and serves as a partial attachment for many muscles, including some of the abdominal wall muscles.

During the administration of cardiopulmonary resuscitation (CPR), it is critical to avoid applying pressure to the xiphoid process, the small, cartilaginous extension at the inferior end of the sternum. Improper hand placement that includes pressure on this structure can lead to the xiphoid process fracturing or breaking off. A fractured xiphoid can become a sharp, mobile fragment that poses serious risks, including potential lacerations or punctures to underlying anatomical structures. These may include the diaphragm, leading to impaired respiratory function, or the pericardium and myocardium, which could result in a life-threatening cardiac injury such as hemopericardium or cardiac tamponade.

To minimize this risk, proper hand positioning for chest compressions during CPR should be centered on the lower half of the sternum, well above the xiphoid process, with the heel of one hand placed on the sternum and the other hand on top, fingers interlocked and off the chest. Ensuring correct technique not only maximizes the effectiveness of compressions but also helps prevent avoidable complications.

Clavicle

The clavicle is known as the collarbone, and the two bones of the clavicle extend from the manubrium. The clavicle serves for attachment of certain respiratory muscles such as the trapezius, pectoralis major, and sternocleidomastoid.

Driving Forces of the Respiratory System

The process of moving air requires a driving force. The force comes from a pressure gradient or difference between the alveolar pressure and the atmospheric pressure (Figures 1–5 and 1–6). Alveolar pressure is the pressure within the alveoli.

Alveoli (not "alveolar pressure") are the smallest gas exchange units of the lung. **Alveolar pressure** refers to the pressure of the air inside the alveoli, which changes during breathing. Normal **alveolar pressure** at rest (when lungs are open and there's no airflow) is approximately equal to atmospheric pressure (about 760 mm Hg at sea level or 1034 cm H_2O).

Alveolar pressure is typically referenced with respect to atmospheric pressure, which is always set to zero. When alveolar pressure is above atmospheric pressure, it is positive; when alveolar pressure is below atmospheric pressure, it is negative.

For the lungs to inflate, the inward driving force must be an alveolar pressure less than atmospheric pressure. This creates a pressure gradient that causes air to flow into the lung (inspiration). On the other hand, for air to flow out of the lung (expiration), the driving force must be an alveolar pressure greater than atmospheric pressure. The pressure of a gas equals the perpendicular force exerted by

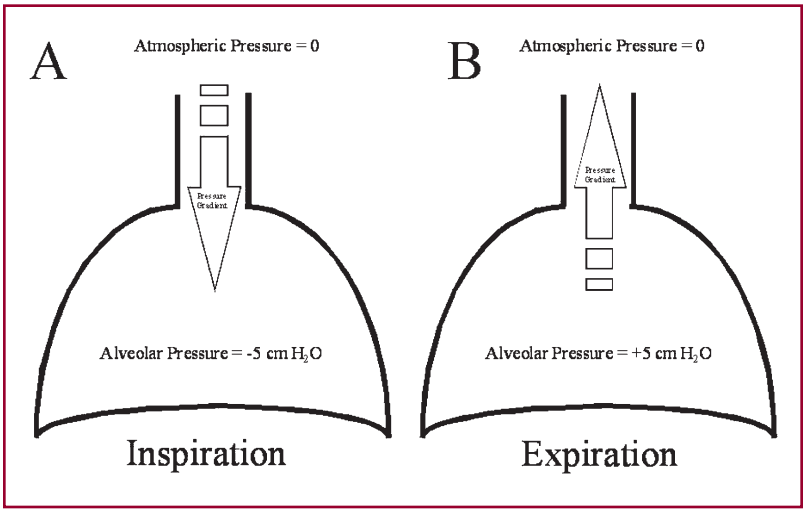

Figure 1–5. Schematic depicting pressure relationships for inspiration and expiration. The arrow indicates the direction of the driving force.

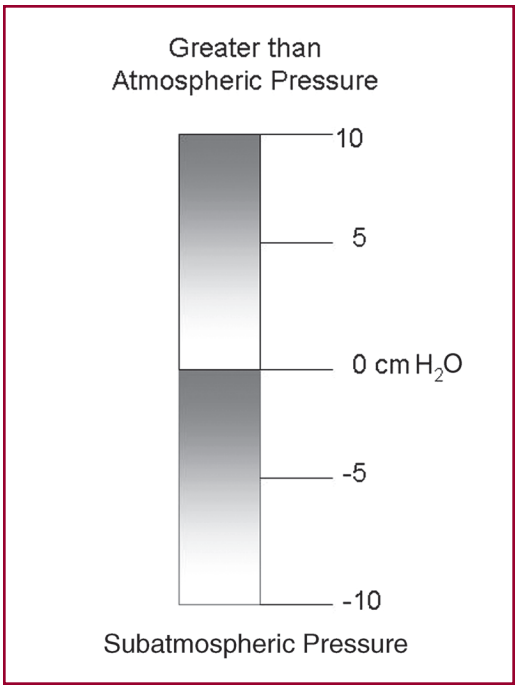

Figure 1–6. Schematic depicting positive pressure and negative pressure generation relative to atmospheric pressure (0 cm H_2O).

the gas divided by the surface area on which the force is exerted.

To produce voice, air moves from the alveolar spaces through the conducting airways, including the trachea, and through the glottis, or the space between the vocal folds; the air movement then vibrates the medial edges of the vocal folds. Sound from the vocal folds is then transferred to the pharynx and oral cavity, where it is shaped by the articulators into speech sounds. Discussion of how the voice is produced by vocal fold vibration is discussed in Chapter 2.

How Does the Human Body Generate These Respiratory Forces?

Alveolar pressure is influenced by two main forces. The first is a **passive force**, which arises from the natural elastic properties of the respiratory system. The second is an **active force**, generated by the contraction of respiratory