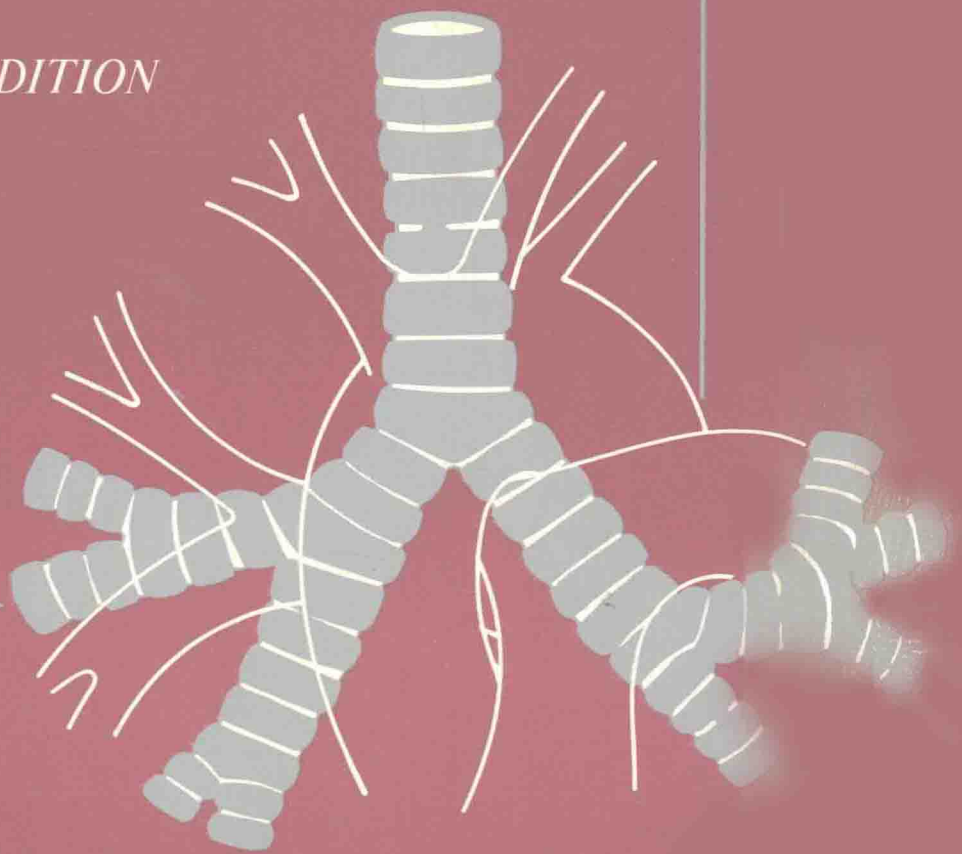
RESPIRATORY EMERGENCIES

Edited by

Kenneth M. Moser

Roger G. Spragg

SECOND EDITION



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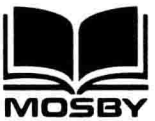

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To our wives, **Sara** and **Carole,** and

to our children — **Greg, Kathy, Margot, Diana; David** and **Adam** —

who once again have survived the psychologic stresses, time warps,
and other negatives that derive from being associated with spouse-fathers
who insist on writing books

PREFACE

The challenges presented by the patient with an acute respiratory emergency are special ones. A swift yet organized approach to diagnosis and management is needed. Such organization requires a full understanding of the pathogenetic factors, the pathophysiologic events, and the technology available for prompt detection and treatment.

These special needs have been recognized during the last decade by alterations in the patterns of medical care. Diagnosis and treatment of the acutely ill patient now tend to be provided in specialized units that have brought together qualified personnel and modern equipment in emergency rooms, intensive care units, and burn and trauma units. Courses and training programs have been devised to prepare physicians, nurses, technologists, therapists, and others to provide emergency care.

Yet, before the first edition of this book, there had not been a grouping, in written form, of the many conditions that may lead to respiratory emergencies. Our concept was to provide, in one convenient and readily accessible package, the conceptual and practical information needed by health professionals who may face respiratory emergencies. The positive reception to the first edition suggests that many individuals found such a repository of information useful.

In preparing this second edition, we have responded to two intervening stimuli: (1) the continued flow of new information that conditions diagnosis and management and (2) the helpful input from colleagues and readers who suggested additions, amplifications, and modifications that would enhance the usefulness of this volume.

We have attempted to respond to these stimuli appropriately. The basic format of the book, however, remains the same: a presentation in the initial chapters of basic respiratory anatomy and physiology, followed by discussions of the many conditions that may lead to acute respiratory compromise in adults, children, and neonates. Current therapeutic approaches and the principles on which they are based are presented.

Developing this second edition has allowed us to gauge the pace of medical change. Clearly, in the relatively brief interval since the first edition, there has been substantial advance in our understanding of, and ability to deal with, acute respiratory disorders. Just as clearly, many questions remain.

We trust that this book will provide a useful reference for the many individuals called on to assist in the diagnosis and treatment of respiratory emergencies. If that objective is achieved, the major credit belongs to the skilled and knowledgeable authors who contributed to this book. That these authors are from various medical disciplines reflects the fact that the care of patients with respiratory emergencies is truly a multidisciplinary effort. Compilation of the book also called on the critical nonmedical expertise of Ms. Dena Lomax and Mrs. Dorie Kehew, whom we

thank for their skills and devotion to making these many pages print-ready.

Finally, we recall, with special warmth and affection, the image of the late Dr. Elaine Shibel's catalytic role in the first edition; she would be pleased to note that a second edition validates her confidence in the need for a quality work dealing with respiratory emergencies.

Kenneth M. Moser
Roger G. Spragg

RESPIRATORY EMERGENCIES

CONTENTS

CHAPTER 1 / *David H. Dail*

ANATOMY OF THE RESPIRATORY SYSTEM

Proper function of the respiratory system is critical to maintenance of normal gas exchange and, therefore, to life. Since the structure of this system is intimately related to its function, structural abnormalities are quickly expressed in functional terms. To provide a framework for the chapters that follow, this chapter will review the normal anatomy of the respiratory system. The respiratory structures that will be described are the nose, mouth, pharynx, larynx, trachea, lungs, and surrounding chest walls and diaphragms (Fig. 1-1).

DEVELOPMENT

A brief review of the development of these structures is helpful. In early embryologic development, one central tube is formed from a grooved inpouching of the surface of the spherical embryo. This tube forms the mainstream of the gastrointestinal tract and its derivatives. Very early in this development, a bud forms from this tube. This bud divides, grows, and becomes the lungs. Partial residual connections in the form of tracheoesophageal fistulas may occur to remind us of these events.

In the head, a transverse septum forms that is destined to become the palate. This divides the intake end of this primitive tube into a nasal passage and an oral cavity (again see Fig. 1-1). The nasal cavity serves a predominantly respiratory function, whereas the oral cavity serves a mixed function, being involved in gastrointestinal function as well as in speech and respiration. Where these divisions rejoin behind the palate, in a space called the pharynx, respiratory and nutritive functions are shared for a short distance until they again separate at the division of the larynx and the pharynx in the upper neck. Food and liquids pass from the mouth anteriorly to posteriorly, whereas air, of course, moves bidirectionally through nose and mouth to the pharynx and larynx. Thus, a crossover of these functions occurs in the pharynx. A flap valve called the epiglottis on the larynx helps direct flow into the proper channels.

The respiratory structures will be considered under groups belonging to the head, neck, and chest. The upper respiratory tract is that portion above the larynx, and the lower respiratory tract consists of the trachea and lungs.

HEAD

Nasal cavity

The nasal cavity forms the gateway to the respiratory system. It begins as two flexible, flared rubbery entryways called wings, or alae, enclosing a space on each side called the vestibule. Stout hairs help protect this entrance. Posterior to the

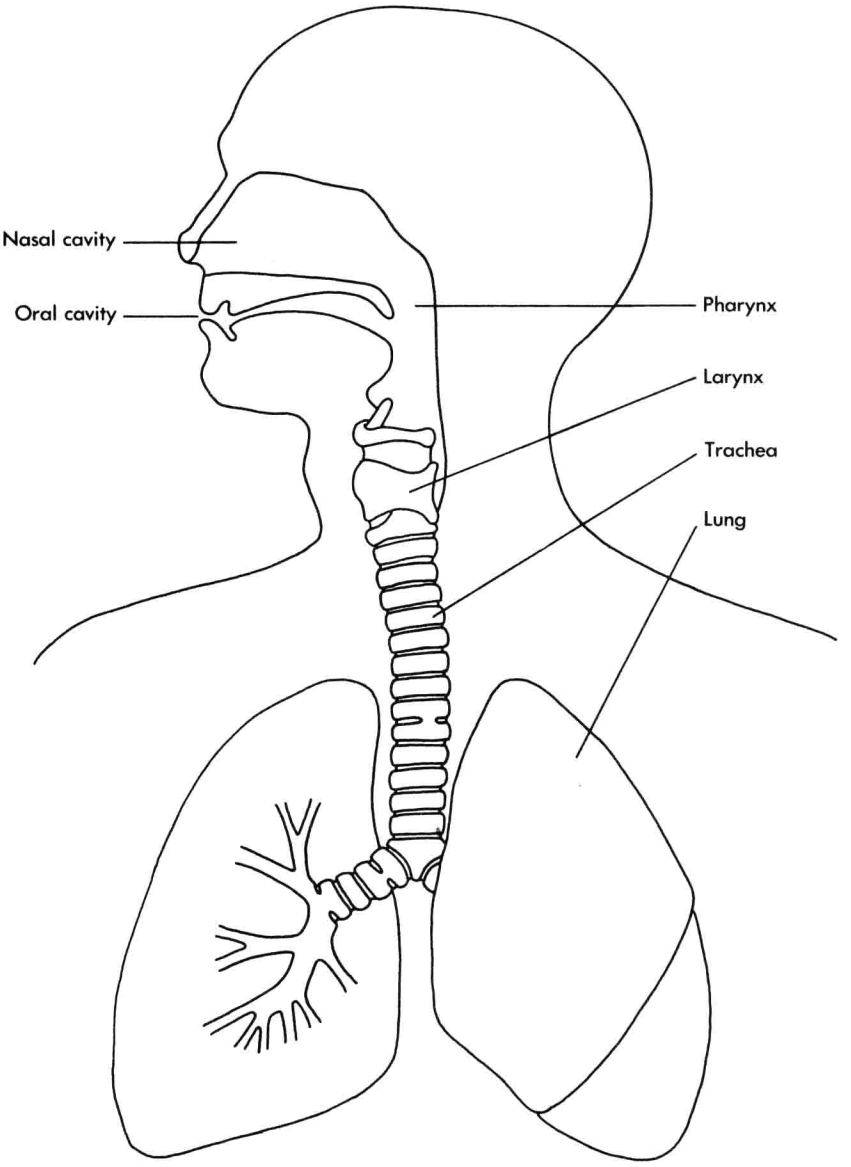

Fig. 1-1 The respiratory tract consists of the nasal cavity, oral cavity, pharynx, larynx, trachea, and lung. The larynx divides the system into the upper and lower respiratory tract.

vestibule are three bony plates, called conchae, extending downward and medial from each lateral wall (Fig. 1-2, *A*). The right and left nasal cavities are separated by the nasal septum (Fig. 1-2, *C*), which deviates slightly to one side or the other in many people. The septum ends posteriorly, and the two separate nasal cavities merge together above and behind the soft palate to form the upper portion of the pharynx, or nasopharynx.

Squamous mucosa lines the vestibule as well as the mouth, pharynx, and larynx. The nasal cavities, sinuses, trachea, and larger and smaller conducting airways in the lung are lined by tall, columnar epithelium. The surfaces of these cells are covered with many fine hair-like projections called cilia, which wave rapidly together. In the lower respiratory tract, this action moves material toward the upper airways to be coughed out or swallowed. In the nasal cavities, material is propelled posteriorly to meet the same fate. It is important for the cilia to remain healthy and active to carry out this function. Extensive surgery or other influences, such as certain drugs, can impair ciliary action.

Lubrication in the respiratory tract is provided by mucus, which is produced by submucosal glands and by individual cells, called goblet cells, within the mucosal lining. Goblet cells are so named because microscopically they look like the bowls of small goblets. The mucous film helps trap small foreign particles. The surface film is moved along by the ciliary action described.

Warming and humidifying of air begins as soon as it starts its two-way journey through the respiratory tract. Particularly in the nasal cavity, where moving air first enters and "air conditioning" is begun, the mucous membranes are supplied with a large amount of blood flow. This helps to warm the incoming air rapidly. This process continues throughout the respiratory tract. If one considers how brief an alternate inspiration and expiration is and notes how warm and wet the air is on its return to the outside, it is apparent that these processes are very effective. In an extremely dry environment, the wetting function may be overpowered, and a person may note drying of his nose and mouth. Likewise, when a common cold injures this tissue, it responds excessively and the

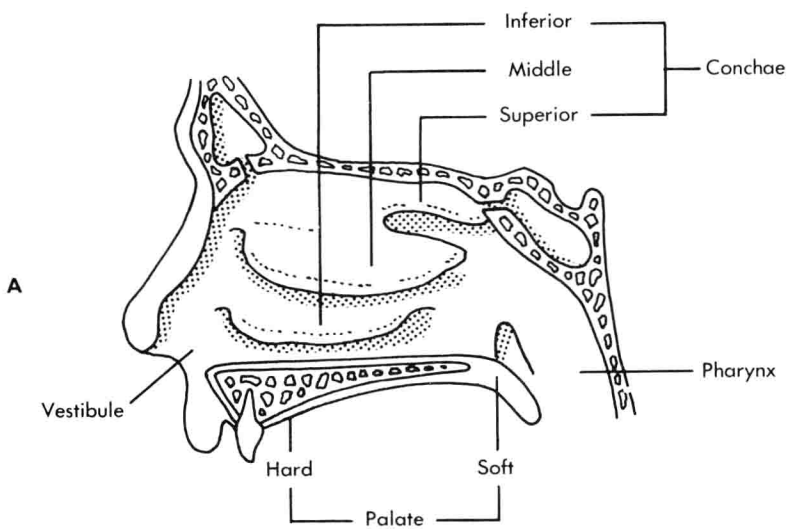

Fig. 1-2 **A,** Lateral view of internal structures of nasal cavity. Note three conchal plates extending from lateral walls. The palate with hard (bony) and soft portions divides nasal cavity from oral cavity. These two cavities rejoin posteriorly as the pharynx. *Continued.*

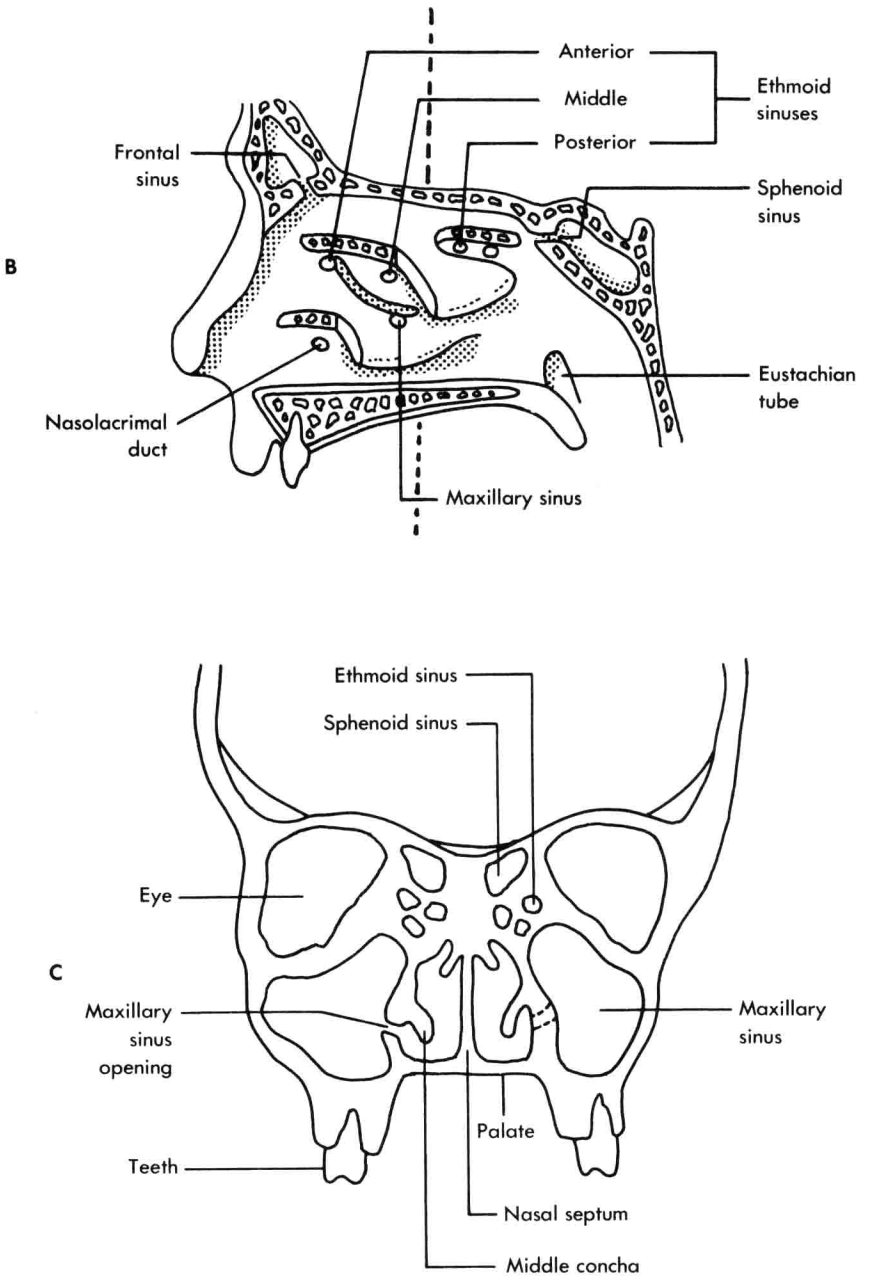

Fig. 1-2, cont'd The nasal sinuses are named for bones in which they occur. **B,** In lateral view (as in **A**) but with chonchae cut away. Note entrances into nasal cavity of various sinuses and their location within these cavities. **C,** Frontal view of face taken at level of dotted line in **B.** Note position of maxillary sinuses in each cheekbone. Sphenoid sinuses are behind ethmoid sinuses, although they appear to be at same level in this frontal view. Their openings are identified in **B.**

surface weeps which results in a runny nose.

The other major function of the nasal cavity is to serve as an exposure chamber for the sense of smell. However, since the sense of smell is not pertinent to this book, it will not be considered further.

Sinuses

Connected with the nasal cavities are empty spaces in the facial and skull bones technically called the accessory respiratory sinuses (Fig. 1-2, *B* and *C*). These are symmetrically paired structures, the most accessible being the frontal and maxillary sinuses. The more anterior ethmoid and more posterior sphenoid sinuses are near the midline above and just behind the nasal cavities. All are named for the bones in which they occur. All open into the nasal cavity, usually under the conchae (Fig. 1-2, *B*). No one knows the exact purposes of the sinuses. Problems develop when these become inflamed, obstructed, or when their bony walls are fractured.

Palate

Separating the nasal cavity from the oral cavity is the roof of the mouth, the palate (Fig. 1-3). The

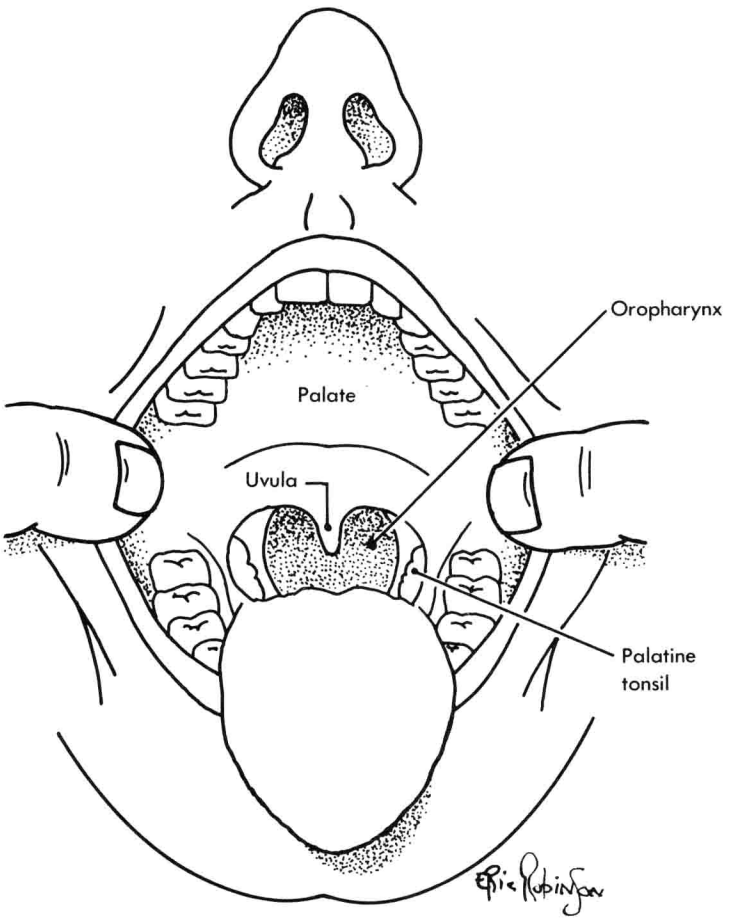

Fig. 1-3 View into opened mouth. Soft midline uvula is seen hanging from fleshy tonsillar pillars.

anterior two-thirds has a bony skeleton that accounts for its designation, hard palate, whereas the posterior one-third is without such support and is therefore called the soft palate. From the midline portion of the soft palate at the back of the mouth extends the soft, fleshy uvula, which points in the direction of the lower respiratory tract. Its purpose, in coordination with the surrounding walls, is to control flow in eating, drinking, sneezing, coughing, and vomiting.

Oral cavity

The mouth may also be considered an accessory respiratory passage. Mouth breathing is used during speech and when nasal obstruction is caused by upper respiratory tract infections or foreign materials. The lips, teeth, tongue, jaw muscles, and spontaneous reflexes help protect the mouth from injury or unwanted intrusion. Care of the mouth and teeth and the quality of chewing are important factors in protection of the lower respiratory tract. The mucosal surfaces here also provide luxuriant wetting and warming qualities for incoming air. Saliva is produced by major and minor salivary glands and provides some moisture for inhaled air. It serves two other major functions. It is a wetting agent for food, and it contains enzymes that start the digestive process while food is being chewed.

The oral cavity ends where a web on each side (posterior palatine pillar) arches toward the midline to join the midline uvula (Fig. 1-3). Against the front of each of these webs sit the palatine tonsils, more commonly just called tonsils. The tongue is a strong muscular mass used not only for speech but for moving materials about the mouth. Taste buds are present on its surface. The posterior surface is supplied with many nerve endings that originate reflexes that account for protective gagging. These reflexes must be considered when passing fingers, tubes, instruments, or other objects through the mouth in the conscious or semiconscious patient.

Pharynx

The space behind the nasal cavities and mouth is called the pharynx, from the Greek word for "throat" (Fig. 1-4, *B*). It extends to the point where the airway (at the larynx) and the digestive tract (esophagus) separate. The portion behind the nasal cavities is called the nasopharynx. The eustacian tubes open into the lateral-posterior-superior nasopharynx walls and connect the nasopharynx with the middle portion of each ear. On the superior posterior wall is the other major lymphoid mass of the upper respiratory tract, the adenoid tonsil, commonly called the adenoids. The two palatine tonsils and one adenoid tonsil comprise the major components of Waldeyer's ring, the so-called guardian ring of lymphoid material surrounding the entries of the respiratory and gastrointestinal tracts.

The portion of the pharynx at the back of the oral cavity is called the oropharynx. This extends from the uvula above to the epiglottis and base of tongue below. Nasotracheal and nasogastric tubes passed through the nose must turn inferiorly at the nasopharynx and continue in that direction through the oropharynx if they are to reach the trachea, lungs, or stomach.

The inferior portion of the pharynx, between the epiglottis and final entries into the larynx and esophagus, is called the hypopharynx (or laryngopharynx). This is a short segment extending into the neck. It corresponds to the height of the epiglottis and is a critical dividing point in separating solids and fluids from air.

NECK

Epiglottis

The epiglottis is a platelike structure that extends from the base of the tongue backward and upward (Figs. 1-4 and 1-5). In adults it is 2 to 4 cm long and 2 to 3 cm wide. It is only 0.2 to 0.5 cm thick. This structure can at times be seen by looking directly through the mouth. It is more readily seen in babies and children than in adults and is especially noticeable in crying babies. This structure is the flap valve over the entry to the larynx. During routine swallowing, the epiglottis closes in coordination with contraction of the muscular walls in the region, covering the airway and directing the swallowed material into the esophagus.